

Mostafa Al-Emran
Khaled Shaalan *Editors*

Recent Advances in Technology Acceptance Models and Theories

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Editors

Recent Advances in Technology Acceptance Models and Theories



Springer

Editors

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Preface

The rapid technological evolution across various domains has attracted the scholars' attention to study the factors affecting users' adoption, acceptance, and continued use of a specific technology. This has been accomplished through the developments, modifications, and extensions of existing theoretical models, such as the technology acceptance model (TAM) and the unified theory of acceptance and use of technology (UTAUT), to name a few. It is essential to understand these factors in order to determine future needs and research directions. These issues are the core of the edited book. In addition, it covers the empirical and review studies that mainly focus on the determinants affecting the adoption, acceptance, and continued use of various technologies across different domains, applications, samples, and countries. This book contributes to the technology acceptance models and theories in several ways. First, it assists researchers in pursuing future research in the area and identifying the possible future developments and modifications of emerging technologies. Second, it helps postgraduate students to gain insights into the recent developments in technology adoption, acceptance, and continued use. Third, it assists decision-makers in formulating and developing the required policies and procedures for adopting a specific technology and sustaining its use.

This book is intended to present state-of-the-art researches on technology acceptance models and theories. It was able to attract 73 submissions from different countries across the world. From the 73 submissions, we accepted 30 submissions, which represents an acceptance rate of 41%. Each submission was reviewed by at least two reviewers, who are considered specialized in the related submitted paper. The evaluation criteria include several issues, such as correctness, originality, technical strength, significance, quality of presentation, interest, and relevance to the book scope. The chapters of this book provide a collection of high-quality research works that address broad challenges in both theoretical and application aspects of various technologies from the lenses of technology acceptance models and theories. The chapters of this book are published in *Studies in Systems, Decision and Control Series* by Springer, which has a high SJR impact.

We acknowledge all those who contributed to the production of this edited book. We would also like to express our gratitude to the referees for their valuable feedback and suggestions. Without them, it would not be possible for us to maintain the high

quality and the success of the *Recent Advances in Technology Acceptance Models and Theories* edited book. Hence, on the next page, we list the reviewers along with their affiliations as a recognition of their time and efforts.

Dubai, UAE
March 2021

Volume editors
Mostafa Al-Emran
Khaled Shaalan

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Dr. Mostafa Al-Emran is currently working in the Faculty of Engineering & IT at The British University in Dubai, UAE. He obtained his Ph.D. degree in computer science from Universiti Malaysia Pahang. He received the M.Sc. degree in informatics from The British University in Dubai with a distinction level along with the top Academic Excellence Award and the B.Sc. degree with honors in computer science from Al Buraimi University College. He is among the top 2% scientists in the world, according to the report published by Stanford University in October 2020. He has published over 75 research articles, and his main contributions have appeared in highly reputed journals, such as *Computers and Education*, *Computers in Human Behavior*, *International Journal of Information Management*, *Telematics and Informatics*, *IEEE Access*, *Technology in Society*, *Journal of Enterprise Information Management*, *Interactive Learning Environments*, *Journal of Educational Computing Research*, and *International Journal of Engineering Education*, among many others. Most of his publications were indexed under the ISI Web of Science and Scopus. He has edited several books published by Springer. He is also a certified recognized reviewer by several leading journals in Elsevier. His current research interests include mobile learning, knowledge management, technology acceptance, wearable technology, and machine learning.

Prof. Khaled Shaalan is a senior academician, researcher, and technical leader with extensive experience in artificial intelligence and information and communication technologies (ICTs). He is a well-recognized thought leader in complex technological and smart applications, such as natural-language understanding, knowledge management, health informatics, education technology, e-businesses, and smart government services. Through a career and affiliation spanning for more than 30 years with the international institutions, such as Swedish Institute of Computer Science, School of Informatics (University of Edinburgh), The British University in Dubai, and Cairo University, international organizations such as UNDP/FAO, industrial corporates, such as Microsoft/FAST search, Prof. Khaled has gained significant experience and insights into understanding complex ICT issues in many industry and governmental domains. Prof Khaled is an Associate Editor on ACM Transactions of Asian and Low Resource Language

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Prof. Khaled has published over 220+ referred publications and the [impact of his research](#) using Google Scholar's H-index metric is 35+. He has several research publications in his name in highly reputed journals, such as *Computational Linguistics*, *Journal of Natural Language Engineering*, *Journal of the American Society for Information Science and Technology*, *IEEE Transactions on Knowledge and Data Engineering*, *Expert Systems with Applications*, *Software-Practice and Experience*, *Journal of Information Science*, *Computer Assisted Language Learning*, and *European Journal of Scientific Research* to name a few. He has guided several doctoral and master students in the areas of Arabic natural-language processing, healthcare, education technology, e-commerce, cybersecurity, and knowledge management. Prof Khaled encourages and supports his students in publishing at highly ranked journals and conference proceedings. He is the Founder and Co-chair of The International Conference on Arabic Computational Linguistic ([ACLing](#)) and International Conference on Emerging Technologies and Intelligent Systems ([ICETIS](#)). He is the editor of many books published by Springer. He has participated in seminars and invited talks locally and internationally, invited to international group meetings, invited to review papers from leading conferences and premier journals in his field, and invited for reviewing promotion applications to the ranks of Associate and Full Professor for applicants from British, American, and Arab universities.

Is It Still Valid or Outdated? A Bibliometric Analysis of the Technology Acceptance Model and Its Applications From 2010 to 2020



Mostafa Al-Emran and Andrina Granić

Abstract During the last three decades, the Technology Acceptance Model (TAM) has emerged as a robust model for examining the determinants affecting users' behavior and use of various technologies. Despite its reliability and applicability across thousands of studies, TAM has been recently criticized for being an outdated model. To determine whether the TAM is outdated or still valid, this bibliometric analysis study aims to review the TAM and its applications based on analyzing 2399 articles published in the Web of Science database during the period (2010–2020). Various characteristics were examined, including the progress of TAM publications, most studied applications, most studied domains, most productive countries, most productive journals, and the main theories/models used with TAM. The main findings indicated that the number of studies on TAM and its applications are on the rise, suggesting that applying, modifying, and extending the model is still valid across several applications and domains. E-commerce was on the top of the list of TAM applications with an increasing number of studies on recent emerging applications like augmented reality. The banking, education, and healthcare were among the most often domains through which TAM applications were applied. Among several theories/models, the TPB, DeLone and McLean IS Success Model, and UTAUT have dominated the integration with TAM across various applications. It is believed that these findings would advance the research wheel of TAM and provide an insight for future research paths.

Keywords Bibliometric analysis · Technology acceptance model · TAM · Applications · Domains

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1 Introduction

In the domain of Human–Computer Interaction (HCI), it is crucial to understand the factors that affect the acceptance or rejection of a particular technology. To understand those factors, several theories/models were developed. One of the well-known and most cited theories in technology adoption is the Technology Acceptance Model (TAM) [1]. Before embarking on introducing the TAM, it is crucial to understand the models/theories that stimulate its appearance. The theory of reasoned action (TRA) [2] and the theory of planned behavior (TPB) [3] constructed the roots of TAM. In that, the TRA was developed with the aim of understanding and predicting users' behaviors and attitudes [2]. TRA seeks the “behavioral intentions” rather than “attitudes” as these are considered the main interpreter of behaviors. It is argued that the main weakness observed when TRA took part in social science settings is that the individuals who lack awareness will have slight power on their “behaviors” and “attitudes” [4]. To overcome this limitation, Ajzen [3] extended the original TRA with another construct called “perceived behavioral control”. This extension has come up with the TPB. The TPB suggests that the performance of the individual for a particular “behavior” is determined by his/her desire to achieve that “behavior”. It has been indicated that the “attitude” towards “behavior” is either a positive or negative assessment in carrying out that “behavior” [3]. While the TPB has solved the limitations of TRA, research has shown that TPB itself has a limitation on its own [4]. In that, TPB operates only when some characteristics of the “behavior” are not under optional control. Furthermore, TPB supposed that individuals are conscious and create organized plans according to the existing information; thus, unconscious intentions will not be taken into consideration.

Despite the drawbacks of the two theories (TRA and TPB), they have succeeded in comprehending the individuals' actual behavior. However, the employment of these models in predicting the individuals' acceptance of information systems raises some problems. Several research studies have failed in generating trustworthy measures that could determine the acceptance or rejection of a particular information system [4]. To handle these issues, Davis [5] has adjusted the theories of TRA and TPB and proposed the TAM, which in turn has the capability to predict the actual usage of any information system. Davis [5] performed two core changes to both models (TRA and TPB). First, the construct “subjective norm” was not considered in understanding the actual behavior, while the individual's attitude towards the system use was considered alternatively. Second, two distinct constructs were considered, namely “perceived usefulness (PU)” and “perceived ease of use (PEOU)”, which were sufficient to understand the attitude of an individual towards the usage of any technology. PU refers to “the degree to which a person believes that using a particular system would enhance his or her job performance”, while PEOU is defined as “the degree to which a person believes that using a particular system would be free from effort” [1].

TAM is a robust and valid model that has been commonly employed for measuring the acceptance of several technologies [6]. Several studies have employed the TAM in examining the use of various technologies, such as e-learning [7, 8], e-government

[9], m-learning [10], wireless technology [11], web-based training [12], online banking [13, 14], m-payment [15], social media [16], and wearable technologies [17, 18] among many others. Since its appearance in 1989, several review studies were conducted on the TAM and its use in several domains [4, 6, 19–22]. However, those reviews have focused on either examining the model's development or extension in general or its application in a specific domain; thus, they were limited in terms of scope and application. Further, there is a common phenomenon across several high-quality journals in which TAM-based studies are straight away desk-rejected. The rejection is usually based on the reason that TAM has become an old model and is not suitable for the journal's audience. To handle the limitations of the previous reviews and determine whether the TAM is outdated or still valid, we have conducted this bibliometric analysis study to review the TAM and its applications during the period (2010–2020). More specifically, we have focused on analyzing the progress of TAM publications across the years (2010–2020), most studied applications, most studied domains, most productive countries, most productive journals, and the main theories/models used with TAM.

2 Methodology

This study uses the bibliometric analysis, as an emerging methodology in comparison with other literature reviews to identify the quantitative and qualitative modifications on TAM and its applications. The bibliometric analysis has been massively employed for evaluating the content of research studies [23] and exploring the patterns and characteristics of a particular topic [24]. The indicators of bibliometrics can assess both the quality (by examining the citations received) and quantity (by examining the number of publications) of the underlying research studies [25].

The VOSviewer tool is selected for bibliometric mapping and visualizing the outcomes [26]. Besides, the tool is user-friendly and useful for presenting and building vast scientific maps in a smooth and comfortable way. Due to the data applicability and the coverage of various scientific domains, this research uses the Web of Science (WoS) database for collecting the relevant articles. To search for the articles related to TAM and its applications in the WoS database, a “Basic Search” is carried out by using the string (“technology acceptance model” AND “TAM”) under the “Topic” field. The publication year is set to 2010–2020. The search was undertaken on 11 August 2020. A total of 2399 articles were retrieved including all types of publications. In order to draw a comprehensive picture of the TAM and its applications, all publication types were taken into consideration and further analysis.

3 Results

3.1 Publications by years

Figure 1 depicts the TAM progress over the publication years (2010–2020). The trend shows that studies on the TAM and its applications have increased from 2010 to 2013, with a slight drop in 2014. A remarkable increase in publications can be noticed in 2015. From 2015 ($N = 236$) to 2019 ($N = 340$), the number of publications maintained its count with an increasing number of 20–30 articles per year. However, the number of TAM publications has dropped down to 170 in 2020. This stems from two main reasons. First, the data were collected in August 2020, which means that the rest of the 2020 publications were not covered in the analysis. Second, at the time of data collection, there might be tens of articles that were still not yet indexed by the WoS database. Overall, the number of studies on TAM and its applications are on the rise, indicating that applying, modifying, and extending the model is still valid across several applications and domains. It is therefore predicted that many publications would be witnessed in the next years.

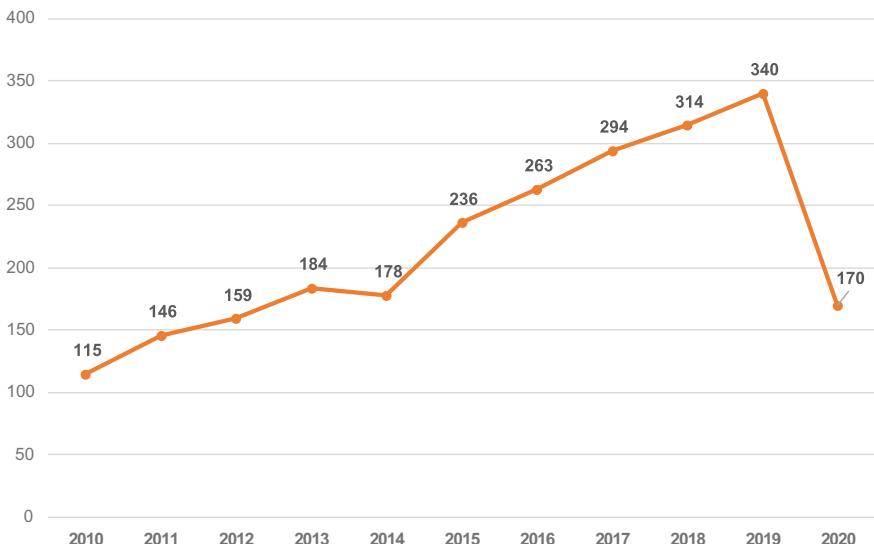


Fig. 1 TAM progress over publication years

Table 1 Top 10 TAM applications

Ranking	TAM applications	Count
1	Electronic commerce/e-commerce	146
2	Internet banking/online banking	120
3	Social media/social networks	105
4	E-learning	101
5	E-government	73
6	Mobile commerce/m-commerce	50
7	Mobile learning/m-learning	48
8	Mobile banking	38
9	Cloud computing	36
10	Augmented reality	29

3.2 *Most Studied Applications*

To identify the TAM applications in the existing literature, we have relied on analyzing the occurrence of the keywords in the underlying studies. The minimum number of keyword occurrences was set to be 10. This means that only the keywords that occurred at least 10 times will be considered for the analysis. This has resulted in a total of 288 keywords. Afterwards, we have carefully analyzed and examined the resulted keywords in order to identify the TAM applications. It is imperative to report that the count of similar terms was merged together, such as “electronic commerce” and “e-commerce”, “internet banking” and “online banking”, “social media” and “social networks”, “mobile commerce” and “m-commerce”, and “mobile learning” and “m-learning”. Table 1 lists the top 10 TAM applications studied in the existing literature. It is evident that the most studied TAM application is electronic commerce/e-commerce. It is also apparent that TAM has been recently applied on new emerging applications like augmented reality.

3.3 *Most Studied Domains*

Figure 2 shows the most studied TAM domains. Figure 2 depicts five different clusters through which each cluster represents a specific domain. The first red cluster shows that TAM has been mostly applied in the banking domain. The majority of the studies under this domain have concentrated on examining the consumers’ intention to use different technologies, such as internet banking, e-commerce, m-payment, m-banking, and m-shopping. The second blue cluster indicates that TAM has also been dominantly applied in the education domain. Most of the studies under this cluster have emphasized on examining university students’ attitudes toward using various educational technologies like e-learning, m-learning, and learning management systems (LMSs). The third green cluster shows that TAM has also been applied

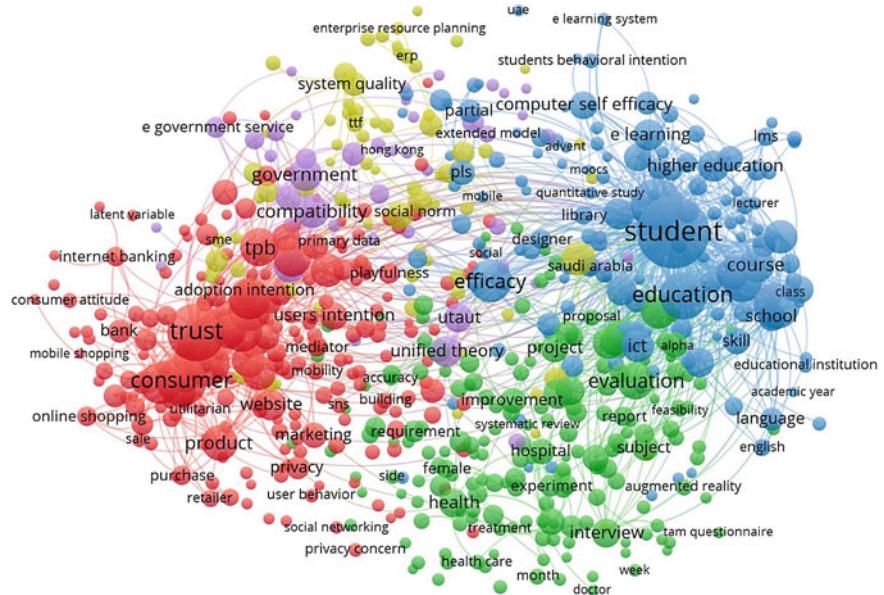


Fig. 2 Most studied TAM domains

in the healthcare domain. It has been noticed that virtual reality, augmented reality, and Internet of Things (IoT) were the most dominant technologies under this cluster. The fourth yellow cluster indicates that TAM has also been effectively employed in studies related to small-medium enterprises (SMEs). Cloud computing and enterprise resource planning (ERP) were among the most widely used technologies under this cluster. The fifth purple cluster shows that TAM has also been employed in studies pertaining to e-government services.

3.4 Most Productive Countries

To determine the most productive and cited countries in TAM-based publications, we have used the “bibliographic coupling” as a type of analysis through the VOSviewer. In that, the minimum number of documents per country was set to 5, while the minimum number of citations per country was set to 1. Table 2 shows the top 10 influential countries in TAM publications. In terms of publications, it is evident that China has dominated the list with 325 publications, followed by the USA ($N = 316$), Taiwan ($N = 294$), Malaysia ($N = 214$), South Korea ($N = 142$), Spain ($N = 139$), England ($N = 101$), Indonesia ($N = 100$), and Australia and India ($N = 83$). Other than considering the number of publications per country, the number of citations was

Table 2 Top 10 influential countries in TAM publications

Ranking	Country	Documents	Citations
1	China	325	3591
2	USA	316	6801
3	Taiwan	294	5268
4	Malaysia	214	1606
5	South Korea	142	3123
6	Spain	139	2299
7	England	101	2180
8	Indonesia	100	92
9	Australia	83	691
10	India	83	569

also considered. It is clear that the USA has the highest number of total citations ($N = 6801$), followed by Taiwan ($N = 5268$), China ($N = 3591$), South Korea ($N = 3123$), Spain ($N = 2299$), England ($N = 2180$), Malaysia ($N = 1606$), Australia ($N = 691$), India ($N = 569$), and Indonesia ($N = 92$).

3.5 Most Productive Journals

To identify the most productive journals that published TAM-based studies, we have used the “bibliographic coupling” as a type of analysis through the VOSviewer. In that, the minimum number of documents per source was set to 5, while the minimum number of citations per source was set to 0. The top 10 journals that published TAM studies are summarized in Table 3. It is clear that “Computers in Human Behavior” is the leading journal that published 80 studies on TAM and its applications with a total of 4213 citations. It can also be seen that most of the listed journals are with a high-impact factor.

3.6 Main Theories/Models Used with TAM

To determine the main theories/models that have been successfully integrated with the TAM, we have relied on analyzing the occurrence of the keywords in the collected studies. The minimum number of keyword occurrences was set to be 5. This has resulted in a total of 574 keywords. Table 4 illustrates the main theories/models used with the TAM. It is clear that the TPB [27] has dominated the list with 78 studies, followed by the DeLone and McLean IS Success Model [28], UTAUT [29], DOI [30], TTF [31], ECM [32], TRA [33], SDT [34], SCT [35], and Flow Theory [36]. It

Table 3 Top 10 influential journals in TAM studies

Ranking	Journal	Documents	Citations	Impact factor (2019)
1	Computers in Human Behavior	80	4213	5.003
2	Computers and Education	32	2381	5.296
3	International Journal of Mobile Communications	32	455	1.328
4	Sustainability	31	111	2.576
5	Advanced Science Letters	25	22	–
6	Behaviour and Information Technology	25	561	1.781
7	Education and Information Technologies	25	98	–
8	IEEE Access	22	87	3.745
9	Telematics and Informatics	18	362	4.139
10	Interactive Learning Environments	15	290	1.938

Table 4 Main theories/models used with TAM

Ranking	Theories/models	Count
1	Theory of planned behavior (TPB)	78
2	DeLone and McLean IS success model	47
3	Unified theory of acceptance and use of technology (UTAUT)	46
4	Diffusion of innovation (DOI)	44
5	Task-technology fit (TTF)	28
6	Expectation-confirmation model (ECM)	23
7	Theory of reasoned action (TRA)	20
8	Self-determination theory (SDT)	12
9	Social cognitive theory (SCT)	12
10	Flow theory	5

is also apparent that most of those theories and models work at the individual level, which can perfectly fit with the TAM.

4 Discussion

TAM has emerged as a powerful and parsimonious model to represent the antecedents of system usage through two main beliefs, namely the PEOU and PU [37]. Those two core TAM variables then influence attitude towards usage, which in the end determines behavioral intention to use. Over the past three decades, a respectable

amount and variety of theoretical perspectives have been advanced to provide an understanding of the determinants of usage. Although the majority of research dealing with TAM has focused on finding behavioral intention antecedents, there is also a growing need for understanding the factors that moderate the relationships among TAM variables.

The selection of a total of 2399 articles within this bibliometric analysis published in the last decade provides interesting and motivating outcomes for all scholars interested in the application of TAM. A clear trend in publication frequency that underlie research on TAM is visible, and the history of publications indicates an unmistakable growth in the number of publications per year (see Fig. 1). It is evident that the interest in the research subject of TAM application has increased significantly in the last decade, once again confirming that TAM is a robust and valid model for facilitating assessment of different technological deployments. Moreover, authors all around the globe are interested in the research on TAM aiming to study users' acceptance as well as to understand users' behavior while using any kind of Information Society Technology (IST), hereby referring to all classes of technologies, interactive systems, environments, tools, applications, services, and devices.

It is always interesting to perceive how different application fields have evolved and improved due to certain technological advancements. Therefore, in order to test TAM's applicability on the one hand and to enhance its predictive validity on the other, the model has been widely used for measuring the acceptance of the whole plethora of IST products and services employed in diverse fields. The topmost application fields listed in Table 1 clearly showed high potential for wide TAM utilization, from mostly studied e-commerce and online banking to prominent cloud computing and augmented reality. Besides, this bibliometric analysis offered insight into the most investigated domains, which have attracted a lot of research dealing with the applicability of TAM and the enhancement of its predictive validity like banking, education, and healthcare domains (see Fig. 2).

This research also showed that TAM had been widely and fortunately integrated with a number of other existing theories and models from the field, thus enabling the development of integrated models for facilitating technology assessment. In that respect, the TPB, with the behavioral intention as the key component to the model, was found to be the most frequently coupled theory with TAM (see Table 4). Besides, one model and two theories have been also quite often used in combination with TAM, specifically DeLone and McLean IS Success Model along with the UTAUT and the DOI theory. The derived integrated models have been acknowledged as solid frameworks for planning and conducting empirical research in technology adoption.

5 Conclusion

5.1 Study Implications

The findings of this bibliometric analysis have both theoretical and practical implications. Theoretically, our study confirmed that TAM is not only worldwide embraced as a credible model for facilitating the assessment of diverse technological deployments but is also acknowledged as a solid framework for conducting empirical research in a variety of application fields. The continuous and steady increase of the number of studies on TAM and its applications per year is evident, thus indicating a progressive growth of publications on TAM in the years to come. Although TAM proved to be a powerful model applicable to various technologies and contexts at the individual level, the analysis revealed that a large number of studies on technology and/or innovation adoption and diffusion within a range of application fields couple TAM with other models and theories. Consequently, in order to advance the explanatory power of individual models, TAM has been successfully combined with a number of existing theories and models from social psychology (TRA), cognitive psychology (TPB, ECM), humanistic psychology (SDT), positive psychology (Flow Theory), sociology (DOI, SCT), and information technology (TTF, DeLone and McLean IS Success Model) among many others.

Practically, our findings provide important implications for researchers and practitioners enriching their understanding of TAM as a credible model for facilitating the assessment of different technologies. In addition, since the integration of other contributing theories/models from the other fields with TAM is proved to be successful, this provides insights for further advancements in predicting users' behavior in future technology assessments applied to diverse contexts. Even though a massive work has been conducted, there is still an excessive potential for research, application, and practice in this area. The latest technological advancements, the steady advance of new IST products and services, together with the growing number and diversity of users, open new research directions in understanding predictors of human behavior towards technology acceptance in numerous application fields.

5.2 Limitations and Future Work

While the present bibliometric analysis study has provided valuable insight into the TAM and its applications, it was also limited in two ways. First, the search period was restricted to the years (2010–2020). Further bibliometric analysis studies might consider the articles published since TAM's appearance in 1989 until the present. This would provide a broader picture of the TAM and its applications. Second, the results were based on the data collected from the WoS database as it is regarded as the most authenticated source of quality publications. Future trials might consider the Scopus database for collecting TAM-based studies. This would undoubtedly retrieve

a more considerable amount of publications, which can be used for drawing a more comprehensive view of the TAM and its applications.

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Models of Acceptance and Use of Technology Research Trends: Literature Review and Exploratory Bibliometric Study



Bráulio Alturas

Abstract Acceptance and Use of Technology Models suggest that some constructs predict behavioural intention towards the acceptance and use of technology. For this reason, these models are increasingly used by researchers around the world. At the same time, teachers of information technology and systems teach these models as part of the content of various courses. This study aims to analyse the publications of the last five years on Acceptance and Use of Technology Models. An exploratory bibliometric study was carried out, using the Proquest and Scopus platforms, in the period from 2014 to 2018, to find out which models are most used by researchers. The findings suggest that the number of articles into the top journals has increased, and that there is a wider array of journals publishing articles about this topic. Also, the study revealed that the most cited models were TPB and TAM.

Keywords Technology adoption · Use of technology · Bibliometric · Models of acceptance · Research trends

1 Introduction

Researchers from around the world have developed models for acceptance and use of technology for several years. Understanding the impacts of IT on people and organizations lives and behaviour can serve as an essential foundation for the development of new technologies. At the same time, teachers of information technology and systems teach these models as part of the content of various courses.

It is not enough to create new technologies, it is necessary to realize if they are useful, easy to use and if are going to be used. Acceptance of the individual and the use of new technologies has been studied over the last decades, and to corroborate these, many models of technology acceptance have been created, such as the Theory of Reasoned Action (TRA) [1], Technology Acceptance Model (TAM) [2–4], Theory

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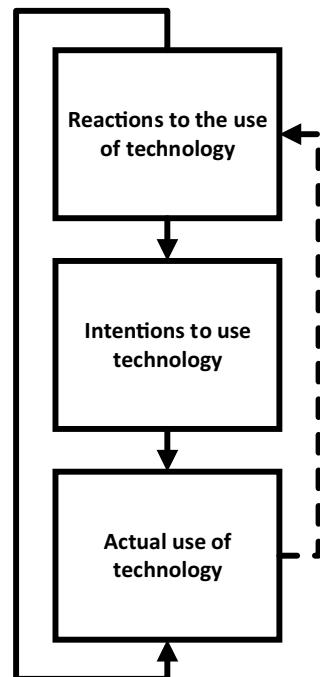
of Planned Behaviour (TPB) [5, 6], Innovation Diffusion Theory (IDT) [7] and, more recently, the Unified Theory of Acceptance and Use of Technology (UTAUT) [8, 9].

Since the mid-1970s, several researchers have sought to demonstrate the main variables and factors that influence technology uptake and adoption, in a hedonistic context and at the organizational level [10].

Studies on the adoption of information technologies seek to understand, for example, the impacts of the introduction of these technologies in work and leisure environments, the behaviour of people in processes of technological innovation and the reason why the use of a technology is discontinued. Figure 1 presents the basic conceptual framework underlying the models explaining the acceptance of technology according to several authors. The study of the adoption of information technology is critical to realizing the benefits of the technology implanted [11], since technological innovations can significantly affect organizations [12]. This importance can be noted when we see multiples theories that focused on attitudes as determinant of intention to adopt IT [13].

The adoption of any technology by its end users is considered as an essential step that precedes the implementation of that technology [14]. Technologies that facilitate electronic collaboration have become an important component of everyday life, so several studies have examined the adoption of these technologies. Adoption of these technologies is not progressing as fast or as broadly as expected and new systems or

Fig. 1 Basic concept underlying technology acceptance models



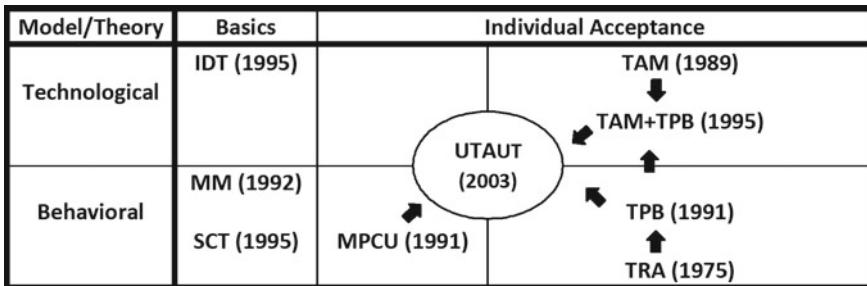


Fig. 2 Models that contributed to UTAUT

new technology acceptances require input at the managerial or organizational level and at the individual level [15].

According to Lee and Coughlin [16], technology is not widely adopted because of insufficient understanding or stereotypes of characteristics, target segment expectations, and needs. There is a substantial difference between what is developed and what is really needed [16].

Venkatesh et al. [8] developed a model called Unified Theory of Acceptance and Use of Technology (UTAUT) [8], where they integrate the elements of eight models on the acceptance of technology: Theory of Rational Action (TRA) [1]; Technology Acceptance Model (TAM) [3]; Motivational Model (MM) [17]; Theory of Planned Behavior (TPB) [6]; Combined Model TAM-TPB [18]; Model of PC Utilization (MPCU) [19]; Innovation Diffusion Theory (IDT) [7] and Social Cognitive Theory (SCT) [20].

The UTAUT consists of four determinant constructs of the intention and use of IT and four moderators that were extracted from the eight models previously mentioned (Fig. 2).

The option for this model as the basis of this study is justified by its comprehensive and integrative approach, which incorporates a wide variety of variables based on the main theoretical models developed to explain the technology acceptance and use. In particular, Venkatesh et al. [8] conducted an in-depth analysis of the literature on this topic and proposed a unified model that integrates common contributions to previous theories.

The present study turns attention to the scenario of scientific production on the subject through bibliometrics as instrument of data collection of the research. Bibliometric has been used as a tool to measure scientific production by making a survey of the inventory of scientific activities in the most diverse fields of knowledge. It is a careful search in the publications, and applying a high degree of methodological rigor, it becomes an important tool to analyse the scientific production and quantify the evolution of the knowledge produced by humankind [21, 22].

This study carried out the accounting of the first eighteen years of the twenty-first century of scientific articles on acceptance and use of technology, with special attention to the years 2014–2018. The article is organized with an introduction of

the research, followed by the presentation of the conceptual bases of the research (literature review); and the description of methodological procedures. Finally, the results of this bibliometric study and the final considerations of the work are presented and analysed.

2 Literature Review

The literature review is a rigorous process that signifies the foundation for conducting any study or research project [14].

Studies of the acceptance of technology have been carried out by different researchers, which have led to countless models that seek to explain the adoption of individual technology. In order to unify these models and generate an even more complete one, covering the main constructs related to IT acceptance, Venkatesh et al. [8] developed the Unified Theory of Acceptance and Use of Technology—UTAUT, contributing significantly to the studies in the area of Information Systems [23]. Although some theories were not directly related to the area of information technology, they contributed significantly to the construction of the model. The models that originated the UTAUT are described below.

In addition to the UTAUT and the eight models that contributed to it, two more models are analysed, which although not connected to UTAUT, were also used to study the acceptance and use of technology: Technology, Organization and Environment (TOE) framework and the Model of Information Systems Success (MISS).

2.1 *Theory of Reasoned Action (TRA)*

The Theory of Reasoned Action (TRA) by Fishbein and Ajzen [1] argues that individual behaviour is determined by the intentions of behaviour, which occur as a function of the attitude of the individual, defined as positive and negative feelings of himself. For this model there is a subjective norm, which involves the individual's perception of what most people think is important for him or her to do in relation to the behaviour in question [4]. The basic constructs of the model are the subjective norms and the behaviour attitude.

2.2 *Technology Acceptance Model (TAM)*

The TAM (Technology Acceptance Model) model of Davis [3], aims to evaluate the behaviour of technology use, analyzing the attitudes to use the IS, from perceived

utility and ease of use [24]. The model considers as main constructs: subjective norms, perceived ease of use and perceived utility.

A respectable amount of work dealing with Technology Acceptance Model (TAM) clearly indicates a popularity of TAM in the field of technology acceptance in general [25].

Davis [3] proposed a model that would aid and predict the use of the systems, developing the Technology Acceptance Model (TAM) that explains the degree of interest of IT users to accept and use a new technology. The model suggests that when users are introduced to a new software package, a number of factors influence their decision on how and when it will be used.

In this model, there are two key variables: Perceived usefulness and Perceived ease of use. The two variables are related to the extent to which the perceived ease of use influences the perceived utility, once the user is already aware of the effort that is needed the system becomes easier, which in turn becomes more useful. In addition, they are directly linked to the Attitude Toward Using, which in turn determines the behavioural intention of use (Behavioural intention) and the actual use of the system.

TAM has been widely used by many researchers because it is considered a valid, robust and user-friendly model [26, 27]. The TAM model has been used to study the acceptance of various types of technology, such as e-learning [23, 28, 29], social media [30–33] telemedicine [34], software maintenance tools [24], buyer–seller technology [35], mobile applications [36], ERPs [37], virtual worlds [38] and even in higher education [39, 40].

Despite the recurrent use of this model, several authors investigated their limitations [41].

- The results obtained are based on subjective measures, thus influencing the conclusions and making it impossible to measure the use/acceptance of a real system.
- The variables and relations present in the model do not allow to explain all the associated phenomena due to the complexity of the processes. This is because engaging people involves several factors that interfere with their perceptions, such as the user's specific technical ability, context and space where the person makes use.
- Behaviour cannot be considered as an end goal, but as a means to an end. Also the intention of use cannot be sufficiently representative of the actual use, since the time period between the intention and the adoption can be affected by a set of uncertainties or other factors that can influence the decision of an individual in the adoption of a technology.

Also, TAM cannot be used as-is because do not take into account the nature of the knowledge shared [42]. Legris et al. [43] show in their empirical study that the results of TAM have not been clear, particularly due to the lack of significance factors related to human and social processes [43].

To reduce the limitations of TAM Venkatesh and Davis (2000) created the model TAM 2 where it is possible to verify that the determining factors are added, thus extending the explanation for the perceived utility and behavioural intention of use.

In this model, new variables appear such as Subjective Norm, Image, Job Relevance, Output Quality, and Result Demonstrability [44].

Later, Venkatesh and Bala (2008) present the model TAM 3, where they add two determining groups in the perception of the ease of use: Anchor and adjustments (Adjustment). Anchor are considered as general beliefs about computers and their use, which consist of variables such as Computer Self-efficacy, Perceptions of External Control, Computer Anxiety and Computer Playfulness. Regarding the adjustments these are considered as beliefs based on practical experiences, it is composed of “perceived enjoyment” and the goal of usability thus having more information about how easy or difficult it will be to use the system [45].

2.3 Model of PC Utilization (MPCU)

The Model of Personal Computer Utilization analyses the acceptance and use of technology based on constructs such as: work fit, complexity, long-term consequences, effects on use, social factors, and facilitating conditions. Thompson et al. [19] analysed the effects of these constructs on the intention to use PCs.

2.4 Theory of Planned Behaviour (TPB)

Ajzen's Theory of Planned Behaviour (TPB) (1991) expands the TRA with the inclusion of the control construct of perceived behaviour as a determinant of the intention and behaviour of the use of technology. This model has as fundamental constructs: behavioural attitude, subjective norms and perceived behavioural control. The hybrid model, which combines the predictors of TPB with the perceived utility of the TAM model, has as main constructs: behavioural attitude, subjective norms, perceived behavioural control and perceived utility.

2.5 Motivational Model (MM)

The Motivational Model (MM) works with motivational theories to explain the behaviour of individuals, based on the constructs intrinsic and extrinsic motivation. Davis et al. [17] used this theory to understand the adoption and use of new technologies.

Some years later Vallerand [46] proposed a general model of intrinsic and extrinsic motivation, the Hierarchical model. This model serves two objectives: provides a framework to organize the literature on intrinsic and extrinsic motivation, and identify the psychological mechanisms underlying motivational changes [46].

2.6 Combined Model TAM-TPB

Taylor and Todd [18] created a new model combining TAM and TPB. The Technology Acceptance Model and two variations of the Theory of Planned Behaviour were compared to assess which model best helps to understand usage of information technology. Decomposing the belief structures in the TPB provided a moderate increase in the explanation of behavioural intention [18].

2.7 Social Cognitive Theory (SCT)

Starting from Social Cognitive Theory [47], Compeau and Higgins [20] used it based on constructs such as expectations of performance and personal results, self-efficacy, affection and anxiety, to study the use of computers, however the nature of the model allows the acceptance and use of information technologies in general to be analysed.

2.8 Innovation Diffusion Theory (IDT)

As for the Innovation Diffusion Theory, Moore and Benbasat (1996) have adapted the characteristics of innovation presented by Rogers [7] and refined the constructs so that they could be used in studies of individual acceptance of technology. The main constructs of this theory are relative advantage, ease of use, image, trialability, compatibility, results demonstrability and voluntariness.

IDT suggests that IT acceptance (termed adoption within this perspective) patterns within a network of users is shaped by a process of communication and social influence, whereby later adopters are informed of the availability and utility of a new IT by earlier adopters within their social network [7].

IDT also suggests that communication channels may have differential effects across the user population in that the more innovative early adopters are likely to be more motivated by mass media while the less innovative late adopters rely more on interpersonal channels [48].

Subsequent IDT research has examined a variety of mass- media channels (e.g., news media, experts) and interpersonal channels (e.g., colleagues, family members) that serve as the conduits of information and influence and studied the impacts of these channels on perceived IT attributes [49]. In fact, according to Momani and Jamous [50], the TAM constructs derive from IDT, given that the variable “perceived utility” has its representation as “relative advantage” and the variable “perceived ease of use” is also present in the IDT [50].

2.9 Unified Theory of Acceptance and Use of Technology (UTAUT)

The UTAUT consists of four constructs that are determinant of the intention and use of IT and four moderators that were extracted from the eight models previously mentioned. The determinants are: Performance Expectancy—degree in which the individual believes that using the system will have performance gains at work; Effort Expectation—where the individual relates the degree of facility associated with the use of the system; The Social Influence—degree of perception of the individual in relation to the others as to their belief in the need for new technology to be used or not; And the Facilitating Conditions—degree by which the individual believes that there is an organizational and technical infrastructure to support the use of the system [8, 51].

From the empirical review of the eight models Venkatesh et al. [8] extracted 31 linguistic statements that represented the most salient factors in the measurement of Technology Acceptance, next they consolidated 28 of the 31 statements into independent constructs [52].

The moderator constructs of TI's intention to use are gender, age, experience of the individual, and voluntariness to use—degree to which the use of technology is voluntary, free, and non-mandatory [8, 51]. This model has been used to study the acceptance of various types of technology, such as web 2.0 technologies [53].

Some years later Venkatesh et al. [9] published the UTAUT2, with the insertion of three constructs, in addition to UTAUT: “Hedonic Motivation”, “Price Value” and “Habit” [9]. The “Hedonic Motivation” construct is perceived pleasure, that is, fun or pleasure that the use of a technology can provides, it plays an important role in the acceptance and use of mobile technology.

The “Habit” construct is defined as the extent to which people tend to perform behaviors automatically due to learning.

The authors also added the “Price Value/Price Relevance” construct to the model because an important difference between organizational use and consumer use is that consumers often bear the monetary cost of using the technology, while employees do not.

Venkatesh et al. [9] point out that costs and prices can have a significant impact on consumers' use of the technology.

The contributors to the UTAUT have suggested that the core determinants (performance expectancy, effort expectancy, social influence and facilitating conditions) in this model can be used to explain actual usage of information technologies [54].

However, some authors have criticized this model. Bagozzi [55] for example, wrote that UTAUT is a well-meaning and thoughtful presentation, but that it presents a model with 41 independent variables for predicting intentions and at least 8 independent variables for predicting behaviour, and that it contributed to the study of technology adoption reaching a stage of chaos [55].

2.9.1 Technology, Organization and Environment (TOE)

The Technology, Organization and Environment (TOE) framework was developed in 1990 [56]. It identifies three aspects of an enterprise's context that influence the process by which it adopts and implements a technological innovation: technological context, organizational context, and environmental context.

The TOE framework as originally presented, and later adapted in IT adoption studies, provides a useful analytical framework that can be used for studying the adoption and assimilation of different types of IT innovation [57], and so has become a useful approach for examining factors affecting the adoption of IT in organizations [58].

2.9.2 Model of Information Systems Success (MISS)

The Model of Information Systems Success [59] was developed due to the finding of the critical role of IS quality in the success of business and information system function. IS quality occupies a very prominent place in IS success models. DeLone and McLean [59] have identified IS success as a multifaceted construct consisting of quality measures (system quality and information quality), attitudinal outcomes (use and satisfaction), and performance-related outcomes (individual and organizational impacts).

An “updated” IS success model was proposed in 2003 by DeLone and McLean, which includes IS service quality. As IT impacts not only immediate users, but also work groups, organizations, industries, consumers, and society, DeLone and McLean (2003) replaced the individual impact and organizational impact constructs of their original IS success model with the “net benefits” construct in their “updated” model [60].

Most empirical studies related to IS success models have dealt with individual impact rather than organizational impact [61]. Later Petter et al. [62] analysed the relationships between the six constructs of the DeLone and McLean model (2003) by reviewing 180 articles related to IS success published in the period of 1992–2007. At the individual level of analysis, the authors found some support for several of the 15 pairwise associations [62].

3 Methodology

The objective of this study was to understand which Acceptance and Use of Technology Models are most used (that is, the most cited) by researchers at the beginning of the twenty-first century.

In addition to the UTAUT and the eight models that contributed to it, two more models are analysed, which although not connected to UTAUT, were also used to study the acceptance and use of technology: Technology, Organization and Environment (TOE) framework, and the Model of Information Systems Success (MISS).

To reach the objective, we used bibliometrics. The first time the term bibliometrics was used was by Pritchard [21] and in this study we used the methodology of Dias [22]. The Proquest and Scopus platforms were used, and all articles of the twenty-first century were counted, in which the designations of the models were present. Care was taken to write the names of the models in quotation marks, to ensure that articles would not be found with just a few of the words that make up the name of each model.

First, all articles published between 2001 and 2018, in which the model was referred anywhere were counted. More than 22,000 articles were found. Then we also count all the articles in which the model was referred, in the article title, in the abstract or in the keywords, meaning that this model had been used in the research referred in that article. Finally, the same articles were counted, but only for the years 2014–2018.

4 Results and Discussion

The study revealed that most of the Acceptance and Use of Technology research had been published in the last five years under review. Almost as many articles from 2014 to 2018 and from 2001 to 2013, which means that scientific production on Acceptance and Use of Technology has been increasing in recent years.

Although it was expected that the UTAUT model was the most used, given that it is the most recent one, the data showed that the most mentioned model in any part of the articles was the TPB, while the most mentioned in title, abstract and keywords was the TAM (see Tables 1 and 2).

When searching the Proquest platform for references to models in any part of the articles, it was found that in the period 2001 to 2018 the most mentioned was the TPB with 26.5%, followed by the TAM with 24.4%, the TRA with 17.6% and the SCT with 17.3% and only then UTAUT with 4.2%. The same five models appear in leadership when analysing only the years 2014–2018: first TPB with 28.5%, followed by TAM with 23.5%, TRA with 16.6%, SCT with 15.3% and only then UTAUT with 6.1%.

Analysing in Scopus the references to the models in any part of the articles, it was found that the four most cited models were the same, although in a different order. It was verified that in the period 2001–2018 the most mentioned was the TPB with 34.3%, followed by the SCT with 29.1%, the TAM with 16.9% and the TRA with 8.0%. The UTAUT appears only in seventh place, with 2.4% after MM and MISS. The same four models appear in leadership when analysing only the years

Table 1 Articles published in the twenty-first century on acceptance and use of technology models (data collected from proquest on November 2019)

		Published papers 2001–2018	Published papers 2014–2018		
Model	Authors	Anywhere	Title, abstract or keywords	Anywhere	Title, abstract or keywords
TRA	Fishbein and Ajzen [1]	3999	400	1848	157
TAM	Davis [3]	5563	1750	2613	1001
MPCU	Thompson et al. [19]	12	0	6	0
TPB	Ajzen [6]	6034	1057	3172	558
MM	Davis et al. [17]	607	43	278	22
TAM-TPB	Taylor and Todd [18]	149	4	90	2
SCT	Compeau and Higgins [20]	3944	405	1706	204
IDT	Moore and Benbasat (1996)	846	154	418	73
UTAUT	Venkatesh et al. [8]	958	238	684	163
TOE	Tornatzky and Fleischer [56]	83	24	59	15
MISS	DeLone and McLean [59]	566	8	253	2

2014–2018: first TPB with 36.9%, followed by SCT with 25.8%, TAM with 17.9%, and TRA with 6.7%. UTAUT appears in sixth place, with 3.9% after MM with 4.7%.

Analysing references to the models in the titles, abstract and keywords of the articles, it was verified that in the period 2001 to 2018 the most mentioned was the TAM with 42.9%, followed by the TPB with 25.9%, the SCT with 9.9%, the TRA with 9.8% and only then the UTAUT with 5.8%. The same five models appear in the lead when analysing only the years 2014–2018: the first TAM with 45.6%, followed by the TPB with 25.4%, the SCT with 9.3%, the UTAUT with 7.4% and only after the TRA with 7.1%.

In recent years, references to UTAUT have increased, but also to TAM, which still seems to be the model on which more studies are based, whereas models such as MM, Combined TAM-TPB and MPCU are very rarely mentioned in the articles analysed.

The findings suggest the number of Acceptance and Use of Technology articles into the top journals has increased, and that there is a wider array of journals publishing articles.

As can be seen, the results obtained on the Proquest platform are similar to those obtained on the Scopus platform (see Tables 1 and 2).

Table 2 Articles published in the twenty-first century on acceptance and use of technology models (data collected from Scopus on November 2019)

		Published papers 2001–2018		Published papers 2014–2018	
Model	Authors	Anywhere	Title, abstract or keywords	Anywhere	Title, abstract or keywords
TRA	Fishbein and Ajzen [1]	11,968	1462	5057	568
TAM	Davis [3]	25,116	5550	13,578	2727
MPCU	Thompson et al. [19]	9	9	5	5
TPB	Ajzen [6]	51,142	7422	28,046	3777
MM	Davis et al. [17]	7345	432	3553	181
TAM-TPB	Taylor and Todd [18]	121	42	99	22
SCT	Compeau and Higgins [20]	43,395	3608	19,593	1698
IDT	Moore and Benbasat (1996)	1197	507	565	203
UTAUT	Venkatesh et al. [8]	3604	1149	2979	767
TOE	Tornatzky and Fleischer [56]	130	87	110	68
MISS	DeLone and McLean [59]	4882	52	2383	20

Although the Scopus platform indexes more journals than the Proquest platform, it is curious to note that on the Proquest platform there are more articles on the MPCU and MM models (see Figs. 3 and 4).

5 Conclusions

It has been found that the TAM model is still the most popular among researchers engaged in Acceptance and Use of Technology. Other models such as TPB and SCT are more commonly used than the latest UTAUT. One explanation may be that investigators consider TAM to be easier to apply than UTAUT. However, the use of UTAUT has also been increasing in recent years.

The paper besides a review of the literature on the main models, includes implications for the development of an effective use of technology research and reviews the literature that has been published in the period of 2001–2018 in top journals.

The study provides both academics and practitioners with an updated review of Acceptance and Use of Technology literature along with a sense of how Acceptance

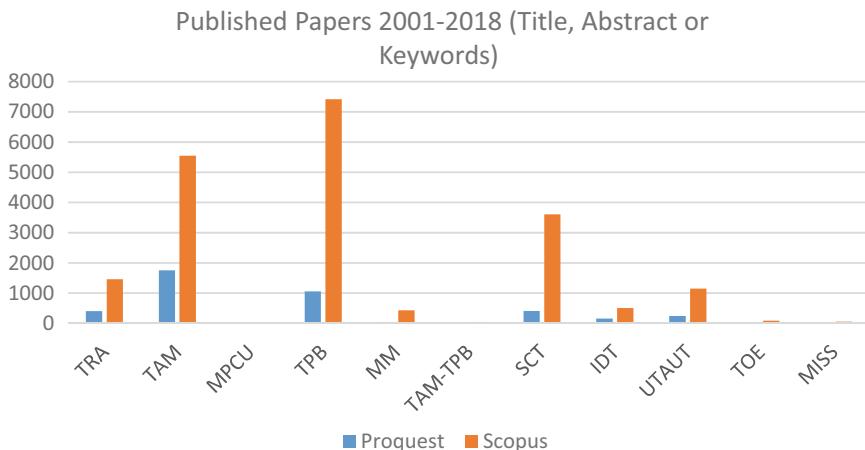


Fig. 3 Published papers 2001–2018

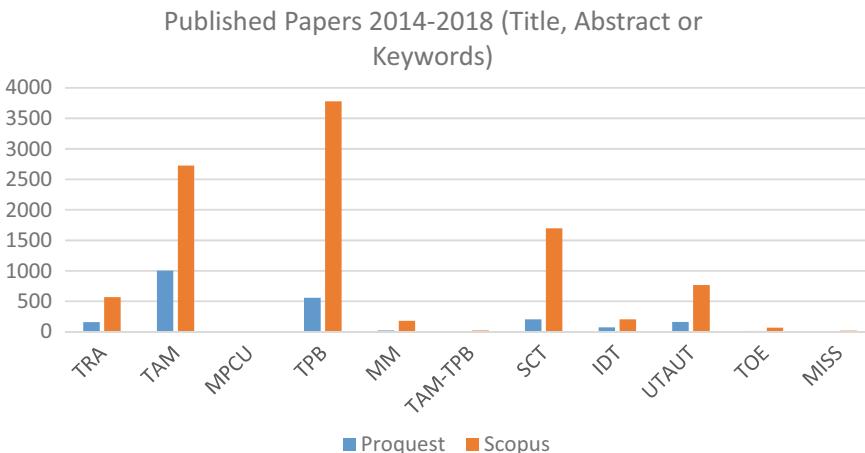


Fig. 4 Published papers 2014–2018

and Use of Technology research is evolving. This review provides academics and practitioners a macro overview of the topics and placement of articles that compose the Acceptance and Use of Technology research literature.

The main limitations of this study are that only two databases of scientific literature (Proquest and Scopus) were used, and some articles may be repeated in the count, because the same article may be based on more than one model.

As future studies, we intend to analyse in which types of technologies were applied the different models, also verifying if there are more suitable models to study the acceptance of certain technology.

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An Integrated Conceptual Model for Understanding the Adoption of Learning Management Systems in Higher Education During the COVID-19 Outbreak



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Abstract Regardless of the varying rates of the novel coronavirus COVID-19 outbreak worldwide, the vast majority of countries have deployed distance e-learning alternatives to flatten the trajectory of the disease proliferation. Despite that, various challenges emerge while endeavoring to deliver purely online education under the emergency lockdowns of all educational institutions with a specific focus on tertiary educational campuses. Online learning has fully substituted the blended modalities of learning prevalent in the period preceding the coronavirus crisis. Thence, the need to examine the factors influencing the full adoption of Learning Management Systems (LMS) in higher education institutions has become even more insisting. Higher education institutions are obliged not to compromise quality assurance benchmarks under exceptional pandemic circumstances accompanying home quarantine encapsulated with anxiety and uncertainty. This theoretical chapter's chief objective is to construct and adopt a hybrid theoretical framework driven from the most comprehensive technology acceptance and information systems success models. This chapter's value lies in proposing an extended model to be validated in subsequent studies to examine the factors influencing LMS adoption under epidemic circumstances.

Keywords Learning management systems · COVID-19 · Technology acceptance · Theoretical framework · Perceived user satisfaction

1 Introduction

The investments into Learning Management Systems (LMS) in higher education has been continually increasing, especially in regions that experience double-digit growth like Africa, Asia, Eastern Europe, and Latin America. Such a massive expansion of LMS in higher education has made it imperative to conduct systematic empirical investigations into the factors influencing LMS acceptance among undergraduates and faculty members [1]. Examining LMS acceptance's decisive determinants

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has also been associated with investigating the pedagogical efficiency parameters of LMS-based education [2]. LMS research has not been limited to initial LMS acceptance, but it has also extended to studying continued LMS adoption, which is considered a distinctive strand of LMS research [3].

LMS's pedagogical and technical affordances have entitled them to function as distance learning platforms, allowing students to learn at their own pace outside spatial and temporal restrictions [4]. The current crisis of COVID-19 outbreak has made universities, and colleges worldwide adopt distance online modalities of learning, especially LMS, entirely and swiftly [5]. That is because distance online learning has the potential of preventing interruption of students' learning and growth [6]. LMS has played a crucial role during the pandemic to mitigate the adverse effects of campuses closures on stakeholders at higher education [5]. For example, in medical education, LMS like Blackboard, Canvas, Moodle, Vista, or Angle allows interactive features like messaging systems, webinars, and pre-recorded sessions providing continuing medical education credit (CME) [4]. Although scarce, an initial trend is currently evolving towards investigating the factors influencing LMS acceptance under the epidemic restrictions enforced by the COVID-19 outbreak. Such studies rarely have adopted comprehensive theoretical frameworks, integrating perceived user satisfaction and technology acceptance approaches.

It is essential to integrate user-satisfaction approaches manifested in the Information Systems (IS) success model into technology acceptance theories to study predictors of LMS acceptance during the pandemic among students and instructors for several reasons. First, maintaining the quality of education and IT infrastructure is crucial to higher education institutions as they are shifting towards e-learning models with the enormous demand for intellectual capital [7]. Second, because of the digital divide in terms of IT infrastructure between urban and rural areas, higher education institutions globally encounter critical challenges related to the quality and sustainability of e-learning [8]. Third, faculty and students are obliged to cope with relying heavily on LMS. Simultaneously, faculty and learners must be well-trained to harness LMS effectively to meet the quality requirements of online distance education during COVID-19 spread [9]. Fourth, the healthcare system, especially front line medical specialists like Internal medicine, anesthesia, and intensive care physicians, has been severely affected by the COVID-19 crisis. This situation has necessarily influenced the quality of clinical training, due to the home quarantine policies [10].

Considering the observed gaps in the theoretical literature related to LMS acceptance during the COVID-19 spread, the current theoretical chapter aims to fulfill various objectives. First, this paper seeks to propose an integrated theoretical model that consolidates the prominent paradigms in LMS research, namely, perceived user-satisfaction, and technology acceptance. Second, the complete utilization of LMS in higher education, especially in medical education, is considered an innovative educational practice. Therefore, it is essential to implement theoretical models that scrutinize quality dimensions, comprehensive technology acceptance models, and sociological theories that examine predictors of diffusion of innovative technologies as collective social actions to combat the coronavirus. Third, the current paper attempts to pave the path for a generic line of research concerned with measuring the

success of LMS adoption in higher education institutions during and after the coronavirus crisis, as factors influencing LMS acceptance shall transform remarkably compared to the period before the disease outbreak.

2 Literature Review

The COVID-19 pandemic has provoked an urgent imperative to substitute conventional face-to-face university courses with modules delivered online [11]. One of the significant challenges is that faculty members are compelled to prepare for and deliver courses online with all that it entails knowledge and technical support. Thus, previous studies have delved into the relationship between university instructors' pedagogical content knowledge (PCK) and their utilization of e-learning platforms. The complexity of online instructional tools to conduct web-based courses challenges instructors' PCK and poses difficulties in planning and organizing online sessions. Although the Coronavirus crisis has been conducive to providing a plethora of pedagogical strategies, the virtual environments where online teaching occurs do not allow instructors to contextualize these pedagogies [12].

Simultaneously, educators have to live up to specific psychological challenges aggravated by the epidemic restrictions. It has been indicated that the COVID-19 pandemic is likely to affect the mental health and emotional well-being of medical educators. For instance, survey studies have found that symptoms of depression, anxiety, and distress, and burnout were increasingly reported among medical educators during the pandemic [13]. Furthermore, studies have divulged a variety of difficulties that medical students encounter because of the epidemic restrictions. Such hurdles manifest in the delay of board exams, inadequate preparedness for those exams, interruption of residency, fellowship, and clinical training programs, lack of conferences, and networking opportunities. Further obstacles encompass insufficient awareness of and training on technology use among faculty [14–19].

While previous studies have acknowledged the pedagogical powerfulness of LMS tools, such studies have also opposed the full use of LMS tools as "sole replacements" of face-to-face instruction [4]. However, scares empirical endeavors have been conducted to understand the factors affecting LMS acceptance and success during this period. For instance, it has been found that e-service quality, information quality, and system quality are significant predictors of perceived user satisfaction with LMS [8]. Although some previous studies have adopted and validated perceived user-satisfaction models as their foremost theoretical foundations, the e-learning challenges that have appeared during the pandemic have not been comprehensively addressed in integrated models.

3 The Contributions of the Current Paper

The present paper contributes to the theoretical literature connected with LMS research in several ways. First, this paper offers a comprehensive theoretical framework that addresses the salient theoretical paradigms underlying LMS acceptance and success. Second, the suggested framework anticipates determinants of LMS acceptance and success during the pandemic based on a literature survey of the most insisting concerns and obstacles that may hinder LMS acceptance and user satisfaction. Third, the proposed theoretical framework is generic in that it can be applied in studies targeting different populations of LMS end-users in higher education with a specific focus on faculty and students.

4 Theoretical Framework and Hypotheses Development

At its heart, the proposed framework embodies the updated IS Success model [20]. To address the hurdles that confront LMS acceptance and success during the pandemic, the theoretical framework of question additionally incorporates the relevant technology acceptance theories that approach such concerns, in the form of external constructs, influencing intention to LMS use. These theories include the extended version of the Unified Theory of Acceptance and Use of Technology (UTAUT2) [21], Diffusion of Innovation Theory (DOI) [22], and the Technology Acceptance Model 3(TAM3) [23], as well as Coronavirus anxiety.

4.1 UTAUT2

UTAUT2 elaborates on the UTAUT [24], commonly used to study ICT use in consumer contexts. Initially, based on sociological and socio-psychological theoretical perspectives, the UTAUT comprises four key constructs (i.e., *performance expectancy*, *effort expectancy*, *social influence*, and *facilitating conditions*) that influence intention to use technology. Subsequently, the UTAUT2 expands the original theory by integrating three new constructs, namely, *hedonic motivation*, *price value*, and *habit* [23].

Hedonic motivation is defined as the fun, pleasure, or perceived enjoyment gained by technology use. Previous studies have substantiated the significant positive effect of *hedonic motivation* on the intention of LMS use [25]. Concerning *effort expectancy*, it is defined as the perceived ease associated with using an application, whereas social influence refers to the extent to which a user perceives that significant referents including family, friends, and colleagues believe that they should use a particular technology [21]. Furthermore, *facilitating conditions* are defined as the perception that resources and opportunities are readily available to the target users

to enable them to use the application of interest [21]. It has been found that *effort expectancy*, facilitating conditions and social influence exert significant effects on the intention to use LMS [26–28]. In light of theory and evidence-based literature, the current paper formulates the following relevant hypotheses;

H1: Social influence significantly and positively impacts the intention to use LMS.

H2: Hedonic motivation significantly and positively influences the intention to use LMS.

H3: Facilitating conditions significantly and positively influence the intention to use LMS.

H4: Effort expectancy significantly and positively influences the intention to use LMS.

4.2 DOI

DOI assumes that individuals or societies perceive technological innovations from a dual perspective to eliminate the uncertainty of technology use outcomes. Such a binary perspective consists of software information and evaluation information regarding the expected outcomes [22]. DOI specifies five critical characteristics of technological innovation that function as parameters of individuals' intention to use it. These determinants are *relative advantage*, *comparability*, *complexity*, *trialability*, and *observability*. Considering LMS acceptance, compatibility with learning tasks, and technical complexity are the most extensively investigated factors. Previous studies have also verified that compatibility with learning tasks and technical complexity exert significant influences on the intention of LMS use [29–31]. Hence, the present study presumes that;

H5: Compatibility with learning tasks significantly and positively influences the intention to use LMS.

H6: Perceived technological complexity has a significant negative influence on the intention to use LMS.

4.3 TAM3

The original technology acceptance model (TAM) [32], has been extended to develop TAM2 by determining the factors influencing the system's *perceived usefulness*. In this regard, TAM2 has identified five additional determinants of *perceived usefulness*, precisely, *perceived ease of use*, *image*, *subjective norms*, *job relevance*, *output quality*, and *result demonstrability* [33, 23]. Afterward, TAM3 has been developed by integrating TAM2 and the model of the determinants of the perceived ease of use [34]. Therefore, TAM3 offers a comprehensive network of the predictors of IT acceptance, adoption, and use. Accordingly, TAM3 hypothesizes three new relationships that TAM2 has not tackled. Notably, TAM3 posits that experience moderates

the relationship between perceived ease of use and perceived usefulness, the relationship between computer anxiety and perceived ease of use, and the relationship between perceived ease of use and the behavioral intention [23]. Furthermore, the anchor factors—computer self-efficacy, perceptions of external controls, computer anxiety, and computer playfulness are significant predictors of perceived ease of use, and adjustment factors, including perceived enjoyment and objective usability, further influence perceived ease of use [23].

Previous literature supports TAM3 hypotheses in that computer self-efficacy and computer anxiety significantly influence perceived usefulness, whereas perceived interaction significantly influences perceived ease of use [35]. Furthermore, it has been found that perceptions of external controls significantly affects the perceived ease of use [36]. Accordingly, the proposed framework presumes that;

H7: Computer self-efficacy significantly, and positively influences LMS perceived ease of use.

H8: Computer anxiety significantly, and positively influences LMS perceived ease of use.

H9: Perceived interactivity significantly and positively influences LMS perceived usefulness.

H10: LMS perceived ease of use significantly and positively influences LMS perceived usefulness.

H11: LMS perceived ease of use significantly and positively influences the intention to use LMS.

H12: LMS perceived usefulness significantly and positively influences the intention to use LMS.

H13: Coronavirus anxiety significantly and negatively influences the intention to use LMS.

4.4 IS Success Model

An extensive literature review has led to the formulation of the initial IS success model, which has identified six critical quality dimensions determining IS success. These quality factors were; system quality, information quality, information use, user satisfaction, individual impacts, and organizational impacts [37]. A decade later, the updated version of the IS success model has been established as a result of successive empirical validations of the IS success prototype [20]. Delone and Mclean's model of IS success is a process-oriented model that shows how causality flows among the interrelated dimensions of IS success in the same direction of the information process [20]. Successive studies have extended the IS success model, and hence, it has come to encompass “*service quality*” as an essential quality dimension [38], in parallel with the semantic and technical dimensions of IS quality, each should be measured or controlled for, respectively. Because of its loose and multiple definitions, the construct of “use” has been replaced with “intention,” a more powerful cognitive

construct, immediately predicting actual system use. At the same time, perceived user-satisfaction significantly and positively influences the intention to use IS.

System quality measures the system's desired characteristics, such as reliability, usability, availability, adaptability, and response time. Moreover, *information quality* captures the degree to which the content of an IS is personalized, interactive, engaging, relevant, and easy to understand. *Service quality* measures the overall support provided to end-users by the IS provider or by the organization's networking department. On the other hand, *perceived user satisfaction* refers to users' opinions of the system's effectiveness and their entire experience with the system use. Finally, the "net benefits" are the most critical success measures that capture the balance between positive and negative effects of the system used on the end-users in terms of cost-effectiveness, time-saving, and attainment of learning goals [20, 39].

Studies that have examined determinates of e-learning success have found that service quality, information quality, and service quality significantly and positively influence user satisfaction, and intention to use LMS [8], and that user satisfaction significantly influences the intention to use LMS [40]. Therefore, the current paper makes the following hypotheses informed by the IS success model;

H14: System quality significantly and positively influences the intention to use LMS.

H15: System quality significantly and positively influences perceived user satisfaction with LMS.

H16: Information quality significantly and positively influences the intention to use LMS.

H17: Information quality significantly and positively influences perceived user satisfaction with LMS.

H18: Service quality significantly and positively influences the intention to use LMS.

H19: Service quality significantly and positively influences perceived user satisfaction with LMS.

H20: Perceived user satisfaction with LMS significantly and positively influences the intention to use LMS.

H21: The net benefits of LMS use significantly and positively influence the intention to use LMS.

H22: The net benefits of LMS use significantly and positively influence perceived user satisfaction with LMS.

H23: Intention to use LMS significantly and positively influences actual LMS use.

H24: Actual LMS use significantly and positively influences the net benefits of LMS use.

Figure 1 illustrates the proposed theoretical framework and hypotheses.



Fig. 1 A theoretical framework of the factors influencing LMS acceptance and success during the corona-virus pandemic

5 Discussion

LMS has proven to be the most potent technological tool in educational institutions taking into account the ever rapidly evolving instructional technologies readily available at the disposal of digital natives [25]. Albeit not being the sole medium of e-learning during the COVID-19 pandemic, almost all higher education institutions Worldwide function through E-learning platforms that are operating chiefly via LMS [41]. Thus, an intense demand emerges to evaluate the LMS success in online education delivery during the COVID-19 pandemic. The current paper has suggested an inclusive theoretical framework that can serve as a rich source of hypotheses on LMS's pedagogical efficiency. Although the proposed model merges technology acceptance and user satisfaction theoretical orientations, user satisfaction lies at the heart of the study's conceptual framework. On the other hand, the external factors that are presumed to affect both LMS acceptance and success have been derived from the most comprehensive technology acceptance models, i.e., UTAUT2, DOI,

and TAM3, that specifically address the challenges, concerns, or obstacles that might hinder LMS acceptance and success while learning online during the pandemic.

The IS success model, a rough proxy of the user satisfaction approach, constitutes the core of the present theoretical framework for three reasons. First, the IS success model is capable of measuring the discrepancy between users' expectations of an IS and IS actual performance experienced by the target users [42]. In this regard, the current model awards peripheral importance to technology acceptance models compared to the IS success model because technology acceptance alone does not warrant success, since technology acceptance does not measure, IS success explicitly and directly [43]. At this critical stage, where both students and educators are overwhelmed with their initial experiences with the extensive reliance on LMS, it is crucial to examine the effectiveness of LMS performance. On the other hand, students and educators are obliged to accept LMS use and cope with it during the quarantine enforced by the epidemic circumstances. Therefore, users' resistance has no longer been the primary concern compared to the effectiveness of LMS performance per se, which has admittedly become the most insisting concern in the potential research lines, during and post the crisis [44]. Third, the IS success model puts forth resilient overarching quality factors that can be adapted and further scrutinized to investigate layers of quality factors that are unique to LMS success in higher education institutions compared to other types of IS such as educational system quality, support system quality, instructor and learner quality.

The current model has utilized the UTAUT2 because it is the most widely used and robust model in LMS acceptance research [25]. For example, UTAUT2 explains over 74% of behavioral intentions to use technological tools [45]. Relying on the UTAUT2, the current model has integrated variables like "facilitating conditions" that encompass the availability of constant access to broadband connectivity, which are fundamental factors. Facilitating conditions are also associated with effort expectancy, the degree to which users perceive the ease of LMS use. The factors mentioned above tackle the perceived difficulties encountered by faculty and students towards the effective LMS use [24].

As far as the TAM3 is concerned, it has been incorporated in the present framework because TAM3 addresses the most pervasive factors examined in LMS acceptance research with a specific focus on computer self-efficacy and computer anxiety [5, 46]. These constructs measure a variety of volitional control aspects that users need to acquire to decide to use LMS. Furthermore, TAM3 examines the influence of perceived interactivity on LMS acceptance. It is essential to investigate perceived interactivity since e-learning, in general, has always been criticized for not securing sufficiently interactive learning experiences compared to conventional modalities of teaching and learning [5].

Simultaneously, the full adoption of LMS in higher education institutions during the pandemic represents a technological innovation; this paper opts to incorporate constructs from the DOI. As mentioned earlier, the full reliance on LMS during the pandemic is a unique, unprecedented experience for both instructors and students. Therefore, the complexity of LMS tools and their perceived compatibility with

the learning tasks and intended outcomes are the most salient factors affecting the intention of LMS use.

6 Conclusion

This paper offers a comprehensive theoretical framework examining LMS adoption during the COVID-19 pandemic. Because of the scarcity of relevant theoretical models, the current theoretical framework can catalyze researchers to examine new factors influencing LMS adoption. By integrating both technology acceptance and perceived user-satisfaction, the advised framework aims to compensate for each theoretical approach's shortcomings.

7 Theoretical Implications

The current paper has several theoretical implications. First, the theoretical framework enables scholars to examine the relevancy and amenability of existing theoretical models for investigating LMS full adoption. Second, the theoretical framework paves the path for research studies to pinpoint LMS adoption's most influential factors. Third, this paper opens an avenue for future studies that can validate the suggested framework empirically. Accordingly, future empirical validations of this model may help extend and further solidify the IS success model, especially in the context of LMS adoption in higher education institutions. As the current framework applies to different populations, including students and faculty, future studies can extend the framework into more specialized models to examine faculty and students' needs and concerns.

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Predicting Adoption of Visual Programming Languages: An Extension of the Technology Acceptance Model



Ibrahim Arpaci

Abstract Technology acceptance is one of the most dynamic research areas in the field of Information Systems (IS). This chapter provides a systematic overview of technology acceptance theories by clarifying the relations among the theories and models. The chapter developed a theoretical model by extending the “Technology Acceptance Model” (TAM) to better explain adoption of visual programming languages by engineering students. The proposed model was tested by using a “structural equation modelling” approach. Results indicated that “perceived enjoyment” was significantly related with perceived usefulness and attitude. Further, the results indicated that “self-efficacy” was significantly related with perceived ease of use. The proposed model better explained the adoption of Scratch by predicting 75% of the variance in continuous use intention.

Keywords Technology · Acceptance · Adoption · TAM · Scratch · Programming · Engineering

1 Introduction

Despite an increasing need for engineers in the area of Information Technology, drop-out rates in software related graduate programs is a significant challenge [1]. A tremendous number of computer science (CS) students change the program they are majoring after they had enrolled the first CS course on computer programming [2]. The high attrition of CS students can be derived from different factors including gender or background knowledge [1]. However, keep in mind that programming activity is complex, abstract, and difficult [3]. Students mostly attend the first programming class without a background in programming basics. On the other hand, they were supposed to learn the abstract programming concepts in a limited time.

However, academics may adopt interactive visual programming environments such as Greenfoot [4], Alice [5], and Scratch [6] to attract attentions of today’s distracted

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students. These programing environments can be considered as a gateway to learn more abstract programing languages such as Java and Python. C. It was suggested the use of these programing environments for introducing basic programing concepts [7].

In May 2007, “Lifelong-Kindergarten group” at the “Massachusetts Institute of Technology Media-Lab” developed a visual programing language called “Scratch” [8]. It has a strong potential for secondary and high school as well as for introductory programing courses in higher education since programs are easily coded by drag-and-drop command-blocks. Thereby, users focus only on algorithm design and problem solving. Further, it motivates trial-and-error and prevents syntax errors [9]. Scratch has a promising potential to easily introduce abstract programing concepts such as threads, repetition, communications, conditionals, variables, and user inputs. It was argued that it also enables the use of object concepts by scripts and sprite graphics [2]. Accordingly, this chapter focused on the adoption of Scratch as a visual programing environment by engineering students.

2 Theoretical Background

2.1 Technology Acceptance Theories

“Technology acceptance” is one of the most dynamic research topics in the field of IS [10–27]. Studies on technology acceptance aims to understand the determinants of users’ behavioral intention to adopt a new technology and ultimately the actual use behavior. The most prominent technology acceptance theories and models explained in this chapter as depicted in Fig. 1. It was argued that “IS success model,” “Innovation Diffusion Theory” (IDT), and “Task-Technology Fit (TTF) theory” form the antecedents of technology acceptance theories [28]. “Theory of Reasoned Action” (TRA) is a priori theory that aims to understand individual behavior [29]. Ajzen

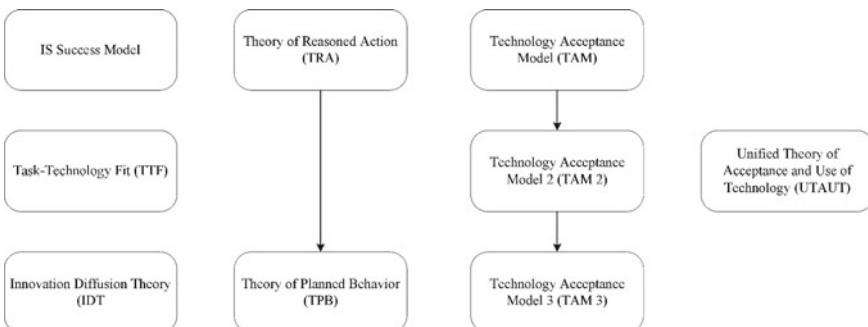


Fig. 1 The most prominent technology acceptance theories and models

extended the TRA by integrating “perceived behavioral control” to develop “Theory of Planned Behavior” (TPB) [30]. Grounding on the TRA, Davis proposed “Technology Acceptance Model” (TAM) [31]. In time, Davis et al. proposed the first modified version of the TAM [32]. Later on, Venkatesh and Davis proposed the second and final modified version of the TAM [33], which was extended by Venkatesh and Davis by integrating “subjective norm” to develop TAM 2 [34]. After a while, Venkatesh and Bala extended the TAM 2 by the determinants of the PU and PEOU along with two moderators; experience and voluntariness to develop TAM 3 [35]. Venkatesh et al. developed the “Unified Theory of Acceptance and Use of Technology” (UTAUT) based on prominent acceptance theories including the TRA, TPB, IDT, and TAM [10].

IS Success Model

“IS Success Model” developed by DeLone and McLean suggests that the use/intention to use and “user satisfaction” are predicted by system, service, and information quality [36]. Further, it suggested significant relationships between the use/intention and “net benefits” along with “user satisfaction” and “net benefits.” Table 1 shows the variables of the IS Success Model.

Task-Technology Fit Theory

TTF theory proposed by Goodhue and Thompson suggests that both task and technology characteristics predict the fit between the task and technology [38]. It also suggests that the match between the task and functionality of a technology predict the individual performance and utilization. This suggests that for a high performance and utilization, the technology characteristics must fit with task characteristics [38]. Table 2 shows the determinants of the TTF theory.

Innovation Diffusion Theory (IDT)

Diffusion can be defined as “the process by which an innovation is communicated through certain channels over time among the members of a social system” [40]. Further, Rogers suggested that an “innovation decision process” involves five

Table 1 Variables of the IS success model

Variable	Definition
“System quality”	“Usability, availability, reliability, adaptability, and response time of a system” [37]
“Information quality”	“Relevance, reliability, completeness of a transaction” [37]
“Service quality”	“The overall support delivered by the service provider” [37]
“Intention to use”	“The degree to which an information system is intended to use” [37]
“User satisfaction”	“The user’s level of satisfaction when utilizing an information system” [37]
“Net benefits”	“The extent to which an information system is contributing to the success of the stakeholders” [37]

Table 2 Determinants of the TTF theory

Variable	Definition
“Task characteristics”	“Some key aspects of user task requirements including ubiquitous account management, money transfer and remittance, and real-time account information inquiry” [39]
“Technology characteristics”	“Some key aspects of mobile banking technology including ubiquity, immediacy, and security” [39]
“Task-technology fit”	“The degree of the consistency between a technology and a task” [38]
“Performance impacts”	“The degree to which an individual believes that using the system will help him or her to attain gains in job performance” [10]
“Utilization”	“The behavior of employing the technology in completing tasks” [38]

stages including “knowledge, persuasion, decision, implementation, and confirmation” [41]. Rogers classified individuals as “innovators, early adopters, early majority, late majority, and laggards” [41]. Moreover, Rogers defined five key characteristics that can predict decision to reject or adopt an innovation. Table 3 presents the five characteristics of an innovation.

Theory of Reasoned Action (TRA)

Fishbein and Ajzen (1975) suggested that TRA is one of the fundamental theories in the field of social psychology. The TRA suggests that actual behaviors are predicted by the behavioral intention, which is predicted by the attitudes, subjective norms, and behaviors. Attitude was defined as “an individual’s positive or negative feelings (evaluative affect) about performing the target behavior”, while “subjective norm” was defined as “the person’s perception that most people who are important to him think he should or should not perform the behavior in question” [42]. Table 4 shows the determinants of the TRA.

Table 3 Characteristics of the innovation

Characteristic	Definition
“Compatibility”	“The degree to which an innovation is perceived as consistent with the social value and beliefs or the needs of potential adopters” [41]
“Complexity”	“The extent to which an innovation is perceived as difficult to understand and use” [41]
“Observability”	“The degree to which the results of an innovation are visible to others” [41]
“Relative advantage”	“The extent to which the potential adopter perceives an innovation is superior to alternative products, services, or concepts” [41]
“Trialability”	“The degree to which an innovation may be experimented with on a limited basis” [41]

Table 4 Determinants of the TRA

Variable	Definition
“Attitude”	“The degree to which a person has a favorable or unfavorable evaluation of a given behavior” [43]
“Behavioral intention”	“The motivational factors that influence a given behavior” [43]
“Subjective norm”	“A social pressure to perform or not to perform a given behavior” [43]

Table 5 Determinants of the TPB

Variable	Definition
“Attitude”	“The degree to which a person has a favorable or unfavorable evaluation of a given behavior” [43]
“Behavioral intention”	“The motivational factors that influence a given behavior” [43]
“Subjective norm”	“A social pressure to perform or not to perform a given behavior” [43]
“Perceived behavioral control”	“The perceived ease or difficulty of performing the behavior” [43]

Theory of Planned Behavior (TPB)

Ajzen extended the TRA by integrating “perceived behavioral control” to develop the TPB, and suggested that the “behavioral intention” to perform a behavior is predicted by the “attitude,” “subjective norms,” and “perceived behavioral control” [43]. Table 5 shows the determinants of the TPB.

Technology Acceptance Model (TAM)

Davis extended the TRA by integrating “perceived usefulness” (PU) and “perceived ease of use” (PEOU), which are considered to be fundamental predictors of users’ acceptance of a new technology [31]. TAM suggested that the actual use behavior is predicted by attitudes toward using a technology. While, the attitude was predicted by the PU and PEOU. PU refers to “the degree to which a person believes that using a particular system would enhance his or her job performance” [31]. Whereas, PEOU refers to “the degree to which a person believes that using a particular system would be free of effort” [31]. Davis et al. proposed the first modified version of the TAM [32]. Later on, Venkatesh and Davis eliminated the attitude since both PEOU and PU had a direct relationship with behavioral intentions [33].

Technology Acceptance Model 2 (TAM 2)

TAM was extended by Venkatesh and Davis by integrating the external determinants of PU and “behavioral intention” [34]. “Social influence” (image and subjective norm) and “cognitive instrumental processes” (output quality, job relevance, PEOU, and result demonstrability) were significant predictors of the PU. Further, voluntariness and experience were significant moderators of subjective norm and behavioral intention.

Technology Acceptance Model 3 (TAM3)

TAM 2 was extended by Venkatesh and Bala with the determinants of the PU and PEOU with two moderators: experience and voluntariness [35]. TAM 3 suggested that the relationships between (i) PU and PEOU; (ii) PEOU and “computer anxiety”; and (iii) PEOU and behavioral intention moderated by experience. Tables 6 and 7 show the determinants of the PU and PEOU, respectively.

“Unified Theory of Acceptance and Use of Technology” (UTAUT)

Table 6 Determinants of the PU

Determinant	Definition
“Perceived ease of use”	“The degree to which a person believes that using a particular system would be free of effort” [32]
“Subjective norm”	“The degree to which an individual perceives that most people who are important to him think he should or should not use the system” [42]
“Image”	“The degree to which use of an innovation is perceived to enhance one’s status in one’s social system” [34]
“Job relevance”	“The degree to which an individual believes that the target system is applicable to his or her job” [34]
“Output quality”	“The degree to which an individual believes that the system performs his or her job tasks well” [34]
“Result demonstrability”	“The tangibility of the results of using the innovation, including their observability and communicability” [44]

Table 7 Determinants of the PEOU

Determinant	Definition
“Computer self-efficacy”	“The degree to which an individual believes that he or she has the ability to perform a specific task/job using the computer” [45]
“Perception of external control”	“The degree to which an individual believes that organizational and technical resources exist to support the use of the system” [10]
“Computer anxiety”	“The degree of an individual’s apprehension, or even fear, when she/he is faced with the possibility of using computers” [46]
“Computer playfulness”	“The degree of cognitive spontaneity in microcomputer interactions” [47]
“Perceived enjoyment”	“The extent to which the activity of using a specific system is perceived to be enjoyable in its own right, aside from any performance consequences resulting from system use” [34]
“Objective usability”	“A comparison of systems based on the actual level (rather than perceptions) of effort required to completing specific tasks” [34]

Venkatesh et al. proposed a unified model based on eight models and theories, namely: “TRA, TAM, Motivational Model, TPB, a combined TPB/TAM, Model of PC Utilization, IDT, and Social Cognitive Theory” [10]. The UTAUT predicts the intention to perform a behavior based on “performance expectancy,” “effort expectancy,” “social influence,” and “facilitating conditions.” “Performance expectancy” refers to “the degree to which an individual believes that using the system will help him or her to attain gains in job performance” [10]. “Effort expectancy” refers to “the degree of ease associated with the use of the system” [10]. “Social influence” is defined as “the degree to which an individual perceives that important others believe he or she should use the new system” [10]. “Facilitating conditions” refers to “the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system” [10]. Further, age, voluntariness, gender, and experience were significant moderators of the behavioral intention and actual use [10].

3 Hypotheses

The present study proposed a research model for the acceptance of “Scratch” based on TAM [31]. The TAM is an influential theory that explains individuals’ technology adoption and acceptance [48, 49]. The study extended the TAM by integrating perceived enjoyment and self-efficacy to better predict students’ adoption of Scratch programming environment. The research model suggested that “continuous use intentions” are explained by attitude, which is explained by PU, PEOU, and perceived enjoyment. Self-efficacy predicts PEOU and both PEOU and perceived enjoyment predict PU.

Continuous use intention

“Continuous use intention” refers to “the degree of a student’s belief that s/he will continue to use a technology” [10]. While, attitude refers to “the degree of students’ overall reaction to use a technology” [31]. Individuals’ negative or positive feelings of Scratch programming environment would significantly predict continuous use intentions. Accordingly:

H1. There would be a significant and positive relationship between the attitude and continuous use intention.

Perceived usefulness

PU refers to “the degree to which a person believes that using a particular system will enhance his or her job performance” [31]. Students’ PU after using the Scratch would significantly predict their attitudes. Therefore:

H2. There would be a significant and positive relationship between the PU and attitude.

Perceived enjoyment

“Perceived enjoyment” refers to “the degree to which the activity of using technology is perceived to be enjoyable” [50]. When students have pleasure and fun while

using Scratch, they would be more motivated to use it. Accordingly, it was postulated that “perceived enjoyment” would significantly predict the attitudes. Therefore:

H3. There would be a significant and positive relationship between perceived enjoyment and attitude.

Perceived ease of use

PEOU refers to “the degree to which a person believes that using a particular system will be effortless” [31]. When students find Scratch easy to program, the complexity would be lower, and PU would be higher. Accordingly:

H4. There would be a significant and positive relationship between PEOU and PU.

H5. There would be a significant and positive relationship between PEOU and attitude.

Self-efficacy

“Self-efficacy” can be defined as “a judgment of students’ ability to use a technology” [51]. It was suggested that there would be a significant relationship between “self-efficacy” and PEOU [52]. Accordingly:

H6. There would be a significant and positive relationship between self-efficacy and PEOU.

4 Method

4.1 Sample and Procedure

The study recruited 186 university students who are majoring in the “Computer Engineering” program in Turkey. Students’ ages were ranged between 17 and 42 ($M = 19.96$, $SD = 3.01$). Most of the students (79.6%) were freshmen and male (68.8%). Majority of the participants unfolded their experience level in programming as moderate (44.1%) or low (49.5%). Participants enrolled in a course, titled “Introduction to Computer Engineering” and then they were administered the survey in online form.

4.2 Instruments

Measurement items for subjective norms, behavioral intentions, and attitudes were adapted from TRA proposed by Ajzen, whereas measurement items for PU and PEOU were drawn from TAM [31]. Measurement items for “self-efficacy” were adapted from the study of Compeau and Higgins (1995) and measurement items for “perceived enjoyment” were adapted from the study of Yang and Lay [52]. The study used the five-point Likert-type scale with 33 items ranged from “strongly disagree” to “strongly agree.”

Table 8 Correlation matrix

Variable	AVE	CR	CUI	A	PU	PE	PEOU	SE
Continuous use intention (CUI)	0.87	0.97	0.93					
Attitude (A)	0.83	0.95	0.89**	0.91				
Perceived usefulness (PU)	0.76	0.95	0.70**	0.77**	0.87			
Perceived enjoyment (PE)	0.82	0.95	0.88**	0.53**	0.72**	0.91		
Perceived ease of use (PEOU)	0.66	0.92	0.45**	0.26**	0.51**	0.59**	0.96	
Self-efficacy (SE)	0.64	0.88	0.50**	0.79**	0.62**	0.62**	0.77**	0.94

** $p < 0.01$

5 Findings

5.1 Validity and Reliability

“Composite reliability” (CR) coefficients exceeded the value of 0.70. Both discriminant and convergent validity were satisfactory since “average variance extracted” (AVE) coefficients exceeded the critical value of 0.50 and the “square root of AVE values” were larger than the inter-construct correlations. Table 8 shows the correlation matrix along with CR and AVE values.

A “confirmatory factor analysis” by using SPSS-AMOS 23 was employed to test the proposed model. Model fit indices suggested the structural model fits the data quite well [Chi Squire/df = 1.81, AGFI = 0.85, GFI = 0.90, RMR = 0.07, SRMR = 0.05, NFI = 0.95, CFI = 0.98, IFI = 0.98, NNFI = 0.97, RMSEA = 0.07]. Cronbach’s α coefficients are used to assess internal reliability. The alpha values ranged between 0.87 and 0.95, indicating a good internal consistency as suggested by Creswell [53]. Table 9 shows Cronbach’s alpha values and sample items.

5.2 Hypothesis Testing Results

“Structural equation modeling” (SEM) was employed to evaluate the proposed relations. Results showed that the proposed hypotheses were supported. Figure 2 shows standardized regression weights, r-squared values along with error terms. Table 10 details the hypothesis testing results. Perceived enjoyment, PU, and PEOU explained 95% of variance in the attitude, which explained 75% of variance in continuous use intention.

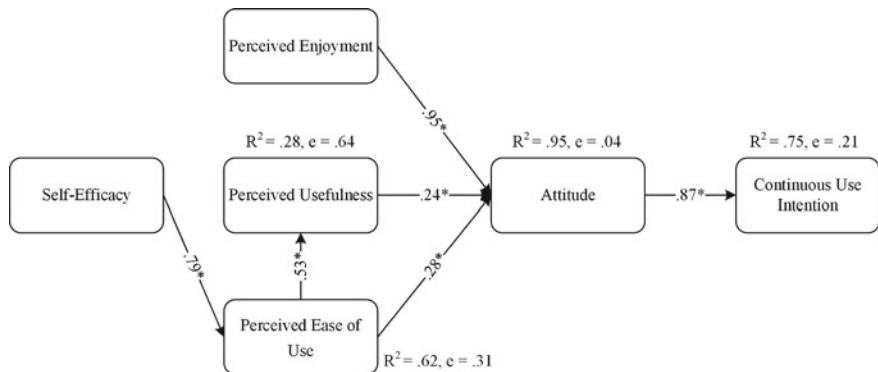
Table 9 Factorability and reliability

Construct	Item	Internal reliability			Principal component analysis		
		Cronbach Alpha	Item-total correlation	Factor load	Community	Total-variance-explained	
PEOU	PEOU1. "Learning to operate Scratch would be easy for me"	0.92	0.81	0.88	0.77	71.41	
	PEOU2	0.54	0.64	0.41			
	PEOU3	0.77	0.84	0.71			
	PEOU4	0.88	0.93	0.86			
	PEOU5	0.83	0.89	0.79			
	PEOU6	0.80	0.87	0.76			
PU	PU1. "Using Scratch would improve my performance in learning programing"	0.95	0.88	0.92	0.85	80.08	
	PU2	0.91	0.94	0.89			
	PU3	0.88	0.92	0.85			
	PU4	0.86	0.91	0.83			
	PU5	0.76	0.83	0.69			
	PU6	0.78	0.84	0.71			
Perceived enjoyment	PE1. "Programming is more interesting with Scratch"	0.95	0.84	0.91	0.83	86.60	
	PE2	0.91	0.95	0.91			
	PE3	0.84	0.91	0.83			
	PE4	0.91	0.95	0.90			

(continued)

Table 9 (continued)

Construct	Item	Principal component analysis			
		Internal reliability	Cronbach Alpha	Item-total correlation	Factor load
				Community	Total variance-explained
Self-efficacy	SE1. "I believe I have the ability to do tasks in Scratch if there was no one around to tell me what to do"	0.87	0.73	0.86	0.74
	SE2		0.72	0.85	0.71
	SE3		0.66	0.80	0.64
	SE4		0.82	0.91	0.82
Continuous use intention	CUI1. "I intend to use Scratch while learning programming in the future"	0.95	0.89	0.94	0.89
	CUI2		0.85	0.92	0.84
	CUI3		0.93	0.96	0.92
	CUI4		0.88	0.94	0.88
	A1. "Using Scratch to learn programming is a good idea"	0.95	0.85	0.92	0.84
Attitude	A2		0.88	0.93	0.87
	A3		0.92	0.96	0.91
	A4		0.84	0.91	0.83



* $p < .001$, Chi-Square = 195.28, df = 108, Chi-Square/df = 1.81, P -value = .000, GFI = .90, RMSEA = .066

Fig. 2 Research model

Table 10 Hypothesis-testing results

	Hypothesized path	Std. estimates	C.R.	S.E.	P	Results
H1	A → CUI	0.87	14.49	0.061	0.001	Supported
H2	PU → A	0.24	6.36	0.035	0.001	Supported
H3	PE → A	0.88	17.22	0.046	0.001	Supported
H4	PEOU → PU	0.53	6.96	0.080	0.001	Supported
H5	PEOU → A	0.26	4.62	0.035	0.001	Supported
H6	SE → PEOU	0.79	9.47	0.082	0.001	Supported

6 Conclusion

6.1 Implications for Research and Practice

The present study extended TAM with perceived enjoyment and self-efficacy to better understand students' adoption of Scratch. In fact, the proposed model better explained the adoption of Scratch by predicting 75% of the variance in continuous use intention. The results suggested that "perceived enjoyment" significantly predicted the attitude. This implies that students involve in the programing activities with pleasure and enjoy. Further, self-efficacy significantly predicted the PEOU. Likewise, it was suggested that "self-efficacy" can significantly predict the PEOU [27]. Finally, findings suggested that Scratch can be effectively integrated to the higher education, specifically, for teaching introductory computer programing courses.

6.2 Limitations and Future Research Directions

Sample of the study was computer engineering students having a relatively greater levels of computer self-efficacy than those students majoring in different departments. The study should, therefore, be replicated with a randomly selected students majoring in various departments to further generalize the results. Lastly, it is important to acknowledge that if the study had used longitudinal data collected over time, the results would be much more credible.

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What Impacts E-Commerce Acceptance of Generation Z? A Modified Technology Acceptance Model



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Abstract E-commerce, in other words electronic commerce, is a digital way of trade of goods and services by transferring data via Internet. It is expected that the future consumers in 2020s will consist of Generation Z. The aim of the paper to investigate as well as incorporate various factors of Generation Z's behavioral intention to use e-commerce based on the modified technology acceptance model (TAM). Together with basic structure of TAM, in this particular study we take into account additional constructs such as price savings, time, trust, perceived risk and satisfaction. Totally of 162 questionnaires are collected via university and high school students who are expected to be Generation Z due to year of birth who live in Turkey. The Structural Equation Modeling (SEM) methodology was implemented by using SmartPLS 3.2.7 software to evaluate the data and test the proposed hypotheses. This study provides new practical insights for authorities seeking to implement e-commerce. Based on Generation Z attitude, companies will have to take strategic actions toward to the business. The results of this study suggest that perceived usefulness and trust are affecting behavioral intention to use significantly and directly. On the other hand, there are some results which are different than general expectations. For instance, price saving is not a significant determinant of satisfaction for Generation Z.

Keywords E-commerce · Generation Z · Structural equation modeling · Technology acceptance model · Price savings · Time

1 Introduction

Throughout the years, people have made trade with each other. Before, trade happened by swapping the goods, yet today trade has changed form. Especially with the Internet coming to daily life, trade can be made easier via electronic environment which Internet provides. These electronic transactions are called as e-commerce. E-commerce is one of the most frequently used word in daily life and it brings

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several concerns. There were numerous studies about how the concerns of users affect toward the usage of e-commerce and what the final behavior is. On the other hand, there are various parameters affects the users' behavioral intention. The ease of use of website and the classification of goods which are desired to buy have definitely impacted on the consumer approach. E-commerce is also changed due to the changing generation. According to researchers, Generation Z will have a high percentage of among all generations in the near future. Generation Z covers the people which were born after 1995. This study aims to understand the technology acceptance of Generation Z in Turkey toward the e-commerce. It is believed that this study insight the approach of Generation Z people which will be the great majority of future consumers and provides both individuals and organizations with the needed information about Generation Z people in Turkey. Understanding the approach toward e-commerce of new generation is necessary to apply strategic decisions that provides being alive in the competitive environment. Technology acceptance model will be used to analyze which parameter effects on the Generation Z people's behavior and how these affect. The relevant data will be collected with the surveys from the university students which are in Generation Z. The obtained data will be analyzed with the usage of TAM model. Therefore; it is crucial to understand the specific model for applying TAM. After understanding the model and its parameters, it helps to continue in terms of defining constructs that are used later to build the model.

The purpose of this study is to discover the intention to use e-commerce, as well as various elements that affect Generation Z's preferences of e-commerce in Turkey. The data have been gathered from potential and actual Generation Z users of e-commerce. The theoretical framework that guides this study is the TAM, which is one of the most commonly used models for user acceptance and usage [1].

In order for e-commerce to be effectively used in an environment, a better understanding of which factors influence user acceptance needs to be developed. The study has three contributions. First, theoretical contribution of this research is to extend the technology acceptance model by integrating factors such as price savings, time, satisfaction, etc. Second, no earlier empirical research explored antecedents of Generation Z's intention to use e-commerce in Turkey. Another contribution is that, this study provides a proof that there is a direct effect of perceived ease of use, perceived usefulness and trust on behavioral intention to use e-commerce. Moreover, price saving and time affect behavioral intention to use e-commerce indirectly through satisfaction.

The rest of this study is organized as the following: Next section reviews the theoretical background and presents hypotheses. Then, research model and methodology are discussed. Finally, results, discussion and recommendations for further research are presented.

2 Literature Review

E-commerce can be stated as a business model conducted in electronic environment. This digital way of conducting business today has significant position for the user side and companies' side, because throughout the years, both people get used to changed trade habits which were brought by e-commerce and this business model makes buying and selling easier.

E-commerce has a rapid growing position all around the world. Especially with the Internet, e-commerce and its application areas were begun to use especially with the Internet coming up. Nowadays there are numerous electronic transactions which can be used in different sectors. For instance; Individuals use e-commerce to make banking transactions, to do online shopping and to receive products or services which are in anywhere in the world. There are manifold facts that makes contributions to the rising and developing of e-commerce such as population size, the rate of Internet users and effective logistic support system [2].

In the literature there are several publications related to "e-commerce" & "technology acceptance model". Experiments were conducted about customer trust feelings in B2C e-commerce and after experiments concluded that decreasing social uncertainty impacts the trust of consumers to ecommerce adoption in a positive way [3]. The researchers worked on WeChat which is a common used mobile payment service in China and applied technology acceptance model to analyze customer intention of use by defining parameters affecting on its popularity [4]. E-commerce leading companies tries to develop innovative delivery systems that will have a great deal of contributions. It was investigated that how customers' adaptation will be about innovative Drone delivery which is taken into account recently by leading e-commerce companies [5]. Besides, it was developed acceptance model to understand adoption of users under defined variables such as customers' place of residence and customers' different features. A modified technology acceptance model was conducted relating to consumers' sense and adoption on Augmented Reality that was recently begun to be integrated with e-commerce websites such as mobile Ikea catalogue [6]. Augmented reality provides interactive shopping experience and has a potential to change consumers shopping habits. The online data of 633 online customers were analyzed to adjust retailers' e-business improvement by making online surveys [7]. A technology acceptance model was conducted which was about the motivations and trust of people to use of Cryptocurrencies in electronic payment process [8]. Auto-ID was researched which is preferred to use by customers and affects the shopping experience. In addition to this, this article explained the technology adaptation of Auto-ID by designing and analyzing defined artifacts [9]. The behavior goal and psychology of web users were researched by methods of empirical study in tourism e-commerce which evolves fast in China [10]. It was conducted that a research about purchase attitude of customers in online fruit trade by applying technology acceptance model and perceived risk theory. [11] Online fruit trade was usually concluded with bankruptcy contrary to expectations. This study sought the

main cause of failure conditions in this area. The customers' adoption and adaptation to the mobile payment in Malaysia was examined [12]. The technology acceptance model was conducted with Bayesian approach to understand the motives of customers in Colombia to the online shopping [13]. A study was conducted in Kuwait how Live Customer Support Chat Services affects the customers' purchase habits by applied Technology Acceptance Model and the Theory of Reasoned Action [14]. It was intended to expose the relationship between privacy concerns and consumer behavior when purchasing goods in Internet under the theory of planned behavior and technology acceptance model [15]. Parameters were explored which can change the decision of customers in online purchasing environment and analyzed parameters using Structural Equation Modelling [16].

2.1 E-Commerce Development

The actual historical beginning of e-commerce dates back to 1990s when was the years of opening Internet to the public. Internet has enabled its users to many options such as gathering information about particular subjects and playing video games, then Internet has begun to spread to people lives with its numerous services. Besides, banking and finance sector has shown development of different payment options which has compatible with the interface of websites. When online and safe payment options were available in Internet, more people began to prefer using e-commerce. People can make shopping in e-commerce websites with credit card or EFT that has a full name of electronic funds transfer. In addition to this, development in logistics industry has made also contributions on usage of e-commerce. Nowadays plenty of logistics companies perform well compared to before, for instance transportation from one country to another has been clearly shorter, despite it can differ with the type of vehicle used for transportation and distance between the locations. The shorter delivery time which can be only just days encourage customers to order anything via e-commerce. It can be said that the increase use of Internet, development of logistics and banking sectors lead the development of e-commerce all around the world.

2.2 E-Commerce in Turkey

Internet has begun to be used in contributions of the studies which was began in 1991 by The Scientific and Technological Research Council of Turkey (TUBITAK) and Middle East Technical University (METU). It was indicated that the first Internet connection in Turkey was set up on 12 April 1993. Science and Technology Higher Board (BTYK) had convened a meeting with the purpose of forming network for e-commerce, thus the base of e-commerce in Turkey was being set [2]. It is known that e-commerce came to Turkey later than the majority of other countries, yet e-commerce in Turkey has a rapid increase. Turkish Business and Industry Association

(TUSIAD) report of e-commerce shows that the volume of e-commerce in Turkey has shown approximately 34% increase between 2013 and 2015. As of 2016, e-commerce received 17.5 billion Turkish liras in volume [17]. As indicated in statistical data given above, e-commerce has gain popularity in Turkey over years. There are several innovations which help to increase the number of people using e-commerce. The innovation of smartphones has a prominent impact on the e-commerce usage as well. The rise of e-commerce companies and its advertisements are also the factors which influence the customer to make the transactions via e-commerce.

After the Internet was began to be used in Turkey, there has been a plenty of e-commerce companies which is seen today highly successful and have great market shares. For instance; Hepsiburada is an e-commerce company which serves the users wide range of products from electronics to cosmetics. Hepsiburada make business not only in Turkey but also in abroad with its “e-export” venture. This venture was discussed in a meeting named “Easy export”, was given details about this program. Customers all around the world are able to receive and offer all products which is been searched for via global website and mobile application of Hepsiburada by the help of this “easy export” program. Ekmekci, who is the International Group President of Hepsiburada, stated about Easy Export model, Hepsiburada has maintained rigorous study in this context about this model which enable the companies to export process easier by uniting custom, logistics, ordering, marketing processes and gathering all these necessary process at single hand. This step leads the Turkish e-commerce companies expand their business to the international market. Trendyol is another Turkish brand which serves in textile industry as an e-commerce company. Trendyol was a small venture when founded in 2010, yet today has succeeded to get investments by various foreign investment companies. Sahibinden.com which is e-commerce company, based in Turkey, has competitive advantages in a second hand trade of real estate and cars, because becoming user and publishing ad can be made with no payment. Yemeksepeti has served the consumer with the purpose of online food ordering since 2001. For tourism sector, Etstur, which is an e-commerce company can be given as an example. Etstur presents complete travel service to its customers and one of the leading e-commerce tourism companies. It can be said that e-commerce provides various sectors such as textile, tourism, and food with advantages to be able to make business in Turkey.

E-commerce has affected a great deal of parts of the businesses. Obviously, it has advantages for the users and for the e-commerce companies. On the other hand, this electronic trade makes contributions to in the followings; manufacturers are the companies that produce goods for selling via e-commerce and make profit from e-commerce indirectly. Banks receive income from e-commerce with commission that can be received via EFT and money transferring processes. Insurance Companies can have also profit owing to e-commerce, because products are insured for guaranteeing safety transport. Software companies form the websites and write program for user-interface so that users can process in e-commerce websites effectively. Shipping companies make deliver goods which are ordered in e-commerce websites. Government can also have taxes generated by online transactions through e-commerce.

It can be understood that e-commerce has benefits for various segments of the industry and institutions as well as consumers. The difference between e-commerce and traditional trade is definitely speed. Transactions made by customer online can take just seconds; but if transactions are made in a traditional way, definitely take so much time. People, using e-commerce, have an opportunity to compare different products from different dealers in a short period of time, hence decision making process would be shorter than before. Besides, benefits of e-commerce exist for the companies. It encourages the e-commerce companies to have better warehouse management systems. E-commerce companies do not have actual stores which customer can enter in, that is why potential customers can view and buy the goods of particular e-commerce company whenever they would like to see. That means it can serve 7 days and 24 h in comparison of traditional stores. Customers do not have to make phone or fax communication to be able to make transactions, the cost caused by these can be eliminated. Suppliers do not have to overstock any goods, because it can be seen easily how many products are left in the warehouse and how many of them are already sold. Although e-commerce has a great deal of benefits for the companies, it is getting harder for the companies to survive in the competitive environment. E-commerce companies make a point of digital marketing to attract more users, therefore these companies have made intense investments in digital marketing. The amount of investments which is made might change in dependence of the sectors. According to the Annual E-commerce 2018 trends report which was prepared by SemRush, Music, book, and flower selling are less invested sectors, while textile sector has received investments at most by the e-commerce companies. Online clothing stores have invested almost 50,000 \$ for advertising. Andrienko, who is Global Marketing leader of Semrush indicated that after the analysis made for which words at most commonly used in e-commerce advertisements in USA, England and Turkey, it was seen that “free shipping and delivery” are the most used words in the advertisements. This shows the customers are sensitive about the free shipping opportunity [18].

2.3 E-Commerce Turkey-Global Comparison

There are several researches about comparing e-commerce retail volume between countries. Despite the population in Turkey is higher than most of the European countries, the research show that ecommerce retail sales volume in Turkey is quite lower than most of the countries. There is a research made by TÜBİSAD in cooperation with Deloitte, Etid and SimilarWeb. Having compared Turkey with the other countries, Turkey has lower percentage of share of online retail in total retail than most of the countries. But over the years, the percentage of online retail in Turkey has risen.

The population of Turkey and usage rate of Internet in Turkey have increased over year, but the percentage of online retail size/total retail size is quite low when considering these increases. For instance, Poland has more percentage than Turkey

has in terms of online retail size, but population of Poland is lower than population in Turkey. This proves that the chance of usage e-commerce to be increased is possible and Turkey has a potential to increase e-commerce usage and online transactions.

Understanding the behavioral intention of users in Turkey is getting important to be able to extend the e-commerce usage, because determining which factors highly influence the users' intention toward using e-commerce would be beneficial for the e-commerce companies. In this study, it will be tried to understand the factors affecting e-commerce users in Turkey, therefore technology acceptance model will be used to show the relations between the factors which will be named as 'construct' later. This model will be planned to apply university students in Turkey as a represent of young population, because Generation Z, which indicates people were born after 1995, will be the major consumer group a few years later. It is planned to prove which factors affecting the future main consumer's decision to use e-commerce with the help of technology acceptance model. This study will show how constructs influence the Generation Z behavior toward e-commerce and the companies which are planning to enter Turkish market with e-commerce will be benefited by the results of this study. The companies will be able to take actions which enable to increase online transactions via e-commerce in regard of constructs that Turkish Generation Z highly concern about them when using e-commerce. E-commerce enable the companies to sustain their business and reach new markets, consequently it cannot be thought the world without e-commerce. The application areas of e-commerce are extensive and varied.

3 Research Model and Hypotheses Development

The primary objective of this study is to examine the dynamics affecting Generation Z's e-commerce acceptance. While constructing our research framework, we utilize the technology acceptance model [19]. Technology acceptance model (TAM) was firstly presented by Fred Davis in 1989, and it had become one of the frequently used models. It was stated that TAM is a theory improved for information systems, to be able to forecast technology acceptance of users' and when a new technology is released, this model helps to understand the determinants which affects the user decision and approach to the new technology [20]. It was mentioned that TAM become the popular model providing the possible result whether acceptance or rejection of the user behavior toward technology [21]. Our model, which contains 9 constructs, particularly, actual use, behavioral intention to use, perceived usefulness, perceived ease of use, time, trust, price savings, satisfaction, perceived risk are provided in Fig. 1.

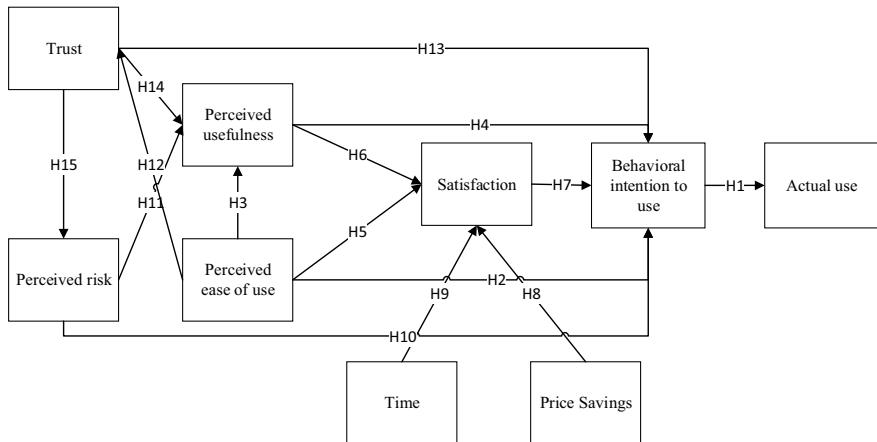


Fig. 1 Research model

3.1 Behavioral Intention to Use (BI)

It was pointed out that the measurement of the individual's intention to apply particular treatment is Behavioral Intention [22]. Behavioral Intention is calculated from two variables. It is affected by perceived usefulness and attitude toward to use, and it has shown that BI affects actual use significantly [22, 23]. So, we hypothesize as follows:

H1. "Behavioral intention to use will have a positive impact on the actual use of e-commerce."

3.2 Perceived Ease of Use (PEOU)

It was described as the degree of whether utilization from one definite system would be effortless or not in terms of people perception [22]. It is found that perceived ease of use and behavioral intention has a significant relationship [24–26]. So, it is hypothesized as following:

H2. "Perceived ease of use will have a positive impact on the behavioral intention to use e-commerce."

3.3 Perceived Usefulness (PU)

The primary intention of users toward new technology is a variable which is entitled as Perceived usefulness and PU is the variable which represents the belief of people about how using specific technology make contribution on their job performance [22]. It is affected by both perceived ease of use and external factors [27]. On the other hand, it impacts directly to attitude towards use and behavioral intention to use. So, we hypothesize as follows:

H3. “Perceived ease of use will have a positive impact on the perceived usefulness of e-commerce.”

H4. “Perceived usefulness will have a positive impact on the behavioral intention to use e-commerce.”

3.4 Satisfaction

It is an ex post assessment of shoppers’ involvement in the administration and is caught as a positive inclination, lack of concern, or a negative inclination [28]. Users’ satisfaction is influenced by both financial and noneconomic factors [29]. Earlier research has shown that PEOU and PU affect satisfaction which positively affects behavioral intention to use [30]. So, we hypothesize as follows:

H5. “Perceived ease of use will have a positive impact on the satisfaction of e-commerce.”

H6. “Perceived usefulness will have a positive impact on the satisfaction of e-commerce.”

H7. “Satisfaction will have a positive impact on the behavioral intention to use e-commerce.”

3.5 Price Savings

It is a proportion of store ability in light of the fact that as administrative costs decline, reserve funds could be given to purchasers. These expenses are the remuneration to showcase creators or sellers and are considered as a proportion of market effectiveness. As market organizations become progressively effective, the expense of exchanging is brought down and shoppers show signs of improvement costs [31]. If e-commerce is price saving, users are going to be satisfied with the overall performance of the electronic channel. Earlier research has shown that price savings positively affects behavioral intention to use [30]. So, we hypothesize as follows:

H8. “Price savings will have a positive impact on the behavioral intention to use e-commerce.”

3.6 Time

Time effectiveness is a proportion of the exchange time costs. According to [32], the shopper amplifies their utility subject to pay requirements as well as time imperatives [33]. By diminishing data asymmetry and amazements, for example, conveying incorrectly items and missing conveyance dates, clients find web based shopping simple to utilize and less tedious. If e-commerce is time effective, users are going to be satisfied with the overall performance of the electronic channel. Earlier research has shown that time positively affects behavioral intention to use [30]. So, we hypothesize as follows:

H9. “Time will have a positive impact on the behavioral intention to use e-commerce.”

3.7 Perceived Risk

Perceived risk is “the consumer’s expectations of suffering loss in pursuit of a desired outcome” [34]. Many papers showed the negative effect of perceived risk on perceived usefulness and behavioral intention to use [35–37]. So, we hypothesize as follows:

H10. “Perceived risk will have a negative impact on the behavioral intention to use e-commerce.”

H11. “Perceived risk will have a negative impact on the perceived usefulness of e-commerce.”

3.8 Trust

It is “an individual belief that others will behave based on an individual’s expectation” [38]. Earlier research has shown that PEOU affects trust positively and it positively affects behavioral intention to use and perceived usefulness [37]; on the other hand, trust has a negative relationship with perceived risk [39]. So, we hypothesize as follows:

H12. “Perceived ease of use will have a positive impact on the trust of e-commerce.”

H13. “Trust will have a positive impact on the behavioral intention to use e-commerce.”

H14. "Trust will have a positive impact on the perceived usefulness of e-commerce."

H15. "Trust will have a negative impact on the perceived risk of e-commerce."

4 Research Methodology

The sample was gathered via online survey which was applied to the students who are studying in high schools and universities. Respondents are in Generation Z that contains the people having birthdate from 1995 until today. There were three parts in questionnaire which are the cover letter and informed consent form, the demographic questions including as age, birth of year, education, and questions related to constructs of the model. The questionnaire did not include any individual data that might specify a respondent's identification.

We collected 162 questionnaires, and all of them were valid and used for the analysis. About 49.4% of the respondents were female and 30.25% of them were born in 1996. The majority of the respondents (82.1%) had an undergraduate education. Table 1 demonstrates the demographic data of respondents.

After collecting the data, it is analyzed with the help of SmartPLS 3.2.7 software program. Partial Least Squares (PLS) statistical method is used for the analyzing process which is a type of regression method and used for a multivariate analysis.

The items related to constructs are gathered from the existing studies as we use a literature-based model. Perceived ease of use was evaluated using the four items

Table 1 Demographics

Variables of the sample		Number of respondents	Percentage (%)
Gender	Female	80	49.4
	Male	82	50.6
Birth of year	1995	36	22.22
	1996	49	30.25
	1997	28	17.28
	1998	19	11.73
	1999	10	6.17
	2000	6	3.70
	2001	5	3.09
	2002	9	5.56
Education	Elementary school	0	0
	High school	19	11.73
	Undergraduate	133	82.1
	Postgraduate	10	6.17

(e.g., PEOU1, PEOU2, PEOU3, PEOU4) from [40, 41]. Perceived usefulness had four items (e.g., PU1, PU2, PU3, PU4) which were developed by [15, 37, 41, 42]. The four items for perceived risk (e.g., RISK1, RISK2, RISK3, RISK4) were taken from [43]. The three items for trust (e.g., TR1, TR2, TR3) were adapted from [37]. The four items for satisfaction (e.g., SAT1, SAT2, SAT3, SAT4) were adapted from [37, 44]. The three items for time (e.g., TIME1, TIME2, TIME3) were adapted from [30]. The three items for price savings (e.g., PR1, PR2, PR3) were adapted from [45]. Four items for behavioral intention to use (e.g., BIU1, BIU2, BIU3, BIU4) taken from [46]. Lastly, three items for actual use (e.g., AU1, AU2, AU3) were adapted from [47]. In this study, so as to quantify the factors, the five-point Likert scale was utilized. Table 2 shows the details about the constructs and items.

5 Results

Convergent and discriminant validity are needed to be measured for evaluating the reliability and effectiveness of the constructs. Cronbach's Alpha, composite reliability and average variance extracted (AVE) measure the convergent validity. One of the special form of factor analysis is confirmatory factor analysis which is applied to control outer loadings. The items concerning with its construct should have outer loadings more than 0.6 to have desirable level of convergent validity [48]. In our model, outer loadings of every items are higher than 0.6 which means all items are above satisfactory level to add further evaluation process. The results of confirmatory factor analysis are shown in Table 3.

In order to assess the model fit, the values of standardized root mean square residual (SRMR), Chi-Square (χ^2/df), d_ULS, d_G, NFI are utilized. For a good model fit, the SRMR has to be smaller than 0.08, NFI has to be above 0.9, d_ULS and d_G have to be at least 0.05 [49]. Table 4 indicates a good model fit as the values of the indicators are within the suggested values for the saturated and estimated models, and the Chi-square values are significant at the 0.05 level ($p = 0.00$).

It was defined that the satisfactory level of Cronbach's Alpha is 0.7 [50]. For all constructs in our study, Cronbach Alpha's ranged between 0.752 and 0.904. According to [51], the values of composite reliability (CR) must be higher than 0.6 [6]. To receive convergent validity, average value extracted (AVE) should be equal or higher than 0.5 [52]. Table 5 shows that our constructs have internal consistency and reasonable reliability.

Once we evaluated the construct reliability and validity, the discriminant validity was checked. To have reasonable discriminant validity, there are two things which must be considered. The square root of AVE represents the diagonal values to corresponding items. The correlation made with itself of one construct must be greater than the correlation between remained constructs [53]. Table 6 indicates the example of reasonable discriminant validity.

Structural equation modelling is applied by using SmartPLS3.2.7 software. Table 7 shows summary of hypothesis and statistics. According to the analysis below,

Table 2 Constructs and items

Construct	Code	Sources	Items
Perceived ease of use	PEOU1 PEOU2 PEOU3 PEOU4	[40, 41]	“Learning to operate e-commerce would be easy for me” “My interaction with e-commerce would be clear and understandable” “It would be easy for me to become skillful at using e-commerce” “I find e-commerce easy to use”
Perceived usefulness	PU1 PU2 PU3 PU4	[15, 37, 41, 42]	“Using e-commerce would increase my productivity” “I think e-commerce is valuable to me” “E-commerce provides me access to wide variety of products and services” “Overall, I find e-commerce useful”
Perceived risk	RISK1 RISK2 RISK3 RISK4	[43]	“I think using e-commerce puts my privacy at risk” “I think using e-commerce in monetary transactions have potential risk” “Using e-commerce may expose me to legal problem” “I find e-commerce to be insecure”
Trust	TR1 TR2 TR3	[37]	“E-commerce is trustworthy” “E-commerce is one that keeps promises and commitments” “I trust e-commerce because it keeps my best interests in mind”
Satisfaction	SAT1 SAT2 SAT3 SAT4	[37, 44]	“I am satisfied in general with my past transactions with e-commerce” “My overall experience of using e-commerce is very satisfied” “My overall experience of using e-commerce is very pleased” “My overall experience of using e-commerce is very delighted”
Time	TIME1 TIME2 TIME3	[30]	“E-commerce helps me to accomplish tasks more quickly” “I did not have to spend too much time to complete the transaction” “I did not have to spend too much effort to complete the transaction”

(continued)

Table 2 (continued)

Construct	Code	Sources	Items
Price savings	PR1 PR2 PR3	[45]	“E-commerce saves money in comparison to traditional commerce” “E-commerce is cheaper than traditional commerce” “E-commerce significantly reduces expenses per transaction in comparison to traditional commerce”
Behavioral intention to use	BI1 BI2 BI3 BI4	[46]	“I intend to use e-commerce more in the future.” “I want to use e-commerce for my everyday living” “It is likely that I will use e-commerce for my future everyday living” “Using e-commerce is something I would do”
Actual use	AU1 AU2 AU3	[47]	“I use e-commerce very intensively (many hours per day)” “I use e-commerce very frequently (many times per day)” “Overall, I use e-commerce a lot”

behavioral intention to use positively affects actual use of e-commerce ($\beta = 0.503$, $p < 0.05$; H1 supported); PEOU does not have positive impact on BI ($\beta = -0.067$, $p > 0.05$; H2 not supported); PEOU significantly influences PU ($\beta = 0.604$, $p < 0.05$; H3 supported); perceived ease of use affects positively to satisfaction ($\beta = 0.252$, $p < 0.05$; H4 supported); perceived ease of use has positive effect on trust ($\beta = 0.377$, $p < 0.05$; H5 supported); price savings does not significantly influence satisfaction ($\beta = 0.013$, $p > 0.05$; H6 not supported); perceived usefulness positively affects behavioral intention to use ($\beta = 0.504$, $p < 0.05$; H7 supported); perceived usefulness positively influences satisfaction ($\beta = 0.223$, $p < 0.05$; H8 supported); perceived risk does not have a negative direct effect behavioral intention to use ($\beta = -0.023$, $p > 0.05$; H9 not supported); perceived risk does not have negative effect on perceived usefulness ($\beta = 0.030$, $p > 0.05$; H10 not supported); satisfaction does not positively affect behavioral intention to use ($\beta = 0.076$, $p > 0.05$; H11 not supported); time has positive impact on satisfaction ($\beta = 0.304$, $p < 0.05$; H12 supported); trust positively affects behavioral intention to use ($\beta = 0.290$, $p < 0.05$; H13 supported); trust positively affects perceived usefulness ($\beta = 0.237$, $p < 0.05$; H14 supported); trust does not influence perceived risk negatively ($\beta = -0.111$, $p > 0.05$; H15 not supported).

R Square shows how strong the constructs explain the related dependent constructs, which are indicated in Table 8. Behavioral intention to use explains

Table 3 Confirmatory factor analysis

Construct	Item	Mean	Standard deviation	Factor loadings	t-Statistics
Perceived ease of use	PEOU1	0.899	0.019	0.899	48.232
	PEOU2	0.876	0.022	0.876	40.251
	PEOU3	0.839	0.037	0.841	22.901
	PEOU4	0.814	0.038	0.818	21.416
Perceived usefulness	PU1	0.800	0.033	0.799	24.534
	PU2	0.817	0.035	0.819	23.501
	PU3	0.765	0.060	0.769	12.749
	PU4	0.828	0.033	0.829	25.229
Perceived risk	RISK1	0.783	0.211	0.848	4.011
	RISK2	0.795	0.220	0.873	3.967
	RISK3	0.753	0.194	0.823	4.236
	RISK4	0.747	0.228	0.835	3.668
Trust	TR1	0.732	0.065	0.733	11.302
	TR2	0.848	0.026	0.849	32.474
	TR3	0.866	0.024	0.868	36.604
Satisfaction	SAT1	0.826	0.032	0.829	25.918
	SAT2	0.906	0.017	0.907	53.642
	SAT3	0.893	0.028	0.895	32.193
	SAT4	0.889	0.027	0.891	33.070
Time	TIME1	0.841	0.032	0.841	26.533
	TIME2	0.883	0.025	0.885	35.297
	TIME3	0.833	0.041	0.835	20.344
Price savings	PR1	0.838	0.047	0.847	17.876
	PR2	0.868	0.034	0.874	25.470
	PR3	0.878	0.027	0.874	32.962
Behavioral intention to use	BI1	0.784	0.036	0.785	21.710
	BI2	0.895	0.016	0.895	56.670
	BI3	0.882	0.020	0.882	43.411
	BI4	0.814	0.034	0.813	24.175
Actual use	AU1	0.894	0.025	0.897	36.086
	AU2	0.929	0.016	0.930	58.407
	AU3	0.890	0.018	0.889	50.640

Table 4 Fit summary

Indicators	Saturated model	Estimated model
SRMR	0.061	0.077
d_ULS	3.089	4.845
d_G	1.418	1.495
Chi-Square	1913.202	1938.132
NFI	0.978	0.975

Table 5 Construct reliability and validity

Construct	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)
Perceived ease of use	0.881	0.919	0.738
Perceived usefulness	0.818	0.880	0.647
Perceived risk	0.867	0.909	0.714
Trust	0.752	0.859	0.670
Satisfaction	0.904	0.933	0.776
Time	0.816	0.890	0.729
Price savings	0.834	0.899	0.748
Behavioral intention to use	0.866	0.909	0.714
Actual use	0.891	0.932	0.820

Table 6 Discriminant validity

	AU	BI	PEOU	PR	PU	RISK	SAT	TIME	TR
AU	0.906								
BI	0.503	0.845							
PEOU	0.241	0.435	0.859						
PR	0.343	0.647	0.467	0.865					
PU	0.311	0.638	0.691	0.553	0.805				
RISK	0.041	-0.089	-0.086	0.008	-0.048	0.845			
SAT	0.260	0.504	0.556	0.405	0.590	-0.190	0.881		
TIME	0.245	0.544	0.471	0.494	0.609	-0.011	0.565	0.854	
TR	0.486	0.543	0.377	0.432	0.461	-0.111	0.561	0.441	0.819

approximately 25% of total variance of actual use. Satisfaction, trust, perceived risk, PU and PEOU explain roughly 49% of BIU. Perceived ease of use, trust and perceived risk explain 52.5% of total variance of perceived usefulness, trust explains only 1.2% of perceived risk. Price saving, time, PU and PEOU explain almost 45% of satisfaction, perceived ease of use explains nearly 14% of total variance of trust (R-square = 0.142).

Figure 2 demonstrates research model with results. Actual use is significantly affected by behavioral intention to use; trust, perceived usefulness have significant impact on BIU, while satisfaction and perceived risk do not significantly affect BIU. Satisfaction is significantly affected by time, perceived usefulness and perceived ease of use but price savings does not have significant effect on satisfaction. Perceived usefulness is significantly affected by trust and PEOU, yet is not significantly affected by perceived risk. Trust does not have significant effect over perceived risk.

Table 9 contains the information of dependent variable which is behavioral intention to use of e-commerce for this model. Regarding this construct, independent

Table 7 Structural model results

Hypothesis	Path	Standard deviation	T statistics	P values	Standardized path coefficient (β Coefficient)	Supported
H1	BIU- > AU	0.057	8.807	0.000	0.503	Yes
H2	PEOU- > BIU	0.088	0.767	0.443	-0.067	No
H3	PEOU- > PU	0.063	9.616	0.000	0.604	Yes
H4	PU- > BIU	0.084	5.999	0.000	0.504	Yes
H5	PEOU- > SAT	0.087	2.902	0.004	0.252	Yes
H6	PU- > SAT	0.103	2.156	0.032	0.223	Yes
H7	SAT- > BIU	0.092	0.833	0.405	0.076	No
H8	PR- > SAT	0.085	0.157	0.875	0.013	No
H9	TIME- > SAT	0.072	4.235	0.000	0.304	Yes
H10	RISK- > BIU	0.057	0.406	0.685	-0.023	No
H11	RISK- > PU	0.092	0.321	0.748	0.030	No
H12	PEOU- > TR	0.070	5.368	0.000	0.377	Yes
H13	TR- > BIU	0.081	3.587	0.000	0.290	Yes
H14	TR- > PU	0.070	3.369	0.001	0.237	Yes
H15	TR- > RISK	0.125	0.884	0.377	-0.111	No

Table 8 R-Square values

Construct	R-Square
Actual use	0.253
Behavioral intention to use	0.491
Perceived usefulness	0.525
Perceived risk	0.012
Satisfaction	0.449
Trust	0.142

variables, direct effects, indirect effects, total effects and p values are handled to make evaluation. PEOU, PU and trust significantly and indirectly affect behavioral intention to use. PU and trust have significant direct effect on behavioral intention to use e-commerce.

6 Conclusions

In this particular research, we created a model which consists of various constructs by using technology acceptance model to evaluate the factors affecting e-commerce usage of Generation Z that is becoming the potential market in following years.

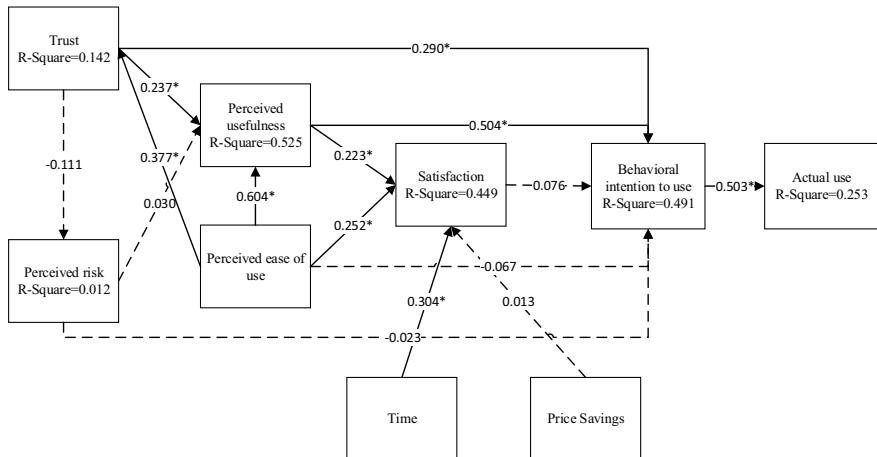


Fig. 2 Research model with results (*: $p < 0.05$, --: insignificant relationship)

Table 9 Direct, indirect and total effects on behavioral intention

Dependent variable	Independent variables	Direct effects	Indirect effects	Total effects	P values
Behavioral intention to use e-commerce	Perceived ease of use	-0.067*	0.491*	0.423*	0.000
	Price savings	-	0.001	0.001	0.930
	Perceived Usefulness	0.504*	0.017*	0.504*	0.000
	Perceived risk	-0.023	0.015	-0.008	0.915
	Satisfaction	0.076	-	0.076	0.405
	Time	-	0.023	0.023	0.505
	Trust	0.290*	0.124*	0.290*	0.000

*: $p < 0.05$

As we use the literature-based model, the items which measures the constructs, were obtained from the literature. Target group of this survey was Generation Z, who are generally students in Turkey. In the literature, there are studies about e-commerce with application of technology acceptance model. Also, there are studies of technology acceptance model and its variations which applied for similar topics such as webpage user intention and online transaction. Despite the related research, our study differs in terms of our constructs and our target group.

This study provides both theoretical and practical implications for e-commerce use, and it is going to be an important guide to understand behavior of Generation Z toward e-commerce and what affects positively or negatively this behavior. For the

future e-commerce companies that would like to enter Turkish market in following years, when Generation Z becomes the majority of the society, the results of this study will be a potential source for this purpose.

In this study, fifteen hypotheses were formed, nine of them were supported. Perceived ease of use, perceived usefulness and trust have significantly and indirectly affected behavioral intention to use. On the other hand, increasing customer satisfaction does not significantly impact behavioral intention to use. While perceived ease of use, perceived usefulness and time have affected satisfaction positively, price savings is not significantly affecting satisfaction contrary to general expectation. Perceived usefulness is the most significantly affecting behavioral intention to use. Therefore, the affected constructs over perceived usefulness need to be considered in detail. According to the result of analysis, trust and perceived ease of use affect the perceived usefulness of e-commerce positively. As a result, to increase actual use of e-commerce, behavioral intention must be increased. Increasing perceived ease of use, perceived usefulness and trust toward usage of e-commerce will have positive influences over people to prefer e-commerce than traditional commerce. When considering survey questions, it can be inferred that people are mostly care productivity and receiving various products or services online with ease. Also, it is proved that time saving increases customer satisfaction to e-commerce. Perceived usefulness has the most significant effect on behavioral intention to use, that means Generation Z cares much more receiving various options at the same time and increasing productivity of e-commerce brings. Also while trust has significant impact on perceived usefulness, perceived risk does not have significantly influence perceived usefulness. This shows that trust toward e-commerce will be more effective metric to take actions about it.

Even though there are several contributions, this study has some limitations which might be directions for future research. Firstly, our research is conducted in only Turkey and for Generation Z so the analysis might be different if the proposed model is tested in another country with a different culture and for different age groups. Secondly, about 49% of behavioral intention to use and 25% of actual use are explained through our model; therefore, additional constructs, that are related to e-commerce, can be taken into consideration in further studies. Lastly, this study did not incorporate demographic features as constructs in the model. Hence, factors such as gender, age, education level can be used in the proposed model as a future work.

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A Systematic Review of Mobile Payment Studies from the Lens of the UTAUT Model



Karrar Al-Saedi and Mostafa Al-Emran

Abstract While the use of Mobile payment (M-payment) systems has been well-perceived across several sectors, the factors affecting its adoption are still not apparent. Since the UTAUT is believed to provide a better understanding of the variance in the behavioral intention to use several technologies, this systematic review aims to analyze the M-payment studies from the lens of the UTAUT model. Out of 377 studies collected, a total of 25 research articles were synthesized and analyzed. The taxonomy of the analyzed studies was based on publication years, contexts, research methods, active countries, databases, factors and their types, participants, and research purposes. The main results pointed out that 48% of the analyzed studies were undertaken in the industrial sectors. Further, 80% of the analyzed studies have mainly relied on questionnaire surveys for data collection. Moreover, perceived risk and perceived trust were found to be the most dominant predictors of M-payment adoption. It is believed that the results of this systematic review will provide an inclusive source for conducting further research in M-payment.

Keywords Mobile payment · Adoption · Systematic review · UTAUT

1 Introduction

Nowadays, mobile technologies play a significant role in enabling users to access a vast amount of mobile applications from anywhere at any time [1–3]. One of such recent technologies is the M-payment that is being used for carrying out online transactions through the use of mobile technologies [4]. M-payment is defined as the service of financial activities that are usually performed using mobile phones [5]. The M-payment system works through the combination of the payment system

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and mobile technology, which both provide access to individuals to perform their transactions using mobile devices [6–8]. Further, M-payment is considered the core of mobile commerce, which includes several m-applications like m-payment, m-banking, money transfer, and digital/mobile wallet. These mobile-based services have replaced the traditional way of visiting banks and ATMs with M-payment that simplifies the process of online transactions at “anytime anywhere” settings [9, 10].

With the rapid growth of mobile phone users through internet subscriptions, advancement opportunities in mobile devices have added a potential value to the retail industry [11]. New shopping services have been enabled through the use of M-payment due to its various advantages such as flexibility, ubiquity, internet access availability, mobility, and information that can fulfill the needs and development processes in the retail industry [12]. The flexibility and ubiquity are the main advantages of M-payment services, which jointly together allow both merchants and customers to carry out their payment processes at “anytime anywhere” settings [13]. In contrast, there are several problems in the mobile development commerce that affect the M-payment adoption, such as limitations of M-terminals (low resolutions, limited power, and small screens), usage complexity in some functions, and the high price of M-services [14].

Furthermore, there are several factors that could affect the M-payment adoption. Those factors might be technological factors, social factors, or individual factors [15, 16]. At the same time, many information systems (IS) theories/models were developed in order to study the factors that affect the adoption of new technologies. Examples of such theories are the Technology Acceptance Model (TAM) that was developed by Davis [17], the Unified Theory of Acceptance and Use of Technology (UTAUT) model that was developed by Venkatesh et al. [18].

The original UTAUT model is considered the most widely used and validated model in empirical studies that aim to predict the adoption or acceptance of new technology [19–21]. In general, the UTAUT model has been used and extended successfully to study the adoption of many technologies and information systems. In the context of this study, the UTAUT model has been extensively used in the acceptance of E-commerce and M-commerce [22]. In comparing with the prior IS theories/models, Venkatesh et al. [18] pointed out that the UTAUT provides a better understanding of the variance in the behavioral intention to adopt a particular technology.

While a number of studies have been conducted to scrutinize the determinants affecting the M-payment adoption, there is a limited number of review studies that can provide a holistic view of this domain. One of such review studies is the one carried out by Shaikh and Karjaluoto [23] in order to review the M-banking adoption studies by examining the theories used in each study. Further, Dahlberg et al. [24] reviewed the M-payment studies by focusing on the reasons that hinder the research diversity in M-payment studies. As per the extant literature, there is a scarce of knowledge concerning what impacts the adoption of M-payment systems from the lens of the UTAUT model. Hence, this study aims to fill this gap by systematically

reviewing and analyzing the existing M-adoption studies that involve the UTAUT as the theoretical model. More specifically, the following research questions are put forward:

- Q1.** How are the analyzed studies distributed according to their year of publication?
- Q2.** What are the major contexts and research methods used in the analyzed studies?
- Q3.** What are the most active countries that undertake the M-payment adoption studies?
- Q4.** What are the most active databases that publish M-payment adoption studies?
- Q5.** What are the most frequent factors that extended the UTAUT model?
- Q6.** Who are the most frequent participants taking part in the data collection procedures?
- Q7.** What are the major research purposes of the M-payment adoption studies?

2 Methodology

A systematic review was carried out based on the analysis of several research articles that were collected from several databases (e.g., “ACM Digital Library”, “Emerald”, “IEEE”, “Sage”, “Springer”, “Wiley”, “Taylor & Francis”, “Science Direct”, and “Google Scholar”). This review study was undertaken based on the systematic review guidelines suggested by Kitchenham and Charters [25] and other relevant systematic reviews [26–28]. The following are the main steps involved in these guidelines.

2.1 Inclusion/Exclusion Criteria

To be selected in this systematic review, each study should satisfy the indicated conditions in Table 1. Otherwise, the studies which are not relevant to the provided criteria will be excluded from the final analysis.

Table 1 Inclusion/exclusion criteria

Inclusion criteria	Exclusion criteria
<ul style="list-style-type: none"> • Should involve M-payment as a primary condition • Should involve UTAUT as the theoretical model • Should include mobile devices while consumers are paying for goods or services. • Must be written in English language • Must be full-text articles 	<ul style="list-style-type: none"> • Studies that involve M-payment but without UTAUT model • Studies that involve UTAUT model but without M-payment • Studies that are written in languages other than English • Non-full text articles

Table 2 Search results across the databases

Online databases	Count
ACM digital library	17
Emerald	24
IEEE	32
SAGE	36
Springer	48
Taylor and francis	29
Wiley	38
Science direct	57
Google scholar	96
Total	377

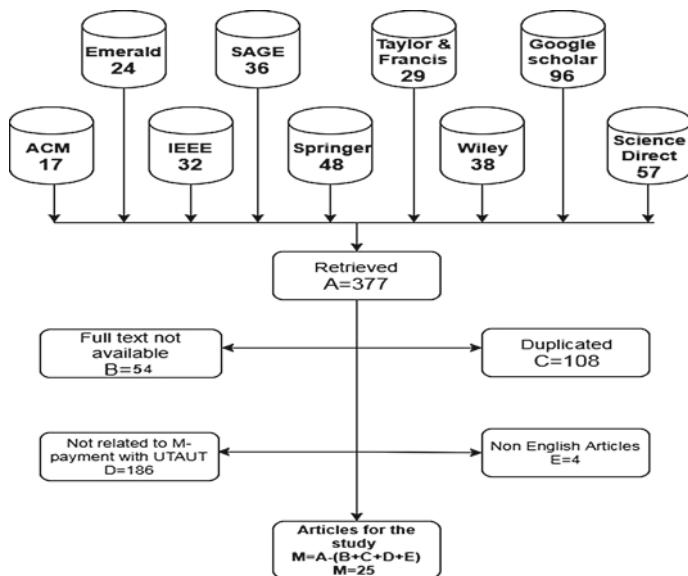
2.2 Data Sources and Search Strategies

The studies included in this systematic review were collected through an extensive search of the following electronic databases: ACM Digital Library, Emerald Insight, IEEE, SAGE, Springer, Wiley, Taylor & Francis, Science Direct, and Google Scholar. The process for articles search is differed from one database to the other depending on the used search tool. In this study, the AND operator was used to link all the various search terms in one string of search. The search terms involve the keywords (“Mobile payment” OR “M-payment”) AND (“Unified Theory of Acceptance and Use of Technology” OR “UTAUT”). The search for the collected studies was undertaken in February 2018. Our search results retrieved 377 articles using the previous search terms as presented in Table 2. 108 articles were found as duplicates, and they were removed from the final analysis.

As shown in Fig. 1, the articles have been filtered out by following the inclusion/exclusion criteria for each study. The filtration process found 108 articles as duplicates, 54 with non-full text, and 4 articles that were written in languages other than English. Besides, 186 articles were found beyond the scope of this study. In total, only 25 articles have met the specified criteria. More specifically, it covers all the articles that involve M-payment adoption along with the UTAUT as the theoretical model.

2.3 Quality Assessment

In addition to the inclusion and exclusion criteria, the quality assessment of the selected studies is considered as another important criterion that needs to be examined [29]. A quality assessment checklist that includes 8 criteria (as described in Table 3) was prepared to afford an evaluation means for assessing the articles that were retained for further analysis ($N = 25$). Each question was scored according to

**Fig. 1** Articles selection process**Table 3** Quality assessment checklist

#	Question
1	Are the research aims clearly specified?
2	Was the study designed to achieve these aims?
3	Are the variables considered by the study clearly specified?
4	Is the study context/discipline clearly specified?
5	Are the data collection methods adequately detailed?
6	Does the study explain the reliability/validity of the measures?
7	Are the statistical techniques used to analyze the data adequately described?
8	Does the study add to your knowledge or understanding?

the three-point scale, with “Yes” being worth 1, “No” being worth 0, and “Partially” being worth 0.5. The quality assessment results for the retained studies ($N = 25$) are demonstrated in Table 4. The results indicate that all the studies have passed the quality assessment, which in turn, reveals that all the studies are qualified to be used for further analysis.

Table 4 Quality assessment results

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Total	Percentage (%)
P1	1	1	1	1	1	1	0.5	1	7.5	93.75
P2	1	0.5	1	1	1	0.5	1	0.5	6.5	81.25
P3	1	1	1	1	1	1	1	1	8	100
P4	1	0.5	1	1	1	0.5	1	0.5	6.5	81.25
P5	1	0.5	1	1	1	0	0.5	0.5	5.5	68.75
P6	1	1	1	1	1	1	1	0.5	7.5	93.75
P7	1	1	1	1	1	1	1	0.5	7.5	93.75
P8	1	0.5	1	1	1	0.5	1	0.5	6.5	81.25
P9	1	1	1	1	1	0	0.5	0	5.5	68.75
P10	1	1	1	1	1	1	1	1	8	100
P11	1	0.5	1	1	1	1	0.5	0.5	6.5	81.25
P12	1	0.5	1	1	1	1	0.5	0.5	6.5	81.25
P13	1	0.5	1	1	1	0.5	0.5	0	5.5	68.75
P14	1	1	1	1	1	1	1	0.5	7.5	93.75
P15	1	1	1	1	1	1	1	0.5	7.5	93.75
P16	1	1	1	1	1	0.5	0.5	0.5	6.5	81.25
P17	1	0.5	1	1	1	0.5	1	0.5	6.5	81.25
P18	1	1	1	1	1	1	1	0	7	87.5
P19	1	1	1	1	1	0	0.5	0.5	6	75
P20	1	1	1	1	1	1	1	0.5	7.5	93.75
P21	1	1	1	1	1	0.5	0.5	0.5	6.5	81.25
P22	1	1	1	1	1	1	1	0.5	7.5	93.75
P23	1	1	1	1	1	1	0.5	1	7.5	93.75
P24	1	1	1	1	1	0.5	1	0.5	7	87.5
P25	1	0.5	1	1	1	1	1	0.5	7	87.5

2.4 Data Coding and Analysis

In this study, there are seven features related to the quality of the systematic review, and these features were coded as follows: (a) factors, (b) factors type (i.e., external factors, contextual factors, and factors from other theories), (c) context (i.e., higher education, higher education and industry, and industry), (d) method (i.e., survey, interviews, and mixed-method), (e) country, (f) databases, and (g) publication year.

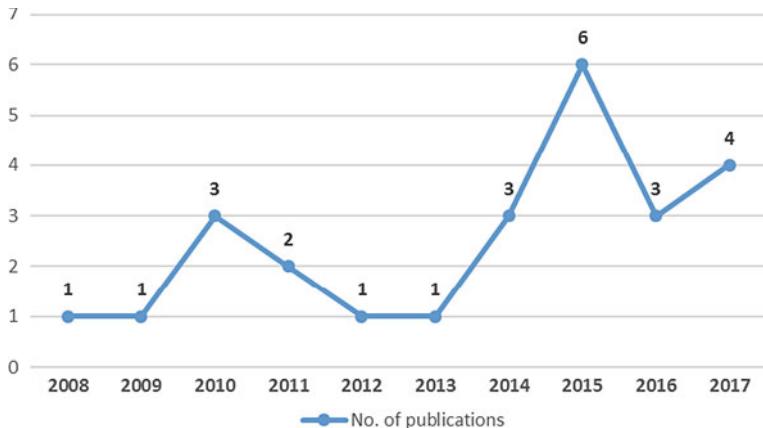


Fig. 2 Publications per year

3 Results

This section mainly relies on the analyzed studies that are demonstrated in Table 6. The answer to each research question is provided in the following sub-sections.

3.1 Distribution of Studies by Publication Year

Figure 2 shows the distribution of M-payment publications in terms of publication year. As we can notice, the studies are ranged from 2008 to 2017. It is evident that the highest number of publications is rapidly grown from 3 publications in 2014 to 6 in 2015. Moreover, there is a drop-down ratio to 3 publications in 2016, and this has been increased to 4 in 2017. To bear in mind, these results reflect only the number of M-payment publications that undertake the UTAUT as the theoretical model and not all M-payment studies.

3.2 Distribution of Studies by Context

Figure 3 shows the distribution of the analyzed studies according to their study context. It is obvious that 48% of the analyzed studies ($N = 12$) were conducted in the industrial sectors. This is followed by the studies that were carried out in the higher educational environments ($N = 9$), and those that were conducted in both (industry and higher education) ($N = 4$), respectively.

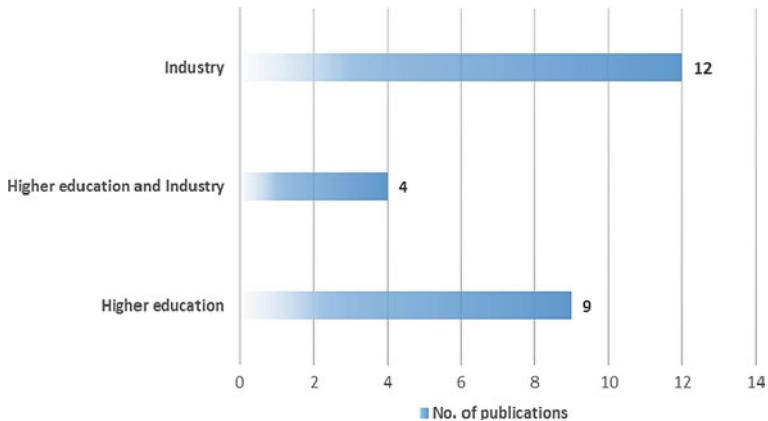


Fig. 3 Publications by context

3.3 Distribution of Studies by Research Methods

As we can notice from Fig. 4, there are three different research methods used to address the adoption of M-payment studies. Out of 25 analyzed studies, 20 articles (80%) have used the questionnaire survey as an essential method for data collection. This is followed by 4 studies that involved both (survey and interviews), and interviews ($N = 1$), respectively.

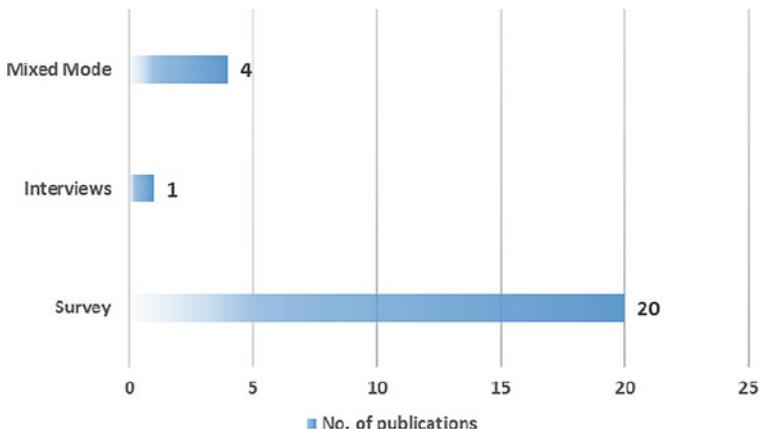


Fig. 4 Publications by research methods

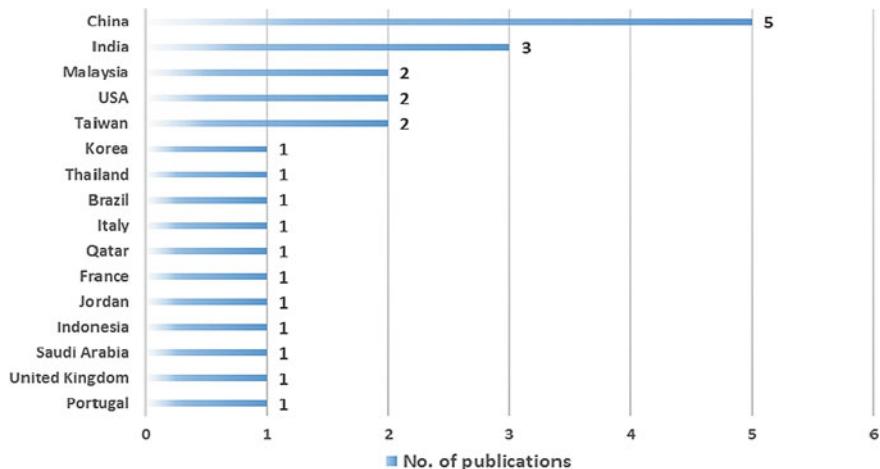


Fig. 5 Publications by country

3.4 Distribution of Studies by Country

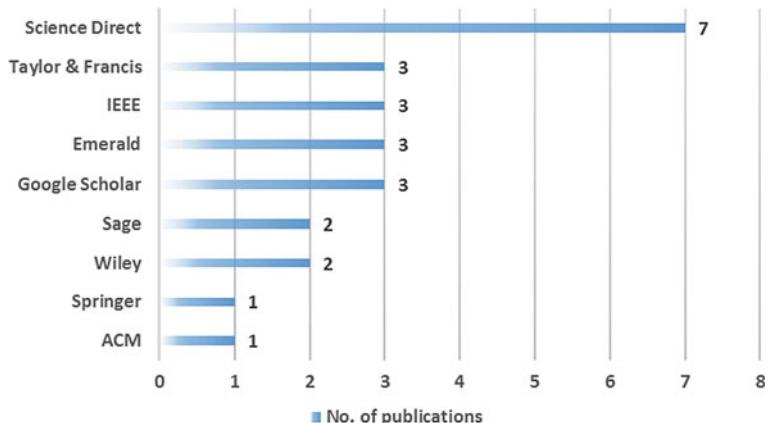
Figure 5 depicts the distribution of the M-payment studies in terms of country. This result shows that there are only 16 active countries in the M-payment domain among others. Among these countries, China is regarded as the most productive country in such type of studies ($N = 5$). This is followed by India with 3 studies; Malaysia, USA, and Taiwan with 2 studies each; Korea, Thailand, Brazil, Italy, Qatar, France, Jordan, Indonesia, Saudi Arabia, UK, and Portugal with 1 study each.

3.5 Distribution of Studies by Database

This section aims to determine the most active databases that publish M-payment studies involving the UTAUT model. Figure 6 shows the distribution of the analyzed studies in terms of databases. In fact, it is evident that Science Direct is considered the most productive database among the others with 7 published articles. This is followed by Taylor & Francis, IEEE, Emerald, and Google Scholar with 3 studies each; Sage and Wiley with 2 studies each; Springer and ACM with 1 study each.

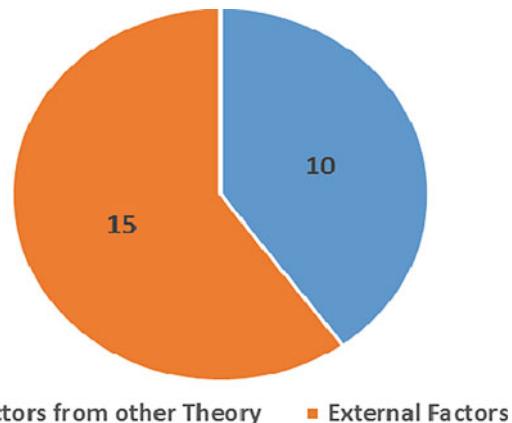
3.6 Distribution of Studies by Factors

Table 5 shows the most frequent factors that were used to extend the UTAUT model in order to examine the M-payment adoption. It is clearly demonstrated that perceived

**Fig. 6** Publications by database**Table 5** Most frequent factors in M-payment adoption studies

Factor	No.	Factor	No.
Perceived risk	9	Anxiety	1
Perceived trust	9	Arabic language support	1
Attitude	6	Awareness	1
Perceived cost	5	Compatibility	1
Perceived security	5	Contextual offering	1
Perceived usefulness	4	CyberLaw	1
Self-efficacy	4	Disturbance concerns	1
Hedonic	3	Experience	1
Perceived ease of use	3	Firm reputation	1
Usage	3	Focused attention	1
Adoption readiness	2	Hacking and fraud	1
knowledge	2	Monetary risk	1
Perceived regulatory support	2	Network externality	1
Personal innovativeness	2	Payment gateway	1
Privacy	2	Perceived control	1
Task characteristics	2	Perceived credibility	1
Task-technology fit	2	Perceived enjoyment	1
Technology characteristics	2	Perceived financial	1
Telecommunication infrastructure	2	Perceived transaction convenience	1
Utilitarian performance expectancy	2	Perceived transaction speed	1
Security risk	1	Perceived value	1
Structural assurances	1	Postal service	1
Usability	1	Promotional benefits	1

Fig. 7 Publications by factors type



risk and perceived trust are regarded as the most frequent factors ($N = 9$) that were used to extend the UTAUT to study M-payment adoption. This is followed by the attitude with 6 studies; perceived cost and perceived security with 5 studies each; perceived usefulness and self-efficacy with 4 studies each; hedonic, perceived ease of use, and usage with 3 studies each.

3.7 Distribution of Studies by Factors' Type

According to the previous systematic reviews [29, 30], the collected studies were analyzed based on the factors' type used (i.e., external factors, contextual factors, factors from other theories). Based on that, the present study has analyzed the collected studies according to the factor type used in each study as shown in Fig. 7. It is evident that 60% of the analyzed studies have extended the UTAUT with external factors for examining the M-payment adoption. This is followed by studies (40%) that extended the UTAUT with factors from other theories.

3.8 Distribution of Studies by Participants

The participants in the analyzed studies were varied from one study to the other depending on the context where the study was conducted. As shown in Table 6, different participants were involved in the data collection process, such as students, individuals, mobile telecom customers, mobile users, citizens, among many others. Overall, students represent the largest number of participants among the others in the analyzed studies.

Table 6 Analysis of M-payment adoption studies based on the UTAUT model

Source	Factors	Factors' type	Context	Method	Research purpose	Country	Participants	Database	Results
[31]	“Technology characteristics, task characteristics, task-technology fit, trust, firm reputation, structural assurances, and personal propensity to trust”	Factors from other theories	Higher education	Survey	To understand the factors that influence the M-banking adoption	Portugal	University students (N = 194)	Science direct	Facilitating conditions and behavioral intentions have directly influence M-banking adoption. Trust, Performance expectancy, technology characteristics and task characteristics fit have a total effect on behavioral intention
[32]	“Technology characteristics, task characteristics, and task-technology fit”	Higher education and Industry			To understand the impact of technological factors on M-payment adoption	China	University students and telecoms service halls customers (N = 265)		Task-technology fit has a significant effect on user adoption. Task-technology fit has a significant effect on performance expectancy

(continued)

Table 6 (continued)

Source	Factors	Factors' type	Context	Method	Research purpose	Country	Participants	Database	Results
[33]	“Perceived credibility, perceived financial cost, and perceived self-efficacy”	External Factors	Industry		To understand the factors that influence the M-banking adoption	Taiwan	Shopping mall individuals (N = 441)	Google Scholar	M-banking is significantly influenced by perceived financial cost, and perceived credibility
[34]	“Innovativeness, perceived risk, and trust”	Higher education			To explore the factors that affect the non-users’ intentions to adopt remote M-payment	United Kingdom	University Students and staff (N = 268)	Wiley	Innovativeness, and perceived risk are significantly influencing the non-users’ intentions to adopt remote M-payment

(continued)

Table 6 (continued)

Source	Factors	Factors' type	Context	Method	Research purpose	Country	Participants	Database	Results
[9]	Design and Language factors (“usability and Arabic language support”), user related-factors (“trust and awareness”), Organizational related-factors (“telecommunication infrastructure, postal service, readiness, cyber-law, telecom, charges, and payment gateway”), System related-factors (“security, hacking & fraud, usefulness, and privacy”)	Higher education and industry	Semi-Structured Interviews	To investigate the factors that make the mobile subscribers reluctant, and which factors make them keen to accept M-transaction	Saudi Arabia	Individuals from (universities, companies, schools, internet, and cafes)			All the studied factors have a significant influence on M-transaction acceptance in Saudi Arabia

(continued)

Table 6 (continued)

Source	Factors	Factors' type	Context	Method	Research purpose	Country	Participants	Database	Results
[35]	“Perceived risk and perceived cost”	External Factors	Banking	Survey	To study the adoption of NFC M-payment	Indonesia	Bank and un-bank users	ACM	For bank users, perceived risk and cost explained 67% of the variance of Behavioral Intention. For un-bank users, perceived risk and cost explained 61.7% of the variance of behavioral intention
[11]	“Utilitarian performance expectancy, hedonic performance expectancy, and attitude”	Industry	Survey	To examine critical determinants of US consumers’ intentions to use mobile shopping services	USA	Mobile services users (N = 400)	Emerald	Utilitarian and hedonic performance expectancy are critical determinants of US consumers’ intention to use mobile shopping services	(continued)

Table 6 (continued)

Source	Factors	Factors' type	Context	Method	Research purpose	Country	Participants	Database	Results
[36]	“Perceived risk and cost”	Higher education	Mixed method (Survey and interviews)	To investigate the determinants of M-payment acceptance	China	Students (N = 186)	IEEE	Perceived cost and perceived risks are considered as barriers to M-payment adoption	
[37]	“Trust and network externality”	Higher education	Mixed method (Survey and interviews)	To provide a better understanding of the factors influencing M-payment acceptance	Jordan	Jordanian citizens (N = 253)	Springer	Network externality was found as the most influential driver of M-payment acceptance	
[38]	“Perceived control and focused attention”	Industry	Survey	To understand the factors that affect the users' continuance intention to adopt M-payment	China	Apple pay service users (N = 200)	Taylor and Francis	Results indicated that perceived control and focused attention have a significant effect on users' continuance intention to adopt M-payment	(continued)

Table 6 (continued)

Source	Factors	Factors' type	Context	Method	Research purpose	Country	Participants	Database	Results
[21]	“Perceived enjoyment, knowledge, perceived ease of use, perceived usefulness, perceived risk, and usage”	Factors from other theories	Industry	Survey	To study the factors that affect the M-payment adoption	France	Young people (N = 316)		Perceived enjoyment has a significant effect on perceived ease of use and usefulness, whereas social influence reduces the perceived risk
[14]	“Contextual offering, usage intention, and actual usage”	Higher education and industry			To examine the factors that affect the M-commerce adoption	China	Higher education, M-service halls, Unicorn service halls, and telecom service halls (N = 250)	IEEE	The contextual offering has a positive impact on usage intention, whereas usage intention itself affects the actual usage
[39]	“Perceived information security”	External Factors	Higher education		To examine the factors that influence the customers’ intention to adopt M-payment	Qatar	Students and teachers (N = 169)	Google Scholar	Perceived information security has a significant effect on consumers’ behavioral intention to adopt M-payment

(continued)

Table 6 (continued)

Source	Factors	Factors' type	Context	Method	Research purpose	Country	Participants	Database	Results
[40]	“Perceived transaction, convenience, and perceived transaction speed”	Factors from other theories		To examine the effects of both perceived transaction convenience and perceived transaction speed on M-payment adoption	Malaysia Students (N = 194)	Emerald	Results found that both perceived transaction convenience and perceived transaction speed have no influence on M-payment adoption		
[41]	Disturbance concerns (“security and privacy”)	External Factors		To study the factors that affect the M-commerce acceptance	China Students (N = 156)	IEEE	Results showed that disturbance concerns have negatively affected the M-commerce adoption		(continued)

Table 6 (continued)

Source	Factors	Factors' type	Context	Method	Research purpose	Country	Participants	Database	Results
[40]	“Trust, perceived financial cost, and experience”	Higher education	Survey	To investigate the antecedents that affect the users’ intention to adopt M-payment services	Malaysia	Students (N = 319)	Google Scholar	Trust has a significant effect on the intention to adopt M-payment. Experience has a moderating effect on the relationship between PE and intention	
[42]	“Attitude towards mobile services, compatibility, usefulness, ease of use, and security”	Factors from other theories	Industry	To examine the users’ acceptance and usage of M-payment	Italy	Public transportation passengers (N = 439)	Science direct	Results showed that the intention to use M-payment is affected by the usefulness, ease of use, and security	

(continued)

Table 6 (continued)

Source	Factors	Factors' type	Context	Method	Research purpose	Country	Participants	Database	Results
[43]	“Perceived risk and perceived cost”	External factors		To evaluate the intention of adopting future M-payment services	Brazil	Mobile consumers of a telecom company (N = 605)			The behavioral intention to adopt M-payment services was affected by perceived risk. However, the perceived cost was found not to affect that intention
[44]	“Anxiety and attitude towards use”	Factors from other theories		To explore the factors that affect the consumers’ acceptance of M-payment with the built-in NFC service	Taiwan	NFC mobile phone users (N = 189)	Taylor and Francis		Anxiety has a negative effect on M-payment adoption. Attitude towards use has a significant impact on the behavioral intention to use

(continued)

Table 6 (continued)

Source	Factors	Factors' type	Context	Method	Research purpose	Country	Participants	Database	Results
[45]	“Security, self-efficacy, and hedonic”	External Factors			To determine the factors that affect the M-banking adoption	Thailand	M-banking users (N = 480)	Science Direct	The hedonic motivation of M-banking users was identified as the most essential factor for motivating customers to adopt M-banking, while M-banking system security has a negative relationship with hedonic motivation

(continued)

Table 6 (continued)

Source	Factors	Factors' type	Context	Method	Research purpose	Country	Participants	Database	Results
[46]	“Perceived value, perceived risk, perceived trust, perceived regulatory support, and promotional benefits”	Higher education and Industry	To understand the factors that affect the consumers’ adoption of the mobile wallet	India	Students and professionals (N = 210)	Emerald	Perceived risk, perceived value, perceived regulatory support, and promotional benefits were found to be significant factors in predicting the behavioral intention to adopt M-wallet		
[47]	“Adoption readiness, personal innovativeness, perceived risk, security risk, privacy risk, and monetary risk”	Factors from other theories	Industry	Mixed method (Survey and interviews)	To examine the factors that affect the usage intention for M-payment	Graduates from different parts of India (N = 774)	Sage	This study confirms that adoption readiness is a critical factor for the behavioral intention to use M-payment	(continued)

Table 6 (continued)

Source	Factors	Factors' type	Context	Method	Research purpose	Country	Participants	Database	Results
[48]	“Security, risk, trust, hedonic performance expectancy, unitarian performance expectancy, self-efficacy, and attitude”		Survey	To provide an integrated model that examines the determinants of (NFC) based M-payment	USA	Restaurant customers (N = 412)	Science Direct	Results revealed that risk, security, and trust have a positive impact on customers' intention to use M-payment	
[49]	“Perceived usefulness, perceived ease of use, perceived security, trust, self-efficacy, and attitude”.	External Factors	Higher education	Mixed method (Survey and interviews)	To understand the consumers' acceptance of M-payment	Korea	Students (N = 326)	Sage	Perceived ease of use is the key antecedent to users' attitude, whereas users' attitude of intentions is influenced by perceived security and trust
[50]	“Attitude and perceived risk”	Factors from other theories	Industry	Survey	To investigate mobile service (M-payment) adoption	India	Individuals (N = 959)	Sage	Perceived risk was negatively related to the behavioral intention to use M-payment

3.9 *Distribution of Studies by Research Purpose*

Since this study sheds the light on the M-payment adoption, most of the analyzed studies share the same purpose. In that, the analyzed studies aim to provide a better understanding of the factors influencing M-payment adoption or acceptance and to discover the effects of the potential factors that were used to extend the UTAUT model.

4 Discussion

According to the literature, a study conducted by Shaikh and Karjaluoto [23] has reviewed and analyzed the M-banking adoption studies with regard to the theories used in such studies. This study was limited to determine the theories that were adopted to study the adoption of M-banking studies only without any further investigation. Besides, another review study conducted by Dahlberg et al. [24] has reviewed the M-payment studies with more focus on the reasons that hinder the research diversity in M-payment studies. However, these studies were limited to the purpose mentioned above and didn't provide an insight into the main research methods used, research purposes, contexts, countries, participants, most frequent factors, factors' type, databases, and publication years. In addition, to the best of our knowledge, the literature neglects to review the M-payment studies that involve the UTAUT as the primary theoretical model. Accordingly, the present study was dedicated to fill this gap.

With regard to the research questions of this study, our systematic review triggered out the following results. First, it is obvious that there is an increasing number of M-payment adoption studies since 2015. It is expected that this number will be increased in the future as this research field is still new, and it requires further examination. Second, 48% of the analyzed studies were conducted in the industrial sectors, and this is followed by those that were carried out in the higher education environments. This indicates that more research is required to be conducted in the higher educational institutions in order to examine the students' adoption of M-payment.

Third, 80% of the analyzed studies mainly relied on questionnaire surveys for data collection. This is a strong indicator that surveys are the most appropriate methods for data collection in such kind of studies. In addition, questionnaire surveys are regarded as the suitable methods for determining the relationships among the variables in the conceptual model [51]. Fourth, China was regarded as the most productive country in conducting M-payment adoption studies. This is followed by India, Malaysia, USA, and Taiwan. According to Fig. 5, there is a few number of M-payment adoption studies in the western and middle east countries. Further research is required to examine this issue. Fifth, Science Direct is considered the most productive database among others in publishing M-payment adoption articles. In that, scholars who intend

to collect M-payment adoption studies should first target the Science Direct database and then move gradually to the others.

Sixth, concerning the most frequent external factors to the UTAUT, which were studied to examine the M-payment adoption, our analyses revealed that perceived risk and perceived trust are regarded as the most frequent factors ($N = 9$) that were used to extend the UTAUT. This is followed by attitude, perceived cost, and perceived security. Further research is required to examine the impact of other factors that may have an influence on the M-payment adoption. Seventh, 60% of the analyzed studies have extended the UTAUT with external factors for examining the M-payment adoption while the rest represent the studies that extended the UTAUT with factors from other theories. Eighth, with regard to participants, students represent the largest number of participants among the others. Ninth, it has been noticed that the research purpose of all the analyzed studies was to study the factors that affect the M-payment adoption. This result indicates that the M-payment adoption is still an open venue for IS scholars, and the factors that affect its adoption are still not apparent and need further examination.

5 Conclusion

Many IS theories/models were developed in order to study the adoption of a specific new technology. One of such models is the UTAUT that was developed by Venkatesh et al. [18]. In this study, we carried out a systematic review by analyzing all the M-payment adoption studies that involve the UTAUT as the theoretical model. The total number of the collected studies was 377. After applying the inclusion and exclusion criteria, only 25 studies were found to fulfill those criteria. The analyzed studies were categorized in terms of the most frequent factors, factors type (i.e., external factors, contextual factors, and factors from other theories), context, method, country, databases, and publication year. This review study provides the following seven findings. First, 48% of the analyzed studies were conducted in the industrial sectors. Second, 80% of the analysed studies mainly relied on questionnaire surveys for data collection. Third, China was regarded as the most productive country in conducting M-payment adoption studies. Fourth, Science Direct is considered the most productive database among the others in publishing M-payment adoption articles. Fifth, our results revealed that perceived risk and perceived trust are regarded as the most frequent factors that were used to extend the UTAUT to study M-payment adoption. Sixth, 60% of the analyzed studies have extended the UTAUT with external factors for examining the M-payment adoption. Seventh, it has been noticed that the primary research purpose of all the analysed studies was to study the factors that affect the M-payment adoption.

In conclusion, this study provides a comprehensive overview of the existing M-payment adoption studies that involved the UTAUT as the theoretical model. Moreover, this study can assist supplement linkages with prior studies and form an essential source for future research in the M-payment context.

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Conceptualizing a Framework for Understanding the Impact of Dynamic Accounting Information Systems on the Business Processes Capabilities



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Abstract Organizations operating in the current unpredictable and turbulent business environment are at risk of having their activities disrupted. As a result, an understanding of how organizations can manage disruptions in their daily activities by adopting technology innovations, such as dynamic AIS, has become an important subject for both academics and practitioners. Hence, for the survival and growth of many organizations in today's business environment, creative and innovative use of IT/IS is essential. In effect, AIS as the main part of an information system is a tool organization can use to survive and succeed in turbulent environments. This study proposed a conceptual framework that relies on resource-based theory (RBT) and dynamic capabilities view (DCV) to evaluate the impact of dynamic AIS capability on business process capabilities. The outcomes of this study have important strategic consequences in today's volatile market climate and substantial value for organizations and practitioners.

Keywords Accounting information systems · Business processes capabilities · Resource-Based theory · Dynamic accounting information systems

1 Introduction

In today's turbulent environment, crises are inevitable, yet, there are striking differences in how organizations cope with problems or disruptions [1]. As such, much investments are being made in information systems (IS) with the belief that IS is essential to an organization's competitive survival [2, 3]. Considering accounting

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information systems (AIS) as the primary information system of organizations, this study investigates the organizational competencies that create dynamic AIS capability. Organizations must invest in improving their capabilities to survive in a dynamic business environment [4].

Many organizations rely on IT systems to improve effectiveness, reduced business process-related cost, increase business data accuracy, and improve crisis management processes [5]. All organizations face different types of risks in both day-to-day operations and long-term management [6]. Organizations are responsible for identifying ways of reducing risks and their impacts on the organization; hence, they ought to design and implement strategies for reducing the risks that could have a significant impact on the financial performance of the organization [7]. The nature of AIS and its capabilities is defined to achieve a common understanding of its concepts. Among the most widely known AIS in business, organizations are enterprise resource planning (ERP) and business intelligence (BI) as a complementary system [8].

AIS enables smooth processing of transactions and the generation of standardized reports and information that aids in decision-making [9]. However, decision-making processes in a turbulent and dynamic environment require different levels of accounting information on an ad hoc basis [10]. The existence of specific dynamic capabilities in AIS, such as flexibility, a technology-driven process, such as BI system, and technical HR competencies for data analysis and presentation of actionable information helps in making informed business decisions.

A significant amount of IS research has focused on either IT investment, IT adoption, and use or IT capability [11–13]. However, very few publications are available in the literature that addresses dynamic IS capabilities in general and dynamic AIS especially on the organization's performance in business processes capabilities context. Furthermore, AIS is not a component by IT only but also deals with procedures and structures, internal control, and processes and people to manage the information effectively [14]. According to Devaraj and Kohli [15], the actual use of these systems is important, and the lack of connection between IT/IS and organization performance is important [3]. Two of the most important areas showing the successful use of AIS and its effects on organization performance are decision-making and business processes capabilities [16]. Therefore, this study investigates the relationship between dynamic AIS capability and business-process capabilities to explore the strategic role of dynamic AIS capability relying on the extended resource-based theory (RBT) and dynamic capabilities view (DCV).

The remainder of this chapter is progressing as follows. In the next section, we highlight the concept of AIS. Then, the dynamic AIS is presented in Sect. 3. conceptual model development and hypotheses are presented in Sect. 4. Section 5 discusses the research contributions to theory and practice and concludes the research.

2 Accounting Information System Concept

The AIS appears to be a logical intersection between the accounting field and the information systems field [17]. From an IT perspective, MIS Quarterly has defined the ERP/AIS resource as “commercial software systems that automate and integrate many or most of a firm’s BP” [18]. An AIS is defined as the system which intends to collect, record and store data processing system to produce information for decision-makers [19]. From other perspectives, AIS stands at the crossroads of two disciplines: “accounting” and “information systems”. Thus, the investigation of AIS is regularly seen as the investigation of computerized accounting systems [20]. Simkin et al. [20] explain: “An AIS is a collection of data and processing procedures that creates needed information for its users.”

Most large organizations use AIS to collect, process, and store data about their business processes. AIS field, just like the Information Systems (IS) field, the IS resources are considered to be a source of competitive advantage and organizational performance [2]. Generally, AIS comprises the processes, procedures, and comprehensive knowledge base of the accounting data-capturing systems from business processes, record the acquired accounting data in the appropriate records, process the detailed accounting data by classifying, summarizing, and consolidating, as well as reporting the summarized accounting data to the external and internal [7].

AIS can naturally provide opportunities for businesses to improve efficiency and effectiveness in decision making to enable organizations to achieve their competitive advantage [21]. Therefore, AISs are considered a vital resource for today’s organizations as it can facilitate effective planning and control of organizational activities [22].

For this study, we depend on the definition of AIS by [23]; AIS is the system that studies the structure, planning, operation, and control of processes to provide the needed information for effective decision-making to the external and internal stakeholders, as well as providing the necessary conditions for quality decision-making; the system also ensures no assets leaves the organization illegitimately.

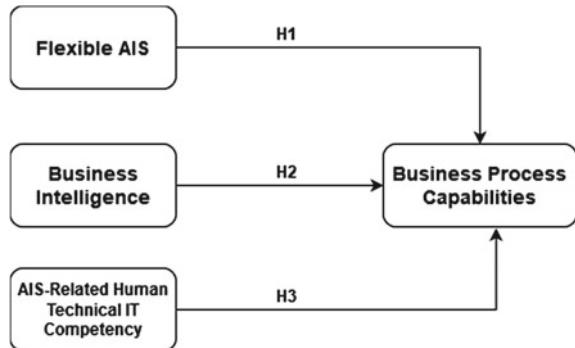
3 Dynamic Accounting Information System

A dynamic capability is the ability of an organization to integrate, build, and configure internal and external competencies to address rapidly changing environments [24]. There are a variety of AIS capabilities acknowledged in the literature, but the focus of this study will be on dynamic AIS capability in the important business functional area of AIS. Such areas would be in the business process (i.e. processing transactions, managing the control environment, and presenting accounting information for decision making), whilst the capabilities involved would be the flexible AIS (i.e. IT infrastructure), a BI system (i.e. software used to process data), and AIS-related human technical IT competency (i.e. the people who use the system).

Building a dynamic AIS capability is vital as a result of the dynamic and turbulent nature of today's business atmosphere [25]. For this study, dynamic AIS is an organization's ability to integrate, build, and reconfigure its competencies to reorganize swiftly the accounting activities and processes in the different business processes [25]. This definition was adopted for two reasons: firstly, highlighting the importance of dynamic capabilities would be consistent with previous researches on IS strategy [25], and secondly, dynamic AIS capability has not been considered in the OR of IT-organization performance research despite their strategic value. Thus, a dynamic AIS capability could be achieved from the synergism between AIS and the related organization competencies, such as BI and AIS-related human technical IT competency. This synergy facilitates the optimal use of both BI and AIS systems. The other benefits of this synergy include [26]: allowing real-time corporate cash flow control; facilitating inter-departmental cooperation; improving customer relationships through sales of in-depth data mining; promotes information sharing with the sales department; allows better decisions based on the macro view of the business; reducing the required time to generate regular reports; improving profitability via forecasting business trends and transaction data analysis.

4 Conceptual Model Development and Hypotheses

This study uses Resource-based theory (RBT) as a lens for understanding how competitive advantage is created and the conditions for sustaining over time [27, 28] whereas the dynamic capabilities view has been used to propose how organizational competencies contribute to a dynamic AIS capability. The dynamic capabilities theory (DCT) is widely paradigm in which used to explain variance in performance across competing organizations [29]. With its roots in resource-based theory, DCT debated that superior organization performance result in from two paradigms of organizational capabilities, namely, dynamic capability and operational capability [30]. The literature of management strategy distinguish between dynamic capability and operational capability [31]. Operational capability refers to an organization's ability to execute and coordinate the various tasks required to perform operational activities, such as accounting functions and activities in sales and marketing, production, distribution logistics [31]. Based on RBT, business processes capabilities as a type of operation capability refers to the competence of an organization to create market value in a unique way to utilize resources [32]. Dynamic capability is considered as fundamental in identifying competitive advantage under environmental volatility [33]. Dynamic capability refers to an organization's ability to integrate, build, and reconfigure internal and external competencies to adapt to changing environments [24]. Thus, a dynamic AIS capability may be a product of the synergism between AIS and related organization competencies. Hence, we proposed that the synergy

Fig. 1 Conceptual model

between the flexible AIS, a BI system, and AIS-related human technical IT competency co-create the dynamic AIS capability. We also proposed that this dynamic AIS capability will improve the business processes capabilities in highly dynamic environments (Fig. 1).

4.1 Flexible AIS and Business Processes Capabilities

Business process capabilities (BPC) consist of an organization's capacity to conduct various business tasks and spanning processes [34]. Others researchers have defined BPC as the ability of the organization to identify, utilize, and assimilate information to facilitate the entire BP activities [35]. For the purpose of this paper, business process capabilities describe an organization's competence to create market value in a unique way to utilize resources; three-categories have been prosed by researchers to classify business process capabilities; outside-in, inside-out and spanning capability [36]. In general, there is evidence that IT-based AIS that are used to streamline processes and automation can speed up transaction processes by substituting labour, thereby increasing operation volumes [37]. The accounting system is designed to improve information and transaction processing to support decision-making [9]. Organizations operate in a competitive environment, hence, IT resources are the major process enablers that manage the business processes [38]. Thus, the possibilities to gain a contribution from IT depends on the existence fitness of other resources within various business processes [39].

In this study, it is proposed that dynamic AIS capability has a direct impact on the accounting process capabilities. The major ways through which AIS can help organizations to achieve this are: (i) through monitoring of BP to support continuous improvement and daily operations [40], (ii) enabling organizations to use new ways of data analysis, capturing, storage, and management [41], (iii) improving the visibility of BP of which degree depends on the level of the accessible information's trustworthiness, timeliness, and relevance [42], and (iv) enabling quick BP activities and innovation (agility) [43].

Many organizational leaders and strategy researchers have shown increasing interest on the role of IT and its impact on financial performance, strategy formulation, and strategy implementation [44]. The resource-based “strategic necessity hypothesis” suggests that organizations can gain sustained competitive advantage from IT by leveraging complementary human [39], and developing capabilities that are valuable, rare, inimitable, and non-substitutable from their internal resources [45]. As per [24], process management is a source of competitive advantage that can be sustained over longer periods. In the same vein, [46] argued that: “resources are not valuable in and of themselves, but are valuable as they allow organizations to perform their activities; hence, BPs are the source of competitive advantage.” Thus, we proposed the following hypothesis:

H1: Flexible accounting information system has a positive impact on business process capabilities.

4.2 Business Intelligence and Business Processes Capabilities

Business intelligence (BI) systems are the available strategic information systems to an organization that is deployed to improve decision-making processes and gain competitive advantage [47]. Achieving these advantages requires a BI system to be effectively integrated into the operational and management processes [48]. IT infrastructure refers to all forms of communication technologies and computers, as well as the shared applications and the databases available to an organization [39]. BI systems, as an aspect of dynamic AIS capability, is considered an analytical instrument that facilitates automated decision-making through dependence on mathematical and statistical analysis, as well as on huge-database analysis and artificial intelligence [49]. BI can be embedded in enterprise systems, such as AIS, to gain an organizational competitive advantage [50]. Typically, BI systems associate with ERP systems that incorporate AIS as a module [48].

In this study, it is argued that BI helps organizations by supporting business processes that offer competitive advantage [51]; that is, a BI system can be complementary to the analytical capability of AIS. In this context, a BI system serves as an aspect of a dynamic AIS capability by offering analytical capabilities to AIS and serving as the AIS control agent [25]. Organizations can also rely on BI for predicting changes in product demand and respond rapidly via the launching of a competing product; BI can also aid in performance improvement and organization adaptation to change [52]. Furthermore, the reviewed literature consistently supports the notion of an IT-based system having a positive impact on the agile capabilities of processes [53, 54]. Therefore, the performance impact of BI can be viewed on the improvement of the efficiency and effectiveness of business processes capabilities and better competitive advantage [55]. Hence, we proposed the following hypothesis:

H2: Business intelligence systems have a positive impact on business process capabilities.

4.3 AIS-Related Human Technical IT Competency and Business Process Capabilities

The human technical IT competency includes the technical and managerial abilities [56]. In this way, IS scholars realize the importance of AIS-related human IT contribution to the flexibility of an organization's IT infrastructure [57]. IT human competencies, as part of dynamic AIS capability, can provide the unique synergy between IT infrastructure and systems and the business processes managed by these systems [25], and align IT and business strategies [58]. Thus, increasing IT human competencies is important to develop a flexible IT infrastructure that will be capable of quick adaptation to change [39] and improve organizational performance [52]. Strong IT human competencies can effectively integrate AIS and business processes; develop cost-effective and more reliable applications; efficiently integrate and communicate with business units; and perform proactively to innovate business ideas and technological infrastructures for business value development [39].

Being that the outside-in capability covers the ability of the organization to anticipate market demands, sense external competitors, create long-term relationships with stakeholders, and respond rapidly to market changes, it implies that IT transforms data into real-time information that can provide insights into business process activities [59]. Hence, organizations rely more on their IT resources to predict market trends, reduce operational risks, and improve their agility [60]. Various researchers have argued that organizations must have a flexible IT infrastructure that is applicable in both external and internal operations for quick and coordinated responses to the market if they must reap the benefits of IT in their business processes [61].

Additionally, researchers have argued that IT-based systems (such as AIS) are significant enablers of process management capability due to their ability to minimize process variability, improve process quality, and enhance process output [62]. AIS capabilities are also a key advantage in improving the visibility of information and process throughout functional borders and hierarchical levels [63]. Dynamic AIS mainly functions to drive improvements in the organization's BP capabilities [64]. ERP, as an accounting system, has been confirmed as a significant enabler of BPs capability as it can minimize process variability, improve process quality, boost process output, and reduce BP complexity [65]. According to [66], IS affects competitiveness by prompting the organization to deliver a quicker response to change. Moreover, previous studies that adopted the RBT found that business process performance is dependent on IS capabilities. Based on these previous studies, we proposed the following hypothesis as shown in the research model:

H3: Human technical IT competency has a positive impact on business process capabilities.

5 Discussion and Conclusion

In conclusion, the study findings have important strategic consequences in today's volatile market climate and substantial value for organizations. Relying on the extended RBT and DCV, this study focusses and seeks to conceptualize the effects of dynamic AIS capability on business process capabilities, as the main objective. Accordingly, the main purpose of this study was to investigate the influence of dynamic AIS capability on organizations' performance in business processes capabilities context. By proposing a conceptual framework to establish the link between dynamic AIS capability and superior firm performance in business processes capabilities context, the study serves to inform managers that organizations should do much more than just invest in IT. The developed conceptual framework is strengthened by three dimensions of dynamic AIS capability which are flexible AIS; business intelligence and AIS-related human technical IT competency. Accordingly, three hypotheses were developed to show the relationship between dynamic AIS capability and business process capabilities.

Managers will recognize specific ways of developing IT capability in their organizations. This research, based on theoretical arguments and realistic examples, has shown why developing such a capability is complex and takes time and effort. Nevertheless, there is little guidance for business managers to build dynamic AIS capability, though more recently an increasing number of studies have begun to address this problem. For example, Prasad and Green [25] Identify three AIS capabilities—flexible AIS, a BI system, and the AIS-related human technical competency—as the primary core activities that need to be effectively managed for overall dynamic AIS capability. For researchers, this study serves as a useful framework for identifying the pathway of effect from IT-enabled resources to organization performance in business processes capabilities context.

Technology innovations, such as dynamic AIS, is one of the capabilities that help organizations in building resilience to disruption. Relying on the dynamic capabilities' framework, we suggest that dynamic AIS capability can be established by a flexible AIS, BI complementary, and related competencies. Hence, BI systems, as components of dynamic AIS, are considered great opportunities for organizations to reduce risks and improve profitability [67], as well as provide the needed analytical skills to process information in the required manner [25]. Organizations can rely on a flexible AIS to update their AIS applications for a swift response to changes in real-world activities [25]. Learning is a major component of any dynamic capability [68]; hence, AIS-related human resource capability can also encourage this learning in a dynamic AIS capability [25] and maintain the dynamic nature of AIS capability [16]. This implies that the human IT competency of the accounting experts will be needed for maintaining the existing and newly identified synergies between competencies and AIS resources [25].

The use of AIS in business is essential today because it is difficult to gain and sustain competitive advantage without the adoption and implementation of certain

technological tools (i.e. business intelligence as a component of dynamic AIS capability). Therefore, it is necessary that organizations pay attention to changes in technology within their business environments, especially regarding the use of AIS. This paper has some limitations with regard measurements and analysis as no empirical data were collected to verify outcomes. On the contrary, future researchers are recommended to use empirical study to examine the effects of dynamic AIS capability on business process capabilities.

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A Review of Learning Analytics Studies



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Abstract Learning analytics has emerged as a new domain for identifying students' behaviors, academic performance, academic achievement, and other related learning issues. Given its paramount importance and recency, several review studies were conducted. However, the previous reviews have mainly focused on the behavioral, affective, cognitive, and metacognitive patterns of learning. It has been observed that the existing reviews neglected to review the learning analytics studies from the lenses of their categories. Therefore, this review sheds the light on analyzing 19 articles published on learning analytics by classifying them into five different categories, including prediction model, learning theory, designed framework, applications, and data-driven decision-making. Under each category, we present a summary of the respective research, its purpose, which dataset was used, how it was sourced, its algorithms, results, and further suggestions and recommendations. This review also tackles the main concepts, including big data, learning analytics, educational data mining, and technology acceptance. Critical remarks and research gaps were also discussed. It is believed that this review will provide an insight into the current research trends in learning analytics and serve as a source for pursuing further research in the domain.

Keywords Learning analytics · Big data · Technology acceptance · Prediction models · Learning theory · Designed framework · Applications · Data-driven decision-making

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1 Introduction

During the last two decades, the role of information technology has significantly increased across various educational settings through the use of different educational tools, including m-learning [1], e-learning [2], social media [3], interactive games [4], learning management systems [5], wearable technologies [6], and Massive Open Online Courses (MOOCs) [7] to name a few. The growing use of those technologies and data in education has paralleled evolving new areas, such as educational data mining, artificial intelligence (AI) in education, and learning analytics, with a particular focus on how data can be employed to improve education [8] and enhance learning experiences [9]. This can be achieved by collecting digital footprints that students leave behind while interacting with technology. Those digital footprints were perceived as a promising data source that can be employed to make informed decisions by administrators and instructors. To reinforce the likely use of digital footprints, learning analytics has emerged to concentrate on collecting, analyzing, and reporting data related to learners and their settings [10]. This is accomplished through data science methods using various textual and visual techniques [11]. The collection of a large sample of students' data could be mined to be used for determining patterns of learning activities that predict students' motivation, achievements, and satisfaction [12].

In line with the increasing interest in learning analytics, a number of review studies were conducted. However, those reviews have mainly focused on the behavioral, affective, cognitive, and metacognitive patterns of learning [13, 14]. It has been noticed that the previous reviews neglected to review the learning analytics studies from the lenses of their categories. Therefore, this review sheds the light on analyzing the existing learning analytics studies through classifying them into five different categories, including prediction model, learning theory, designed framework, applications, and data-driven decision-making. Under each category, we present a summary of the respective research, its purpose, which dataset was used, how it was sourced, its algorithms, results, and further suggestions and recommendations. This review also discusses the main concepts, including big data, learning analytics, educational data mining, and technology acceptance. It is believed that this review will provide an insight into the current research trends in learning analytics and serve as a source for pursuing further research in the domain.

2 Background

2.1 Big Data

Big data refers to large sets of data that can be evaluated computationally to disclose associations, trends, and patterns revolving around human interactions and behavior. Big data is a broad field that elucidates the methods of analysis, extracting information

systematically, and dealing with complex and large data [15]. Big data focuses on the advanced processes of handling datasets that are gigantic and complex to be processed by traditional techniques. This refers to the complex process of extracting, analyzing, and handling big data that could not have been possible using conventional approaches. Big data is a complex term that refers to data types and the complex processes of handling them [16]. The first notion of big data stems from the complex and large sets of data that cannot be analyzed and processed using traditional software. The second notion refers to the sophisticated methods of evaluating, extracting, handling, and computing large sets of data.

Big data applications involve the techniques and processes through which organizations handle and process big data [17]. Several big data applications are used across industries and businesses, including health, financial market analysis, marketing, human resources, environmental protection, energy exploration, and fraud detection [18]. Big data applications facilitate various organizational practices like observing customer trends and patterns and consumer behavior. The techniques and tools of big data also facilitate the interpretation of large volumes of data rapidly and within a short period [19]. This facilitates the enhancement of production efficiency as well as the development of data-driven services and products. Therefore, big data applications are revolutionizing the way through which many industries operate. There are various applications of big data such as bioinformatics, medical physics, particles, genomes, health, and other sub-sciences concerned with collecting and analyzing data to come up with results and solutions that may contribute to enriching a specific field. In recent years, big data has entered the education sector, where the use of learning management systems and virtual learning environments is increasing day by day. The distance learning process also yielded a considerable amount of data that can be analyzed. Artificial intelligence (AI) applications in education result in a lot of big data that needs to be analyzed to get further benefits [20].

2.2 *Learning Analytics*

Learning analytics refers to the collection, measurement, reporting, and analysis of data related to students and their settings [17]. This is aimed at optimizing and understanding erudition and the environments where learning occurs. Three major elements appear through this concept, including data, analysis, and action. In this context, the raw data is the data that requires several types of analysis using machine learning algorithms to obtain real insight and interesting patterns. Figure 1 shows the learning analytics process. The analytics method is a technique of defining, conceptual analysis, and explicating a problem through various approaches to develop a deeper understanding [16].

Numerous data analytics applications can be used to enhance learning outcomes [18]. Data analytics applications include identifying the effects of learners, forecasting the modeling and performance of students, identifying undesirable behaviors among learners, recommending learning resources, improving social learning

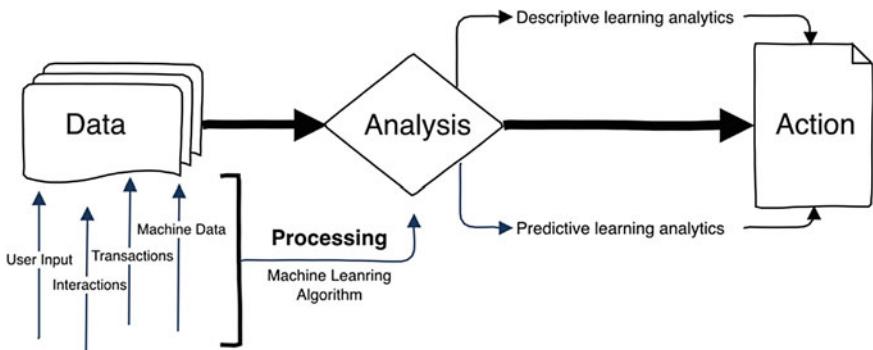


Fig. 1 Learning analytics process

settings, and improving awareness and reflection. Some studies also focused on studying students' behavior through virtual learning environments and linking that to the students' academic level and achievement [21]. Students' responses to solve activities and exercises and the cursor's movement on the screen during the solution process are among the important indicators that researchers have considered to study the students' behavior.

As shown in Fig. 2, the learning analytics consists of four primary levels, including descriptive, diagnostic, predictive, and perspective. The “descriptive” level describes

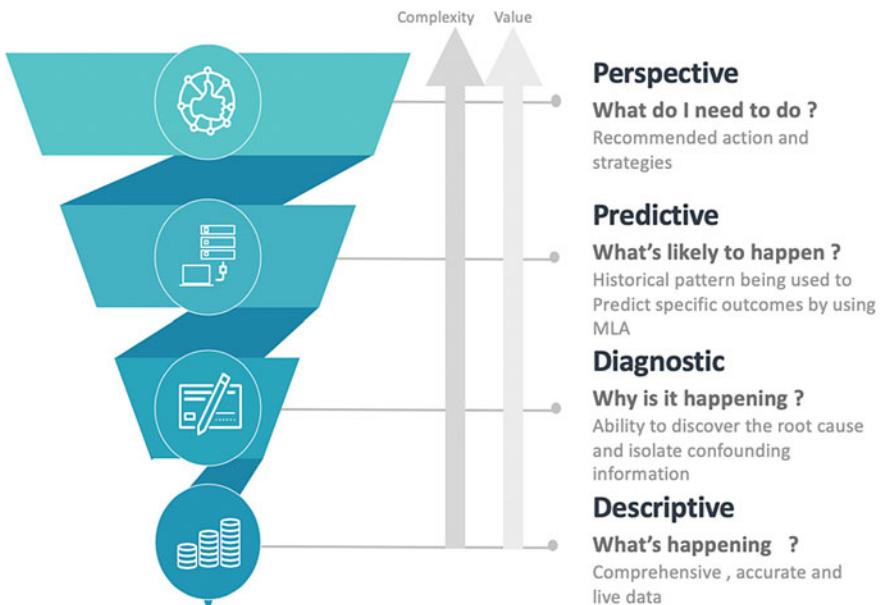


Fig. 2 Levels of learning analytics

what learners do and what happens in the teaching and learning environment. The “diagnostic” level refers to the stage that covers the factors that affect students’ performance and their academic level. The students’ behavior is also analyzed under this stage. The “predictive” level refers to the forecasting and prediction of certain outcomes based on specific types of analysis using machine learning algorithms. The “perspective” level refers to the process through which the learners can be guided and directed to the appropriate procedure based on the prediction model that has been developed.

2.3 Learning Analytics Versus Educational Data Mining

During the last decade, there is a growing interest in determining the factors affecting learners’ performance using data mining approaches [22]. This has been accomplished through learning analytics and educational data mining. Learning analytics and educational data mining are related as both concepts serve the same purpose but are applied differently [23]. Educational data mining refers to the development of techniques used to explore exclusive and large-scale data from the educational settings and apply suitable methods to better understand learners and their learning environments.

2.4 Learning Analytics and Technology Acceptance

During the last three decades, technology acceptance has become one of the most growing topics in human-computer interaction (HCI). In the context of this study, big data analytics entails using complex approaches to assess a large amount of information and produce simple reports [24]. Despite the increasing interest in using learning analytics, there is a scarce of knowledge concerning the factors affecting the users’ adoption of its tools [25]. Therefore, further research is required to examine those factors from the organizational and individual levels. Understanding these factors helps to improve the use of learning analytics tools to provide more insightful patterns.

3 Methodology

A total number of 19 articles were collected concerning the topic of learning analytics. The collected articles were analyzed according to five different categories, including prediction model, learning theory, designed framework, applications, and data-driven decision-making. Table 1 shows the analyzed articles and their categories.

Table 1 Analyzed articles and their categories

Category	Study No.	Source
Prediction model	P_01	[26]
	P_02	[27]
	P_03	[28]
	P_04	[18]
Learning theory	P_05	[29]
	P_06	[30]
Designed framework	P_07	[16]
	P_08	[31]
	P_09	[32]
	P_10	[11]
Applications	P_11	[23]
	P_12	[17]
	P_13	[33]
	P_14	[34]
Data-driven decision-making	P_15	[19]
	P_16	[15]
	P_17	[35]
	P_18	[36]
	P_19	[37]

4 Learning Analytics Categories

4.1 Prediction Model

Several research studies have focused on studying students' behavior during the learning process, while some studies have attempted to predict academic performance based on students' behavior in the learning environment. Studies have also examined the time each student spends on finding the solution to a problem in interactive classroom activities. In that, Abdous et al. [26] conducted a study on a public university with more than 17,000 undergraduate students and 6000 graduate students to analyze students' online learning behavior. The goal of the study was to identify the impact of live streaming on students' academic performance by analyzing the relevant data using a hybrid model of educational data mining and regression analytics. It turned out that the students' final grades were not the only measure that can be used to determine the students' level of mastering the subject, as several factors can have a major impact on students' achievements. These factors include teaching methods, student motivation, examination difficulty, student background knowledge, grades, and evaluation criteria. The students' interaction with the platform, such as chatting and logging in and out of the system, are among the factors that have a major impact

on students' achievements and must be taken into account. It was also discovered that those students who ask more questions and frequently engage in chat forums were the most advanced in academic terms. However, the study didn't succeed in predicting students' performance. To do so, the authors recommended increasing data collection and examining many variables to make appropriate decisions and measure the real level of student mastery of the material.

Another study aimed to predict the academic performance of students by considering the experience of 59 students in a calculus course that combined online learning and traditional learning [27]. The study examined 21 variables. These variables included some related to traditional learning, such as the number of homework problems solved, the performance on homework problems, the results of weekly paper tests, and so on. It also considered variables related to adaptive learning, including the number of times students log in to the learning platforms, the number of days students watch videos, the number of days students participate in online conversations, the number of times the front and back searches are clicked while watching videos, and other variables. The study concluded that one-third of a semester must elapse before researchers can predict the academic level of a student. This allows time for data to be collected, which enables the machine learning algorithm to predict students' achievements. As identified through learning analytics, seven basic variables affect students' performance. The study recommends the implementation of the examined model in parallel with the use of an early intervention strategy in learning analytics, which is believed to lead to better results.

Mwalumbwe and Mtebe [28] studied the relationship between the student's use of the learning management system and his/her level of academic achievement. The study was conducted by analyzing data from the Mbeya University of Science and Technology learning management system derived from the use of the learning analytics tool, which was subjected to a linear regression analysis that treated the students' final grades as the outcome variable. Several variables were used in the analysis, such as the number of times users logged in to the learning management system, time spent within the system, the number of downloads, discussions, and dialogues between students, the number of exams that were taken, the number of forums students participated in, among others. The study found that the number of discussions and interactions among students in the LMS, combined with the number of exercises a student solved, raised the student's academic performance level. However, the time the student spends browsing the system and the number of login and exit times did not have a significant impact on student's achievement.

Self-thinking is also one of the important aspects that researchers have been studying to predict students' behavior by considering the student's response time and the sequence of actions that the student performs when identifying the solution. Other studies also considered learning analytics by monitoring data derived from the students' use of simulation devices that give students entry into the virtual world and allow them to act as if they are in the real world [26].

Iraj et al. [18] conducted a study to examine the link between course success and feedback engagement as well as predict the reaction of students to feedback. In the study, the data were sourced from an empirical study of students on the subject

of time management. Focus groups were also used to source data on the perceptions of students on feedback messages. The datasets included two sets of feedback messages on learners' time management. The study used a series of trackable call to action (CTA) connections to evaluate the link between course success and feedback engagement as well as to predict the perceptions of students. A sustainable feedback program was proposed as an ideal means for determining the effectiveness of learning analytics. The study recommended the use of "why questions" by instructors to enhance feedback and reduce the feedback gap. The findings indicated that early engagement with feedback leads to increased chances of achievement in the course. In addition, previous engagement with feedback predicts the future engagement by students. Female students are more likely to engage than their male counterparts. Therefore, early engagement with feedback is positively associated with higher course outcomes.

4.2 Learning Theory

Through learning analytics, it is possible to develop approaches that contribute to raising the student's achievement level, behavior modification, and procedures to be followed by the learner to achieve the learning outcomes as the data collected and analyzed lead to building theories and generalization.

Shaffer and Ruis [29] aimed to provide a practical example of a theory-based method of learning analytics. The study endeavored to evaluate the role of data-driven approaches in learning analytics. This has been achieved by creating a theory, collecting data, and analyzing them using epistemic network analysis. The data for the study was sourced from the epistemological game in the form of discourse and other forms of information. The dataset involved discourse and the forms of complex thinking data. The data were diverse and multifaceted, requiring an associated approach. The epistemic network analysis was used to evaluate discourse along with other data evidence of sophisticated thinking. A theory-based model of learning analytics is proposed since it offers a reliable and comprehensive evaluation. The data-based methods were limited to the type and availability of data and did not provide further meanings. The study recommended the development of mechanisms that reflect best practices in learning analytics. The theory-based method of learning analytics was identified and described as the best practice. This indicates the significance of using theory in learning analytics and not data.

Another study aimed to examine the sustainable effect of practice and research in learning analytics by evaluating the learning analytics through a review of published literature [30]. The data were drawn from the vast field of learning analytics. The dataset was diverse since the study considered the growing nature of learning analytics along with frameworks applied. The study employed a case study research literature to examine the analysis of data on educational technology. A consistent evaluation of the evolving issues that undermine the future maturation of learning analytics was proposed. The study recommended that computational

elements of analytics should be integrated appropriately in existing educational research. Besides, integrating the computational dimensions of learning analytics with current pedagogical research is important in guaranteeing the future success of the field.

4.3 Designed Framework

When there is a clear and instructive framework for how to deal with the various analysis resulting from educational practices, such as students' data, data resulting from the virtual learning environment, and test results, there becomes a quality in developing curricula, quality in analyzing the current status of the learner, and that the student's behavior and academic level achieve the required learning outcomes. Numerous studies have been conducted in this field to examine the impact of learning analytics on the student's academic level and the educational process in general. One of the significant areas of research in learning analytics is the design of frameworks.

Greller and Drachsler [16] suggested and evaluated a generic design framework that can offer a guideline for developing learning analytics support services for educational practices. The study used data obtained from educational stakeholders across data analytics. The dataset involves the limitations and soft barriers to learning analytics among educational stakeholders. The study used a qualitative theoretical approach to examine the potential hazards of the beneficial exploitation of educational data, key dimensions of learning analytics, and crucial problem zones. The study proposed a generic design framework that can be used as a guide for developing learning analytics to aid educational practices. The model facilitates enhancing the efficiency and effectiveness of teachers, guarantee quality assurance, and curriculum development. It is recommended to create a policy guideline that addresses all privacy and ethical issues of learning analytics. The findings indicated that creating frameworks that guide the development of learning analytics reinforcement services for pedagogical design is important in facilitating the success of learning analytics in educational settings. The effectiveness of learning analytics in education is based on access to support services that provide the necessary support for pedagogical processes.

Athanasiadis et al. [31] collected data from 33 learners from diverse knowledge backgrounds on e-learning platforms. The study aimed to examine the role of affect-driven adaptation in maximizing knowledge acquisition. This was based on the growing emphasis on affect-driven adaptation as a conduit for efficiency in knowledge acquisition. The dataset comprised diverse experiences of learners from different backgrounds on e-learning platforms. The matrix factorization techniques were used to examine the richness of datasets and determine the underlying implications. An integrated learning system was proposed to accommodate the various factors influencing the efficacy of learning analytics. The study recommended the development of adaptation mechanisms to maximize knowledge acquisition by learners. The examination of matrix factorization methods assisted in demonstrating

the richness of the dataset in revealing the significance of affect-driven adaptation in maximizing the acquisition of knowledge by students. The findings indicated that affect-driven adaptation directly influences the maximization of knowledge acquisition. Therefore, affect-related information and processes should be developed to increase the rate of information acquisition for learners. There should be a shift to affect-driven processes that have proven to be effective in facilitating advanced learning outcomes.

A systematic review of the literature for empirical evidence regarding learning analytics for education design was conducted by Mangaroska and Giannakos [32]. The study also presented an evaluation of the use of learning analytics in informing design decisions in a variety of contexts. The data were sourced from a long process of empirical research by relying on first-hand data from participants. The dataset comprised empirical evidence regarding learning analytics for education design purposes. The study conducted a systematic evaluation of experimental evidence about learning analytics for education design. A framework detailing how learning design can be systemized and captured based on learning theory and learning analytics was proposed. Such a framework facilitates the inculcation of all crucial parameters for successful learning analytics. It is recommended that learning design choices developed by educators can be documented to influence future performance and learning activities. The findings also indicated that the ongoing learning phenomenon and design configuration exert on the existing status of learning technologies. Therefore, design patterns can significantly influence learning incidence and design configuration by exerting pressure on current technologies calling for the advancement of know-how for learning analytics.

Gašević et al. [11] proposed and examined a consolidated approach of learning analytics that comprises three related dynamics, namely data science, theory, and design. The study concentrated on defining each of the three components regarding their essence and relationship. The data were collected from a previous study in learning analytics. The datasets comprised a collection of current frameworks and models of evaluating learning analytics and their connections with underlying disciplines. The study was conducted from a qualitative and theoretical perspective by examining the various ways through which learning analytics is examined. A multi-perspective model of examining learning analytics is proposed since it accommodates the major core dimensions of the practice. The study recommended a holistic examination of learning analytics from a multifaceted perspective to examine all dimensions of the subject. The findings indicated the significance of multi-perspective methods of learning analytics anchored on the three significant dimensions for a strong and sustainable development of practice and research on learning analytics. A multidimensional approach to learning analytics is important in contributing to the effectiveness and success in this broad field.

4.4 Applications

Learning analytics is also defined as the process by which some educational problems are radically analyzed by examining the underlying data to gain access to learning singularity. Verbert et al. [23] analyzed datasets that are applicable in research regarding knowledge and learning analytics. The study started by providing a framework for evaluating educational datasets. The data were sourced from primary and existing empirical research to build on the development of learning analytics. Four generic models of learning analytics were identified for enhancing learning outcomes and processes. The study was conducted using a two-dimensional framework that includes reflection versus prediction and individual versus social. A general design framework that encompasses essential aspects of learning analytics is proposed to assist in the development of learning analytics services for effective educational support. The findings indicated that the analysis of datasets from different sources is possible through the application of a multidisciplinary approach. Such an approach helps to group the datasets based on their essence and related patterns. This implies that analyzing datasets from diverse sources is not just possible but also effective in facilitating effectiveness in learning analytics.

Seufert et al. [17] aimed to propose a universal design framework that entails various dynamics to facilitate learning analytics to provide support for educational practice. The proposed framework is based on a two-dimensional pattern, namely individual versus social, and reflection versus prediction. The data were collected from various sources that included previous research and literature, along with a first-hand investigation. The study used existing and new open datasets for knowledge and learning analytics for analysis purposes. The method used was the analysis of existing datasets based on the dimensions of a framework for evaluating educational datasets. Such a framework was proposed as the best rationale for evaluating the information on learning analytics. A holistic framework for the analysis of existing datasets based on the ability to determine and overcome future challenges regarding sharing and collecting educational datasets was recommended. The findings indicated the validity of the learning analytics model based on the two-dimensional framework in facilitating the effectiveness of learning analytics. This implies that the future of learning analytics is based on the application of multidimensional frameworks.

Shaffer et al. [33] provided a tutorial of epistemic network analysis (ENA), which is a new method for recognizing and quantifying association among dimensions in coded data and in characterizing the lessons in dynamic network models. The data were sourced from previous studies as well as published materials on the subject. The datasets were multidimensional underpinnings of network data and connections amongst the various structures. The study involved a qualitative evaluation of secondary data on the methods of evaluating and quantifying data. An ENA is recommended as ideal in detecting and quantifying linkages between elements in encrypted data. The findings indicated that the ENA is an effective method in learning analytics because it has the ability to identify and quantify parameters in the vast field and construe them for effective educational outcomes.

Johnson et al. [34] examined the higher education trends concerning learning analytics. It was aimed at evaluating the degree to which learning analytics has been integrated into higher education. The data were gathered from the previously published research and through empirical research by a team of experts. The study involved a qualitative evaluation of developments in higher education by focusing on learning analytics. A holistic approach to trends in higher education was proposed as the solution to gaps in understanding learning analytics. The study recommended a multidimensional and collaborative approach to understand the nature of learning analytics, particularly its role in higher education. The findings indicated that learning analytics had transformed higher education in a way to increase its outcomes. However, there were some gaps in the application of learning analytics in higher education, prompting researchers to recommend further adjustments to increase effectiveness.

4.5 Data-Driven Decision-Making

The primary goal of learning analytics is to make the appropriate decision concerning the educational process, the student, the teacher, the curriculum, or other related matters. Therefore, learning analytics can be defined as the science of data analysis and evaluation to reach a specific conclusion. Siemens [19] investigated and examined the evolution of learning analytics through various avenues and revealed the current state of learning analytics. The data were sourced from the existing published research studies. Previously researched and published datasets on learning analytics were used in the process of conducting the study. The method used was the evaluation of secondary resources of learning analytics as a research discipline. An integrated and holistic vision for enhancing learning analytics as a domain practice and research discipline was proposed. A framework for learning analytics is developed that incorporated possible avenues of collaboration like the education system, learning, and teaching. The findings indicated that learning analytics has effectively evolved through research labs, conferences, summer institutes, and journals. This indicates that learning analytics has evolved through various avenues to become an important field of study. However, more research should be carried out to facilitate the development of learning analytics into maturation.

Siemens [15] examined and presented a holistic and integrated idea of promoting learning analytics as a domain of practice and field of research. This involved examining how learning analytics has evolved to serve the two purposes. The data were collected from the previous research studies on learning analytics and empirical research. Privacy and data ownership legal framework were proposed as the solution to the ever-developing field of learning analytics. The study recommended the proper consideration of learning analytics as a mature field of study and research since it has grown through research labs, conferences, summer institutes, and journals. The findings of the study indicated that learning analytics has indeed evolved into a field of research as well as a domain of practice. This implies that learning analytics has

attained maturation as an integrated field of research. However, the study presented various avenues that require reinforcement in facilitating further developments in learning analytics.

Koedinger [35] investigated the most appropriate learning technologies for learning analytics. This was based on the fact that there are several technologies based on several theories. The data were sourced from an empirical study on effective learning technologies and theory. The study involved a broad dataset comprising information on learning technologies and cognitive theory. Empirical research was conducted to determine the best learning technologies that are informed by cognitive theories through both primary and secondary data. The study proposed the concept of cognitive tutors as the best framework for understanding learning analytics. It refers to a blend of research on cognitive psychology and artificial intelligence techniques on human learning abilities. The study recommended the use of effective technologies of erudition that are based on comprehensive cognitive theory. The findings indicated that the best learning technologies for learning analytics are based on cognitive theory. This implies that cognitive theories influence the development of learning technologies for learning analytics by increasing their effectiveness. There is a need for further development of learning technologies based on cognitive theory to advance the success of learning analytics.

Elias [36] examined many techniques for evaluating learning analytics. The data were sourced from empirical research regarding the numerous approaches for evaluating learning analytics and their implications. The dataset was broad because it entailed empirical and countable data from respondents as well as published data from previous research. A quantitative empirical study was conducted regarding the various approaches for analyzing learning analytics. A contemporary framework of learning analytics is proposed to enable the effective understanding of learning analytics through diverse perspectives. It is recommended that learning analytics is examined from a holistic perspective, irrespective of which model is being used to evaluate learning analytics. The findings indicated that the most appropriate techniques for evaluating learning analytics are diverse and contemporary in the sense that they incorporate various parameters. Such methods help to develop a comprehensive understanding of learning analytics by focusing on various parameters. However, since learning analytics is an evolving field, advanced and recent approaches for evaluating the developments in learning analytics are required.

Picciano [37] evaluated the developing trend of analytics and big data with a special focus on the American higher education. The data were sourced from existing literature on data-driven decision-making, particularly the role of big data analytics. The dataset comprised blended information from the evolving field of analytics and big data and its role in decision-making. The study conducted a theoretical evaluation of the evolving nature of big data and analytics through existing data. A systematic framework for evaluating the evolution of analytics and big data was proposed as the best rationale for understanding the role of big data in decision-making. The study recommended a comprehensive method of examining analytics and big data by identifying issues regarding growth and implementation. The findings indicated that analytics and big data are still at a formative stage in the American higher education

and there is a need for further developments to integrate their role in higher education. Therefore, more research and developments are required to develop the efficiency of these fields.

5 Conclusion and Critical Remarks

Learning analytics has quickly evolved to become one of the trendy fields in computer science and education. This stems from its ability to collect, measure, report, and analyze a large amount of data related to learners and their settings. While a number of studies were conducted on learning analytics, providing a holistic view of those studies and their categories is still neglected. Therefore, this study aimed to shed the light on the main concepts, including big data, learning analytics, educational data mining, and technology acceptance. It is also aimed at analyzing the existing studies by classifying them into five different categories, including prediction model, learning theory, designed framework, applications, and data-driven decision-making.

Although the previous literature provided significant insights into the conceptual basis for learning analytics, this review highlighted some gaps that need to be considered in future trials. First, it has been noticed that predictive models have some gaps in predicting students at risk. Identifying those students earlier will assist the instructor in making informative decisions to rectify the students' academic status. Second, identifying the factors affecting the use of learning analytics tools at the individual and organizational levels is still scarce. Thus, much research is required to examine what impacts the use of learning analytics tools in order to assist decision-makers in strategizing their plans. Third, it has been observed that research on learning analytics in schools' level is overlooked. This provides an opportunity for further research to consider this important point.

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Examining the Factors Affecting the Adoption of IoT Platform Services Based on Flipped Learning Model in Higher Education



Ali S. Al-Musawi and Issa Alghatrifi

Abstract The current status of the 4th industrial revolution has offered some sophisticated technological tools for higher education institutions. One of these technologies is distance learning based on Internet of Things tools and cloud computing, that make the student the main pillar of learning, through engaging in Flipped Learning Model (FLM). For successful IT integration in higher education, designing a distance-learning training platform is vital. Although research has identified the factors that can directly determine the behavioral intention to use technology, little is known about the effects of these factors on the successful design of a distance-training platform. Therefore, this study examines the effects of these factors in determining the successful design and use of IoT-applications through distance learning platform based on FLM for higher education within the context of Oman technological colleges. This would be implemented by developing a conceptual framework in scope of the Unified Theory of Acceptance and Use of Technology (UTAUT), Technology Acceptance Model (TAM), and literature review. Data will be collected from employees at these colleges, and analyzed using partial least squares—structural equation modeling (PLS-SEM), in addition to the Importance-Performance Map Analysis (IPMA).

Keywords Internet of things · Cloud computing · Flip learning model (FLM) · Importance-performance map analysis (IPMA)

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1 Introduction

In recent years, the trend toward distance learning has been paid more attention represented in the online learning environment as well as Flipped-Learning (FL), which is defined by Kopp (2004) as “*a technique in which instructors deliver online instructions to students before and outside the class, and guide them interactively to clarify the problems*” [1] P.188. In the classroom, instructors deliver effective knowledge in an efficient manner, but FL has become an active approach for boosting learning capabilities, showing significant evidence of its preference over traditional learning [2]. The advent of the fourth industrial revolution applications has made most of the educational institutions under pressure to adopt distance and FL due to the common traditional way of learning, and the campus infrastructure inability to accommodate online learning for all students. Therefore, adopting a platform for distance learning and FL is inevitable to align with new education trends.

Many factors appeared to influence the possibility of adopting distance and FL approaches, whether at individual or organizational levels. Studying these factors and their relationship to the successful implementation is necessary to broaden our knowledge in this field. Further, this chapter addresses the gap in the current literature by providing information about the factors associated with an instructor’s decision to adopt IoT-platform services based on FL. This inventory can also help educational administrators and policy makers to understand a series of key factors that could influence higher education institutions to adopt the successful implementation of IoT-platform services to transfer the education processes from traditional way to a digital one. In addition, the authors are proposing a design for IoT platform services based on FL (IoTP-FL) using cloud computing to prepare IT students at technical colleges for early FL practice, hoping for a gradual replacement of traditional education. Hence, our motivation is to investigate the effectiveness factors of designing IoT-platform services in distance learning based on FL, supported by cloud computing for higher education institutions.

The remaining sections of the chapter are organized as follows; a literature review of the state of art closely related to the current study objectives, and presenting the IoT-training based on FL (Working Scenario) architecture. Then, a conceptual framework is developed in scope of the Unified Theory of Acceptance and Use of Technology (UTAUT-2), Technology Acceptance Model (TAM), and a literature review for the working scenario architecture. The chapter concludes with a summary of the research findings and future directions.

2 Literature Review

This section describes the IoT technologies and the theoretical framework that guide this study in its investigation of the factors that affect the successful implementation of IoT flipped learning platform in higher education by developing a conceptual model

based on the Unified Theory of Acceptance and Use of Technology (UTAUT-2), TAM and some reference to literature review extracts.

2.1 *Internet of Things (IoT)*

With the rapid ubiquity of Internet technology, we can see the rapid growth in the number of smart devices where every device is capable of being connected to internet network, and accessing information anytime, anywhere. From this point, it can be stated that IoT devices stand as a core to this growth, and therefore can be categorized as the fourth generation of computer development [3]; meaning that teaching IoT applications will build advanced services [4]. The Cloud computing technology has Integrated with IoT applications and developed a comprehensive infrastructure that students can make use of through engagement in active interactions based learning, which is one of the main motivations of our proposed flipped-learning platform [5–7].

2.2 *IoT in Higher Education*

Transitions from traditional to digital approach in the educational sector was promoted in response to the twenty-first century students' trend to use smart devices and to fulfill their learning needs, which led to the ascendency of these devices as learning tools. It is imperative for higher education institutions to cope with these rapid changes [8]. The necessity of educators to reexamine the ways of teaching students is maximized to provide them with competitive skills to address global learning levels and deal with current work environments referenced by Selinger et al. [9].

In the same connection, Ervin [10] points out that learning based on knowledge transformation from the educator to the student must be changed to be self-coordinated, that is enabling learners to be self-educated and learn multiple skills that support them in digital disciplinary in the digital milieu. On a broader perspective, the number of the Internet of Things (IoT) devices that are connected by 2025 will reach 75.44 billion. This allows IoT devices to be the center of technology working to disrupt the old traditional approach of teaching and changing it to digital learning [11].

The dramatical increase in the number of IoT devices will enable faculty educators to transit from first traditional teaching toward a flipped learning approach, and encourage their students to be active participants in a technology centered learning environment, and become self-regulated learners.

IoT application platforms allow students to engage in distance learning based on flipped-learning, will increase the potential of knowledge availability with unique value-added learning experience with considering that students can form distance learning in groups [12]. In related, cisco indicated that the IoT itself as a platform

can be work to spread the collaborative research between educators and students from anywhere at any time with bringing different disciplines in one platform. Moreover, the IoT devices and applications augmenting the technological dimensions of distance learning [13]. In addition, integrating IoT into the application domain will enhancing design strategies that enhance teaching and learning and can bring students to virtual classrooms [14, 15].

Flipped learning classes are considered one of the novel approaches used by instructors to enable students in the learning process, providing them with resources anytime and anywhere. This puts heavy demands on institutions to use IoT platform services to support learning [16–18].

For example, Strawser [19] reports that integrating IoT platform services in the digital learning environment will allow other technologies to be part of flipped-learning, enriching students with a real-world experience such as augmented reality (AR) and virtual reality (VR). Therefore, and from previous literary review, the institutions need to bridge digital education requirements, and develop ubiquitous learning platforms such as IoT platforms that are believed to open different learning environments [20].

Despite the potential opportunities provided by IoT platform services to enhance learning, some factors are impeding the adoption of IoT platform technology into higher education. Typically, these factors have been themed in the following categories: physical factors, technical factors, and environmental factors.

Until now, there is only a paucity of studies that have attempted to examine the factors affecting IoT-platform adoption in the educational context. For instance, Gao and Bai [21] used TAM to examine the factors that could affect the adoption of IoT in China. The result show that the perceptions (usefulness, ease of use, enjoyment, behavioral control), and social influence have a significant relationship and effect on determining the behavioral intention to accept IoT in China.

In a study done by [22], 2000 respondents from the US were selected with a focus on studying IoT technologies adoption behavior. The study found several factors affecting IoT devices adoption behaviors, which can be summed up as: awareness of technology, usefulness, security, and data privacy. In the same context, [22, 23], also report that awareness of technology, usefulness, security, data privacy, and knowledge, affect the behavioral intention to adopt IoT technologies.

Moreover, although IoT paradigm has been popular in research related to some disciplines including healthcare and supply chain management, limited research is available on the factors that may affect the Internet of Things platforms adoption in higher education institutions that seek to develop countries; the Sultanate of Oman in this case.

Therefore, the primary purpose of this chapter is to explore how IoT technology can enhance distance learning based on flipped learning model integrated into the teaching and learning process at Oman technological colleges. It examines the factors that affect the successful implementation of IoT technology. The nature of this study is quantitative, and the UTAUT2 framework along with the TAM model are applied in this study to come up with a conceptual framework and develop hypotheses. This

conceptual framework predicts and explains technology acceptance behaviors for novel technologies by educators.

2.3 IoT-Platform Based on Flipped-Learning (IoTP-FL) (Working Scenario)

In this section, Fig. 1 shows the proposed IoTP-FL platform architecture design. The IoTP-FL architecture in this proposed design integrates the individual platforms for both the instructor and students and can be used for FL. This architecture is composed of three layers, which are abstractly divided into communication resources, individual platforms, and local cloud processing. The first and third layers present the individual platforms for both the instructor and the students. The Middle layer is responsible for data preprocessing. These layers' complement each other to cover important features, including data interoperability under local cloud processing. It should be noted that the proposed design does not address the security aspects related to cloud computing that must be included within the different education platforms, because the purpose of this chapter is to study the factors that may affect the behavioral intention to successful implementation of these platforms.

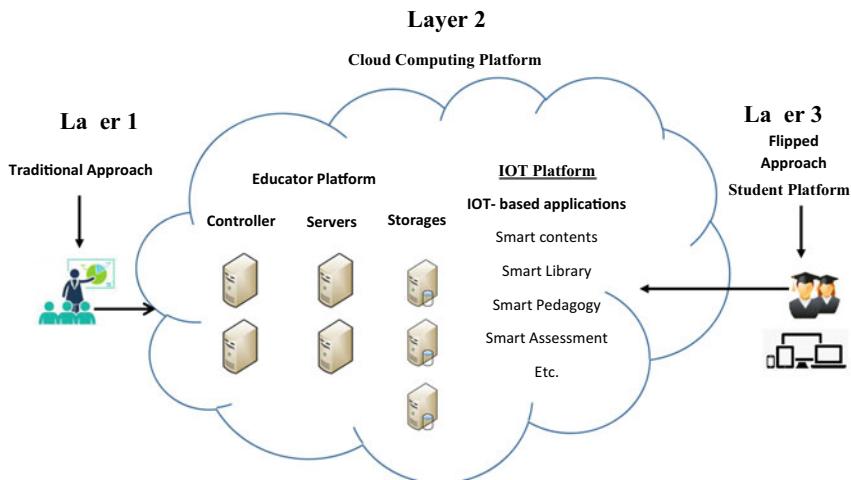


Fig. 1 Proposed IoT-platform services based on flipped learning (IoTP-FL) (working scenario)

2.4 Related Research on TAM and UTAUT2 Models Used in Technology

The Technology Acceptance Model (TAM) [24], and the Unified Theory of Acceptance and Use of Technology (UTAUT) model [25] that are related to information system (IS) and information technology (IT) are the most cited models in technology use/adoption and diffusion research [26]. It is worth mentioning that testing different types of hypotheses related to UTAUT and TAM in the context of distance learning is not new. However, extending and testing a new conceptual model and its proposed hypotheses in the context of distance learning in higher education institutions is essential to extend theoretical knowledge. Although TAM model was applied in different research such as [27], it is limited in the use of variables, and this one limitation makes this model insufficient to fully explain the relationship between technology and user adoption decision, and may lead to inconsistent outcomes. Originally, TAM is used to predict technology use in the workplace and individuals' technology adoption [28], showing high validity in a variety of studies. It should be noted that a new TAM model specifies the acceptance pattern and the role of Internet self-efficacy [28]. From this point, TAM can be used as a foundation model for investigating end-user acceptance of IoT technology. Researchers from different disciplines have proposed modifications to improve TAM's predictive capability by adding new constructs or integrating it with another model [29]. As a result, the authors perceive the importance of extending the theoretical paradigm of this study by integrating TAM model with UTAUT model together in different disciplines. Therefore, this study takes into account the scarcity of studies related to using IoT-platform services for distance learning adoption in Omani higher education institutions by applying both TAM and UTAUT models in order to enhance their applicability into IS and IT research.

3 Conceptual Framework

This part of the chapter explains the conceptual model that serves as the base of knowledge. This conceptual model represents the concepts used in this study, and the operational meanings of the research area. Based on review of previous studies we found that TAM model is widely used in studies accepting technology though UTAUT, and is proven to be more powerful in explaining technology acceptance variation [21, 30, 31].

Oman Technological Colleges have recently started working on providing distance learning through a digital approach represented in Flipped Learning (FL) as an alternative to the traditional approach. The shift to adopting flipped learning in these colleges was not gradual, as no steps were taken to raise instructors' awareness of IoT as the main learning services platform, which eventually eases its acceptance. Therefore, this chapter attempts to examine the factors that affect the successful acceptance and use of IoT-platform services, and thus fill the existing gaps in literature.

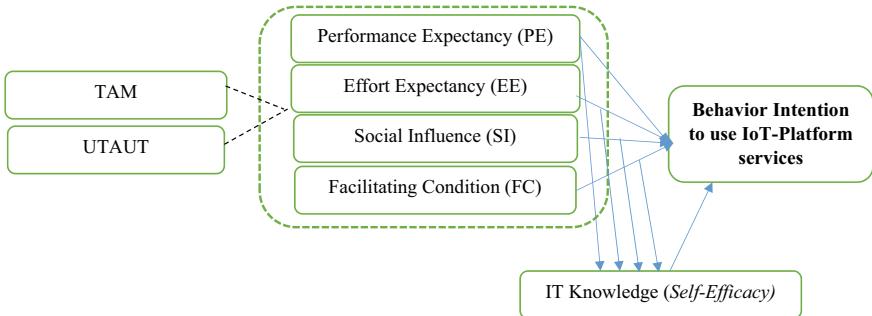


Fig. 2 A conceptual model for IoT services acceptance

Our conceptual framework is a result of integrating TAM with UTAUT, combined with factors extracted from previous literature supported by theories. There are five independent variables in this conceptual framework that are expected to affect the behavioral intention to successful IoT-platform services implementation that depict the relationship between antecedent variables and behavior intention to use IoT technologies. This conceptual framework considers UTAUT factors with IT Knowledge as key factors for this study. These factors are selected from UTAUT framework to provide a clear view about the impact of external and internal attitudes, and intentions to successful adoption and use of the new technology. They include: Performance expectancy (PE) (usefulness), Effort expectancy (EE) (ease of use as a primary key for information technology adoption at the individual and organizational levels) [32], Social Influence (SI), and Facilitating Condition (FC) [25, 33].

Based on previous studies, UTAUT was developed with the assumption that performance expectancy in UTAUT comes across perceived usefulness in TAM. Similarly, effort expectancy in UTAUT comes across ease of use in TAM. This review reveals that UTAUT model is the most appropriate to use as a baseline framework for this study. However, this study expects Performance expectancy (PE), Effort expectancy (EE), Social Influence (SI), Facilitating Condition (FC), and IT Knowledge to have a positive and significant relationship with behavioral intention toward the use of IoT technologies. Figure 2 illustrates the conceptual model of this study.

4 Hypotheses Development

4.1 Performance Expectancy (PE)

The user accepts innovations when they provide a unique advantage compared to existing innovations [The innovation diffusion theory (IDT)]. Therefore, IDT indicate the reasons for the slow implementation of any technology showing no clear potential benefits to users [34]. In the context of TAM and UTAUT, the perceived usefulness

in TAM and the performance expectancy of UTAUT are significant determinants of the behavioral intention to use IT [25, 33]. Likewise, UTAUT has been investigated in earlier studies, which found that PE has a significant effect and positively affects behavior intention (BI) to use a new technology. For example, [35–37].

Therefore, we propose:

H1. Performance Expectancy (PE) has a positive impact on the behavior intention to use IoT-Platform services.

4.2 *Effort Expectancy (EE)*

The user's effort to use technology is indicated by perceived ease of use in TAM and effort expectancy in UTAUT [25]. This means that the end-users need to feel that technology is easy to use. Previous studies like [24, 27, 38] note that perceived ease of use has a significant effect on behavioral intentions to use and accept technology. Therefore, we propose:

H2. Effort Expectancy (EE) has a positive impact on the behavior intention to use IoT-Platform services.

4.3 *Social Influence (SI)*

The social context is one of the most important factors that influence decision-making, and thus should not be neglected. Therefore, the social context should be included in any study related to acceptance and use of technology. Social influence can happen through peers, family, and even media on users' intention to adopt technology. Sanny [39] found that social influence factors are the second largest affecting factor on technology acceptance. Also, Chong et al. [40] argue results of [39] that social influence has significant impacts on technology adoption intention. Since TAM ignores the social influence variable for adopting technology, it has gained extensive attention in the information systems field [41]. Depending on a previous study [33], the social context in our research model is considered one of the main determinants of technology acceptance, defined as “the degree to which an individual perceives that important other (individuals) believe he or she should use the new system” [33] P.451. Therefore, we need considerable Social influence attention in technology acceptance and use. Linked to previous studies, we propose:

H3. Social influence has a positive influence on the behavior intention to use IoT-Platform services.

4.4 Facilitating Conditions (FC)

Facilitating condition was used in certain technology adoption models. It is defined as “the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system” [25] P.159. In addition, Venkatesh et al. [25] demonstrate that there is no significant relationship between facilitating condition and behavioral intention in the original UTAUT model. Moreover, previous studies did not suggest any uniform result with regard to analyzing the relationship between facilitating condition, usage behavior, and behavioral intention. For example, in one of the studies that looked into the relationship between facilitating condition and adoption of e-Government, the researcher found a significant positive relationship between these variables [42]. In a similar context, Gupta and Dogra [43] also found a significant positive relationship between these variables when using the applications.

Deriving these results into the current study, the following hypothesis can be stated:

H4. Facilitating Conditions (FC) will have a positive influence on the behavior intention to use IoT-Platform services.

4.5 IT Knowledge (Self-efficacy)

IT Knowledge is defined as the knowledge of end-users that enables them to deal with new technologies and their applications [22]. Through review of related literature, we argue that the end-user should be knowledgeable about how to use technology for successful implementation [44]. IT Knowledge can be measured by Self-Efficacy that include the following aspects: creating multimedia, locating online multimedia resources, designing learning activities, facilitating students’ use of online tools, guiding students to communicate with each other by using online tools, using online tools to engage students in collaborative group learning, and the instructor’s ability to use online tools other than email (such as; Blackboard, Wiki, and Google document) [28]. Moreover, a scarcity of studies related to information system (IS) research have investigated the possible effects of self-efficacy; therefore, the theoretical foundations need to be investigated in more depth. The findings of the aforementioned studies have led us to hypothesize that, when possessing IT Knowledge, self-efficacy can mediate the relationship between the Performance Expectancy (PE), Effort Expectancy (EE), and Social Influence (SI), and Behavior Intention to use IoT-Platform services:

H4. There is a significant positive effect of IT Knowledge (self-efficacy) on the behavior intention to use IoT-Platform services.

H5. Self-efficacy mediates the relationship between Performance Expectancy (PE), Effort Expectancy (EE), and Social Influence (SI), and behavioral intention.

5 Research Methodology

5.1 Research Sample

All IT educators working at Nizwa College of Technology, and specialized in different disciplines in the Information Communication Technology (ICT) Department constitute the sample of this study. The sample was selected based on their knowledge of delivering learning activities through educational technologies. In addition, they have the capabilities to shift from traditional teaching approach to a digital approach based on flipped learning [45, 46]. The educators involved in this study were preliminary requested to take part filling out the study survey through emails.

5.2 Research Instrument

The research tool is a questionnaire designed to conform to the study objectives. This questionnaire consists of two parts; the first part is designed to collect the demographic data, and the second part includes questions about the factors which respondents are requested to evaluate through a five-point Likert scale ranging from “1 = Strongly Disagree” to “5 = Strongly Agree”. Table 1 presents the measurement variables and associated items.

5.3 Data Analysis

This study employs the PLS-SEM to analyze the research model according to the general guidelines which include the measurement model and the structural model [47, 48]. In addition, the researchers concentrate mainly on examining the importance-performance map analysis (IPMA) to determine the factors that affect the acceptance of IoT services to transfer from the traditional education approach to a digital education approach based on flipped learning.

6 Results

6.1 Demographic Variables

The questionnaire was distributed in a single-round to the study sample—Information Communication Technology (ICT) educators—who have technical knowledge or expertise in distance learning and flipped-learning. Nizwa College of Technology

Table 1 Measurement variables and associated items

Variables code	Items to measure variables	Sources
PE1	I think using IoT-platform will help me in my daily tasks	[25]
PE2	I think using IoT-platform will help to increase students' learning motivation	
PE3	I think other instructional models in IOT-platform can help students to apply what they learned more effectively	
PE4	I believe using IoT-platform will improve students' problem-solving skills	
PE5	I think using IoT-platform will help students to show their content-related creativity in class	
PE6	I feel that using IoT-platform will help students to develop group work skills	
PE7	I think using IoT-platform will help students to locate needed information to extend learning	
PE8	I believe other instructional models (for example Flipped learning) can better help to increase students' interest in learning	
EE1	Learning how to use the IPv6 protocol is easy for me	
EE 2	My interaction with the IPv6 protocol is clear and understandable	
EE 3	I find the IPv6 protocol easy to use	
EE 4	It is easy for me to become skilful at using the IPv6 protocol	
SI1	People who are important to me think that I should use IoT-Platform services	
SI2	People who influence my behaviour think that I should use IoT-Platform services	[25]
SI3	Other people on campus can help me adopt an IoT-Platform service	
FC1	I have the resources necessary to use IoT-Platform services	
FC2	My institution offers training that can help me use IoT Platform services	
FC3	My institution offers instructional design support for the development of flipped classroom instructional courses	
FC4	My institution offers technical support for instructors to use IoT-Platform services	
SE1	I am confident I can create multimedia presentations (e.g. PowerPoint slides, Prezi) to communicate curriculum content to students	[44, 28]
SE2	I am confident I can locate online multimedia resources (e.g. YouTube videos, Khan Academy videos) to support my instruction	
SE43	I am confident I can design learning activities that integrate technology and course content for my students	
SE4	I am confident I can facilitate students' use of online tools (e.g. Dropbox, Onedrive, discussion board) to share learning materials	

(continued)

Table 1 (continued)

Variables code	Items to measure variables	Sources
SE5	I am confident I can help students to communicate with one another through online tools (e.g. discussion board)	
SE6	I am confident I can use online tools to engage students in collaborative group learning	
SE7	I am confident I can communicate with students using online tools other than email (e.g., Blackboard, Wiki, Google document)	
SE8	I am confident I can use technology to encourage students to help one another in the learning process	
BI1	I intend to use IoT-Platform services in the future	[25]
BI2	I predict I would use IoT-Platform services in the future	
BI3	I plan to use IoT-Platform services in the future	
BI4	I will recommend to others to use IoT-Platform services	

was selected as a representative sample for several theoretical and statistical reasons that have been applied on this case of sampling. First, according to the methodological literature [49], the preliminary study should be designed with 90% power and two-sided 5% significance. Second, researchers in this area recommend sample sizes between 75, 25, 15, and 10 participants; with standardised effect sizes between extra small (≤ 0.1) to large (0.8). Third, from a statistical perspective, methods using probability sampling and simple random sampling are the most likely to produce a representative and accurate sample consisting of not less than 30 participants. Therefore, the sample size of this study, which consists of 40 participants, exceeds the size of the sample required by preliminary studies. Moreover, the results obtained from this study will be used to ensure the validity and reliability of the study tool in order to generalize its initial findings and collected data to include other Omani higher education institutions.

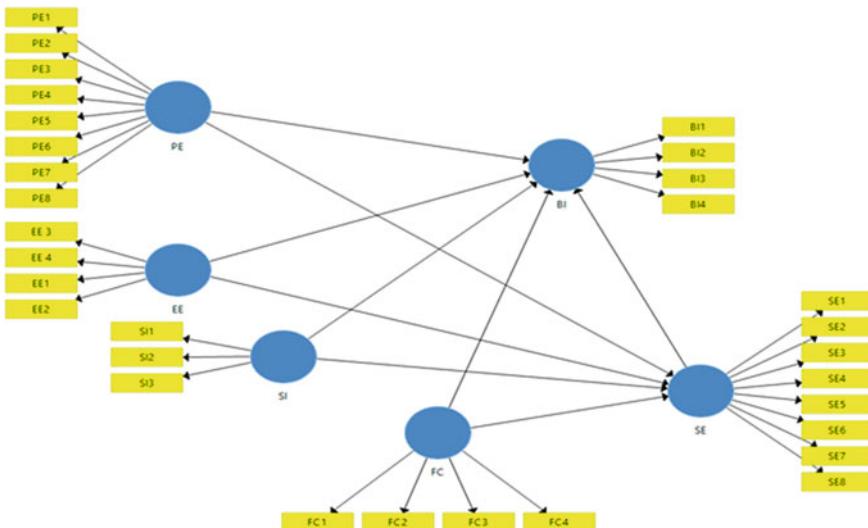
The questionnaire was distributed to a total sample size of 41, giving a response rate of 100%. A summary of the demographic data is provided in Table 2. The next section discusses the reliability test analysis.

6.2 Measurement Model Assessment

The researchers assess the reflective measurement model in this research study using confirmatory factor analysis (CFA). CFA was conducted on all the measurement scales used for assessing the variables in this study. Five reflective constructs were used, measured using 31 items. Through CFA, the reliability of all reflective scales was examined, followed by an assessment of their convergent and discriminant validities. The model with all latent constructs (shaded circles) and respective measurement items (rectangles) are depicted in Fig. 3.

Table 2 Demographic data

Demographic data	
Respondents %	
<i>Type of gender</i>	
Male	87.2%
Female	12.2%
<i>Job type</i>	
Tutor	51.2%
Tutor assistant	39%
Technical	10.8%
<i>Years of work</i>	
Less than 1 year	4.8%
1–3 years	9.8%
Over 3 years	85.4%
<i>Years of experience</i>	
Less than 1 year	19.5%
1–3 years	4.9%
Over 3 years	75.6%

**Fig. 3** Measurement model. Key: PE = performance expectancy, EE = effort expectancy, SI = social influence, FC = facilitating conditions, SE = self-efficacy

After the model had been properly built in the Smart-PLS software, essential statistics were estimated by running a PLS algorithm (2000 maximum iteration, standardized values, and centroid weighting scheme). This process is commonly called measurement (outer) model. The algorithm results in loadings above the threshold of 0.70 [50], confirming that all items used in this study demonstrate satisfactory indicator reliability. The next section discusses the assessment of convergent validity.

6.3 Reliability and Validity Tests

In information system research, Cronbach's Alpha is a widely practiced method for measuring the results' degree of consistency [45, 46]. In other words, internal consistency is the assessment of multiple items to ensure that they measure only one variable and also measure the relationship between other variables [47, 48]. To ensure the reliability of the questionnaire items, the value of Cronbach's Alpha should be equal to 0.70 or higher ($\text{Cronbach Alpha} \geq 0.70$) for confirmatory purposes [46], while items with low reliability can be removed [47].

To analyze the data collected for the study, the researchers used the following descriptive statistical procedures: Cronbach's Alpha, Composite Reliability (CR), and assessing Average Variance Extracted (AVE). Table 3 reviews the descriptive statistical data of Cronbach's Alpha, Composite Reliability, and AVE collected from the initial data collection process.

To confirm validity, both "convergent validity" and "discriminant validity" need to be calculated. However, the indicators loadings and the Average Variance Extracted (AVE) need to be examined to assess the "convergent validity". The values of AVE should be equal to or greater than 0.50, whereas the values of indicators loadings should be equal to or greater than 0.70. Table 3 indicates that the values for both indicators loadings and AVE are accepted; therefore, the "convergent validity" is established. Moreover, to assess the "discriminant validity", Chin [50] suggests using the "Heterotrait-Monotrait ratio (HTMT)" technique; however, the discriminant validity encounters a problem when the HTMT value is greater than $HTMT \pm 1.0$. Table 4 below presents the HTMT results. The result is regarded as satisfactory; thus, the "discriminant validity" is confirmed.

6.4 Structural Model Assessment

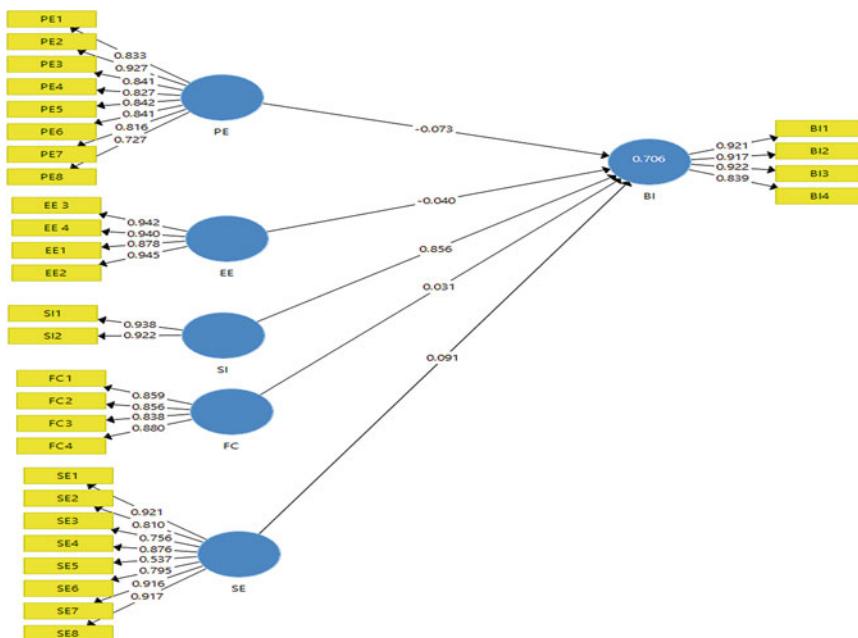
The second step in SEM analysis is the structural model. After the measurement model is validated, the representation of the structural model can be made to specify the relationships in each dimension discussed in this study and links between the variables [47, 51]. The outcome of the PLS bootstrapping (T Statistics), which was drawn from the version of PLS 3.0, can be viewed in Fig. 4.

Table 3 The descriptive statistics data (reliability and validity results)

Construct	Items	Factor loading	Cronbach alpha (CA)	Composite reliability (CR)	Average variance extracted (AVE)
BI	BI1	0.914	0.913	0.938	0.793
	BI2	0.902			
	BI3	0.921			
	BI4	0.821			
EE	EE1	0.919	0.949	0.963	0.866
	EE2	0.931			
	EE3	0.947			
	EE4	0.927			
FC	FC1	0.788	0.891	0.922	0.748
	FC2	0.869			
	FC3	0.891			
	FC4	0.907			
PE	PE1	0.693	0.922	0.936	0.648
	PE2	0.857			
	PE3	0.842			
	PE4	0.819			
	PE5	0.849			
	PE6	0.813			
	PE7	0.819			
	PE8	0.733			
SE	SE1	0.900	0.953	0.961	0.755
	SE2	0.867			
	SE3	0.852			
	SE4	0.911			
	SE5	0.761			
	SE6	0.867			
	SE7	0.867			
	SE8	0.915			
SI	SI1	0.942	0.709	0.892	0.641
	SI2	0.926			
	SI3	0.421			

Table 4 HTMT result

	BI	EE	FC	PE	SE	SI
BI						
EE	0.448					
FC	0.366	0.663				
PE	0.653	0.396	0.410			
SE	0.356	0.438	0.354	0.383		
SI	0.813	0.719	0.743	0.833	0.640	

**Fig. 4** PLS bootstrapping (T-statistics). Key: PE = performance expectancy, EE = effort expectancy, SI = social influence, FC = facilitating conditions, SE = self-efficacy

6.5 Direct Hypotheses Testing

6.5.1 The Significance and Relevance of Hypothesized Relationships

The structural model of the current study contains 5 direct hypothesized relationships. It examines the influence of the factors; Performance Expectancy (PE), Effort Expectancy (EE), and Social Influence (SI), on Behavior Intention of IoT-Platform services use. The researchers calculated the path coefficients (β), and the bootstrapping procedure (T-value and P-value) using the bootstrapping procedure in PLS

Table 5 Hypothesis testing

Hypo	Relationship	Std beta	Std error	t-value	p-value	Decision
H1	PE -> BI	0.245	0.152	1.609	0.098	Not supported
H2	EE -> BI	0.080	0.0163	0.493	0.452	Not supported
H3	SI -> BI	0.540	0.188	2.868	0.016	Supported
H4	FC -> BI	-0.044	0.160	0.276	0.536	Not supported
H5	SE -> BI	-0.001	0.156	0.009	0.822	Not supported

algorithm [52–54] to determine the significance level of the hypothesized relationships, which are considered significant with less than 5% probability error (at 95% confidence level). Table 5 presents results of Structural Model and Hypothesis Testing.

Bootstrap analysis was used to hypotheses testing. Table 5 illustrates that only one relationship is statistically significant, while the other 4 relationships are not statistically significant. This result shows that the relationships between the constructs are not all positive.

6.5.2 Mediating Effect of Self-efficacy

The assessment of direct and indirect relationships between variables is a vital part of the structural model evaluation [55, 56]. This assessment is called mediating effect, and is defined by Hair et al. [48] as a third variable that intervenes between two other related variables. In this study, as mentioned earlier, the researcher placed Self-Efficacy as a mediating factor between PE, EE, and SI, and BI. To carry out a mediation analysis by PLS-SEM, an underlying theoretical and practical support is required. According to [57], the strongest mediation occurs when the result is equal to zero. In this study, the bootstrapping method advocated by Preacher and Hayes [58] for mediation analysis was adopted though calculating the individual path coefficient of the independent variables and the dependent variable. Then, the path coefficient was calculated between the independent variables and the mediating variable to the dependent variable. At the end, the mediation is established when the results of the indirect effect from the confidence interval bias are corrected as all positive or all negative. The results of the bootstrapping procedure are illustrated in Table 6.

Table 6 Bootstrapping procedures

Hyp	Path a	Path b	Indirect effect	SE	t-value	95% LL	95% UL	Decision
H1	0.073	-0.038	-0.003	0.199	-0.014	-0.393	0.387	No-mediation
H2	0.234	-0.038	-0.009	0.148	-0.060	-0.299	0.281	No-mediation
H3	0.305	-0.038	-0.012	0.206	-0.056	-0.415	0.392	No-mediation

The results show that the SE failed to mediate the relationship between PE, EE and SI, and BI.

7 Importance-Performance Map Analysis

To gain more accurate results from PLS-SEM analysis, the researchers need to use the importance-performance map analysis technique (IPMA). This technique is used for generating additional findings, as well as prioritizing constructs to improve a certain target construct. The researcher conducted an IPMA analysis using PLS-SEM, which offers direct, indirect, and total relationships to include another dimension showing the actual performance of each construct [48, 59]. Figure 5 and Table 7 show the indicators' importance-performance map [48, 59].

The IPMA analysis highlight five most important variables; namely PE, EE, SI, FC, SE. The researchers found that FC, and SE are not significantly influencing technology use. Based on [59], any negative signs should be removed. In addition,

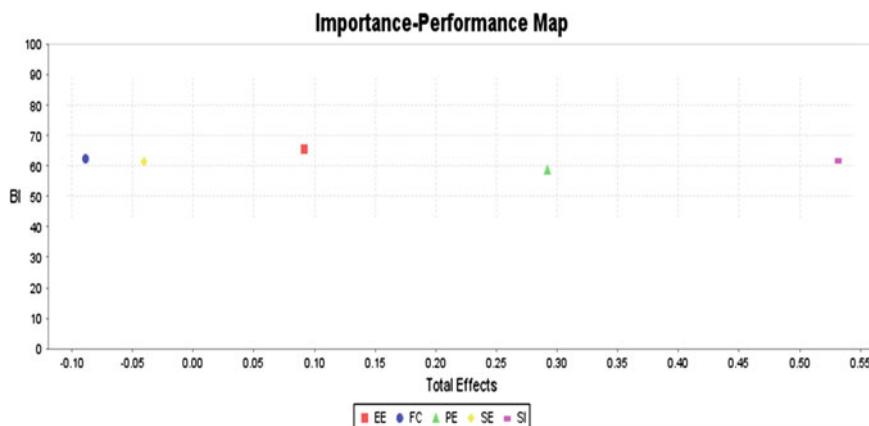


Fig. 5 Importance-performance map analysis

Table 7 Importance-performance map analysis (IPMA) result

Latent constructs	IMPA for technology adoption (importance total effect)	Performance (index values)
PE	0.292	58.687
EE	0.092	65.418
SI	0.532	61.791
FC	-0.089	62.392
SE	-0.041	61.331

he indicates the necessity to focus on the constructs with high weights; which are EE, SI and PE (65.418, 61.791 and 58.687) respectively. All of this will guide the College's management to take actions and improve the construct's performance. From the above analysis, stakeholders should focus on constructs with high weights, which will help determine whether technology use will succeed or fail.

8 Discussion

This study examined the "Effectiveness Factors of the Design/Use of IoT-Platform services in Distance Learning based on Flipped Learning Model (FLM) in Higher Education" within the context of Nizwa College of Technology. In addition, the study examined the effects of UTAUT model key factors on behavioral intention to use IoT-Platform services, and the mediating effect of IT knowledge (Self-Efficacy) between these factors and behavioral intention. To accomplish this aim, UTAUT model was applied and integrated with TAM model to come up with a new conceptual model. The study used employees from Nizwa College of Technology as a representative sample of all universities and colleges in the Sultanate of Oman. Data were collected using a 5 point-Likert scale questionnaires, and analyzed using SEM-PLS (SmartPLS 3.0) and SPSS 21.0.

Analyses of results shown in the measurement model assessment confirm that all items used in this study demonstrate satisfactory reliability indicator. Additionally, the results confirm the tool validity. After the measurement model is validated, the analysis of structural model was obtained and the outcome of the PLS bootstrapping (T Statistics) confirmed that all items were in satisfactory levels. Moreover, the analysis shows that four out of the five constructs; namely performance expectancy, effort expectancy, facilitating condition, and self-efficacy were found to have no statistical significance in influencing intention to use IoT-Platform services. Only one construct (i.e. social influence) was found to have a statistical significance to influence the intention to use the platform services.

From a theoretical perspective, the result of this study takes an initial step toward expanding the research to include factors influencing behavior intention to adopt technology. The main theoretical contribution is adding self-efficacy factor to be a mediating variable between UTAUT and behavioral intention. This factor was derived from previous studies that have investigated technology use and adoption in different areas such as e-learning, m-learning, and other online methods for distance learning.

This study reveals interesting results related to the assessment of indirect relationships between variables. The result of this assessment is not in line with any previous research. This finding is significant when compared to similar findings on the mediation of self-efficacy in technology adoption. As a result, it paves the way for researchers to carry out further investigations in the future.

With reference to using Importance-Performance Map Analysis (IPMA) technique to obtain accurate results, it was found that facilitating condition and self-efficacy do not significantly influence technology use. However, the findings indicate the need to focus on high-weights constructs; namely efforts expectancy, social influence, and performance expectancy. This step offers stakeholders with a broad view on building strategies and focusing on high-importance constructs.

9 Conclusion and Future Work

This study contributes to the perspectives of knowledge that can be envisaged to take an initial step toward extending and validating existing studies on factors influencing behavior intention to use IoT-platform services. This was achieved by examining the factors that affect the behavior intention to use IoT-technology using TAM and UTAUT models in the context of Nizwa College of Technology. The study expanded the model by adding self-efficacy as a new construct and a mediation factor in examining behavior intention to use IoT-platforms. The present study found unique results in the PE, EE, FC, and SE having neither positive nor significant influence on behavior intention to use IoT-platform services. It was found that only SI has this influence.

The study also revealed that, among all the factors, only self-efficacy was found to have no mediated effects on behavioral intention. Therefore, the present study has also confirmed the need to extend the target group to study the applicability of TAM and UTAUT in other Omani universities and colleges, in addition to the improvement of overall predictability of TAM.

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Evaluating the Impact of Knowledge Management Factors on M-Learning Adoption: A Deep Learning-Based Hybrid SEM-ANN Approach



Mostafa Al-Emran , Ghazanfar A. Abbasi , and Vitaliy Mezhuyev

Abstract This research aims to evaluate the impact of knowledge management (KM) factors, including acquisition, sharing, application, and protection on students' behavioral intention to use m-learning. Unlike the previous m-learning empirical studies which primarily relied on structural equation modeling (SEM) analysis, this research employs an emerging hybrid analysis approach using SEM and artificial neural network (ANN) based on deep learning. This research also applies the importance-performance map analysis (IPMA) to identify the importance and performance of each factor. Through the means of an online survey, a total of 319 IT undergraduate students have participated in the study. The findings indicated that all KM factors have significant positive impacts on m-learning adoption except knowledge sharing. The analysis of both ANN and IPMA revealed that knowledge protection is the most crucial predictor of behavioral intention. Theoretically, the proposed model has provided ample explanations concerning what impacts the behavioral intention to use m-learning from the perspective of KM factors at the individual level. Practically, the results will enable decision-makers and practitioners in higher educational institutions to determine which factors should be given more importance than others and strategize their policies accordingly. Methodologically, this research ascertains the capability of the deep ANN architecture in determining the non-linear relationships among the factors in the theoretical model.

Keywords Knowledge management factors · M-learning · Adoption · Deep learning · Artificial neural network · PLS-SEM · IPMA

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1 Introduction

Information and communication technologies (ICTs) have been extensively used in higher educational institutes as these technologies have changed the landscape through which the students learn, communicate, and collaborate [1–3]. Mobile learning (m-learning) as one of such technologies, refers to the learning that is engaged with the mobility of learners using small computerized digital devices in “anytime anywhere” settings [4]. In this research, m-learning is defined as the learning that is concerned with the mobility of the student where knowledge can be personally managed using mobile applications.

From the m-learning perspective, it has been suggested that knowledge management factors (i.e., acquisition, sharing, application, and protection) need to be incorporated in m-learning systems in order to improve the learners’ learning capabilities [5]. With regard to KM, m-learning is one of the KM practices that supports a reliable learning atmosphere, in which knowledge has been effectively acquired and shared among individuals [6, 7].

A recent systematic review indicated that KM factors have significant impacts on adopting many technologies [8]. For example, Lin and Lee [9] investigated the impact of knowledge acquisition, knowledge sharing, and knowledge application on the adoption of e-business systems. The findings revealed that the adoption of e-business systems is positively influenced by all KM factors. Additionally, Garrido-Moreno et al. [10] examined the effect of knowledge acquisition, sharing, and application on customer relationship management (CRM) success. The findings showed that CRM success is positively affected by all KM factors. Further, Cheung and Vogel [11] explored the influence of knowledge sharing on Google applications adoption. The findings revealed that knowledge sharing has a positive influence on Google applications adoption. Moreover, Arpacı [12] examined the influence of knowledge creation and discovery, knowledge sharing, knowledge application, and knowledge storage on cloud computing adoption. His results pointed out that perceived usefulness of cloud computing services is significantly influenced by knowledge sharing, knowledge creation & discovery, and knowledge storage.

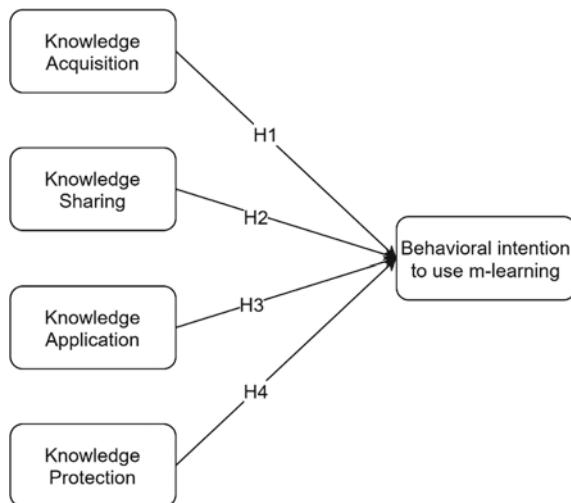
A tremendous amount of research indicated that KM factors have significant impacts on different technologies at the organizational level [9, 13, 14]. What is not yet clear is the influence of these factors on technology adoption at the individual level. While some studies have targeted the individual level [11, 12, 15, 16], these studies did not fully explore the four KM factors highlighted in this research. Further, prior research suggested examining the impact of KM factors on educational technologies (e.g., e-learning, m-learning) as educational institutes are the essential pillars for generating knowledge [8]. On the other side, there has been little agreement on the factors affecting m-learning adoption, and further research is highly encouraged to examine this phenomenon [17–19]. Therefore, the core theoretical contribution of the present study is to explore the influence of KM factors on m-learning adoption at the individual level.

In terms of methodology, most of the previous research studies have only considered the single-stage linear data analysis [20], particularly using the Structural Equation Modeling (SEM) approach. The single-stage of SEM analysis could only determine the linear relationships among the factors in the theoretical model, which could not be adequate to predict the complicated decision-making process [21]. To handle this limitation, some scholars have applied the Artificial Neural Network (ANN) approach as a second-stage of analysis [22, 23]. However, this approach involves a single hidden layer only, which has been considered as a shallow type of ANN [24]. It has been suggested to employ the deep ANN architecture instead of the shallow ANN as it could enhance the accuracy of non-linear models by using more than one hidden layer [25]. In line with these arguments, this research employs a hybrid SEM-ANN approach based on deep ANN architecture that provides deep learning.

2 Hypotheses Development and Research Model

The theoretical model examined in this research is shown in Fig. 1. It is suggested that the behavioral intention to use m-learning is influenced by four KM factors (i.e., acquisition, sharing, application, and protection). The description of each factor along with the developed hypotheses are discussed in the following subsections.

Fig. 1 Research model



2.1 *Knowledge Acquisition (KA)*

Knowledge acquisition (KA) refers to “the business processes that use existing knowledge and capture new knowledge” [13]. A considerable amount of research reported that KA has a significant impact on adopting several technologies [26, 27]. Hence, we propose the following:

H1: KA has a significant positive effect on the behavioral intention to use m-learning.

2.2 *Knowledge Sharing (KS)*

Knowledge sharing (KS) refers to “the business processes that distribute knowledge among all individuals participating in process activities” [13]. Prior research indicated that KS has a significant effect on adopting various technologies [28, 29]. Therefore, this leads to the following hypothesis:

H2: KS has a significant positive effect on the behavioral intention to use m-learning.

2.3 *Knowledge Application (KAP)*

Knowledge application (KAP) refers to “the business processes through which effective storage and retrieval mechanisms enable a firm to access knowledge easily” [13]. Several studies concluded that KAP has a significant impact on adopting various technologies [9, 14, 27]. Hence, we posit the following hypothesis:

H3: KAP has a significant positive effect on the behavioral intention to use m-learning.

2.4 *Knowledge Protection (KP)*

Knowledge protection (KP) refers to “the ability to protect organizational knowledge from illegal or inappropriate use or theft” [30]. Prior research pointed out that KP has a significant effect on adopting e-business systems [30]. Accordingly, this study proposes the following hypothesis:

H4: KP has a significant positive effect on the behavioral intention to use m-learning.

3 Research Methodology

3.1 Context and Subjects

The sample of this research consists of the IT undergraduate students registered at Al Buraimi University College (BUC) in Oman. The targeted students were enrolled in three different majors, including information systems, computer science, and software engineering. The students were requested to take part in the study through emails that include the survey link. The convenience sampling approach is employed to select the participants. A total of 319 students have successfully completed the online survey. Out of the 319 respondents, there were 166 females and 153 males. Moreover, about 69% of the respondents are aged between 18 and 22 years old.

3.2 Research Instrument

The survey instrument involves two parts. The first part collects the demographic information from the students, whereas the second part gathers answers for the indicators involved under each factor. The indicators that represent the factors were adopted from the previous literature and were measured using a five-point Likert scale ranging from “1 = Strongly Disagree” to “5 = Strongly Agree”. The indicators used for measuring KA, KS, KAP, and KP were adopted from Al-Emran et al. [5] and Al-Emran et al. [31].

3.3 Data Analysis

Unlike the prior empirical studies that employed the single-stage analysis through SEM, this research applies a hybrid SEM-ANN approach based on deep learning to validate the hypothesized relationships among the factors in the research model. This approach involves two phases. First, analyzing the proposed research model using the partial least squares-structural equation modeling (PLS-SEM) using SmartPLS [32]. The main purpose of employing PLS-SEM in this study stems from the exploratory nature of the theoretical model and the absence of previous related literature. This study follows the general guidelines for using the PLS-SEM in information systems research [33]. As suggested in prior research [34], a two-step approach (i.e., measurement model and structural model) needs to be followed to analyze the research model. As an advanced technique in PLS-SEM, this research also applies the importance-performance map analysis (IPMA) to identify the importance and performance of each construct in the research model.

Second, the ANN is adopted to investigate, complement, and authenticate the PLS-SEM analysis and determine the effectiveness of independent variables on the

dependent variable. The ANN is regarded as a function approximation instrument that is appropriate in situations where the nature of the collaboration among input(s) and output(s) is complex and nonlinear. ANN entails three essential mechanisms, including network architecture, learning rule, and transfer function [35], which additionally cascades into subcategories, namely radian basis, feed-forward multilayer perceptron (MLP) network, and recurrent network [21]. The MLP neural network is one of the most widely applied approaches, and it is comprised of several layers, such as input and output. The input and output layers are further connected to each other through hidden nodes. The input layer includes some neurons (i.e., independent variables) which take the raw data and forward it to the hidden layers in the form of synaptic weights. The output of each hidden layer is based on the choice of an activation function. The sigmoidal function is regarded as the most commonly applied activation function [36, 37]. Consequently, this study espouses the MLP neural network to train and test the proposed research model.

4 Results

4.1 Measurement Model Assessment

It has been suggested that both reliability and validity should be verified during the assessment of the measurement model [38]. Reliability is usually evaluated by “Cronbach’s alpha (CA)” and “composite reliability (CR)” [38]. The values of both CA and CR should be equal to or greater than 0.70 in order to be accepted [38]. As shown in Table 1, both reliability measures are confirmed.

For validity testing, it has been argued that both “convergent validity” and “discriminant validity” should be confirmed [38]. In order to assess the “convergent validity”, the indicators loadings and the Average Variance Extracted (AVE) should be examined. To comply with the accepted cut-off values [34], the values of AVE should be equal to or greater than 0.50, whereas the values of indicators loadings should be equal to or greater than 0.70. The results in Table 1 demonstrate that the values for indicators loadings and AVE are accepted, and therefore, the “convergent validity” is confirmed. In order to assess the “discriminant validity”, Henseler et al. [39] suggested testing the “Heterotrait-Monotrait ratio (HTMT)” of correlations. A value of less than 0.85 should be ascertained. According to Table 2, the HTMT results are regarded to be satisfactory; and hence, the “discriminant validity” is ascertained.

4.2 Structural Model Assessment

After meeting the measurement model criteria, the next step is to test the proposed hypotheses through the structural model. To check the significance of the hypotheses,

Table 1 Reliability and convergent validity results

Constructs	Items	Factor loading	Cronbach's alpha	CR	AVE
BI	BI1	0.888	0.871	0.921	0.795
	BI2	0.894			
	BI3	0.893			
KA	KA1	0.838	0.865	0.903	0.650
	KA2	0.803			
	KA3	0.782			
	KA4	0.797			
	KA5	0.809			
KAP	KAP1	0.849	0.864	0.908	0.711
	KAP2	0.841			
	KAP3	0.854			
	KAP4	0.827			
KP	KP1	0.849	0.861	0.906	0.706
	KP2	0.855			
	KP3	0.872			
	KP4	0.783			
KS	KS1	0.821	0.860	0.899	0.642
	KS2	0.790			
	KS3	0.831			
	KS4	0.793			
	KS5	0.767			

Table 2 HTMT results

	BI	KA	KAP	KP	KS
BI					
KA	0.662				
KAP	0.734	0.747			
KP	0.782	0.670	0.810		
KS	0.657	0.789	0.836	0.840	

a nonparametric bootstrapping process with 5000 iterations was employed [40]. The statistical results indicated that the four KM factors had explained 53.5% of the variance in BI. In addition, the hypotheses testing results are provided in Table 3. Based on the beta values, *t*-values, and *p*-values, it is evident that all the proposed hypotheses were accepted with an exception to H2.

Table 3 Hypotheses testing results

Hypotheses	Beta	T-value	P-value	Remarks
H1: KA → BI	0.209	3.278	0.001	Accepted
H2: KS → BI	-0.048	0.622	0.267	Rejected
H3: KAP → BI	0.242	2.944	0.002	Accepted
H4: KP → BI	0.423	5.889	0.000	Accepted

4.3 ANN Results

The ANN analysis is performed using Python. The ANN analysis relies only on the significant predictors generated from the PLS-SEM results. In that, only the KA, KAP, and KP factors are considered for the ANN analysis. As shown in Fig. 2, the ANN model consists of one output neuron (i.e., behavioral intention) and several input neurons (i.e., KA, KAP, and KP). Two-hidden layer deep ANN architecture was employed to allow deeper learning and to take place for each of the output neuron node [41]. This research employs the sigmoid function as the activation function for both hidden and output neurons. Similarly, the range for both input and output neurons is standardized between [0, 1] to augment the performance of the proposed research model [42]. To avoid the overfitting in ANN models, a ten-fold cross-validation technique was employed with a ratio of 90:10 for both training and testing data, respectively [36]. Concerning the accuracy of the neural network

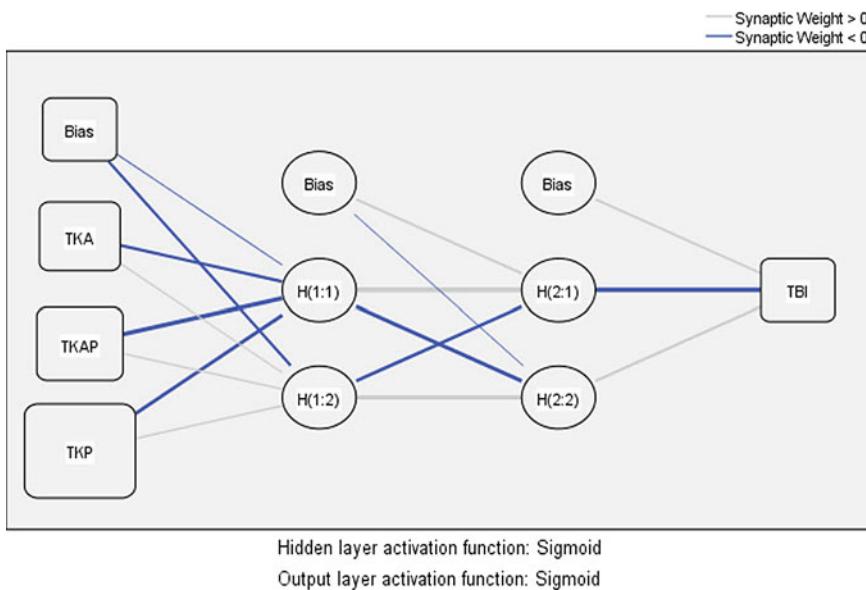
**Fig. 2** ANN model

Table 4 RMSE values

Model (BI)	
Training	Testing
0.152	0.156
0.135	0.1541
0.138	0.1295
0.138	0.1419
0.141	0.1499
0.137	0.1301
0.136	0.1405
0.138	0.1334
0.141	0.1421
0.139	0.1273
Mean	0.1394
SD	0.0046
	0.1405
	0.0098

model, the root mean square of error (RMSE) is suggested. As per the results shown in Table 4, the RMSE values of the ANN model for both training and testing data are 0.1394 and 0.1405, respectively. Due to the minuscule variances among RMSE values and the standard deviation for both training and testing data (i.e., 0.0046 and 0.0098), it can be suggested that the proposed research model accomplishes higher precision with the application of ANN.

4.4 Sensitivity Analysis

To compute the normalized importance, the average of each predictor is used against the highest mean value, articulated in percentage. Table 5 shows the mean importance and the normalized importance of all the predictors used in ANN modeling. According to Table 5, the findings of the sensitivity analysis indicate that KP is the most crucial predictor of behavioral intention, followed by KAP and KA. To further authenticate and validate the accuracy and performance of the ANN application, it was suggested to estimate the goodness of fit, which is similar to R^2 in PLS-SEM analysis [43]. Based on that, the results reveal that the predictive power of ANN analysis ($R^2 = 79\%$) is much higher than that of PLS-SEM ($R^2 = 53.5\%$). These findings indicate that the endogenous constructs are rigorously elucidated by the ANN method compared to that of the PLS-SEM. Besides, the difference in variances can also be attributed to the superiority of the deep learning ANN approach in determining the non-linear relationships among the constructs.

Table 5 Sensitivity analysis

Importance	KA	KAP	KP
ANN1	0.292	0.376	0.332
ANN2	0.243	0.289	0.469
ANN3	0.240	0.284	0.476
ANN4	0.247	0.270	0.483
ANN5	0.329	0.277	0.394
ANN6	0.221	0.290	0.489
ANN7	0.237	0.242	0.522
ANN8	0.240	0.283	0.477
ANN9	0.282	0.362	0.356
ANN10	0.264	0.294	0.442
Mean relative importance	0.26	0.30	0.44
SD	0.03097	0.03887	0.0593
Normalized relative importance (%)	58	67	100
Ranking	3	2	1

4.5 *Importance-Performance Map Analysis*

In this research, we have applied the IPMA as an advanced technique in PLS-SEM using the behavioral intention as the target variable. Ringle and Sarstedt [44] stated that IPMA improves the understanding of PLS-SEM analysis findings. As an alternative for only testing the path coefficients (i.e., importance measure), IPMA also involves the average value of the latent constructs and their indicators (i.e., performance measure) [44]. The IPMA suggests that the total effects indicate the predecessor factors' importance in framing the target factor (i.e., behavioral intention), whereas the average of latent constructs' values indicates their performance.

Figure 3 shows the IPMA results. In that, the importance and performance of the four KM factors (i.e., acquisition, sharing, application, and protection) were calculated. The results suggest that KP exhibits the highest values with respect to both importance and performance measures. In addition, it can be noticed that KAP exhibits the second highest values with regard to importance and performance measures. Besides, KA exhibits the third highest value concerning the importance measure, but it indicates the lowest value on the performance measure. While KS exerts the lowest value on importance measure, it is worth mentioning that it has the highest similar value to the KP on the performance measure.

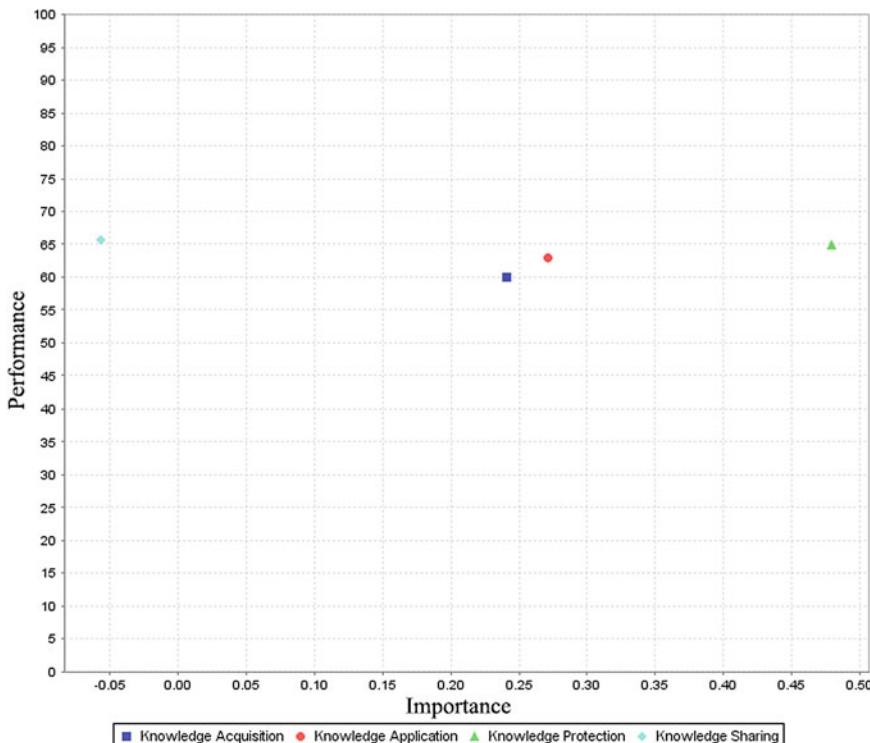


Fig. 3 IPMA results

5 Conclusion

5.1 Study Implications

This research offers a number of theoretical, practical, and methodological implications. Theoretically, this study is one of the forefront studies that investigated the direct impact of four KM factors (i.e., acquisition, sharing, application, and protection) on the behavioral intention to use m-learning at the individual level. We, therefore, believe that the proposed model had provided ample explanations concerning what impacts the behavioral intention to use m-learning from the perspective of KM factors. Practically, the results of this research will enable decision-makers and practitioners in higher educational institutions to determine which factors should be given more importance than others and strategize their policies accordingly.

Methodologically, unlike the previous empirical studies which primarily relied on SEM analysis, this research has contributed to the extant literature in general and the m-learning domain in specific by employing a hybrid SEM-ANN approach based on deep learning. The predictive power of the ANN model is considerably higher

than that of PLS-SEM. We believe that the higher predictive power obtained through the ANN analysis is stemmed from the capability of the deep ANN architecture in determining the non-linear associations among the factors in the theoretical model.

5.2 Limitations and Future Work

This research is limited by the sample through which the data were collected. The data were collected from one academic institute, and therefore, generalizing the outcomes to the other institutions should be treated with caution. It is advised to test the proposed model in other academic institutions in other developing or developed countries to verify the effectiveness of the model in predicting the behavioral intention to use m-learning systems from the standpoint of KM factors. Moreover, the collected data were obtained through a questionnaire survey only. Therefore, future research might use other methods like interviews or focus groups besides surveys to further enlighten and interpret the causal-relationships among the factors in the research model.

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Exploring the Determinants Affecting the Students' Engagement with Online Learning: A Preliminary Investigation



Junaid Hassan and Fayaz Ahmad Nika

Abstract Innovative insurgency and advancements have cut a path for improving new, successful, productive, and reliable conveyance and preparing channels. It has prompted the presentation of creative items and administrations in the education sector. As such, there has been a paradigm shift from classroom learning to online educational portals and learning applications. Since the inception of online learning, scholars have been doing marvelous work and over the period of time have identified different variables that impact students' intention towards the adoption of online education. But, if we look from the perspective of India, research within the segment of online education remains to be in its earliest phases. In that limit, there is a prerequisite for the better intellectual capacity of the components that sway the acknowledgment of online education. This investigation was completed in the union territory of Jammu and Kashmir and using purposive sampling method, 460 respondents were focused on, which finally resulted in 403 functional responses. The results uncovered that the dimensions; Perceived usefulness, Perceived ease of use, Facilitating Conditions, Relative Advantage, Perceived self-efficacy, Social Influence, Trust and Awareness have a positive influence on students' intention to acknowledge online learning. Considering the developing significance of online education in day to day affairs of students, this investigation is a substantial contribution. The outcomes of this investigation will provide useful insights to the academicians, policymakers and marketers.

Keywords Jammu and Kashmir · Online learning · Perceived ease of use · Perceived usefulness · Social influence

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1 Introduction

Amid the circumstance approaching all around the globe, education sits at the cusp of change. The emergence of natural disruption has not only affected the ordinary calendar of individuals but has also posed a severe challenge in maintaining educational delivery services. To ensure that students are not deprived of their fundamental right of education and their future is sans peril, the policymakers and instructors are ensuring that access to knowledge is guaranteed through different mechanisms of innovation [1]. The management of diverse learning establishments is being called upon to develop alternative tactics to deliver online learning to alleviate the distraction of education delivery. However, the constrained supplies, assets, and challenging geographical context may result in long postponements before education resumes its track once more, resulting in children losing the time of tutoring. To ensure the delivery of education services amid the closure of educational establishments, innovation turns into an instructive need, a social need and a national need [2]. It can provide access to education for learners who often cannot assemble in conventional school settings at present. Among these advancements, online learning serves as the key player as far as promotion and diligence of education are concerned [3].

Online learning is one of the creative enhancements that can be a potential methodology at present to ensure diligent education amid the closure of educational institutes and offer substantial benefits and learning opportunities to students, including the convenience of time and place [4]. It incorporates the elements of both online instruction and online student learning [5]. While online training incorporates the utilization of innovation, it isn't equivalent to innovation used in the study hall where potentially physical research facilities use an online segment to support education and guidance [6]. Nonetheless, the challenge stays to be on the bleeding edge since this new and dynamic strategy for educating has not been rehearsed to a colossal degree in India until now. In addition, there is a challenge of creating awareness among the instructors and the students since the magnitude of students does not coordinate with the expectations, thereby warrants further examinations. In the past years, much attention has been given to explore the traditional means of imparting education as it was the lone way of imparting education. However, the emergence of online education created a new era in the field of innovations. Researchers began looking at it as a possibly robust medium for offering education and started researching the students i.e. How, when, where they use such a potent medium. The extant literature reveals that a colossal number of elements create a notion within a student's mind. Usually, students opt for online education when they develop a sense that it fulfills their needs. Conversely, some rule in opposition to it if they see the development to be flighty and challenging to utilize. Despite the fact that online learning can't supplant human connection [6], no medium is at disposal that can be utilized at present. This paper endeavors to highlight the determinants that impact a student in acknowledging online learning when formal, eye to eye instruction can't be conveyed.

2 Literature Review

The requirement for instructive advancements has got intense. It is broadly accepted that nations' social and monetary prosperity relies upon the nature of their residents' education. The present frameworks of education are required to be viable and effective, or at the end of the day, to arrive at the objectives set for it while utilizing accessible assets [7]. Among the viable sources that fit the standard of learning, online learning serves one among them. Online learning is defined as an education procedure where learning materials are conveyed through innovative devices utilizing the internet. It depends on an assortment of inventive apparatuses to convey learning materials and guidance, including sight and sound applications, web-based life devices, print materials, email, the web program, and sound and video conferencing. The market of online education, as predicted by marketers, in India is expected to grow \$1.96 billion by 2021.

In today's era, a student, before adopting any new advancement, makes sense of its advantages and disadvantages. To figure out the reasons behind the students' adoption of online learning, the current investigation was undertaken. For the development of the questionnaire for this study, items were adopted from the researches carried by diverse researchers representing seven independent factors along with one dependent variable including Perceived Usefulness, Perceived Ease of Use, Social Influence, Facilitating Conditions, Relative Advantage, Trust, Perceived Self Efficacy, Awareness, and Intention.

3 Research Model and Hypotheses Development

3.1 *Perceived Usefulness (PU)*

PU refers to how much utilizing a particular item will expand a person's ability to gain preferred purpose or wanted objective. The principal conception that makes use of "Perceived Usefulness" as a precursor of the acknowledgment of the latest technologies is the "Technology Acceptance Model" which was proposed by "Davis" [8]. Over the preceding literature, PU has been seen as a standout amongst the mainly powerful drivers of Behavioral Intention to acknowledge online learning [9–12]. However, in this study, it is defined as the extent to which online learning will serve a students' purpose in fulfilling his/her need for education. As such, it is hypothesized that:

H_{1a}: "Perceived Usefulness has a significant impact on students' intention to adopt online learning".

3.2 Perceived Ease of Use (PEOU)

PEOU is characterized as how much an individual trusts that utilizing a specific framework/approach would be free of exertion [13]. “Perceived ease of use” is the precursor of Technology Acceptance conception (TAM), which predicts the appropriation of new advanced and innovative technologies by the people. Due to the meticulous character of online learning which entails a positive level of familiarity and proficiency, PEOU may perhaps dole out a decisive position in shaping the students’ intention to play such technology. This contemplation has been pragmatically supported by diverse studies [9, 11, 14–16]. In the context of this study, PEOU is outlined as how much a student trusts that online learning will mostly be effortless to become skillful at and to operate. As such, it is hypothesized that:

H_{1b} : “Perceived Ease of Use has a significant impact on students’ intention to adopt online learning”.

3.3 Social Influence

Social influence is one of the main factors of the “Theory of Planned Behavior” (TPB) propounded by Ajzen [17]. “It is also known as social norms, subjective norms, or normative pressure” [18]. It has been characterized as the degree of influence that others’ opinions can have on the adoption of a given system [11]. The prior literature has established that it has a significant influence on the intention of students to adopt online learning [14, 19–21]. Social Influence in the context of this study is illustrated as the driver which pushes a student into consenting to the choices offered by the societal individuals’ regarding online learning that are imperative to him. Subsequently, it is hypothesized that:

H_{1c} : “Social Influence has a significant impact on students’ intention to adopt online learning”.

3.4 Facilitating Conditions

Facilitating conditions or encouraging conditions is defined as “the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system” [22]. Terry [23] referred to it as the outside controls that act as a catalyst within the embracing conditions to encourage the acknowledgement and dispersion of new technological advancements. “Facilitating Conditions” serve as an antecedent of the TTF conception which was set forth by Goodhue and Thompson [24] and UTAUT which was propounded by Venkatesh et al., [22]. Over the preceding literature, Facilitating Condition has been seen as a standout amongst the mainly powerful drivers of behavioral intention to acknowledge online learning

[20, 21, 25–27]. However, in this study Facilitating Conditions alludes to the level of compatibility that a student perceives in terms of the knowledge, resources, and support which will in general increment their inclination to online learning services. Subsequently, it is hypothesized that:

H_{1d} : “Facilitating Conditions have a significant impact on students’ intention to adopt online learning”.

3.5 *Relative Advantage*

Relative advantage is a discussion of every person in the present times. It is quite apparent from our day to day lives that each and everything is being compared (whether it is product, service, or any technological development) with its forerunner. It is being assessed what edge a product, service, or a particular technology provides than its precursor. As such the construct has been under the lens of researchers and a number of studies in the past have incorporated this. “Relative Advantage” is characterized as how much an advancement presents extra advantages than its forerunner. The predominant conception utilizing “Relative Advantage” as the key driver that impacts the selection of a new innovation is the IDT put forth by Rogers [27]. The studies of Hsbollah, [28] Pillai and Sivathanu [29] established that Relative Advantage has a significant influence on adoption decisions. However, this study, Relative advantage alludes to the extent to which online learning is perceived as a better alternative in terms of offering greater value to students than other forms of education. Consequently, it is hypothesized that:

H_{1e} : “Relative Advantage has a significant impact on students’ intention to adopt online learning”.

3.6 *Trust*

Trust has been characterized as a person’s eagerness to acknowledge vulnerability on the grounds of constructive expectations regarding the habits or intention of one another in a circumstance described by interdependence and threats. “...It is basically built on two dimensions, one being believability and the other being generosity. Believability is the conviction that business partners will fulfill their roles effectively, adequately, and dependably, while generosity is the conviction that business partners have the expectation and inspiration to give benefits in explicit new circumstances” [30]. “Trust’ serves as a key driver as far as rejection or acknowledgment of an item or innovation is concerned and develops over a span of time as a result of expertise and familiarity with an offering. It has been established in the prior literature that it has a significant and momentous impact on student’s intention to acknowledge online learning [21, 31–33]. In line of this study, Trust is defined as a belief that students endow in online learning in terms of meeting the expectations and serving the purpose

of performing educational exchanges optimistically. Therefore, it is hypothesized that:

H_{1f} : “Trust has a significant impact on students’ intention to adopt online learning”.

3.7 Perceived Self-Efficacy (PSE)

PSE has been defined as an individual’s potential to ace an undertaking or circumstance and thereby effectively arrive at a preferred effect [34]. Bandura [35], defined Self-Efficacy as the conviction of one’s capacity to effectively perform the undertaken task and a measure to which one is optimistic about finishing the errand. The concept of Self-Efficacy is established within the “social cognitive theory,” which was propounded by Bandura in the year 1989. The earlier studies have proven that PSE is one of the prevalent beliefs that impact in acknowledging e-learning [2, 36–38]. In the context of this study, Perceived self-efficacy is defined as the extent to which a student believes that he’s embedded with a required set of competencies and capabilities to utilize the online learning and to acquire the anticipated outcome. Therefore, it is hypothesized that:

H_{1g} : “Perceived Self-Efficacy has a significant impact on students’ intention to adopt online learning”.

3.8 Awareness

Awareness has been characterized as a procedure of information, influence, choice, and affirmation by a customer before being prepared to undertake an offering i.e. product or service. It portrays a person’s information about the presence of a development. Awareness is viewed as one of the strategic develops that a user’s adoption intention and aids in reducing the negative effect on the apparent threat. It is explained as the key construct in the extant literature as far as acknowledgment of e-learning is concerned [19, 39]. However, in the setting of this study, Awareness is portrayed as how much a student realizes that online learning is accessible with the availability of adequate facilities and support, and if the same is put forth for use, it will be beneficial. Consequently, it is hypothesized that:

H_{01h} : “Awareness (AW) has a significant impact on students’ intention to adopt online learning”.

Figure 1 portrays the research model of this investigation as far as the past writing’s proposition. It exemplifies the factors that influence an understudy as far as recognizing online learning is concerned.

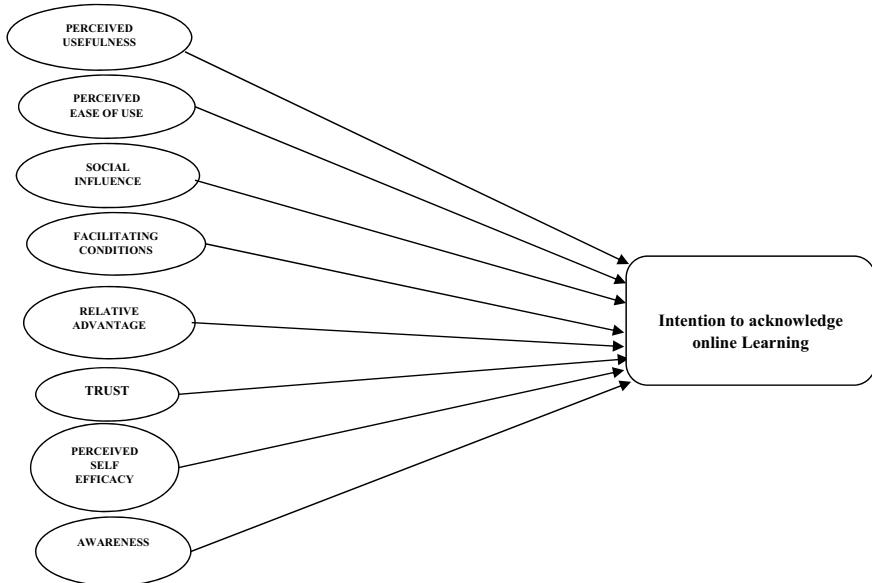


Fig. 1 Research model of the study

4 Methodology

A quantitative research design was used for this study. In order to infer the reaction about the facets associated with the intent of acknowledging online learning, an online survey was conducted. The link to the questionnaire was disseminated to 470 students. Purposive sampling method was adopted and the respondents were reached through various approaches (Direct contact, Referrals). Out of 470 questionnaires dispersed 427 questionnaires were returned, indicating a response rate of 92.82%. Out of 427 questionnaires honored, only 403 questionnaires were deemed to be fit for analysis.

5 Data Analysis

The demographic distinctiveness of the respondents' was scrutinized. Results revealed that the percentage of Males (65.85%) in the sample is more than that of Females (34.14%). The majority of respondents, 44.71%, belonged to the age group of 16–20, years followed by 47.64% in 21–25 years age group. Further, 7.65% belonged to the age group of 26 and above.

5.1 Normality-Multivariate Normality Tests (Skewness and Kurtosis)

In order to determine the normality, “Skewness” and “Kurtosis” were used in this study [40]. The outcomes were well inside the scope of ± 0.96 [41], portraying normality (Table 1).

5.2 Scale Properties

5.2.1 Reliability

The reliability of the instrument was assessed using the overall Cronbach Alpha. The Cronbach Alpha estimation determined through SPSS 20.0 was 0.841 (Refer Table 2), which is above the acceptable level of 0.70 in social sciences research [42], signifying that reactions are profoundly predictable and dependable.

5.2.2 Exploratory Factor Analysis

Using SPSS 20.0, the data collected was examined. So as to investigate the principal information structure, “Exploratory Factor Analysis” was performed [43], and to ensure the dimensionality, exploratory factor analysis was run independently for each construct at first. “Principal Component Analysis” with “Varimax rotation with Kaiser Normalization” [44] was utilized to exhibit the structure of variables and describe the things as indicated by their separate measurements. The criterion to select the items for the main study was laid down [45]; just those factors with factor stacking more prominent than or equivalent to 0.50 and Eigenvalue more than 1 were chosen. As such the EFA resulted in the extraction of 8 independent factors and 1 dependent factor (Refer Table 3).

5.3 Measurement Model

In order to assure the passable level of model fitness as well as construct validity and reliability, Confirmatory Factor Analysis was utilized and the outcomes specified an acceptable data fit for the model. The results showed that: Chi-square = 1237.356, with degree of freedom 332 at probability level = 0.000($P < 0.05$), AGFI = 0.817, CFI = 0.852, GFI = 0.877, RMSR = 0.063, NFI = 0.889 and RMSEA = 0.037.

In addition, validity and composite reliability (CR) were also assessed. The values of CR for all constructs are above the minimum acceptance level of 0.70 [46]. The

Table 1 Sample characteristics (skewness and Kurtosis)

Items	Skewness value	Kurtosis value
PU1	-0.529	-0.244
PU2	-0.12	-1.168
PU3	-0.212	-0.157
PU4	-0.254	-1.322
PE1	0.353	-1.040
PE2	0.553	-1.086
PE3	0.053	-0.785
PE4	0.191	-1.314
SI1	-0.431	-0.411
SI2	-0.394	-0.722
SI3	-0.756	0.577
SI4	-0.528	-0.355
SI5	-0.548	-0.723
FC1	-0.633	-0.489
FC2	-0.541	-0.757
FC3	-0.263	-0.177
FC4	-0.361	-1.022
FC5	-0.522	-0.890
RA1	-0.961	0.205
RA2	-0.454	-1.024
RA3	-0.893	0.518
RA4	-0.448	-0.818
TR1	-0.841	1.036
TR2	-0.425	-0.196
TR3	-0.851	0.317
TR4	-0.444	-0.931
TR5	-1.353	1.130
PSE1	-0.984	1.044
PSE2	-0.805	-0.392
PSE3	-0.711	0.708
AW1	-0.914	-1.025
AW2	-1.634	1.106
AW3	-1.461	0.407
AW4	-1.472	0.578
INT1	0.341	0.124
INT2	-0.623	0.145
INT3	-0.432	-1.294

Table 2 Overall reliability statistics (Cronbach's alpha)

Cronbach's Alpha	No. of Items
0.841	37

estimations of composite reliability for all develops are over the base acknowledgement level of 0.60 which thereby signifies the CR of the scale. In order to determine the validity of the scale, the Values of AVE (average variance extracted) were used. All the estimations of AVE were over the base limit level of 0.50 which affirms convergent validity for the constructs [47] (Table 4).

5.4 Regression Analysis

In order to establish whether the “independent variables” are statistically momentous in foreseeing the adoption of the students, the following regression equation was designed:

$$\begin{aligned} \text{Intention} = & \alpha_0 + \beta_1 \text{PU} + \beta_2 \text{PEU} + \beta_3 \text{SI} + \beta_4 \text{FC} \\ & + \beta_5 \text{RA} + \beta_6 \text{TR} + \beta_7 \text{PSE} + \beta_8 \text{AW} + \epsilon_i \end{aligned}$$

Using the SPSS 20.00, Regression analysis applied on the dependent variables and independent variable produced results as shown in Table 5 which summarizes our regression model.

The regression Table 5 summarizes the mannequin of the adoption dimensions with respect to the intention of students. R represents the correlation coefficient, the value of which is 0.78 that can be deciphered as the intention has a positive relationship with the “PU, PEU, PSE, Social Influence, Facilitating Conditions, Relative Advantage, Trust and Awareness” while as R^2 is the coefficient of determination, the value of which was found to be 0.6084, representing that 60.8% of the variation in adoption intention is explained by the “PU, PEU, PSE, Social Influence, Facilitating Conditions, Relative Advantage, Trust, and Awareness. Moreover, the model was found to be fit.

Table 6 shows that the model equation for our analytical model can be written as:

$$\begin{aligned} \text{Intention} = & \alpha_0 + (0.114) \text{ Perceived Usefulness} + (0.381) \text{ Perceived Use of Ease} \\ & + (0.074) \text{ Social Influence} + (0.072) \text{ Facilitating Conditions} \\ & + (0.76) \text{ Relative Advantage} + (0.124) \text{ Trust} \\ & + (0.036) \text{ Perceived Self Efficacy} \\ & + (0.911) \text{ Awareness} + \text{Error Term } (\epsilon_i) \end{aligned}$$

The parameter estimates of multiple regression show that Perceived Usefulness, Perceived Ease of Use, Facilitating Conditions, Relative Advantage, Trust, Perceived

Table 3 Rotated component matrix

	Component									
	1	2	3	4	5	6	7	8	9	10
PU1							.789			
PU2							.752			
PU3							.863			
PU4							.673			
PEU1									.622	
PEU2									.683	
PEU3									.729	
PEU4									.841	
SI1						.643				
SI2						.661				
SI3						.746				
SI4						.921				
SI5						.711				
FC1			.859							
FC2			.765							
FC3			.742							
FC4			.885							
FC5			.801							
RA1								.613		
RA2								.733		
RA4								.871		
RA5								.889		
TR1	.860									
TR2	.883									
TR3	.781									
TR4	.746									
TR5	.702									
PSE2					.866					
PSE3					.804					
PSE4					.839					
AW1			.874							
AW3			.669							
AW4			.793							
AW5			.802							
INT1									.842	
INT2									.808	

(continued)

Table 3 (continued)

	Component									
	1	2	3	4	5	6	7	8	9	10
INT4										.769

Extraction Method: Principal Component Analysis

Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 9 iterations

Self-Efficacy, Social Influence, and Awareness positively influence the adoption intention of students towards the online learning. As such, H_{1a} , H_{1b} , H_{1c} , H_{1d} , H_{1e} , H_{1f} , H_{1g} , and H_{1h} are accepted.

6 Conclusion

The equanimity of learning through online modes is on the upward push after the nation experienced the wave of the pandemic. The central government and the educational establishments since then have been encouraging to opt for online channels of delivering education. As a result of which there is a surge in the usage of online learning. The present study has attempted to empirically test the relation of various variables impacting a student as far as acceptance and rejection of online learning is concerned. From a theoretic viewpoint, this investigation has made some imperative offerings. The findings of this research are the foremost contribution to the under-researched domain. The contribution of this research is multifold. First, for researchers, this investigation provides an establishment to the additional headway of the acknowledgment and utilization of the lucid platform. Besides, the proposed model gives a comprehensive methodology since it has incorporated builds of well-known theories. Second, the outcomes of this examination will offer a course to the educational institutions regarding the understanding of the need of students. Third, the current model adds to the existing body of literature on education. Fourth, this study will persuade and prompt educational institutions to take critical consideration while implementing online learning platforms.

From the administrative point of view, the outcome of this study holds several ramifications for the upliftment of online learning services. The findings of the study uncovered that there is a significant positive relationship between PU and intention to adopt online learning among the students which indicates that students will adopt this service when they perceive this headway to be helpful. For this reason, the key holders and the educational establishments should come up with some ingenious strategies that may build up a conviction among the students that this new framework is more valuable than the customary procedure. Second, PEU has been found to have a significant positive impact on the students' intention to adopt online learning in which construes that they will acknowledge online learning only when they find it easy in terms of usage. For this rationale, the stakeholders should have to think about

Table 4 Discrimant Validity

	CR	AVE	PU	PEU	SI	FC	RA	TR	PSE	AW	INT
PU	0.844	0.589	0.768								
PEU	0.925	0.713	0.144	0.842							
SI	0.927	0.718	-0.200	-0.230	0.846						
FC	0.906	0.658	0.048	0.031	0.212	0.811					
RA	0.890	0.622	-0.078	0.262	-0.026	-0.019	0.787				
TR	0.903	0.702	0.440	0.051	-0.097	0.054	0.098	0.836			
PSE	0.905	0.709	0.294	-0.187	-0.056	-0.318	0.263	0.077	0.840		
AW	0.915	0.733	-0.190	-0.105	0.512	-0.035	-0.007	-0.146	-0.091	0.854	
INT	0.966	0.903	0.272	0.179	0.211	-0.035	-0.136	0.089	0.192	-0.086	0.949

Note 1 Values in the diagonal of the above matrix are the square root of the AVE

Note 2 PU-Perceived usefulness, PEU-Perceived ease of use, SI-Social influence, FC-Facilitating conditions, RA-Relative advantage, TR-Trust, PSE-Perceived self efficacy, AW-Awareness, INT-Intention

Table 5 Model summary

Model	R	R square	Adjusted R square	Std. error of the estimate
1	0.78 ^a	0.6084	0.547	0.40983

^aPredictors: (constant), "Awareness, trust, social influence, perceived self efficacy, perceived ease of use, facilitating conditions, relative advantage, perceived usefulness"

Table 6 Parameter estimates of multiple regression

Model		Unstandardized coefficients		T	Sig.	Collinearity statistics	
		B	Std. error			Tolerance	VIF
1	(Constant)	3.458	0.417		8.123	0.000	
	PU	0.114	0.046	0.106	2.345	0.018	0.721
	PEU	0.381	0.169	0.191	2.328	0.022	0.831
	SI	0.074	0.034	0.101	2.242	0.024	0.830
	FC	0.072	0.043	0.084	1.676	0.012	0.817
	RA	0.76	0.027	0.202	2.553	0.013	0.804
	TR	0.124	0.049	0.128	2.484	0.015	0.816
	PSE	0.036	0.053	0.036	1.669	0.003	0.788
	AW	0.911	0.041	0.094	2.112	0.037	0.702

^aDependent variable: intention

^b1 and 5% level was used

the design of the learning platforms. It ought to be developed according to the needs of the students and should be user-friendly. Third, it was also found that Facilitating Conditions have a positive and significant impact on the students' intention to adopt online learning, which surmises that students will embrace online learning when they have an impression that an institution or a platform possesses enough help administrations and assets. Considering this result, the stakeholders should enlarge and highlight their support services and assets so that students keep on adopting online learning. Other than that, constant attempts should be made to reach the students at regular intervals. Fourth, the Relative Advantage was accounted for having a positive and significant impact on the students' intention to adopt online learning which suggests that students will adopt online learning when they perceive something distinctive in comparison to the traditional methods of education. The stakeholders should keep on adding new highlights so that students feel that this progression is relatively valuable than standard ways. Fifth, trust also stands among the factors which impact the adoption intention of students in a positive and significant manner. It implies that students who believe that online learning is embedded with all the vital conventions will adopt online learning. Trust serves as the base of online learning. The stakeholders should give priority towards building trust among the students by providing hassle-free and

quick exchange administrations at whatever point performed regardless of the time and spot along with the necessary support. Sixth, Perceived Self Efficacy also stood among the key factors that impact the student's intention. It can be established that students have a considerable amount of information that is needed to use the online medium of education. However, the key figures of this sector should keep on highlighting the mediums through which students can upgrade their viability. Seventh, awareness likewise stood among the factors that impacts the adoption intention of students in a positive and significant manner. It induces that students who have an appropriate understanding of online learning will intend to use online learning continuously. The educational establishments and the policymakers for this purpose should keep on instructing the students by way of texts or emails about the structure and advantages of online learning. In order to deal with social influence, the educational establishments and the policymakers should try to spread the word of mouth and increase referral promotion schemes in society.

Alongside the significant findings, this investigation contains some limitations and requires further assessment and extra examination. The first and the main limitation of the study was that respondents were selected from the urban areas; future studies should take account of accomplices from both urban and rural areas. Second, the proposed model explained only 60.84% of the variance in the aim to utilize online learning services due to the proposed constructs. The subsequent studies should include more variables to the model. Third, the current study found that all eight factors significantly impact the students' intention of acknowledging online learning. This outcome does not conform to some of the investigations that have scrutinized the significance of these factors on students behavior worldwide. As such, investigators are aggravated to revise the indispensable role of these variables and the last being that the findings drawn from this investigation are based on cross-sectional data. Future studies should implement longitudinal studies.

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Cloud Computing Adoption in Higher Education: An Integrated Theoretical Model



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Abstract Several studies were carried out earlier to investigate the determinants affecting cloud computing adoption at the individual level. However, the question of what impacts the cloud computing adoption at the organizational level is still not yet fully answered. Therefore, this research develops an integrated theoretical model to explore the factors affecting cloud computing adoption at higher education institutions (HEIs). The developed theoretical model is based on the integration of four well-established models, including the technology-organizational-environmental (TOE) framework, the fit viability model (FVM), the diffusion of innovations (DOI), and the institutional theory (INST). The partial least squares-structural equation modeling (PLS-SEM) approach is used to validate the developed model based on survey data collected from 205 academics and IT staff. The results pointed out that 58.9% of the variance in cloud computing adoption is explained by the FVM and the INST theory factors. The validation of the developed theoretical model provides empirical evidence concerning what affects the HEIs to adopt cloud computing services. The findings of this research are believed to assist the top management in HEIs

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in strategizing cloud computing adoption by identifying the critical factors in their institutions.

Keywords Cloud computing adoption · Higher education · Technology-organizational-environmental framework · Fit viability model · Diffusion of innovations · Institutional theory · Organizational level

1 Introduction

The transformative advancements in digital technology that have arisen in the last part of the twentieth century have witnessed rapid rates of adoption in the developed world than in the developing world [1]. The typical factors impeding technology services adoption include knowledge, infrastructure, cost, government policy, education, user resistance, and security challenges [2]. Many of these factors are particularly salient in the developing world [3]. While this trend has continued in the early years of cloud computing, more recently, there has been considerable attention given to cloud computing in developing countries from global IT players such as IBM, Microsoft, VMware, and Amazon on the one hand, and national governments, international agencies, and IT firms on the other hand [4]. Cloud computing refers to “sharing computing technology services that provide accessible resources such as storage, computing control, and application delivered through the Internet as service” [5, 6].

In the education sector, there is an anticipation that the higher education institutions (HEIs) should keep pace with technology [7]. Previously, this has created an issue for such institutions due to the increasing costs in IT investments. Yet, the expectation is that the education services they provide to the community will be affordable while maintaining excellent quality [8–10]. Cloud computing is a good alternative to running own-managed systems that HEIs should consider due to the relative lack of in-house IT expertise [11], hardware upgrades, and software updates issues [12]. Given the lower cost of cloud computing services as compared to the traditional methods, it has been asserted that the cloud model will not only provide significant development opportunities for the developing world but will move forward to minimize the development gap with the West [4], as geographical factors will no longer dominate in determining who can and who cannot have access to leading-edge technologies.

Several studies on cloud computing have been carried out in small and medium enterprises [12, 13]. Nevertheless, a limited number of investigations have concentrated on cloud computing adoption and its use at the organizational level, particularly HEIs [14–19]. The decision to institutionalize cloud computing in the HEIs is slow, particularly in developing countries, which indicates a low success rate [8, 17]. This might be related to the absence of a suitable cloud computing adoption guideline and lacking successful stories from HEIs that have successfully adopted cloud computing [17]. Furthermore, cloud computing adoption studies, especially in developing countries, remain scarce [14–18]. Therefore, to address the gaps in the existing literature,

the main aim of this research is to identify and validate the significant factors affecting the HEIs to adopt cloud computing by developing an integrated theoretical model. The developed theoretical model is based on the integration of four well-established models, including the technology-organizational-environmental (TOE) framework [20], the fit viability model (FVM) [21], the diffusion of innovations (DOI) [22], and the institutional theory (INST) [23].

The methodological approach employed in this research is a mono quantitative using a questionnaire survey. The survey was distributed randomly to the academics and staff in Malaysian HEIs. The findings of this research may assist the top management in HEIs in strategizing cloud computing adoption by recognizing the essential factors in their institutions. This study applied structural equation modeling (SEM) for evaluating the determinants influencing cloud computing adoption, and predicting how cloud computing is adopted in HEIs.

2 Cloud Computing in Higher Education

There is no single definition for the notion of cloud computing as the discussion is still ongoing concerning this point. This stems from the similarity between cloud computing and other types of high-performance computing (HPC), such as grid computing, peer-to-peer computing, market and service-oriented computing, and cluster computing [24]. As the advancements in technology keep evolving, the debate concerning this issue continues. However, examining the extant literature on the topic exposes some mutual features across the different definitions.

The “National Institute of Standards and Technology (NIST)” defines cloud computing as a model that allows wide-ranging, on-demand, and network access to shared configurable computing resources, such as services, storage, applications, and networks. These resources can be provided swiftly and with minimal efforts by either the customer or provider [25, 26] as such resources could be used in integrating technologies that already exist, and introducing them in a new way to assist businesses in making a fundamental change in their operations [27]. This is accomplished by integrating existing technologies, such as grid computing, utility computing, and software-as-a-service (SaaS) [28]. The next-generation data centers that integrated virtual services (e.g., hardware, database, user interface, and application logic) in a network was the core objective for the employment of cloud technology [29]. Practically, these new data centers have enabled users to access their applications not only from one location but also from “anytime anywhere” settings.

Cloud computing has remarkably affected the field of information technology around the world, as it has appeared to be the most advanced and ground-breaking technology [30]. An important goal to be achieved in the upcoming years is to store and withdraw knowledge at “anytime anywhere” settings [17]. Several models and options are involved in the cloud; therefore, it is not easy to protect the knowledge and web from different devices and places (e.g., academic sectors) [18]. Furthermore, it offers remarkable knowledge space for storage and rapid processing, which

is mostly required by the educational institutions. As the standards of educational courses are constantly changing, the incorporation of such efficient technologies in the educational sector is considered significant [31]. Through this technology, the web can be accessed rapidly, and a huge amount of data can be stored.

Since cloud computing is much reliant on the usage and environments of the higher educational institutes, this may create hurdles in its adoption [32]. It has been stated previously that cloud computing can perform the functions of calculation and information storage effectively [5]. Cloud computing offers active measurability, virtualization technology, failure recovery, best server facilities, and on-demand cloud facilities, which are useful for increasing the adoption rate of cloud computing [1]. The additional process buffer of cloud computing is raised by active measurability without any extra investment by organizations. An essential characteristic of cloud computing is disaster recovery through which accessible information can be recovered rapidly from various sites to make it more inexpensive and useful [33]. Though, this technology creates hurdles in implementing the plans of disaster recovery as the higher education institutes manage the infrastructure of technology. Another significant characteristic of cloud computing is virtualization, which shows that the computing atmosphere does not appear to be real, the capacity of the hardware is further extended, and facilitating the reconfiguration technique in different codes [34].

3 Adoption Models and Theories

When the organization or individual (the adopter) goes through the process of considering a new product, idea, or service, this is known as the adoption process [22]. This process has a number of phases, and the outcome is the decision of whether or not to adopt the new item [35]. This is usually made by an entity about a certain object in a particular context. The outcome, or decision, has a number of influencing factors. In this study, the entity is the academics or staff in HEIs, and the object is the adoption of cloud computing. By analyzing the existing literature, it has been observed that while a number of studies considered the factors affecting the adoption of cloud computing at the individual level [5, 36, 37], there is a shortage of material concerning this issue at the organizational level [14–18]. The four dominant theories used to consider the adoption of technology from the organizational perspective are the TOE framework [20], the FVM [21], the DOI [22], and the INST theory [23].

3.1 *Technology-Organization-Environment Framework*

Tornatzky et al. [20] posit the notion that the TOE framework is able to define the innovation process within an enterprise context, as TOE considers that three aspects

of an enterprise-technology, organization, and environment can influence the adoption of innovation. In this framework, technology implies the technical knowledge that an enterprise has, both internally and externally, as well as the mechanization that may affect the potential for adoption. The characteristics of the company, including its communication channels and resources are covered by the organization, while the external forces, such as competition and the regulatory and market conditions can be placed under the environment aspect [20, 38, 39].

3.2 Diffusion of Innovation Theory

The DOI theory uses five stages to explain how the innovation process works within an organization [40]. The five stages are: knowledge, persuasion, decision, implementation, and confirmation. This theory is broad-based and offers a persuasive explanation of the process by which an enterprise may adopt new innovations. By concentrating on this process, the DOI theory provides a complementary perspective to the more technological focus of the TOE framework, and the two frameworks each add value to the other when used together [40].

3.3 Fit-Viability Model

The FVM model, which was initially proposed to analyze the adoption of Internet initiatives in organizations [21], has since been used to consider the adoption of new technology more broadly. The model considers two key elements, including technological characteristics or fit and organizational readiness or viability. This model can be viewed as an extension of the Task-Technology Fit model, which explores the effects of several factors in order to ascertain whether technology will benefit individual performance [41]. When an organization decides to implement a system that is dependent on new technology, a certain degree of risk is involved. It would, therefore, be of value to devise a model that can predict how new technology will work in practice within a given context [42]. The literature revealed that the DOI factors had a close relationship with the fit dimension, specifically its technological aspects [43].

3.4 Institutional Theory

In the institutional theory (INST), companies or organizations are acting as institutions as they influence the behavior and perceptions of their employees [23]. This theory provides a valuable understanding of how important the actions of an organization and its structure are [44]. More specifically, it suggests factors that may

influence or even constrain the adoption of new technology. When used alone, the INST theory does not consider factors that exist outside the institutional pressure, but when used in combination with the TOE framework, it provides a more precious insight that is further enhanced when combined with the DOI theory.

Three equal pressures on organizations are described by DiMaggio and Powell [45], and these include coercive, normative, and mimetic. The coercive concerns the pressure exerted on companies from external institutions, while normative pressure comes from regulation that affects the professional activity of the firm. The mimetic pressure describes how companies may mimic the way that other firms operate in order to respond to situations that are seen as risky or uncertain [46].

4 Research Model and Hypotheses

By analyzing the previous cloud computing studies reviewed in a recent study [19], it has been noticed that several studies have considered the adoption of technology through the medium of a single theory, while some had formulated their research based on two or more models. The use of a single theory presents some difficulties [47], as it cannot be applied to all kinds of innovations. Hence, a model of several theories is a more advantageous proposition when considering the innovation adoption process. Ideas from previous studies were considered as part of the literature review, and the information from these studies was filtered and consolidated so that the broad range of factors derived from past searches could be incorporated [48].

In this study, the research model integrates the four dominant theories used in studying the adoption of innovation at the organizational level, namely the FVM Model, TOE framework, DOI theory, and INST theory. The proposed hybrid model is believed to offer a superior framework by which the drivers of cloud computing adoption in HEIs can be determined (see Fig. 1). A review of the existing literature on the subject had suggested that the TOE framework and the DOI theory could be used in combination to increase the efficacy of the model with regard to IT adoption [49]. The enrichment of DOI by the TOE (specifically the TOE's technological context) [50] is mirrored by the combination of the INST theory and TOE framework (specifically the environmental context) [51].

When new technology is used to implement a system, a degree of risk is usually involved. Thus, it is valuable to develop a model that can predict how the new technology will be applied within a particular context. The context's readiness and the characteristics of the technology will affect the adoption of a new technological innovation [43], and the environmental characteristics will also exert their influence. The FVM model is useful in establishing whether or not cloud computing is appropriate in facilitating the delivery of cloud computing in HEIs. In this context, the fit is used to describe how far cloud computing is suitable for the delivery of services, and it can be measured by defining the tasks related to cloud computing. This is combined with the use of DOI factors to establish the effect of cloud computing on the HEIs [41]. The viability in this context describes how much added-value cloud computing

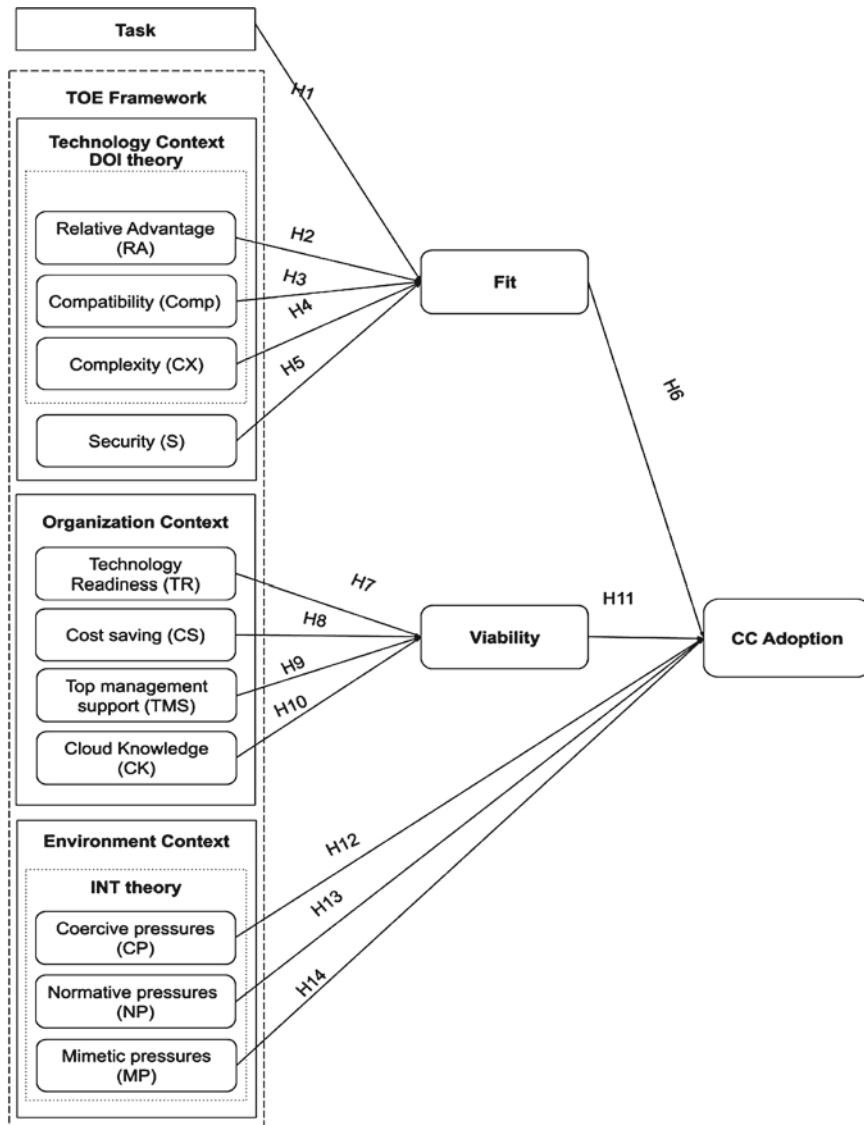


Fig. 1 Research model

might bring to the HEIs services and to what extent HEIs are ready for the adoption of this technology. These theoretical perspectives are significant in a way that they provide a hypothetical basis from which to assess the factors that affect the adoption of cloud computing in HEIs, including task, organization, technology, and environment characteristics. This approach has received a great deal of empirical support

in the previous literature [43, 50, 52]. Therefore, fourteen research hypotheses were formulated:

H1: Task positively influences the fitness of cloud computing to HEIs computing needs.

H2: Relative advantage positively influences the fitness of cloud computing to HEIs computing needs.

H3: Compatibility positively influences the fitness of cloud computing to HEIs computing needs.

H4: Complexity negatively influences the fitness of cloud computing to HEIs computing needs.

H5: Security concerns negatively influences the fitness of cloud computing to HEIs computing needs.

H6: The fitness of cloud computing has a positive influence on cloud computing adoption.

H7: Technology readiness has a positive influence on the viability of cloud computing adoption in HEIs.

H8: Cost saving has a positive influence on the viability of cloud computing adoption in HEIs.

H9: Top management support has a positive influence on the viability of cloud computing adoption in HEIs.

H10: Cloud knowledge has a positive influence on the viability of cloud computing adoption in HEIs.

H11: The viability of cloud computing has a positive influence on cloud computing adoption.

H12: Coercive pressures have a positive influence on cloud computing adoption.

H13: Normative pressures have a positive influence on cloud computing adoption.

H14: Mimetic pressures have a positive influence on cloud computing adoption.

5 Methodology

The methodological approach followed in this research is a mono quantitative using a cross-sectional questionnaire survey for data collection. The quantitative data are primarily used for examining the variables and validating the relationships hypothesized in the research model [53, 54].

The fifteen reflective constructs in the developed model were measured using 73 indicators adopted from the previous studies, as illustrated in Table 1. A note at the beginning of the questionnaire is added to explain the purpose of the research and state that the confidentiality of the data would be maintained. The questionnaire was divided into two parts. The first part of the questionnaire had demographic questions about the participants (gender, age, and education), while the second part involves questions measuring the fifteen constructs of the research model. The indicators related to each construct were measured using a five-point Likert scale using values ranging from “1 = strongly disagree” to “5 = strongly agree”.

Table 1 Constructs and their sources

Constructs	No of items	Sources
Task	4	[41, 55]
Relative advantage	6	[56, 57]
Compatibility	6	[56, 58]
Complexity	5	[59, 60]
Security concerns	4	[61, 62]
Fit	5	[41, 55]
Cost savings	5	[63]
Technology readiness	6	[39, 64]
Top management support	5	[65, 66]
Cloud knowledge	5	[67]
Viability	3	[41, 55]
Coercive pressures	4	[50]
Normative pressures	5	[50]
Mimetic pressures	5	[50]
Cloud computing adoption	5	[18, 55]

The population of interest consists of academics and IT staff working in Malaysian universities. An online survey was employed to collect data from the targeting population using Google Form. The link of the online survey was distributed randomly to the academics and IT staff in Malaysian HEIs via emails and through the Facebook groups pages of these institutions. A total of 205 usable questionnaires were collected for final data analysis. The collected data were analyzed using the partial least squares-structural equation modeling (PLS-SEM). PLS-SEM has a dual-stage analytical method, including the measurement model (i.e., “outer model”) and structural model (i.e., “inner model”) [68]. PLS-SEM also provides a parallel analysis of the measurement model and the structural model [69].

6 Results

6.1 Measurement Model Assessment

The measurement model specifies the relationship between the constructs and their indicators [70, 71]. To assess the measurement model, this study followed a set of procedures to evaluate the internal consistency reliability and convergent validity, as recommended by Hair Jr et al. [68]. The composite reliability (CR) and Cronbach’s alpha (CA) were employed to evaluate the reliability, while the average variance extracted (AVE) and factor loadings were used to evaluate the convergent validity.

Furthermore, the Heterotrait-Monotrait Ratio of correlations (HTMT) was used to assess the discriminant validity [71].

As per the readings in Table 2, the CA and CR values were all above the threshold value of 0.7 [68]. Therefore, the results illustrate that the items used to represent the constructs are reliable. Concerning the convergent validity, Table 2 demonstrates that the AVE is greater than 0.5 for all of the model constructs [68]. In addition, Table 2 shows that the factor loadings for all the instrument indicators have exceeded the threshold value of 0.70 except the indicator COMT1 that has a value of 0.667. According to Hair Jr et al. [68], we can remove the factor loading only if it falls below the cut-off value of 0.708 and causes low AVE value. Therefore, the indicator COMT1 is maintained in the model as the AVE values of all the constructs are above 0.50. Accordingly, the results indicate that the convergent validity is established.

In respect of the discriminant validity, Table 3 depicts that all the HTMT values were below the threshold value of 0.85. Therefore, the results confirm that there are no concerns in terms of discriminant validity [70, 71].

6.2 Structural Model Assessment

After validating the measurement model, the assessment of the structural model is considered as the second stage to evaluate the research model [68, 69]. To assess the structural model, there are several criteria to be considered. The structural model is estimated using the structural equation modeling (SEM) by calculating the coefficient of determination (R^2) [72], path-coefficients (β -values), t -values, and p -values using the bootstrapping and following the one-tailed tests with 1.65 at a significance level of 5% as suggested by [68, 69]. The path coefficients have standardized values ranging between (-1) and (+1). The estimated path coefficients close to (+1) represent strong positive relationships and vice versa for negative values [68, 69].

According to Cohen [72], the R^2 is a measure of the model's predictive accuracy and is calculated as the squared correlation between a specific endogenous construct's actual and predicted values. The R^2 values of 0.75, 0.50, or 0.25 for endogenous constructs can, as a rough rule of thumb, be respectively described as substantial, moderate, or weak. Based on the R^2 values shown in Table 4, the three endogenous constructs, including CC adoption, Fit, and Viability have the R^2 values of 0.589, 0.688, and 0.309, respectively. This indicates that the R^2 values satisfy the requirements.

As per the results in Table 5, the hypothesized relationships among the constructs have been assessed through the path coefficients, t -values, and p -values. As shown in Table 5, it is evident that all the proposed hypotheses were supported with an exception to H9, H10, H12, and H14 that were rejected. It is also clear from the results that the viability construct represents the most crucial factor affecting the cloud computing adoption in HEIs ($\beta = 0.524$).

Table 2 Reliability and convergent validity

Constructs	Items	Factor loading	Cronbach's alpha	CR	AVE
Cloud computing adoption	CCA1	0.865	0.906	0.930	0.728
	CCA2	0.887			
	CCA3	0.884			
	CCA4	0.820			
	CCA5	0.808			
Cloud knowledge	CK1	0.850	0.870	0.905	0.657
	CK2	0.771			
	CK3	0.757			
	CK4	0.871			
	CK5	0.799			
Coercive pressures	CP1	0.841	0.831	0.887	0.665
	CP2	0.889			
	CP3	0.708			
	CP4	0.812			
Cost savings	CST1	0.884	0.934	0.947	0.750
	CST2	0.890			
	CST3	0.873			
	CST4	0.863			
	CST5	0.829			
Compatibility	COMT1	0.667	0.874	0.906	0.616
	COMT2	0.793			
	COMT3	0.755			
	COMT4	0.823			
	COMT5	0.841			
	COMT6	0.819			
Complexity	CMX1	0.817	0.893	0.921	0.701
	CMX2	0.828			
	CMX3	0.843			
	CMX4	0.833			
	CMX5	0.865			
Fit	FIT1	0.773	0.894	0.922	0.704
	FIT2	0.832			
	FIT3	0.868			
	FIT4	0.853			
	FIT5	0.864			
Technology readiness	TR1	0.760	0.884	0.912	0.634

(continued)

Table 2 (continued)

Constructs	Items	Factor loading	Cronbach's alpha	CR	AVE
	TR2	0.800			
	TR3	0.892			
	TR4	0.867			
	TR5	0.718			
	TR6	0.726			
Mimetic pressures	MP1	0.795	0.898	0.924	0.710
	MP2	0.858			
	MP3	0.874			
	MP4	0.847			
	MP5	0.836			
Normative pressures	NP1	0.759	0.874	0.908	0.665
	NP2	0.869			
	NP3	0.838			
	NP4	0.821			
	NP5	0.785			
Relative advantage	RA1	0.813	0.939	0.952	0.768
	RA2	0.865			
	RA3	0.882			
	RA4	0.916			
	RA5	0.904			
	RA6	0.874			
Security concerns	SC1	0.927	0.937	0.955	0.841
	SC2	0.909			
	SC3	0.931			
	SC4	0.900			
Top management support	TMS1	0.831	0.911	0.934	0.738
	TMS2	0.863			
	TMS3	0.900			
	TMS4	0.825			
	TMS5	0.874			
Task	Task1	0.738	0.829	0.883	0.654
	Task2	0.855			
	Task3	0.812			
	Task4	0.825			
Viability	VI1	0.852	0.873	0.922	0.797
	VI2	0.911			
	VI3	0.914			

Table 3 HTMT results

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CCA															
CMX	0.428														
COMT	0.515	0.482													
CP	0.573	0.416	0.572												
CST	0.521	0.349	0.634	0.519											
CK	0.541	0.298	0.559	0.749	0.515										
FIT	0.589	0.657	0.817	0.602	0.656	0.556									
TR	0.309	0.283	0.544	0.565	0.471	0.628	0.414								
MP	0.496	0.266	0.389	0.671	0.453	0.612	0.389	0.550							
NP	0.598	0.375	0.541	0.698	0.535	0.776	0.536	0.586	0.735						
RA	0.478	0.358	0.683	0.451	0.524	0.495	0.671	0.325	0.399	0.584					
SC	0.733	0.294	0.465	0.590	0.523	0.548	0.563	0.306	0.496	0.544	0.489				
TMS	0.487	0.374	0.612	0.533	0.608	0.575	0.595	0.618	0.328	0.479	0.519	0.456			
Task	0.263	0.277	0.311	0.336	0.155	0.215	0.362	0.148	0.163	0.207	0.122	0.273	0.242		
VI	0.802	0.315	0.575	0.512	0.517	0.458	0.571	0.483	0.456	0.514	0.436	0.600	0.488	0.233	

Note: RA relative advantage, COMT compatibility, CMX complexity, SC security concerns, CST cost savings, TR technology readiness, TMS top management support, CK cloud knowledge, CP coercive pressures, NP normative pressures, FIT fit, Task task, VI viability, and CCA cloud computing adoption

Table 4 Coefficient of determination (R^2) results

Endogenous constructs	R^2
CC adoption	0.589
Fit	0.688
Viability	0.309

Table 5 Hypotheses testing results

Hypotheses	Path	Path coefficient	T-value	P-value	Results
H1	Task → FIT	0.090	1.939	0.026	Supported
H2	RA → FIT	0.196	3.002	0.001	Supported
H3	COMT → FIT	0.384	5.416	0.000	Supported
H4	CMX → FIT	0.293	4.751	0.000	Supported
H5	SC → FIT	-0.165	3.096	0.001	Supported
H6	FIT → CCA	0.132	1.957	0.025	Supported
H7	TR → VI	0.178	1.985	0.024	Supported
H8	CST → VI	0.277	2.964	0.002	Supported
H9	TMS → VI	0.115	1.248	0.106	Not supported
H10	CK → VI	0.125	1.393	0.082	Not supported
H11	VI → CCA	0.524	7.032	0.000	Supported
H12	CP → CCA	0.085	1.462	0.072	Not supported
H13	NP → CCA	0.160	2.317	0.010	Supported
H14	MP → CCA	0.036	0.500	0.308	Not supported

Note: RA relative advantage, COMT compatibility, CMX complexity, SC security concerns, CST cost savings, TR technology readiness, TMS top management support, CK cloud knowledge, CP coercive pressures, NP normative pressures, MP mimetic pressures, FIT fit, Task task, VI viability, and CCA cloud computing adoption

7 Discussion and Conclusion

The primary objective of this study is to identify and validate the significant factors affecting the HEIs to adopt cloud computing by developing an integrated theoretical model. The results of the developed model pointed out that 58.9% of the variance in cloud computing adoption can be explained by the fit-viability model factors along with the INST theory factors. Furthermore, 68.8% of the variance in the fitness of cloud computing has been explained by HEIs-related task requirements and DOI theory factors. Besides, 30.9% of the variance in the viability of cloud computing has been explained by the organization context factors. This indicates that the R^2 values satisfy the requirements.

Fourteen hypotheses were proposed to examine the relationships among the constructs in the developed research model. The first hypothesis (H1) posited that HEIs-related task requirements positively influence the fitness of cloud computing

to HEIs computing needs. The results of the structural model ($\beta = 0.090, t = 1.939$) indicated that H1 is accepted. The second hypothesis (H2) proposed that relative advantage positively influences the fitness of cloud computing to HEIs computing needs. The results of the structural model ($\beta = 0.196, t = 3.002$) showed that H2 is accepted. The third hypothesis (H3) proposed that compatibility positively influences the fitness of cloud computing to HEIs computing needs. The results of the structural model ($\beta = 0.384, t = 5.416$) indicated that H3 is accepted. The fourth hypothesis (H4) posited that complexity negatively influences the fitness of cloud computing to HEIs computing needs. The results of the structural model ($\beta = 0.293, t = 4.751$) pointed out that H4 is accepted.

The fifth hypothesis (H5) hypothesized that security concerns negatively influence the fitness of cloud computing to HEIs computing needs. The results of the structural model ($\beta = -0.165, t = 3.096$) indicated that H5 is accepted. The sixth hypothesis (H6) suggested that the fitness of cloud computing has a positive influence on cloud computing adoption. The results of the structural model ($\beta = 0.132, t = 1.957$) indicated that H6 is accepted. The seventh hypothesis (H7) hypothesized that technology readiness has a positive influence on the viability of cloud computing adoption in HEIs. The results of the structural model ($\beta = 0.178, t = 1.985$) indicated that H7 is accepted. The eighth hypothesis (H8) posited that cost saving has a positive influence on the viability of cloud computing adoption in HEIs. The results of the structural model ($\beta = 0.277, t = 2.964$) indicated that H8 is accepted.

The ninth hypothesis (H9) suggested that top management support has a positive influence on the viability of cloud computing adoption in HEIs. The results of the structural model ($\beta = 0.115, t = 1.248$) indicated that H9 is not supported, and top management support didn't exert a positive influence on the viability of cloud computing adoption in HEIs. Likewise, the tenth hypothesis (H10) hypothesized that cloud knowledge has a positive influence on the viability of cloud computing adoption in HEIs. The results of the structural model ($\beta = 0.125, t = 1.393$) indicated that H10 is rejected, indicating that cloud knowledge didn't influence the viability of cloud computing adoption. The rejection of H9 and H10 can be justified by the fact that the respondents of this study are academics and IT staff who possess enough knowledge and IT background.

The eleventh hypothesis (H11) posited that the viability of cloud computing has a positive influence on cloud computing adoption. The results of the structural model ($\beta = 0.524, t = 7.032$) indicated that H11 is accepted. The twelfth hypothesis (H12) suggested that coercive pressures have a positive influence on cloud computing adoption. The results of the structural model ($\beta = 0.085, t = 1.462$) indicated that H12 is not supported. The thirteenth hypothesis (H13) proposed that normative pressures have a positive influence on cloud computing adoption. The results of the structural model ($\beta = 0.160, t = 2.317$) indicated that H13 is accepted. The fourteenth hypothesis (H14) posited that mimetic pressures have a positive influence on cloud computing adoption. The results of the structural model ($\beta = 0.036, t = 0.500$) showed that H14 is not accepted.

As a result, this study will have significant implications for cloud computing adoption research, particularly in HEIs. The main contribution of this study is the

combination of the four dominant models, including TOE, FVM, DOI, and INST to explore the factors that affect the HEIs to adopt cloud computing services. In addition, the findings of the research may assist the top management in HEIs in strategizing cloud computing adoption by recognizing the important factors in their institutions. Furthermore, the validation of the developed theoretical model provides empirical evidence regarding what affects the HEIs to adopt cloud computing services. This will assist the decision-makers in these institutions to undertake informative decisions regarding the determinants influencing the viability and fitness of cloud computing services to HEIs requirements.

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Consumer's Perceived Trust and Subjective Norms as Antecedents of Mobile Wallets Adoption and Continuance Intention: A Technology Acceptance Approach



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Abstract Mobile wallets have gained wide popularity amongst Indians post demonetization but still the adoption rate of a truly multi-channel mobile wallet is considerably low. Various studies on the subject revealed that consumers are using mobile wallets for day to day expenses but for large transactions they are still relying on internet banking. Therefore, this study tries to develop a model based on technology acceptance models and theories and test it to evaluate the role of consumers' Perceived Trust and Subjective Norms as antecedents of their adoption and continuance usage intention for mobile wallets. This study depends on information gathered utilizing designed questionnaire survey from the individuals dwelling in Delhi-NCR in India. Structured Equation Modelling was utilized to test the research hypotheses. The results of this study can enable various stakeholders to devise strategies for increasing use of mobile wallets in India consequently satisfying the vision of Cashless Economy. This research had been conducted with 465 opinions taken. Recent trend represents tremendous increase in online payment and use of wallet.

Keywords TAM · Perceived trust · Subjective norms · Continuance intention · Mobile wallets · SEM · Technology acceptance

1 Introduction

India has preponderantly been a cash-obsessed nation where people tend to prefer doing financial transactions using cash. Demonetization has been a game changer as it compelled the people to opt for mobile wallets. When people of the nation were

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deprived of using cash, then they looked for other modes of payment resulting in a sudden multifold increase in mobile wallet transactions. A report from Global Data reveals that the mobile wallets transactions in India increased from INR 24 billion in 2013 to INR 955 billion in 2017 [1].

Moreover, moving towards Digital and Cashless economy in India all department whether government or non-government are moving towards digital transaction. Indian Government is coming up with various policies and promotion scheme to attract all organization and end user. Tools which are basically used is mobile wallet like “BHEEM” which is majorly used by Indian Government. Similarly, many E-wallet like Pay TM, MobiKwik, FreeCharge, State Bank Buddy, HDFC PayZapp, ICICI Pockets, LIME of Axis Bank, PhonePe from Flipkart Group Company, Ola Money and Airtel Money.

A recent report [2] indicates that the total digital transaction is expected to reach \$500 billion by the year 2020. Also, India has the third largest internet user base in the world with approx. 483 million internet users out of which, 337 million are active smartphone users [3]. This increase in the number of smartphone users drives the growth of mobile wallets usage. The experts of the field are quite optimistic that the digital payment companies would take the best advantage of India’s growing internet population.

Despite of all these facts, there is still a large chunk of population in the country who are still using cash. Getting them convinced for using mobile wallets is an uphill task. In such a situation it becomes imperative to study the factors which could play an influential role in accepting mobile wallet and continually use it. Different examinations in the field uncovered that for any new innovation, there are numerous factors which influence the people’s decision making procedure about how and when they will utilize.

Numerous researchers over the years have developed various technology acceptance theories and models. Some of the well-known and widely used have been Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT), Theory of Innovation, Theory of Reasoned action, Theory of Planned Behaviour and many others. Some of the prominent factors suggested by these theories which influence technology acceptance are perceived usefulness, perceived trust, perceived ease of use, self-efficacy, perceived risk, prior experience, technology anxiety, beliefs and evaluations and subjective norms.

However, the research studies have demonstrated that factors effecting on technology acceptance are varying with the applications [4]. For the purpose, this study endeavours to relate the consumer’s perceived trust and subjective norms or social influence with their intention to adopt and use mobile wallets. This would help different stakeholders devise strategies to increase the usage of mobile wallets in India thereby fulfilling the vision of Cashless Economy.

2 Theoretical Background and Research Framework

All the theories of technology adoption are structured to calculate the degree of approval and happiness of individual consumers against any device or knowledge system, but from various points of view based on the mechanisms or determinants underlying their function. The most widely used is the Technology Acceptance Model [5] which focuses on the primary determinant of use to accept or not to accept a new tool. The purpose to use is influenced by the attitude of the user towards utilizing a certain device. Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), the two variables influence the state of mind of an individual regarding the usage of a particular device. Perceived utility is characterized as how much individual confidence that using a specific tool would improve the execution of his or her task. Perceived Usefulness is the main determinant that greatly affects the beliefs and aspirations of consumers in allowing use of the invention. Perceived user-friendliness is defined by how often the consumer utilizes a given device, which is effortless. Previous work has shown that perceived usefulness affects target in two ways: overt and indirect effect by tool-usefulness.

As suggested by Davis, PEOU may not have any important effect on relational norms to be utilized in spite of the reality that the influence of PU interfered. PEOU does not specifically impact the therapeutic goal of the consumer because it influences therapeutic perceptions by PU.

A study [6] further expanded TAM by naming it TAM2 with social impact and neural mechanisms on the usage of perceived usefulness and intent. In TAM2, the hypothesis of subjective norm is that it has a direct effect on an individual's intention to choose to perform a certain behavior even if he/she is not in favor of that behavior, but because of other references he/she thinks he/she should; hence the individual complies with those referents. Subjective norms have been shown to have direct impact on goal over PU and PEOU in mandatory program use environments. The model posits voluntariness as a vector of tolerance to differentiate between obligatory and voluntary. Subjective norms, though, may implicitly affect behavior by perceived usefulness, which is called internalization.

Therefore, according to TAM2, the subjective norm's immediate compliance-based impact on intention over PU and PEOU should arise in compulsory, though not optional, device use environments. Determinants for cognitive instruments on PU are task importance, performance efficiency and demonstrability of tests. Thus TAM2 theorizes that the demonstrability effect identified by another study [7] as "tangibility of the effects of using the invention" would directly affect perceived usefulness.

TAM3 is an expansion of TAM in which anchors and modifications are speculated in the model to affect PEOU. Anchors are the degree to have general opinions regarding machines and their use, while changes are the degree of conviction formed by direct interaction with the target technology. The findings indicate good associations to PEOU for these variables. Software self-efficacy, expectations

of external influence, machine fear, software playfulness, perceived pleasure, and practical accessibility are the antecedents for perceived ease of use.

In 2003, Venkatesh et al. [8] presented another, influential theory of Unified theory of acceptance and use of technology (UTAUT). UTAUT was developed by consolidating eight constructs of different models applied to IS usage behaviour. Such eight models are TAM, TRA, TPB, motivational model, TAM and TPB integration, PC utilization model, social cognitive theory, and innovation diffusion theory. The two dependent variables were behavioral intent and usage behaviour. On the other hand, eight independent variables include expectation of results, expectation of commitment, social impact, condition facilitation, class, age, experience, and voluntariness of use. Three key structures are the determinants of intention to use and usage behaviour: expectation of performance, expectation of effort and social influence. Performance expectancy was among the eight variables with the best indicator. UTAUT theorizes that social influence has meaning only in the compulsory use of situations by technology.

This study makes use of the parsimonious TAM as the basis for our model framework. The sub-sections that follow identify the causal interactions between the structures included in this analysis.

2.1 *Perceived Trust*

Trust is essential in human relationship building. It is to be considered as cognitive expectation along with emotional viewpoint. For the growth of organisation trust is defined as “Customer reliance on the quality and reliability of the service/ product” Somebody faith is also explicitly linked with perceived trust [9]. Groups also plays vital role in developing the belief of an individual or group depending on word, pledge, or verbal or written declaration.

Once the customer uses online medium of transaction researcher [10] suggested to examine the creation of trust based in web-based business. Accordingly, model is designed using questionnaire. The finding revealed that the company established credibility and ability to tailor goods and services significantly influenced the initial confidence. In addition to these it has been monitored that there are various factors effecting trust like GUI based tools used, usefulness and also major role of security control.

A study [11] is conducted to analyse consumer confidence in United States, Singapore and China. It has been discovered that network reliability and Internet vendor's credibility plays major role in achieving customer satisfaction and trust.

Another study [12] also analysed the function of a series of factors such as: profitable receipts, security receipts, secret receipts, high quality infrastructure, high-speed networks, efficiency of the internet, protection and trust. Security and trust have been found to play an important role in attracting and building customer loyalty.

2.2 *Subjective Norm*

Subjective norm can be expounded to mean an individual's feeling that a large number of the people to which he holds in high esteem or believes are significant to him think he ought to or not to execute the act in consideration [13]. The construct subjective norm or social influence is included in the Theory of Reasoned Action [13] and Theory of Planned Behaviour [14]; both of which posited that social influence can be an important determinant in technology acceptance and usage. Consumer purchasing decisions are prejudiced by effectual external communication (advertising and promotion) and internal communication (made up of verbal and propensity to comply with reference group influences) [15]. The adoption of novel products like mobile phones, which is widely utilized, is considered to be clearly motivated or inspired by the consumers' reference groups [16].

Subjective norm is associated to innovativeness as people habitually tend to perform on the basis of their perceptions of what others believe they should do. It has been discovered that subjective norm is more significant before, or during the initial phase of innovation implementation when users seize controlled direct knowledge or experience from which to acquire attitudes [17–19]. According to study [20] cited in [19], the adopter's family, friends and peers are those groups which could sturdily influence this adoption. Although there is no base to predict how each of these groups will impact adoption behaviour, even so it is likely that together these groups could significantly influence the individual's intention to adopt a particular mobile phone.

Another study [21] used theory of planned behaviour to understand the effect of consumer's attitude, subjective norms and perceived behavioral control on their purchase intention. 300 respondents were sampled on their intention to use laser printer, based on their level of product knowledge (both objective and subjective) as well as their awareness of information regarding social comparison. The study established that purchase intention of consumer varies with the degree of their subjective product knowledge and awareness of social comparison information.

A study [22] on the role of social influence on consumer purchasing behaviour in the United States (US) and China. 232 Americans and 34 Chinese participated in the survey using three reference group measures, namely, informational, utilitarian and value-expressive influences. The results revealed that even though all three reference group influences were significantly related to purchasing behaviour, they were very different between both countries. Chinese consumers relies on word-of-mouth communication for getting product information with the conviction that good products doesn't require advertising whereas US consumers have faith on advertising and focus largely on their personal wants and needs.

2.3 Behavioural Intention/Intention to Adopt

Intention is clearly described as how hard individuals are able to work and how many determinations, they intend to use for performing a behaviour. Behavioural intent (BI) refers to “the subjective probability of a person performing some conduct” [13]. Another study [3] indicated that behavioral intent to use a specified system has a significant impact on the actions of usage. Nevertheless, theory of reason action (TRA) indicates that behavioural intent is the most important indicator of actions. Study [13] proposed that the purpose of a person drives activity implementation in the same direction. Behavioural intentions [14], are motivating variables that catch how much commitment an individual is willing to create to execute an action. A similar study [23], however, argued that promoting a better understanding of the behavioural intention of consumers remains a primary concern of marketing researchers. A research on the purpose of the customer offers a crucial foundation for predicting the real actions of the customer about the manner of a specific action [24, 25].

2.4 Satisfaction

Satisfaction has been described as “the summary psychological condition arising from the combination of the emotion accompanying unconfirmed expectations with the previous feelings of the customer about the experience of consumption.” These concepts take satisfaction as a cognitive evaluation of the difference between intention and results (confirmation). It can be mentioned that greater assurance results in lower standards and/or higher efficiency. Accordingly, they influence the satisfaction and intention of continuation of people [26].

2.5 Continuance Intention

The continuance intention is the target of the ECM model. It is defined as the intention to continue using an information system [27]. The proposed ECM was built on the notion that the continuing use intention of a system will be influenced by the satisfaction of system use and perceived utility [27]. A report [28] stated that when an individual starts using an information system, psychological motivations can occur which may have an effect on the individuals’ continuance decision.

Taking useful insights from the literature, a conceptual model has been formulated which comprises the research hypotheses as depicted in Fig. 1. The model utilises the structured relationships given in Technology Acceptance Model [5], Theory of Planned Behaviour [13], Expectation-Confirmation Model [26] and Theory of Reasoned Action [14] as the foundation.

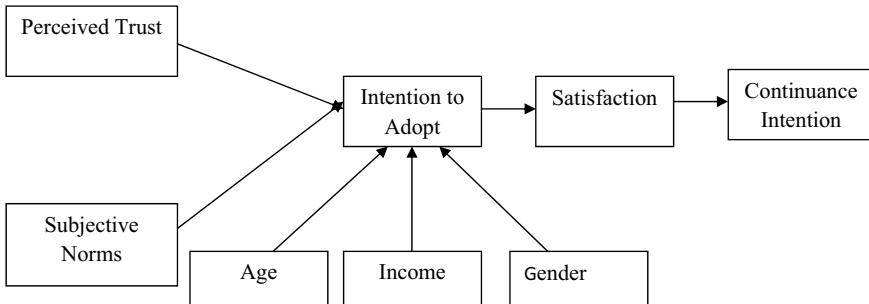


Fig. 1 Proposed research model

Table 1 Definition of research hypotheses

Hypotheses	Description	Path
H1	Perceived trust significantly affect intention to adopt mobile wallets	PT → INT
H2	Subjective norms significantly affect intention to adopt mobile wallets	SN → INT
H3	Age significantly effect intention to adopt mobile wallets	AGE → INT
H4	Income significantly affect intention to adopt mobile wallets	INCOME → INT
H5	Gender significantly affect intention to adopt mobile wallets	GENDER → INT
H6	Intention to adopt mobile wallets significantly affect satisfaction	INT → SAT
H7	Satisfaction significantly affect continuance intention	SAT → CONT

It is further argued that factors that influence consumer behavioural intent to embrace digital wallets differing based on their demographics. Therefore, it becomes necessary to assess the impact of various demographic factors on the intention of the consumer to adopt it. In light of this, the study proposes and validates a model for considering consumers' intention to adopt and use such services.

The intention to adopt mobile wallets is defined by Perceived Trust, Subjective Norms, Income, Age and Gender in the proposed study model. Here are numerous test hypotheses framed for this study (Table 1).

3 Instrument Development

Random gathering of data was done from respondents to test the proposed study pattern and to carry out systematic cross-sectional methodology. A Questionnaire was designed to collect data keeping in view the parameters which is essential to carry out effective study and productive outcome [29]. Parameters defined for

preparing of questionnaire consists of various items like perceived trust, subjective norms, satisfaction, intention to adopt, continuance intention and several other demographic questions. Except demographic parameter in questionnaire all parameters are measured on five-point scale varying from “Strongly Agree” to “Strongly Disagree”.

To determine the efficiency of the Research Instrument a pilot test was performed with 50 respondents. After analysing the result several changes were made in Test Instrument based. Cronbach alpha values were determined for all constructs, and the value was found to be greater than 0.7 for all constructs which is found appropriate for all except one which was removed.

4 Data Collection and Sample

After looking all factors questionnaire is modified and is used for data collection. Data collection techniques used in hard copy form and electronic form. Electronic form is designed using Google form and the link for the same is shared via Facebook, E-mail, Whatsapp, Linkedin to access large number of respondents. We have received response from 465 persons out of which 19 respondents had no opinion about digital wallets and 7 response were incomplete. Therefore, 439 response have been used for the purpose of data analysis.

The survey respondents were individuals who reside in the Delhi National Capital Region. The survey respondents' sample demographics (Table 2) show a fair proportion of female and male respondents, i.e. 58% are male and 42% are female. An overwhelming majority of respondents are young—35% are up to 30 years of age, and 41% are 31 to 40 years of age, whereas just 6% are over 50 years of age range. 81% of respondents served for certain organisations, 13% were self-employed and 6% of students were in remainder. In terms of their educational background, 44% are postgraduate, 24% doctorate, while only 31% graduate. Eventually, 20% of respondents had total monthly income above 100,000; 23% between 50,000 and 100,000; 44% between 25,000 and 50,000 while just 7% have income up to 25,000.

5 Data Analysis and Findings

Analysis of the data was carried out using SPSS AMOS Program v.24.0. In this study latent constructs, that is, each construct represented by a number of measures, were used. Accordingly, data were analyzed using the SEM 2-step approach [30], whereby the CFA Measurement Model (MM) evaluation precedes the Structural Model (SM) estimation to research the connection between the model constructs.

Table 2 Respondents: demographics

Demographics		Frequency	Percentage (%)
Gender	Male	254	58
	Female	185	42
Age	Up to 30 year	156	35%
	31–40 year	179	41
	41–50 year	78	18
	Above 50 year	26	6
Occupation	Self employed	58	13
	Service	357	81
	Student	24	6
Gross monthly income (Rs)	NIL	21	5
	Up to 25,000	32	7
	25,000–50,000	192	44
	50,000–100,000	104	23
	Exceeding 100,000	90	20
Educational qualifications	Graduate	137	31
	Post graduate	196	44
	Ph.D.	106	24

5.1 Measurement Model Assessment

The Measurement model employs CFA to assess how much the measured variables correspond to the conceptual model constructs, and also to maintain the validity and reliability of the instrument. For the study, the MM Model identified five latent constructs, namely: Subjective Norms, Perceived Trust, Intent to Adopt, Satisfaction and Intention to Continue/Continuance Intention. All of these constructs were calculated using 10 items i.e. indicators. The overall GIF—goodness of fit of the measurement model was measured using 3 most relevant forms of prescribed performance metric indices: incremental fit indices, absolute fit indices and parsimonious fit indices [31]. Table 3 explains the results of those fit indices along with the proposed

Table 3 MM (CFA) model: goodness of fit (GoF) statistics

Fit indices	MM values	Recommended value
$\chi^2/d.f.$	1.96	$1 < \chi^2/d.f. < 3$
NFI	0.93	≥ 0.90
CFI	0.95	≥ 0.90
AGFI	0.85	≥ 0.80
RMR	0.03	≤ 0.05
RMSEA	0.05	≤ 0.07

Table 4 Measures of reliability and validity

Construct	Items	Standardized factor loadings	Cronbach's alpha	CR	AVE
PT	Q6	0.83	0.82	0.84	0.72
	Q7	0.85			
SN	Q1	0.79	0.79	0.81	0.80
	Q2	0.86			
INT	Q15	0.74	0.76	0.77	0.63
	Q16	0.82			
SAT	Q21	0.84	0.91	0.89	0.79
	Q22	0.93			
CONT	Q23	0.84	0.79	0.80	0.67
	Q24	0.78			

cut-off values. Then, (Table 4) the analysis continues to determine the psychometric properties of the reliability and validity of the test, as the measurement model demonstrates reasonable compatibility with the observed results.

Analysis of findings (Table 4) states that Factor Loadings (Standardized) are above 0.7 as recommended for all measurement items [31]. In addition, the alpha-reliability coefficients of Cronbach were used to evaluate internal consistency and both coefficients of reliability were found to be higher than the appropriate norm of 0.70 (Table 4) [31, 32].

The measurement of convergent validity of the model was carried out using the provided criteria [33] which specifies that the Average Variance Extracted (AVE) for each build should be greater than or equivalent to 0.5 (Table 4) which has been adequately checked.

For each build, the discriminant validity was tested by comparing the AVE to a square correlation between construct. The discriminating validity was tested as it was observed that the AVE importance for increasing construction was greater than the squared inter-construction correlation for that construct (Table 5) [31, 33].

Table 5 Discriminant validity

	PT	SN	INT	SAT	CONT
PT	0.72				
SN	0.30	0.80			
INT	0.19	0.20	0.63		
SAT	0.14	0.26	0.14	0.79	
CONT	0.12	0.24	0.12	0.27	0.67

Note Diagonal (i.e. bold) values are AVE and off diagonal are inter-construct squared correlations

Table 6 Results of hypotheses testing

Hypotheses	Relationship (positive)	Standardized estimate (SE)	Critical ratio (CR)	P value	Accepted/Rejected
H1	PT → INT	0.067	4.663	***	Accepted
H2	SN → INT	0.142	2.127	0.073	Rejected
H3	AGE → INT	0.078	4.534	***	Accepted
H4	INCOME → INT	0.016	1.790	0.067	Rejected
H5	GENDER → INT	0.034	4.191	***	Accepted
H6	INT → SAT	0.138	9.106	***	Accepted
H7	SAT → CONT	0.046	18.989	***	Accepted

5.2 Structural Model Assessment

Use the endogenous and exogenous latent variables [34], the structural model tests the directions that have formed between the various structural equations and also to express the effect of one variable on others [35]. As shown, standardized regression weights have been used for this purpose [35] because these weights help determine the relative influence of the independent variable on the dependent ones. The standard regression estimates and their output of the study hypotheses are listed (Table 6).

The Critical Ratio of the regression estimation was used as the basis for the importance level [35, 36]. Once this ratio, as suggested, values equivalent to or over 2.58 mean a 99% degree of importance. Conversely, when C.R. Value is greater or equal 1.96 and lesser 2.58, it reflects a value standard of 95%.

The findings show that Perceived Trust has a major impact on the intention for mobile wallets to be adopted by the consumer while Subjective Norms and Income has little meaningful connection with Intention to Adopt. This seems surprising as it sounds a strange behaviour especially in a country like India. This needs to be examined further with a more detailed study. The other two demographic factors-Age and Gender display a favourable impact on the intention of adoption, according to many another research. Nonetheless, the results indicate that the Intention to Adopt affected Satisfaction substantially and strongly influences the intention to proceed.

6 Theoretical and Practical Implication

The data from this study reveals several theoretical and practical applications worthy of future study. This study has contributed to the existing literature by adding dimensions to the various models of technology acceptance. With this study, the key factors affecting the trust of every individual for using mobile wallets have been identified. The study could serve as a base for other similar studies with large sample size or in

other geographic locations. The results of the study could help practitioners devise strategies for increasing the mobile wallets adoption in India.

7 Limitations

This study suffers from some limitations, which could be addressed in future studies. Firstly, this study has been conducted in Delhi NCR only which could be further studies on a larger sample in geographically dispersed areas. Secondly, this study taken into consideration the impact of very few variables which could be further increased and the impact of various other factors could be studies. Thirdly, the results revealed that Subjective Norms does not have strong positive impact on Intention to adopt, this needs further detailed examination.

8 Conclusion

Through the research conducted it has been analysed that Perceived Trust and Subjective Norms have proven to be very critical factors for determining the intent of customer to start using e-wallet or online transaction medium. Income of any individual hardly impact in the thought process of using online transaction process. Gender play hardly any role in the use of adoption of online transaction process. Age effect slightly to develop the trust of any individual. Age group above 55 still hesitate to use online transaction. As developing trust at that age takes time as a result, they prefer to go for cash transaction. But surprisingly, age group above 60 who are not much comfortable in moving around take time to develop trust and gradually move towards online transaction. Through this study we have also analysed factors which helps in developing trust of any individual for the use of online transaction. With this analysis we can promote and design the strategy which helps us to move forward towards cashless economy.

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Examining Mobile Financial Services in Pakistan: Rural and Urban Perspective with Gender as a Moderator



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Abstract This study demonstrates the adaption of Unified Theory of Acceptance and Use of Technology 2 to investigate how factors like effort expectancy, performance expectancy, social influence, price value, habit, facilitating conditions and hedonic motivation influences consumers intention, subsequently impacting users' mobile financial services adoption. This study also shed light on the rural and urban perspectives by comparing the results of two different models. Also, this study applied gender as a moderator to gauge its effect between users' intention and their adoption process. A self-administered questionnaire was developed using established scales. A survey on 392 respondents was conducted in Pakistan. Both SPSS and SmartPLS was used to analyze the data. The study findings revealed that there is a significant difference between factors which influences both rural and urban populations. However, the moderating role of gender was found supported only in the rural sample. This study provides an insight into the perspective of Pakistani consumers' Mobile Financial Services adoption. The research findings can be adopted as a reference source by the service provider companies in formulating a strategic marketing plan.

Keywords UTAUT2 · Mobile financial services · SmartPLS · Effort expectancy · Performance expectancy · Price value · Social influence

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1 Introduction

Development of the internet has altered the way people connect and network with others in their community. The mounting calls for “always-on” internet connectivity are everchanging usage from old-style computers to gadgets like smartphones, laptops etc. The telecommunication industry is also journeying not only from fixed to mobile but also from voice to data, enabling users to be connected anytime, anywhere in the world [1]. The quick embracing of mobile phones and their role in the progress of personal and professional happenings has been one of the most significant high-tech events in recent times [2, 3]. Global data specify that consumers mobile subscriptions globally is projected to exceed the eight billion subscribers for the first time, mounting a total of 8.3 billion mobile subscriptions internationally up from 7.9 billion in 2018 [4].

In the purview of such advances, traders, financial services corporations and telecommunication operators are concentrating their exertions on snowballing the number of mobile-enabled services accessible to mobile phone users to upsurge customer ease, decrease costs and uphold profitability [5]. Therefore, to upsurge customers’ banking expediency, financial services businesses are initiating facilities employing mobile networks. Services which brings the usage of mobile phone-related technology in users banking-related services are referred to as mobile banking or mobile financial services. Within the financial industry, this novel service is regarded as a marvel in the current day and age [6]. Mobile financial services are a multibillion-dollar business which takes place through numerous technology devices via many service providers, applications, and services to enable the consumers in achieving their financial requirements. At the same time through the use of mobile financial services consumers are able to attain access to banking services at the palm of their hands even in countries where the level of income is significantly lower than others [7]. Its spread is so common that it was reported 61% global population have access to mobile financial services [8]. Moreover, mobile financial services enable has enabled consumers to make easy and quick access to both financial and non-financial related services anywhere in the world [6]. Resultantly, owing to its sheer presence and significance, businesses all around the world are now incorporating and making use of such service in their daily personal and professional life [9].

Mobile financial services have transformed service distribution means and business models by generating ground-breaking and expedient channels of smoothing consumer with data and order placement remotely. Due to MFS rising status, investigating consumer intentions in adapting MFS has interested countless researchers [10, 11]. Two streams of MFS are through channels of mobile banking and mobile wallet or m-payment. M-banking is the non-financial (notifications, balance enquiries) and financial (remote funds transferring) services provided to consumers over a portable mobile device [6]. On the other hand, m-wallet includes advanced services such as bill payments, Easy-load or mobile credit recharge, insurance, international remittance, savings, making donations, phone banking, campaigns, other than money transfers, cash deposit and withdrawal. Users can avail m-wallet services by either

downloading the respective apps of service providers or by visiting the retailer. Both of these streams together provide the bulk of value-added financial services to users [12]. While mobile banking constantly tries to attract potential customers, it inevitably encounters many challenges which make its mass usage uncertain [13]. As researchers have posited that mobile banking is still in its early stages and has, so far, failed to earn the trust of potential consumers, especially in developing countries, warrants more research in future.

In the year 2009, mobile financial services were familiarised in Pakistan [14]. Fascinatingly, according to State Bank of Pakistan [15], 139 million mobile subscribers are representing 54% of the entire population. These statistics are in the near future, expected to grow to 170 million subscribers by 2020 [16]. Resultantly, Pakistan ranks 8th in the world with the greatest number of mobile subscribers [5, 10]. However, the number of registered mobile banking users in Pakistan totals to 1.6 million, highlighting the disinclination of mobile banking in a developing country like Pakistan.

Theoretically, this study contributes to the literature in the following ways. Firstly, it discovers the determinants of mobile MFS adaption in a developing country like Pakistan. Secondly, obeying with fresh fondness, this study intends to extend the UTAUT2 theory to the context of MFS adaption in Pakistan by exploring the moderating role of gender. This is primarily since females' role in decision making is very inadequate owing to cultural norms and constrained roles defined for women [17]. Same is eminent in the case of bank accounts, with only 11% of adult females in Pakistan holding a bank account, compared to 21% of men, one of the widest bank accounts ownership gender gap in the world.

Furthermore, numerous studies have explored the role of gender, and its influence on the adoption of mobile-related technologies has remained an inconclusive and mystery. Therefore, fulling this potential gap and bringing more clearer stance of gender in mobile rebased adoption and responding to the call of Glavee-Geo et al. [18] and Haider et al. [19] studies which suggested to further highlight the role of gender especially in banking-related actives, researchers in this study believe that it is equally essential to study the moderating role of gender difference for mobile financial service adaption in the country's context. Fourthly, this study also examines a significant difference in the adoption of mobile financial services between rural and urban population. Hence, this study will also compare the two models to explore the determinants of MFS adaption for these two different geographical regions, i.e. rural and urban population. Fifthly, the application of UTATU2 model in determining the factors behind consumer mobile financial services adoption (MFA) enables the researchers to offer recommendations to help boost the rate of mobile financial services in the country. Concerning Practical contributions, this study's findings can set important directions for MFS providers in the way they strategically approached and market to the specific geographic segments. Moreover, this study will also intend to help the different stakeholders, such as MFS providers, managers, government, and regulators to realise the factors determining the adaption of MFS in Pakistan and better understand consumer perceptions and intentions regarding

mobile financial services and so that better efforts can be directed to escalate financial inclusion in the country.

As per the UTAUT2 model, effort expectancy (EE), facilitating conditions (FC), performance expectancy (PE), Hedonic Motivation (HM), Social Influence (SI), Habit (HAB), and price value (PV) are the major factors which can have a great impact on BI of individuals using technologies. Furthermore, along with the core elements of UTAUT2, this study investigates the moderating role of gender. Extending the reach of the UTAUT2 in terms of context and through the addition of new moderators, this study aims to increase the generalizability of the theory under discussion.

2 Literature Review

2.1 MFS Adoption

Most of the literature in MFS is based on its stream of m-banking [6, 10, 13, 18]. Although these studies have examined the consumers' adaption intention of mobile banking comprehensively and contributed immensely to the body of knowledge on MFS, there is still gap existing in the context of m-wallet studies. Based on our extent literature review, we found that in Pakistan, there is a little number of studies conducted on m-wallet, an indispensable form of mobile financial services in today's age.

M-wallet services are the financial services offered to customers by cellular network providers in collaboration with banking institutions. On the back end, a bank account is created for the sim owner, which he can register easily without visiting the bank. The user can then access the financial services via his mobile device, thorough a downloaded app, or by visiting a retailer. The advanced services accessible via m-wallet include bill payments, fund transfers, withdrawal and deposit, savings, phone banking, Easy-load or mobile credit recharge, international remittance, insurance, making shopping payment, and making donations. Altogether, m-banking and m-wallet can provide the bulk of value-added financial services to end-users [12].

There are a limited number of studies available on m-wallet, even outside the context of Pakistan [20]. The study conducted in Japan uncovered that PV given by Japanese mobile wallet applications are contributing to positive attitudes regarding the usage of mobile wallets; furthermore, it also reinforced the BI in order to use the applications. Similarly, in developed countries context, [12] in their research studied both m-banking and m-wallet users in one of the leading digital banking countries, i.e. Finland. These findings have imminent implication for banks and service providers for increased business and customer reach. Similarly, it is equally important that the determinants of m-wallet financial services adaption are explored in Pakistan too so that similar financial inclusion and adaption results can be achieved.

Furthermore, even the existing research on mobile banking is disintegrated, commonly based upon various theoretical frameworks [6]. For example, there are

inconsistent shreds of evidence in the result of m-banking and m-wallet, such as Karjaluoto et al. [12], they found that personal innovativeness yields no effect on hedonic value for m-wallet users. In contrast, a significant effect happens in the m-banking sample. These inconsistent finding calls for researchers to see m-banking and m-wallet as two distinct streams of MFS and study the intention and adaption of both end-users separately.

The individual behaviour to adopt technology has been studied in various theories, including TAM, UTAUT, IS Success Model, and UTAUT 2. These models hinge to provide a key underlying theoretical mechanism to learn what drives individuals' behaviour toward technology usage. Usage behaviour is quite self-explanatory and is defined as the consumers' usage rate for a certain product, service or technology. The predictors of behaviour to adopt a particular technology or product had interested researchers and practitioners alike for a quite long time now.

2.2 *Role of Gender*

With a doubt, gender is one of the most extensively known and explored variance constructs [21] Owing to its dearth of existing literature; researchers have not been able to investigate the true effect of gender particularly in mobile banking industry [22]. Furthermore, the scantiness of research in this exceedingly developing area, Faqih and Jaradat [22] sturdily narrated its significance for additional research to advance the knowledge and gauge the influence of gender on new and novel technology, i.e. mobile financial services, predominantly in a developing country context like Pakistan. Researchers have exerted that gender does display a significant effect in adopting the novel information systems [23]. Research has also provided inconclusive results regarding the moderating role of genders, such as Riquelme and Rios [24] Faqih and Jaradat [22]. Therefore, owing to earlier inconclusive results, the current study fulfils this research by investigating its moderating role between the user's intention and their MFS adoption in a developing country like Pakistan.

3 Hypothesis Development and Theoretical Development

This study aims to investigate the MFS adoption in both rural and urban perspectives. In this regard the proposed model is grounded on UTAUT2 model with effort expectancy, performance expectancy, social influence, price value, hedonic motivation, facilitations conditions and habit as core variables influence consumers intention and subsequently their adoption towards MFS. This study also enriches the extant body of knowledge by using gender as a moderator. According to previous studies, researchers have not been able to investigate the true effect of gender, particularly in an emerging country like Pakistan mobile banking industry's perspective [21–24].

3.1 BI

The UTAUT model is well-thought to be the most comprehensive and well-suited research model used to predict individual behaviours through BI regarding technology system acceptance [3]. BI is defined as “assumption to capture the motivational factors that influence behaviour; they are indications of how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behaviour. As a general rule, the stronger the intention to engage in a behaviour, the more likely is its performance.” BI of a consumer is extremely important as it can directly and most precisely forecast users’ real-time usage behaviour of technology [25]. BI manage to facilitate the correlation between both behavioural constructs and real-time behaviour also, thus affecting intentions to predict upcoming events precisely. Indeed, BI demonstrates that how much an individual is inclined to affect a certain behaviour.

Similarly, usage intention mould consumer’s view and are also thought to have a straight pattern to the actual behaviour [26]. Thus, performance could be influenced by intentions to a limit that an individual has control over his/her behaviour and is motivated to try. Researchers have repeatedly proved that usage of technology is mainly initiated by BI and evaluations of an individual [27].

H1: BI is a significant determinant of adoption of MFS.

3.2 PE and BI

PE is defined as a degree to which a consumer or user receives benefits out of using technology, helping him in performing certain activities [28]. It is an individual’s perception that using a particular system could improve their task performance [29]. PE shares comparable features with five other similar constructs from various models. The similarity exists with perceived usefulness (from the model TAM), extrinsic motivation (from the MM), job-fit (from MPCU), relative advantage (from IDT) and outcome expectations (from SCT). On close comparison with all the listed variables, the definition of PE is most alike to perceived usefulness from TAM, which is the belief of an individual about the enhancement of one’s job performance through the use of a certain system [30]. For consumers to choose any service or technology, their belief that they can derive better performance out of using a certain technology is the main decisive factor. Many researchers believe PE is the most significant factor in for BI [5, 31].

H2: PE has a significant impact on BI.

3.3 EE and BI

EE is defined as the degree of ease that the consumers feel in using technology. EE suggests that how much of an effort is essential to use technology, that is linked to apprehensions associated to the level of quality of life [32]. Its definition is, “the degree to which an innovation is perceived as difficult to understand and use” [33, p. 16], which is directly related to the easiness that adapter can initiate his/her service and a strategic variable that positively affects the intentions of an adapter (both early adopters and late adapters) to adapt to m-payment technology [34]. Difficulties with usage explained low-level adaption of various payment systems, including both mobile banking and smart cards [35]. In case it is challenging to initiate the usage of totally new or innovative service, most probably there will be different barriers [36] that can harm the adaption [37]. Laukkanen and Kiviniemi [37, p. 383] researched about information in m-banking resistance and barriers concluded that guidance and information provided by banking systems have a strong influence on the perception of consumers of practical usage. Still, on the same hand, it positively enhances the image that is associated with such innovation. Thus, the ease coming with the adaption of mobile payment service that is new or possesses complete lack of complexity is most likely to result in positive attitudes vis-a-vis new service by the users. Especially for people from countries where education level and technology familiarity are low, the ease in using technologies is extremely important to consider. As otherwise, although technology usage has many benefits, such people still might show reluctance in the adaption of the technology. Consequently, the researcher hypothesises:

H3: EE has a significant impact on BI.

3.4 SI and BI

SI is when the consumer perceives that his acquaintances, such as friends and family, believe they should be adopting a specific technology or system. SI is quite similar to the subjective norms (SN) existing within given two different models: TPB, by Fishbein and Ajzen [38] and TAM2 [39]. The similarity is owed to the explanation that SN is the perception of an individual that the people important to him/her believe that he/she should or should not adopt a particular system [30]. Lin [40] study shows that SN has a great impact on BI to adopt new technology in collectivistic cultures. Lai et al. [41] discovered that the association between SI and BI of using a novel technology is higher in high uncertainty avoidance cultures. SI is a perception of an individual that his/her significant other individuals in life consider that they ought to adopt a brand-new technology [25]. Various studies proved that SI is very important whenever it concerns the user rate of adaption of technology, i.e. mobile banking applications [42]. Furthermore, in the event where the individuals who have only limited span of experience with any brand-new form of technology, social norms and influences are quite noticeable it is mainly due to the referee opinions become

main determinants of individuals' intentions [43]. It is quite evident in the case of mobile application, specifically the ones which are thought as fight off competitively larger online social networks, due to which others' opinion intensifies [25]. Hence, SI can be a significant factor to move a person either toward or away from a particular product or service. SI is an especially important factor in the context of a country like Pakistan, which is a collectivist society [44], and people tend to associate themselves to families, peers and friends more closely. Because individuals of such a society prefer their peers' opinions over personal beliefs, so for peers to agree on the adaption of a certain system is especially important. Hence, the researcher posits:

H4: SI has a significant impact on BI.

3.5 *FC and BI*

FC are those perceptions of consumers that decide the resources and support available to act a particular way [45]. Due to these conditions', individual depicts that environment factors both external and internal overpower the barriers created by technology, and it helps in adapting and accepting of the technology. It also points out that the resources being accessible and readily available promotes and triggers the adaption of such behaviours. The respective construct being rooted upon various variables, which includes behavioural control, external FC and style compatibility [25]. FC provides an individual authority and consciousness of control (psychological) which in response influence the willingness of an individual to adapt any behaviour; also greatly influenced by individuals cultural, social, and technological background along with his or her beliefs and perception [46]. Justifiably, it is not likely to adapt services of mobile banking unless individual possesses some kind of FC such as financial resources, working mobile connection and necessary skills required to operate these applications or services [42]. Hence, researcher stipulates:

H5: FC has a significant impact on BI.

3.6 *HAB and BI*

HAB, defined as those behaviours that are automatically performed by people due to an individual's learning [47], whereas Kim et al. [48] called HAB automaticity. Kim et al. [48] have described it in two distinct ways: first, as past repeated behaviour; and second as the extent to which a behaviour is automatic [47]. An individual who performs any specific behaviour repeatedly and automatically without any certain knowledge and experience to learn or to required overtime is known as HAB [49]. Individuals resisting any unfamiliar or new interaction with their respective bank is mainly due to the reason that consumer is not quite likely to change HAB [42]. This commonly results in hesitation from consumers' side towards adaption of new services our applications such as mobile banking. Similarly, individuals HAB and

past experiences become unconscious factors that can have a major influence on consumers preference and willingness towards learning new ways because they commonly rely on their past experiences whenever they have to make the decision, but do not utilise their cognitive reasoning [27]. Various studies indicate that individuals due to their HABs are more inclined to human interaction concerning banking, and hence these individuals are not quite keen to adopt online banking services [50]. Hence, the researcher posits:

H6: HAB has a significant impact on BI.

3.7 HM and BI

HM is the pleasure and fun aspects attained by the user of a technology which affects acceptance and usage level of technology significantly [51]. In the context of Pakistan, where the number of internet users has almost doubled since 2016, and mobile's influence on the population is noticeably high, transactions through mobile wallet have more potential to stand as pleasurable and fun than the traditional over the counter banking. Hedonic instincts in nature are emotional and non-functional, mainly based upon affective needs of an individual [52]. In improving a consumer's adaption intentions, the enjoyment and pleasure that are as a result of any brand-new technology, and it plays a vital role [49]. Furthermore, recent researches proved that the frequent use of interactive services, i.e., mobile banking apps, are based on functional motivations also being highly driven hedonic values and needs [53]. Similarly, Curran and Meuter [54] specify that HM is an important determinant in a users' possibility to adopt self-service technologies. Moreover, Arcand et al. [55] believe that enjoyment and mobile devices are directly associated with each other so mobile banking applications are commonly seen as sources of pleasure and entertainment, more specifically when the visual characteristics and designing of any app along with its complete layout is believed to become aesthetically pleasant [56]. The element of applications (visual), i.e. music, colour, font and animations collectively evoke the feeling of gratification and happiness, and it also enhances the consumer's experiential evaluation [57]. An individual is motivated towards the adaption of mobile banking services that fulfil the individuals' emotional and aesthetic needs [58]. Thus, the researcher hypnotises:

H7: HM has a significant impact on BI.

3.8 PV and BI

PV is the monetary cost associated with the technology use, not existing in the case of employees in the original UTAUT model but does significantly impact technology usage in the case of consumers. For instance, short messaging services (SMS) in

China is extremely popular due to its low pricing compared to other similar applications [59]. Similarly, in Pakistan, where almost 25% of the total population lived under the poverty line as of the year 2015, making conscious choices while spending is important in which cost is an indispensable factor. PE is that how an individual evaluates the overall worth of a given product or service through comparing the expected costs vs anticipated benefits [60]. The PE of mobile banking applications involves a user's subjective insight and hedonic advantages of an application's usefulness along with service quality, accessibility, enjoyment, functionality, interactivity and overall usefulness [55]. It is perceived that consumers adopt technology which increases the subjective value and presents the consumer with maximum advantage [61]. High perceived values ease the fears faced by individuals by increasing the likelihood of satisfaction that an individual gets after using the technology [20]. Hence, it is believed to be one of the key cause of an individual's intention and adaption of technology usage [62]. Similarly, it is believed that mobile banking related apps create an extra value for the consumer by providing services which can be customised [63]. Hence, the researcher deduces:

H8: PV has a significant impact on BI.

3.9 Moderating Relationships

Pertinent literature suggested that gender plays an important role in developing the adoption of online banking services [64]. There are a handful studies which investigates the moderating impact of gender on online banking and found it to be an important moderator [37]. The results of these past studies also show that males are more inclined towards online banking compared to females. Another study in Malaysian and Thailand context supports similar findings [65]. Hence, we believe that although a few studies on m-wallet have been conducted in countries outside Pakistan, it is still crucial to not simply generalise the findings to the context of Pakistan, rather have a separate dedicated study.

H9: BI to adapt the MFS will be higher for the males compared to females.

4 Methodology

4.1 Measurement

The survey items used were adopted from past studies and were slightly modified to fit the context of this study. All items were measured using a Likert scale where respondents selected 1 for "strongly disagree" to 7 for "strongly agree". Most of the constructs are already tested for studying the adaption of technology, particularly service settings (i.e. online banking technology adaption) and found to be reliable for

further research. Some modifications are made in the wordings of items/statements to maintain consistency among the variables. The questionnaire (instrument) consists of ten constructs which BI (3 indicators), PE (4 indicators), EE (5 indicators), SI (4 indicators), FC (4 indicators), HAB (4 indicators), HM (3 indicators), PV (3 indicators) and MFS adaption.

4.2 *Procedure and Sampling*

This study has used the quantitative data collection technique with the help of survey forms. The survey method allows the researcher to gather quantitative data and analyse it using parametric and nonparametric statistics [66]. This study used the mall intercept technique for data collection. The data is collected through a personal-administered questionnaire from every fifth customer who visits the franchise outlet or the retail outlet for some services or information. Respondents are approached when they are going to visit the outlet, and upon their will, they are requested to fill the questionnaire and return at their departure from the outlet.

Moreover, the researcher themselves collected the data from Islamabad while for the rest of the cities the research assistants were hired for data collection. The researcher demonstrated the questionnaire to the research assistant and gave them the proper directions for data collection. They were further told to contact the researcher immediately if he faces any confusion for interpretation and elaboration of the questionnaire to the respondents. The population of this study are the individuals of Pakistan who use cellular services. The objective to include cellular consumers as the population of this study is to develop relevancy with the individuals who use the cellular services and are familiar with the cellular offerings, including the MFS. Since one of the objectives of this study to find out the difference among the determinants of mobile financial adaption for urban and rural consumers, the data is collected from both urban and rural cities. The sample size is determined based on the recommendation given by Krejcie and Morgan [67]. To cater to common method bias, the researcher applied procedural techniques as suggested by Podsakoff et al. [68]. Out of 600 questionnaires distributed, 420 were returned, and only 392 were deemed fit for data analysis with the response rate of 65%.

5 Data Analysis

Researchers have applied Partial Least Squares (PLS) for data analysis owing to its increased popularity and is commonly used in marketing and business-related studies [69]. As a full-fledged structural equation modelling (SEM) technique, PLS permits instantaneous analysis of numerous independent and dependent variables in a complex research model that is not possible in typical regression analyses [69]. In

this research, SmartPLS 3.2.9 was used to perform PLS for data analysis, see Abbasi et al. [70]. Moreover, SPSS was used for descriptive analysis.

6 Results

6.1 Assessment of Measurement Model

This study measures the inner model (validity and reliability of the constructs, factor loadings, composite reliability (CR), average variance extracted (AVE), and the heterotrait-monotrait ratio (HTMT)) as per Hair et al. [69] instructions. The results of the inner model can be seen in Table 1. Conforming to the results, factor loadings, CR, and AVE are above 0.7, 0.7, and 0.5, respectively [69]. Therefore, the convergent validity of all the constructs was established, see Table 1. Besides convergent validity, the current study also examined the discriminant validity of the outer model by applying HTMT criteria as suggested by Henseler et al. [71]. As all HTMT values were lower than 0.85 (see Table 2); hence, no issues on discriminant validity were not found in this study, see Tables 1 and 2. Thus, measurement model validation as achieved satisfactorily.

6.2 Assessment of Structural Model

Once satisfying the measurement model criteria, this study tested the hypotheses using the structural model. To check the significance of the hypotheses, a nonparametric bootstrapping process with 5000 iterations was employed [69]. Current study statistical results supported the conceptual model by explaining 45.32% and 1.8% of the variance in BI and MFS, respectively. In addition to R^2 , to investigate the predictive relevance of the path models used in the study, the researcher applied Stone and Geisser's (Q^2). According to the results, the Q^2 for all the endogenous constructs are above the zero, i.e. BI (0.281) and MFS (0.032). Furthermore, the results of the significant path coefficient, R^2 and the effect size can be seen from Table 3.

6.3 Hypotheses Testing for Both Rural and Urban Sample

The findings reveal that in the urban sample, only three hypotheses were supported, i.e. BI → MFS; EE → BI and PU → BI, whereas all other relationships were found insignificant. Whereas, researchers found a significant difference in the rural sample where both relationships such as EE → BI and PU → BI, which was found significant in the urban sample were found insignificant. On the contrary to urban sample, PE

Table 1 PLS result of convergent validity measures

Latent variable	Measurement item	Loading	Cronbach's alpha	CR	AVE
Behavioural intention	BI1	0.846	0.744	0.853	0.660
	BI2	0.805			
	BI3	0.784			
Effort expectancy	EE1	0.735	0.843	0.888	0.614
	EE2	0.767			
	EE3	0.889			
	EE4				
	EE5				
Facilitating conditions	FC1	0.827	0.802	0.871	0.628
	FC2	0.849			
	FC3	0.773			
	FC4	0.715			
Habit	HAB1	0.822	0.830	0.886	0.661
	HAB2	0.777			
	HAB3	0.853			
	HAB4	0.799			
Hedonic motivation	HM1	0.844	0.750	0.857	0.667
	HM2	0.780			
	HM3	0.825			
Performance expectancy	PE1	0.904	0.869	0.911	0.720
	PE2	0.844			
	PE3	0.903			
	PE4	0.731			
Perceived value	PV1	0.808	0.735	0.850	0.654
	PV2	0.774			
	PV3	0.842			
Social influence	SI1	0.635	0.816	0.881	0.652
	SI2	0.876			
	SI3	0.857			
	SI4	0.838			

→ BI, SI → BI, HB → BI and HM → BI were found significant. Table 4 reveals the details of the results.

Table 2 Discriminant validity: HTMT criterion

	BI	EE	FC	HBIT	HM	PE	PV	SI
BI								
EE	0.638							
FC	0.626	0.891						
HBIT	0.648	0.4	0.413					
HM	0.571	0.618	0.674	0.636				
PE	0.691	0.79	0.702	0.668	0.684			
PV	0.692	0.674	0.742	0.502	0.706	0.665		
SI	0.643	0.633	0.716	0.685	0.732	0.878	0.682	

Table 3 Structural model results

Hypothesis	Paths	Beta	T value	P values	Decision	R ²	Q ²
H1	BI → MFS	0.133	2.397	0.008***	Supported	0.018	0.032
H2	PE → BI	0.150	2.112	0.017**	Supported	0.453	0.281
H3	EE → BI	0.163	2.401	0.008**	Supported		
H4	SI → BI	0.012	0.173	0.431	Not supported		
H5	FC → BI	0.073	1.059	0.145	Not supported		
H6	HAB → BI	0.278	4.380	0.000***	Supported		
H7	HM → BI	-0.022	0.383	0.351	Not supported		
H8	PV → BI	0.201	3.658	0.000***	Supported		
Moderating effect							
H9	BI*gender → MFS	-0.081	1.004	0.158	Not supported		

Note **p < 0.05, ***p < 0.01

7 Discussion

In this section, the results of the study based on the research objectives are discussed. This study has set five objectives in the introductory section. The first objective was to investigate the determinants of MFS adaption in Pakistan. As per results, a factor which has a substantial positive impact on MFS adaption and BI are PE, EE, HAB and PV. However, SI, FC and HM don't have a significant impact on MFS adaption and BI. Thus, the results suggested that when individuals have BI, they use to perform a transaction via MFS. Moreover, findings suggest that if the MFS offer high benefits (e.g. convenience, saves time, etc.) to its users, the users seek high PE, which causes to effect BI positively to adapt MFS.

Table 4 Hypotheses testing for both urban and rural population

Hypothesis	Paths	Results for urban			Results for rural		
		Beta	P values	Decision	Beta	P values	Decision
H1	BI → MFS	0.403	0.000	Supported	0.403	0.000	Supported
H2	PE → BI	-0.156	0.000	Supported	-0.156	0.214	Not supported
H3	EE → BI	0.168	0.280	Not supported	0.168	0.031	Supported
H4	SI → BI	-0.102	0.040	Supported	-0.102	0.248	Not supported
H5	FC → BI	0.067	0.482	Not supported	0.067	0.234	Not supported
H6	HAB → BI	-0.098	0.000	Supported	-0.098	0.250	Not supported
H7	HM → BI	0.076	0.012	Supported	0.076	0.211	Not supported
H8	PV → BI	0.173	0.325	Not supported	0.173	0.024	Supported
H9	BI*gender → MFS	0.071	0.228	Not supported	-0.214	0.013	Supported

Furthermore, results suggested that when the individuals have high ease of use to utilise a technology, which is MFS in our case, their BI raised to adapt MFS. Likewise, those individuals who are habitual of using technologies, e.g. smartphones, online banking etc. to perform the financial tasks, they are more likely to have high BI to adapt the MFS. Similarly, while developing the BI to adapt the MFS, users conduct the cost-benefit analysis, so if the PV is high to use/adapt mobile financial services to perform a financial transaction, the users are more likely to develop BI to adapt the MFS.

Opposite to these factors, SI does not help to develop BI to adapt MFS. This finding reveals that individuals in Pakistan are not merely influenced by the peers, family or friends to adapt the mobile financial services. Similarly, FC does not affect the BI to develop behavioural intention to adopt mobile financial services. So even if the mobile financial services are widely available and all the FC are available, they do not lead to developing BI among individuals to adapt MFS. Lastly, HM has no impact on BI to adapt the MFS in Pakistan. So even if the companies in Pakistan try to make the MFS fun, it does not affect the BI. So, these findings draw a clear line of action for the marketers to develop their strategies to increase the MFS adaption in Pakistan. For example, the marketers should focus on telling the consumers how their performance will increase by using the MFS.

Similarly, they should try to make the mobile financial services apps or website user friendly to increase the adaption. The marketers should target those segments of the society who have high adaption for mobile/online services compared to those

who have a very low inclination toward mobile and online technologies. Lastly, their product which is mobile financial services should offer better/high benefits compared to their rival products, e.g. online banking. These strategies will help marketers to increase the behavioural adaption for mobile financial services. The high behavioural intention will eventually lead to high mobile financial adaption.

The second objective of this study was to study the moderating role of gender for the relationship of BI and adaption of MFS in Pakistan. The results suggest that gender does not affect the BI to increase the adaption of MFS. Hence, marketers should target both males and females for mobile financial service adaption as there is no effect of gender on BI and MFS.

Meanwhile, the last objective of the respective study has been to compare the two mobile financial services' adaption models for rural and urban consumers. The results show some interesting facts about rural and urban consumers of Pakistan, as the determinants of BI for mobile financial service adaption are different for rural and urban samples. For rural respondents, EE and PV are significant determinants of BI for MFS adaption. However, PE, SI, HAB and HM found to be significant determinants of BI for mobile financial services adaption for urban respondents. Hence these findings foreground some very useful insights for marketers. Since the determinants for BI are different for different respondents, the marketers should not target both rural and urban consumers similarly. They should devise some very specialised marketing strategies and promotional campaigns to increase the BI for MFS adaption for both rural and urban consumers. For example, the rural respondents are keener for the EE and perceived value, so the focus of companies for these segments should be devising the easiest ways to perform a financial transaction. They should try to make the process of performing a transaction as easy as possible.

Moreover, the companies should communicate the rural consumer the benefits of using mobile financial services for financial transactions. Furthermore, the results show that gender plays the role of a moderator between BI and MFS adaption for rural respondents. So, these findings support the argument that males have high mobile financial adaption compared to females when both males and females have the behavioural intention to adopt mobile financial services. These findings provide an opportunity for marketers to target the female segment of rural areas to increase their adaption for mobile financial services.

8 Implications

This study has both theoretical and managerial contributions. By investigating the main factors affecting the adaption of MFS in the context of Pakistan, this study offers a comprehensive addition to the UTAUT2 model investigating the role of gender and the adoption process of both rural and urban population in Pakistan. Thus, theoretically, this study expands the existing body knowledge regarding MFS adoption in an emerging country like Pakistan. Furthermore, this study also explores the role of gender in MFS adoption, which has been mostly ignored by researchers. At the same

time, scholars have warranted its exploration in an emerging country perspective [21–23]. Thereby, this study has contributed by investigating the moderating role of gender as a moderator which has been keenly suggested by Faqih and Jaradat [22] to advance the existing body of knowledge, especially through the lens of an emerging country like Pakistan.

Practically, the study will also intend to help the different stakeholders, such as MFS providers, managers, government, and regulators to realise the factors determining the adaption of MFS in Pakistan and better understand consumer perceptions and intentions regarding mobile financial services and so that better efforts can be directed to escalate financial inclusion in the country.

The mobile technology and its related services in Pakistan have evolved exponentially recently. MFS has revolutionised the life of Pakistani citizens. For industry practices, this study highlights crucial constructs to be considered by merchants, and financial service providers in Pakistan, e.g. findings reveal that both price value and effort expectancy has a significant effect on user's intention. Therefore, service providers have to formulate strategies by making sure that the MFS is economical, doesn't require too much effort from people to use it and the most importantly the overall benefit of MFS usage is perceived as valuable to users all across Pakistan.

9 Limitations and Conclusion

By investigating the main factors affecting the adaption of mobile financial service adaption in the context of Pakistan, this study offers a comprehensive addition to the UTAUT model. The study also tried to help the different stakeholders, such as mobile financial service providers, managers, government, and regulators to realise the factors determining the adaption of mobile financial services in Pakistan and better understand consumer perceptions and intentions regarding mobile financial services and so that better efforts can be directed to escalate financial inclusion in the country.

The current study has precisely and successfully addressed all the research objectives and questions regardless of few limitations associated with this study. In addition to the existing theoretical contributions made, the results found from the respective study provide us with some significant practical implications of mobile financial service providers, for approaching the consumers in a more effective manner to increase the mobile financial service adaption in Pakistan.

Overall, this study has proposed nine hypotheses in total in general. According to the results, five hypotheses are supported, whereas the rest of them were not accepted. So, the supported hypotheses include H1, H2, H3, H6 and H8 which imply that PE, EE, HAB and PV proved to be major determinants of BI for MFS adaption in Pakistan. Moreover, there are different results for rural and urban samples, e.g. H1, H3, H8 and H10 are supported for the rural sample which reveal that EE and PV are significant determinants of BI for MFS adaption. Opposite to this H1, H2, H4, H6 and H7 are supported for the urban sample which suggests that PE, SI, HAB and HM are

significant determinants of BI for MFS adoption for urban respondents. The study has its limitations in terms of its cross-sectional nature. Also, our area of study is restricted to some regions of Pakistan which might create concerns over the generalizability of the study, especially if extended to highly-technologically-advance developed countries.

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Integration of Knowledge Management in a Virtual Learning Environment: A Systematic Review



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Abstract In recent years, significant development has ensued confronting e-learning academically and practically. This evolution in information technologies attempts to capitalize on individual intervention and interaction in the learning process to be more efficient and effective, especially in e-learning adopted in virtual communities. The main concern in adopting e-learning in virtual environments is the transfer and acquisition of knowledge in all its aspects. Thus, many tools and frameworks have been developed to solve this issue and to help managers in integrating knowledge management (KM) efficiently and effectively with their learning management systems (LMSs). A systematic literature review was performed from 2005 to 2020 from many databases: Springer, IEEE, Elsevier, and Emerald, where 198 papers were found. After duplications were removed, 94 papers were left, followed by the elimination process, which includes applying inclusion and exclusion criteria. Sixteen papers remained. The main research method used was analyzing and reviewing previous research in these fields. The studies took place in different countries, but the leaders in this field were China, Europe, and Iran. The systematic review mainly highlighted the role of knowledge management processes (KMPs) in virtual learning environments (VLEs), including the concept of e-learning. In addition, it focused on how KM could be integrated successfully in LMS in the VLE. Furthermore, it emphasized the impact of this integration and its advantages on e-learning elements: the learners, the instructors, and the organization. Additionally, it indicated that the most adopted KMP in LMS was knowledge creation. The finding was that KM plays a major role in e-learning in terms of creating a different and distinct education method capable of bringing about change—a Renaissance—in the current era. It also guides thought, experience, and knowledge in the right direction through the use of technology.

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Keywords Knowledge management (KM) · Knowledge management process (KMP) · E-learning · Virtual learning environment (VLE) · Learning management system (LMS)

1 Introduction

The field of information technology, computers, and communication is continuously growing and is rapidly expanding beyond the future [1]. In addition, the mechanisms of knowledge creation and management have made the world a small global village where the entire population interacts in one place and shares knowledge and experience [2]. The learning process is constantly evolving to keep pace with recent developments, whether scientific or technological [3, 4]. The e-learning environment is also constantly evolving to take advantage of all the modern features of the digital world [5, 6]. One of the processes of promoting education lies in useful technology that supports the student's learning opportunities without adherence to time and space and is actually done through the e-learning environment. Many educational institutions have invested in e-resources and have provided them with an appropriate e-learning environment that has effectively transformed into a virtual online learning environment and has become a model for delivering many courses and lessons in virtual classrooms [7]. A virtual learning environment (VLE) is a set of technological tools combined in an online virtual environment that supports learning and teaching, distance learning, and Internet research and helps the learner access data, information, communication, and training [8]. The VLE must be able to exploit the vast amount of knowledge that flows from time to time. Knowledge management (KM) concepts exist to achieve this goal [9]. KM is the ongoing, organized, or unstructured process [10] through which information is created, acquired, organized, shared, evaluated, selected, archived, stored, and applied in practice [11] while supporting business decision making, problem solving, and future planning in line with the organization's objectives and strategy [12]. A review of the systematic literature indicates a significant role for knowledge management processes (KMPs) in VLEs. Many studies have focused on the subject of KM in e-learning or, more precisely, in VLEs and have proven the importance of KMPs in creating, sharing, applying, and processing information to transform it from explicit knowledge to implicit knowledge capable of changing the learner's thinking and enriching his/her experiences. In this study, the relationship between KM and the e-learning environment was analyzed by reviewing their respective concepts. Then the role of KMPs in organizing and enriching the content of the VLE was investigated. Many of the studies that have influenced this subject have been addressed through real experiences or through scientific studies on samples from different scientific, medical, social, and other fields, where the requirements of the application of KMPs in e-learning are mentioned. Examples of successful models in highlighting the role and importance of KM in this type of education and how it has had the greatest impact in raising the level of learners are also identified. From the studies, we notice some

still-existing issues that these environments suffer [13]. In general, the main objective of this systematic study is a comprehensive analysis of the information obtained on the subject of KM in the VLE. The study answers the following questions:

- RQ1: What are the main KMPs applied in the VLE?
- RQ2: What are the main research methods found in the collected studies?
- RQ3: What types of VLE tools are mainly involved in the KMP?
- RQ4: How many studies apply KM in the VLE, and which databases are active in publishing related papers?
- RQ5: How many countries have applied KM in the VLE and when?
- RQ6: What is the impact of applying KM in the VLE?
- RQ7: What are the most important models addressed in the analyzed articles related to KM and VLEs?

2 Literature Review

2.1 E-learning

E-learning has different definitions. European eLearning has defined it as “the use of new multimedia technologies and the Internet to improve the quality of learning by facilitating access to resources and services as well as remote exchanges and collaboration” [14]. The main applications and processes in e-learning are web- and computer-based learning, virtual classrooms, and digital collaboration. The ultimate goal of e-learning is to enhance the performance of both the individual and the organization. E-learning applications in the formal education field include the content of the course, the applications, the students’ homework, and the exams. However, in the nonformal educational field, the collaboration environment has been realized. The major objective in nonformal education is to develop and update the employee’s knowledge. The activities in e-learning have been classified into two groups: synchronized and asynchronous. When the student interact with the instructor without delay, the activity will be classified as synchronized. Mainly, they are in the same virtual environment at the same time, like chat sessions and Blackboard. On the other hand, asynchronous e-learning is when the instructor and the student interact by leaving messages, leaving no need to be online at the same time [14]. The e-learning system is monolithic, which means it cannot support the sharing and development of knowledge. Thus, it requires KM.

2.2 Knowledge and Knowledge Management

Knowledge represents a deep level of understanding. It is based on experience, the root of content, values, wisdom, contextual information, and valuable insight. Hence,

the focus nowadays goes beyond tangible products to intangible products. Knowledge and information are examples of intangible products or assets. Tangible assets are limited; their value would decrease once they are used, and only one person can use them at a time. On the contrary, intangible assets such as knowledge are unlimited and can be shared and used by more than one person without decreasing their value. Moreover, when knowledge is integrated properly with other streams, this could interfere in its enhancement and may produce new knowledge. The value and importance of knowledge can be determined if it is created, shared, and used appropriately [14].

Hence, knowledge, as an intangible asset, cannot be managed directly, but it will be formed indirectly by analyzing and improving the relevant conditions that influence KMPs: knowledge creation, development, and sharing. Mainly, the two basic types of knowledge are the following: Explicit knowledge is knowledge that can be measured, stored, and communicated directly to others—that is, knowledge that can be expressed in an official language in the form of data [15]. Implicit knowledge is the knowledge of the individual inherent in the perception of the human mind and is knowledge based on experience and observation [15].

Knowledge management is the processes of development knowledge assets in the organization (Grover and Davenport 2001) which allows creating, sharing, transferring, capturing, storage and evaluating of knowledge [16]. Knowledge management can also be defined as the ability to relate structured and unstructured information in organization in a way that ensures its use and utilization [11].

2.2.1 Knowledge Management Processes in E-learning

- Knowledge Creation: The acquisition of information and ideas, whether from internal or external communities, to form tacit intangible knowledge that is of great benefit to the learner [14].
- Knowledge Sharing: The learning process through which knowledge is created and flows from one person to another or to a particular community to share and transfer expertise to develop new knowledge [17].
- Knowledge Capture: The process by which tacit knowledge is converted to clear knowledge or vice versa [17].
- Knowledge Storage: The process of retaining knowledge for the purpose of retrieval and then use to achieve the goal of utilizing it [17].
- Knowledge Application: The process of using knowledge in learning management systems (LMSs), for example to achieve a competitive advantage [17].
- Knowledge Evaluation: The process of verifying that the knowledge captured and used is beneficial to the learner [17].

2.2.2 Requirement of Knowledge Management in E-learning

E-learning programs are abundant these days, but most of them rely on content transfer and support only content management systems, mimicking traditional education with all its problems. Current e-learning is merely an “automation” of traditional education and a dedication to the status quo but in an innovative way. The world needs an e-learning environment linked to knowledge building, transfer, and sharing among individuals and groups to achieve the goal of knowledge sharing and acquisition based on the needs of each learner [18]. E-learning supports only individual learning, not participatory learning. So collaborative VLEs come to create tremendous knowledge growth supported by KMPs [19].

Some objectives of e-learning systems and KM systems are different. In e-learning systems, the learner’s knowledge would be supported by providing structured learning content and intercommunication. The case is vice versa in KM systems, where KM supports content management systems to provide knowledge through facilities such as sorting, searching, and collaboration with experts [20]. On the other hand, e-learning systems and KM systems also share common objectives. Knowledge is provided to the user from both systems in different forms, and it can be reused or modified. Furthermore, the concept in the architecture is almost the same in both systems. Moreover, both systems support interaction facilities regardless of the tool used—email, chat, or forum. Also, both systems support personalization and have access regulation, which means each user will take specific information [20].

2.3 Virtual Learning Environments

VLEs may be formal and informal. They should be accredited by official bodies, such as universities, schools, or institutes specialized in offering educational materials. Informal VLEs are those created by an individual or group of individuals for the purpose of raising and learning specific topics. All informal VLEs need technical and technological support to enhance the concept of knowledge and ensure that it reaches its ultimate goal [21]. In this paper, we will discuss formal VLEs, which, are managed by certain educational institutions in which we will learn how to organize and manage knowledge. The VLE is a relatively open online system that contributes significantly to the management of the distance learning process by enriching the participation of all parties [22]. Beyond the boundaries of the classroom with great expertise, knowledge, and sciences by activating the communication process and reaching a wide range of educational resources [13].

The theoretical bases of the VLE include the following [38]:

1. Constructivism Learning Theory

- Virtual learning communities are the best place for constructivist learning theory, which states that the learner builds knowledge within his/her mind internally, influenced by his surroundings, society and language and is not

transmitted to it by the external community. The learner also explains what he/she receives and builds meaning based on his/her information. The community in which the learner lives also has a major impact on knowledge building. This is indeed the role of virtual learning communities that encourages the transfer and consolidation of knowledge in the learner's mind.

2. Community Learning Theory

- Dewey's community learning theory states that active learning raises experience stimulates and enriches the imagination. It is based on two foundations. The first is social reinforcement that shortens distance and brings all learners in a particular place and then gives the learner a sense of existence. The second key is the ability to participate and enrich the community in which the learner lives, creating an environment of the same views and guidance for all learners. Here, the building of knowledge for each learner can be enhanced by sharing and building different experiences and knowledge.

3. Cognitive Learning Theory

- The process of cognition that occurs during the receipt of knowledge depends not only on the information received but also on the individual himself/herself and the environment, the culture, the community, and time. This is called distributed perception. It states that cognitive development is a reciprocal rather than isolated process among all the parties involved as it provides learners an opportunity to share quality learning and exchange ideas. Virtual learning societies can be considered as a model of distributed cognition.

2.4 *Integration of the Virtual Learning Environment and Knowledge Management*

Integrating the VLE with KM mostly depends on the KM model used. Therefore, knowledge creation and transfer in virtual communities are challenging and need efficient interaction to assure the transfer. Tacit knowledge is transferred mostly from socialization [23]. This paper also highlights how to practice knowledge transfer and innovation in the virtual communities efficiently. The application of VLEs as tools in educational institutions leads to the effective acquisition of knowledge and management of the process of distance learning with ease. The VLE, as defined by [13], is seen as an educational literature reinforced by modern technological technologies and virtual resources. The convergence between KM and e-learning have critical milestones: creating an efficient management strategy to state the standards and building learning materials from different knowledge objects to be used in the e-learning system [24].

KM plays a significant role in virtual learning communities through several aspects, the most important of which are the following [22].

- Management of personal knowledge, where the individual within these communities needs tools to help them manage their knowledge in terms of collection, storage, dissemination, and use for innovation and development
- Management of learning organizations, where the organizers or teachers of these communities must integrate and invest in this knowledge by linking it and storing it in a database used to enhance learning processes aimed to discover new knowledge as well as knowledge sharing and innovation
- Management of organization memory, where the gathering of knowledge, experiences, and sciences from all participants needs to be organized and managed effectively to achieve the goal of this large educational community; as that knowledge is scattered and unclassified, storing it in a particular place will facilitate its referral when needed (here, KMPs play a major role in organizing that knowledge).

2.5 Implantation of Knowledge Management in the Virtual Learning Environment

The success of implementing KM is not excluded to the adoption of e-learning but also needs an appropriate structure for the organization and task management. The organization must start with awareness about the importance of adopting e-learning to influence KM. Also, it must help the employee build trust in these technologies. Moreover, the organization must create a budget for investing in the technologies needed to expand and meet expectations. Encouraging and supporting the employees to enrich and develop their experience in adopting e-learning is very important in implementing KM successfully [25]. Adopting a virtual LMS in the library will give comprehensive knowledge and information not only about the current status but also about the future. The managers should know how to use these tools to enhance their strategies and objectives.

2.6 Virtual Learning Environment Issues

Some issues [13] are faced by Malaysian schools in implementing an effective VLE, as follows:

- Lack of experience in how to apply pedagogical aspects in online virtual environments
- No specific framework to guide VLE
- No evaluation criteria to evaluate VLE

Several frameworks for VLEs (such as SETT, TPACK, SAMR, TEST-L, the eighth dimension e-learning framework) have been studied, a lack of focus has been observed not only on the user but also on the technological tools used and the educational content. The user is the basis for knowledge transfer, sharing, creation,

enrichment, and enhancement. Therefore, the KM component of these frameworks is missing. One of the issues mentioned by [26] is the insufficient ability to manage knowledge in VLEs. Note that most of what happens in the educational community falls under approaches of knowledge telling or knowledge transfer, both of which offer little opportunity to build creative knowledge and progress.

2.7 The Main Theoretical Models for Organizing Knowledge Management in VLE

Technology is continuously evolving, especially the technology used in the teaching and learning process. The virtual learning environment is an essential tool to manage all parties' knowledge in the educational platform. However, one issue either contributes to the proper management of knowledge in the VLE or contributes to the dispersal of knowledge and makes it of no value, which is acceptance of the technology. Many studies have been conducted to study the importance of the technology acceptance model, which is concerned with the need to accept technology and use it in the best way to benefit from it. TAM used in many information systems research to clarify the user's intentions regarding using the technology [27]. In our study, we designed a model for organizing knowledge management in VLE through the teaching and learning process. This model includes three basic models: The Governance enabler model, SECI model, and PCDA model. The first model [18] consists of the three most essential elements to improve the performance of using VLE, which are technology and its uses, people and their cultures, and finally, processes that are among the essential elements in promoting any institutional work. The second model is the SECI [23], which is the essential model to identify the nature of knowledge creation. The last model is the PCDA to manage the e-learning process [28]. Combining these three models gives us an integrated technology acceptance model as if the tool is available. The appropriate conditions are provided for training on it and how to use it properly (processes) the person's culture of use will be changed and thus used correctly resulting in valuable knowledge based on a scientific basis in the creation of knowledge (SECI model) and most certainly for the success of any model must go through the stages of the PCDA model to obtain a result and feedback that continuously improves its work and maintain the sustainability of this model.

3 Research Methodology

In any research paper, the first step will be the literature review as it is the baseline of research and gives the researcher accumulative knowledge about his/her research topic. This way, the researcher can find gaps to fill, improve an existing model, or even cover a new field that has not yet been covered properly. Three distinct stages

Table 1 Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Paper should involve KM	Paper didn't use the English language
Paper should involve e-learning or VLE	Paper didn't use KM
Paper should be in English	Paper didn't use e-learning or VLE
Paper should be between 2005 and 2020	Paper didn't include any KMP
Paper should involve KMP	

have been considered in building this systematic review, identifying the criteria of inclusion and exclusion in any paper [29–35]. Data sources and search strategies have been used to extract the articles. Also, we have assessed the quality of these papers using some questions. The last step was coding and analysis. Each part is described below.

3.1 *Inclusion/Exclusion Criteria*

Any article we have included in this systematic review following these inclusion and exclusion criteria shown in Table 1.

3.2 *Search Strategies/Data Source*

To build up this systematic review, a broad search has been done in different databases (e.g., IEEE, Springer, and ScienceDirect).

- Search strategies/Index (search words)
 - In the search for this systematic review, we have used these words:
 - “Knowledge management” and “E-learning”
 - “E-learning” and “Knowledge management”
 - “Knowledge management” and “Learning management system”
 - “Learning management system” and “Knowledge management”
 - “Knowledge management” and “Virtual learning environment”
 - “Virtual learning environment” and “Knowledge management”
 - “Knowledge integration in e-learning”
 - “Virtual learning environment as a tool for knowledge management”

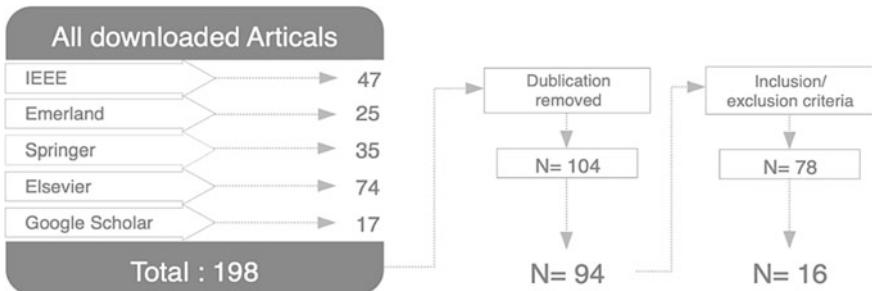


Fig. 1 Selecting articles procedure

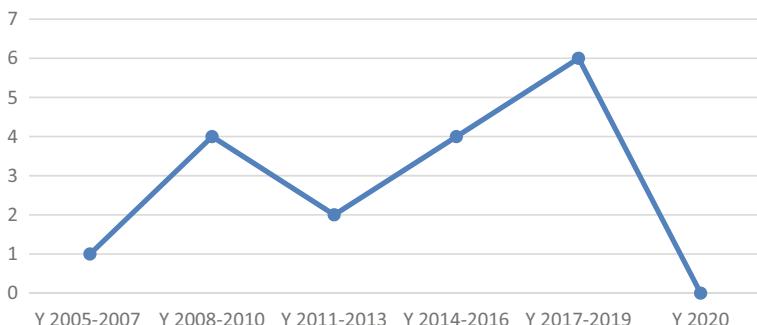


Fig. 2 Selected articles based in period of time

- Databases

- Figure 1 shows the database and the number of articles that were used. The graph shown in Fig. 2 shows that the most selected articles were between 2017 and 2019

3.3 Quality Assessment

To evaluate and criticize the quality of the chosen articles, seven criteria have been identified in the quality assessment checklist. A three-point scale has been used in this assessment. If the answer for the question is yes, then the article will score 1 point. If the answer is no, then it will score 0 points, but if the answer is partially answered, then it will score 0.5 points. So each article will have a range between a minimum of 0 and a maximum of 7.

1. Was the aim of the research clear?
2. Are there any e-learning tools mentioned in the article?
3. Is the integration between e-learning and KM clearly explained in the article?

Table 2 Quality assessment results

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Total	Percentage (%)
S1	1	1	1	1	1	1	1	7	100
S2	1	0	1	1	1	0	1	5	71
S3	1	0	1	1	1	1	1	6	86
S4	1	1	0	1	1	1	0	5	71
S5	1	1	0	1	1	0.5	0	4.5	64
S6	1	0	1	1	1	0	1	5	71
S7	1	1	1	0.5	0.5	1	1	6	86
S8	1	1	1	1	1	1	1	7	100
S9	1	1	1	1	1	0	1	6	86
S10	1	1	1	1	1	0	1	6	86
S11	1	1	1	1	1	1	1	7	100
S12	1	1	0	1	0.5	0	0	3.5	50
S13	1	1	1	0.5	1	1	1	6.5	93
S14	1	1	1	0.5	1	0	1	5.5	79
S15	1	1	1	1	1	0	1	6	86
S16	1	1	1	1	1	1	1	7	100

4. Is the study useful for your systematic review?
5. Is the study useful, and does it enrich your general knowledge?
6. Is the method used in the article specified clearly?
7. Are any of the KMPs mentioned?

As a result, Table 2 presents the quality assessment results of all 14 studies. As all of the studies passed the quality assessment, hence, it is eligible for further analysis.

4 Results and Discussion

A good set of studies have been read and analyzed according to the systematic review in relation to KM in e-learning environments. Sixteen research papers were analyzed, giving the following results of the research questions prepared in advance.

4.1 RQ1: What Are the Main KMPs Applied in the VLE?

Many of analyzed articles focused on the process of creating knowledge in VLEs ($N = 9$), followed by knowledge capturing and knowledge sharing ($N = 8$), knowledge transfer, knowledge application and exchange ($N = 7$), knowledge storage ($N = 6$),

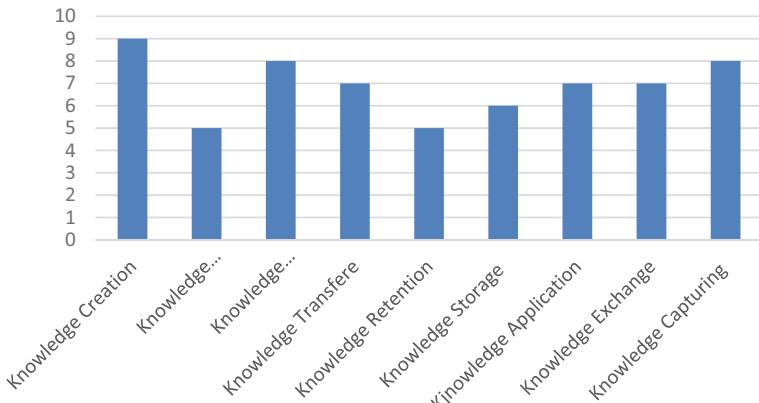


Fig. 3 KMPs applied in VLE

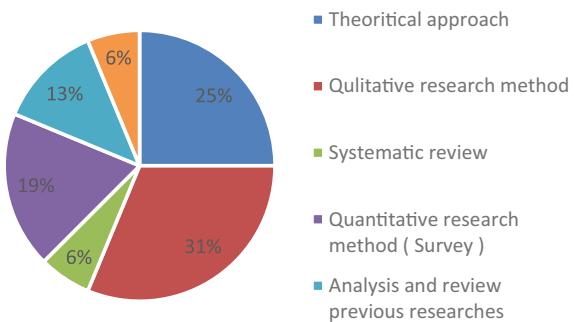
and knowledge acquisition and retention ($N = 5$) as shown in Fig. 3 and Table 3. The process of creating new knowledge requires the creation of appropriate knowledge of what you know and what you will learn through interaction, sharing, and experimentation to reach the required knowledge. A VLE can be created through the creation of this new knowledge as it is conducive to communication and brainstorming as well as an environment in which strict regulatory practices do not overlap [36]. The process that comes second is the process of transferring knowledge from explicit knowledge to useful implicit knowledge, which called is knowledge capturing [23]. Gathering large amounts of documents for reuse will not be useful in preserving knowledge, but capturing knowledge is useful in providing reusable content later. An example of this is the database used in one project and stored in the enterprise database and later referenced to use the appropriate ones in another project. In VLEs, capturing existing knowledge for later use is a basic process organized according to the rules and regulations enacted by KM [22].

Knowledge sharing, transfer, exchange, and application are the third most important aspects in this study [37]. The process of sharing knowledge in VLEs is the basis of other processes because through it, explicit knowledge is shared, while implicit knowledge is shared through training and direct social interaction. The sharing and transfer of knowledge means the recipient of the knowledge can adequately understand and apply it, and knowledge sharing can take place among individuals and groups [26]. Knowledge acquisition and retention, on the other hand, are less important in the articles that have been analyzed and have not been addressed much. However, the importance of retaining knowledge and referencing it for other uses was mentioned [21].

Table 3 Analysis articles in term of the main KMPs applied in the VLE

Source	Know. creation	Know. acquisition	Know. sharing	Know. transfer	Know. retention	Know. storage	Know. application	Know. exchange	Know. capture
[21]	✓		✓			✓			
[22]			✓						
[13]	✓					✓			
[26]	✓	✓	✓	✓	✓	✓	✓	✓	✓
[38]									
[18]	✓	✓	✓	✓	✓	✓	✓	✓	✓
[15]	✓				✓				
[39]	✓	✓	✓	✓	✓	✓	✓	✓	✓
[40]	✓	✓	✓	✓	✓	✓	✓	✓	✓
[23]	✓					✓			
[28]	✓						✓		
[25]					✓				
[41]						✓			
[42]							✓		
[43]					✓				
[44]						✓			

Fig. 4 Main Methodologies used in KMP and VLE research from 2005 to 2020



4.2 RQ2: What Are the Main Research Methods Found in the Collected Studies?

Qualitative methods are the most commonly used methods in this type of research (thirty-one from the analyzed articles) based on a case study approach as shown in Fig. 4. A study of the Arab Open University examined the role of e-learning systems in KM [39]. Another study also explored virtual LMSs such as Blackboard in the activation of positive posts and the opportunity to explore future ideas through library activities [42]. There is also a case study of the Moodle system to measure the performance of e-learning and its importance in making the right decisions [45]. On the Malaysian education system and its role in the use of VLEs, a focus on the technology used rather than the knowledge provided was noted [13]. Meanwhile, 19% of the studies adopted a quantitative approach based on the use of questionnaires to collect and analyze information. A study was conducted to measure the levels of students and measure the impact of online education on student performance. A relationship was noted where good KM within e-learning systems leads to higher student performance in VLEs [36]. Another quantitative study has resulted in a framework on organizing KMPs in e-learning communities [21]. Some of the studies analyzed were based on the theoretical approach, and the collection of information was 25%; 13% of the studies followed the review of previous studies in this subject. On the other hand, some of the studies analyzed relied on a systematic review and investigation approach to examine what was prepared in this area and was 6% for both approaches.

4.3 RQ3: What Types of VLE Tools are Mainly Involved in the KMP?

From the chart, we note that the LMS is one of the most technological tools that have been researched on the application of KMPs as shown in Fig. 5, where nine articles highlighted that the LMS is a real transformation from the traditional system based

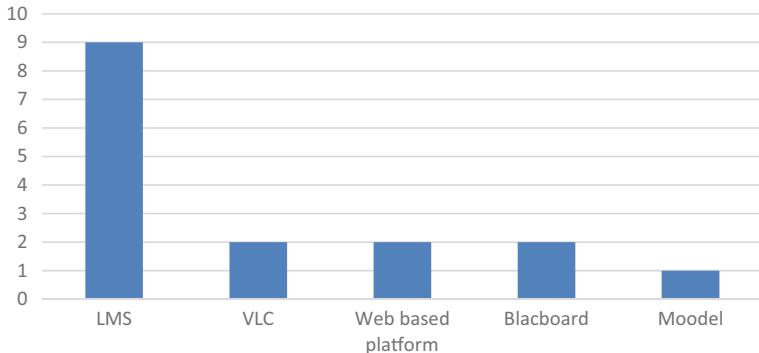


Fig. 5 Virtual learning environment tool

on classroom walls [46]. The LMS has many features that offer many benefits to students and content creators and is the ideal environment for learning. When using the LMS platform, students have flexibility in times and appointments, which means they can access all the content available at their own pace. In addition, students and teachers do not need to travel to get content and knowledge. Thus, KMPs are effective here in terms of sharing experiences and knowledge as well as the actual application of knowledge, the creation of new knowledge, and conservation and other processes of KM [47]. Two research articles dealt with Blackboard as a tool of VLEs in which KMPs take place, and the same number of virtual learning communities have a major role in the process of interaction and sharing information and experiences. Only one of the analyzed studies examined the model, and another two studies reported that the tool used was web based in user interactions, but the name was not mentioned.

4.4 RQ4: How Many Studies Apply KM in the VLE, and Which Databases Are Active in Publishing Related Papers?

A total of 198 papers were found. After the duplications were removed, 94 papers were left, followed by the elimination process, which includes applying inclusion and exclusion criteria. Sixteen papers remained; 16 papers have mentioned the integration between KM and VLE. These 198 articles have been published. Elsevier is considered the leader in publishing in this field. Around 74 as shown in Fig. 6 have been published, which represents 37% of the total number of articles in this field. This is followed by IEEE, with 24% of the total papers. Springer had published 18% of the papers. Other databases published in this field, such as Google Scholar and Emerald.

Fig. 6 Percentage of articles by database

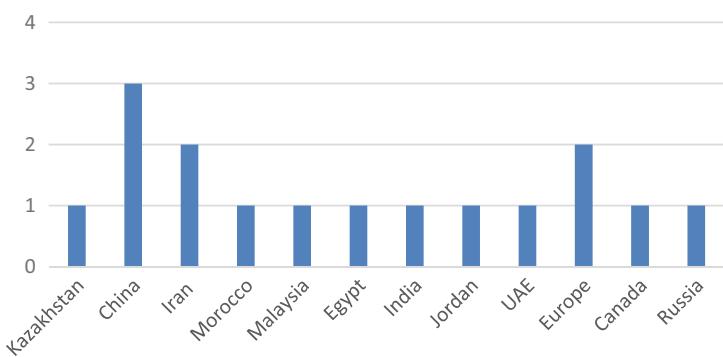
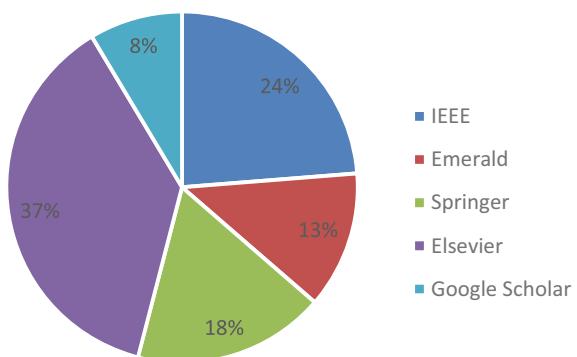


Fig. 7 Countries applied KM in the VLE

4.5 RQ5: How Many Countries Have Applied KM in the VLE and When?

As shown in Fig. 7 the most active countries that focus on researching the integration between KM and VLE are China and Iran, followed by the UAE, Jordan, Germany, Morocco, Malaysia, Egypt, and India.

These studies had been performed from 2005 to 2020, as shown above. The number of publications regarding this topic reached a peak in the period 2017–2019.

4.6 RQ6: What is the Impact of Applying KM in the VLE?

Many tools and frameworks have been developed to apply KM in the VLE to maximize the efficiency and effectiveness of LMSs. KM is considered as a model for the development of learning environments in most educational settings, and the reason for this is the shift from walled learning environments to VLEs, dominated by the

process of information sharing, storage, creation, and use. The sharing of views and the dissemination of experiences among all participants in VLEs has the greatest impact in the development of the learning process and raises the level of performance of learners in it [48]. Most researchers explained that e-learning is the management of scientific content and that KM is able to transform this content into dynamic knowledge that can be shared, used, applied, and transferred to other KMPs [40]. Also, the researchers assured that many advantages will be attained from applying KM in the VLE regarding the learner, the instructor, and the organization. The learner will be able to access the information permanently, and his/her educational performance and creativity will increase [49]. A variety of approaches will be provided in the teaching process [44]. In the perspective of the instructor, he/she will be able to monitor and control the progress of the learner and specify tasks for him/her relying on his/her special case. From the organization point of view, the focus is on reducing the cost; hence, they can serve the learning process without any need to pay tickets and expenses for the instructors. Moreover, the organization will take the benefit of saving all the knowledge in its repository so it will not be affected by the attrition rate [44].

4.7 RQ7: What are the Most Important Models Addressed in the Analyzed Articles Related to KM and VLEs?

Some see e-learning as an integral part of KM, while others see KM as a tool used in the e-learning process. Most researchers explain that e-learning is the management of scientific content. KM is able to transform this content into dynamic knowledge that can be shared, used, applied, and transferred to other KMPs [40]. KM is considered a model for the development of learning environments in most educational settings, and the reason for this is the shift from walled learning environments to VLEs, dominated by the process of information sharing, storage, creation, and use. The sharing of views and the dissemination of experiences among all participants in VLEs has the greatest impact in the development of the learning process and raises the level of performance of learners in it [48]. The following are some models of KMPs within the VLE:

- Tan and others [28] proposed the EL-PDCA model and developed an extended topic map tool that will include knowledge requirement level (KRL) and information extraction tools. The main aim for adding these tools is to highlight significant knowledge for the learner. On the other hand, these tools highlight outdated knowledge for the knowledge provider, so they will need to redevelop it

The EL-PDCA model is another e-learning service model, proposed by [28] as shown in Fig. 8. This model manages e-learning processes in the overall lifecycle: plan, do, and check action. It detects the behavior of the learner and monitors their activities in the learning environment and the policies that have been scheduled to

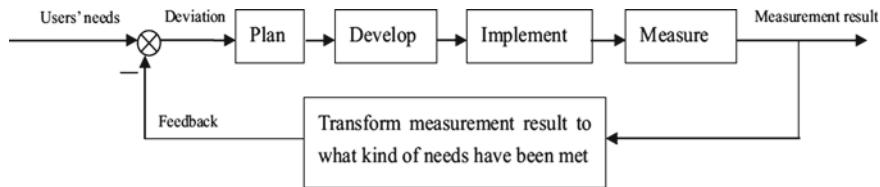


Fig. 8 PDCA in e-learning process

develop this model. Also, during the development phase, e-learning will be supported in the design, maintenance, and enhancement of the process. Moreover, both learners and instructors will be supported by this model to complete the innovation efficiently for all of the team.

To validate this proposed method, [28] developed a new tool based on a well-known topic map by extending it to involve two new layers as shown in Fig. 9. One of them is to add a KRL, and the other layer is for extracting information. The KRL will help highlight significant knowledge for the learner as well as outdated knowledge for the knowledge provider so that they can redevelop it. The second layer is to extract the knowledge required to support the learner and the instructor using a web extraction tool.

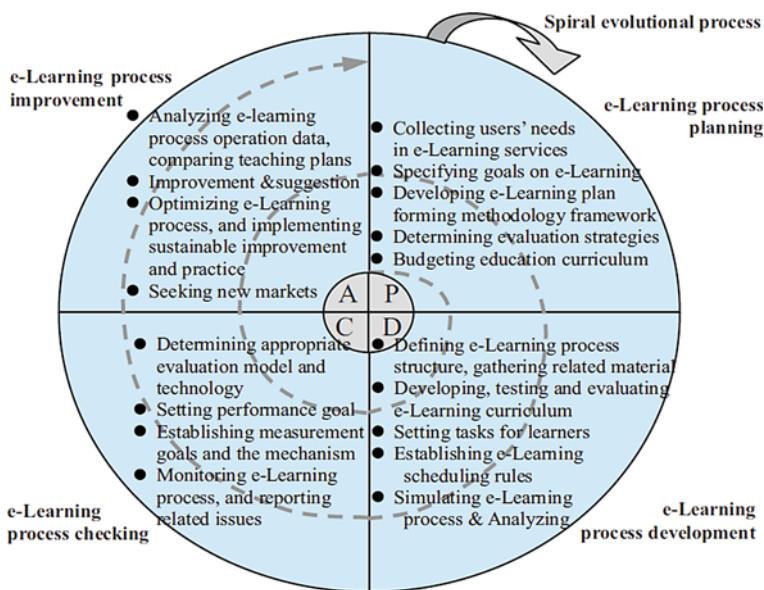


Fig. 9 New tool in PDCA in e-learning process

- A study about KM strategies in VLEs proposed a KM model to develop the performance of the English teacher. The model consists of three phases as follows [26]:
 1. The first phase is to study the basic experiences and knowledge of learners and how to acquire them; the main objective of this stage is to reformulate this knowledge with the aim of development.
 2. The second phase of this model is based on the establishment of a KM community so that this community is communicative and participatory and the transfer of expertise and knowledge according to the rules and foundations.
 3. The third and final phase of this module focuses on basic KMPs such as organization, construction, storage, and reuse, which, in turn, are aimed at acquiring and evaluating established knowledge. It also focuses on higher KMPs such as creating and building new knowledge.
- The SECI Model [23] of Knowledge Dimensions, developed by [50], is another KM model in the VLE that was created to understand the nature of knowledge creation and management. The model shown in Fig. 10 includes four elements to integrate and transfer knowledge. [22] explained the four elements of the model to be compatible with KM in the VLE. The explanation is as follows and as shown in the figure below [22].
 - *Socialization:* This is the process of exchanging ideas and disseminating experiences among learners in virtual learning communities. In this case, virtual learning communities help impart tacit knowledge among participants (learners) through observation, sharing, discussion, tradition, and practice, where new value-added knowledge (explicit knowledge) is created as a result of this vast amount of knowledge accumulations.

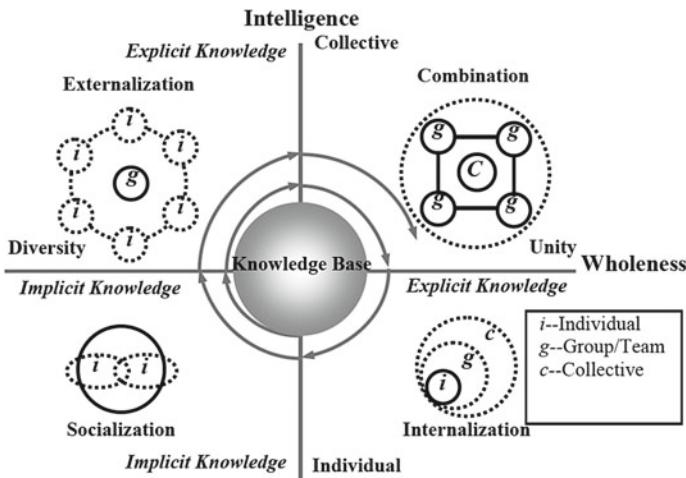


Fig. 10 SECI model

Table 4 LMS with SECI

SECI components	Requirement	LMS feature
Socialization	Virtual space for interaction	Virtual learning space
Externalization	Expression tool	Forum, chat
Combination	Sharing and discussion	(Coded knowledge) Slides, books, forum
Internalization	Measurement tool to evaluate knowledge understanding	Assessment and Evaluation

- *Externalization:* This is the process of transferring tacit knowledge to explicit knowledge in virtual learning communities through discussions, dialogues, the exchange of ideas and experiences, perception and interaction, as well as sharing experiences and special feelings. The role of KM in virtual learning communities lies in the collection of explicit knowledge resulting from the sharing of tacit knowledge being linked, categorized, and stored in the database that learners can retrieve in their time of need to achieve the exchange and transfer of knowledge.
- *Combination:* In virtual learning communities, if knowledge is not aggregated, summarized, and categorized according to metadata rules and regulations, it is difficult for learners to benefit from this vast amount of information. Here, the collection process (combination) comes in, which is the conversion of all the tacit knowledge obtained from the externalization process to a system of knowledge organized and classified according to rules and regulations, and thus, the process of knowledge exchange and conversion is achieved.
- *Internalization:* This process of assimilating the knowledge that emerges from the previous three processes is a valuable asset of knowledge and can be considered active/inactive knowledge that enriches the experience of all participating learners.

The integration OF SECI MODEL and VLE can be seen in Table 4, which shows the four elements in SECI, its requirements and how it has been reflected by LMS feature.

- In another study on KM and its integration with e-learning, it was recognized that what is stated in this model is really suitable for applying KMPs in VLEs (Judrups 2015).
- Another study proposed a framework to take advantage of KM in e-learning [18], employing the following conditions as shown in Fig. 11.
- Technology tools (LMSs, VLEs, web-based platforms, collaboration communities, expert systems) should support e-learning and KM.
- People (learners, instructors, administrators) should be a source of knowledge.
- KMPs are the essential part of collaboration and knowledge transfer in e-learning.
- The repository's purpose is to store and retrieve knowledge that has been converted from implicit knowledge to explicit knowledge and vice versa.

The usefulness of the model designed shows that e-learning and KM must be integrated. E-learning management systems provide an environment for acquiring

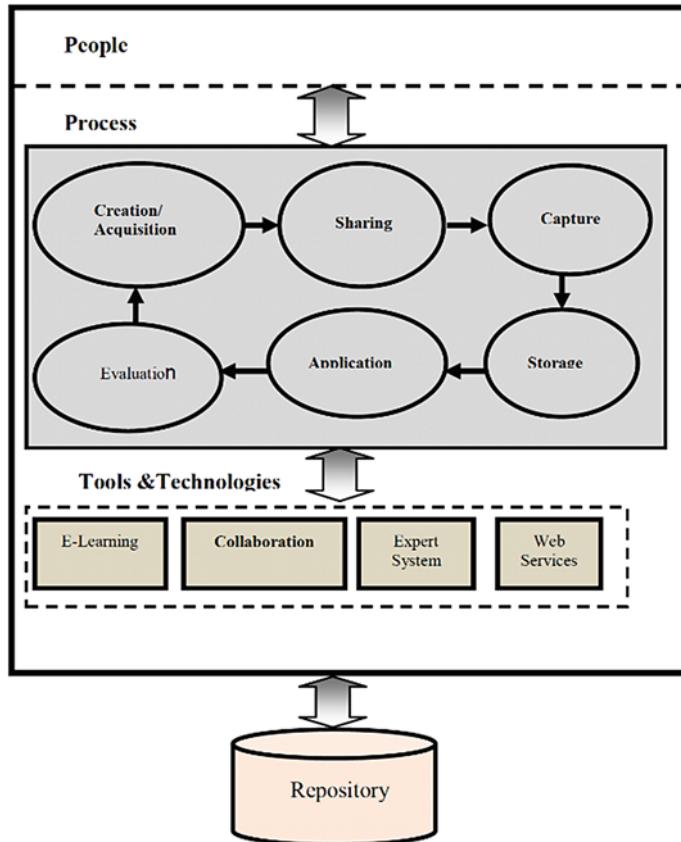


Fig. 11 Proposed knowledge management framework

content and KMPs that ensure the dissemination, storage, use, and application of such content and knowledge so that it becomes valuable knowledge.

5 Proposed Model

In this part we have proposed new model in order enhance the previous mentioned models as shown in Fig. 12.

In Technology part web information Extraction tool will added to LMS; in order to give the model more flexibility for the model. This tool will allow the system to search in the web for any missing information so the knowledge in LMS will not be rigid and fixed. Table 5 shows the features will be added to support SECI components when WIE added.

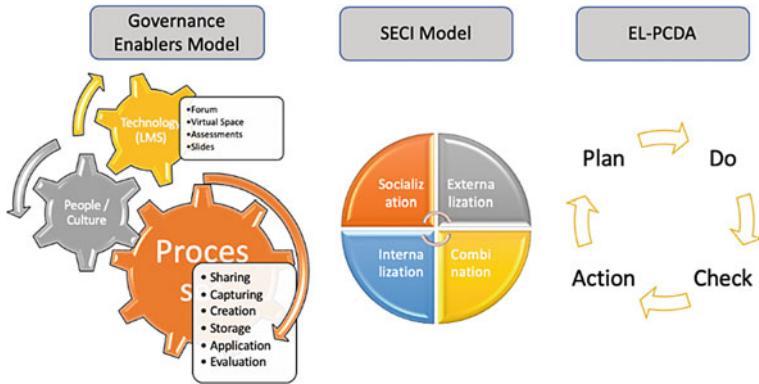


Fig. 12 Components of proposed model

Table 5 LMS with SECI and WIE (web information extraction)

SECI components	Requirement	Feature	Tools
Socialization	Virtual space for interaction	Virtual learning space	• LMS
Externalization	Expression tool repository to store explicit knowledge	Forum, chat digital repository	• LMS • Digital library (web)
Combination	Sharing and integration	Coded knowledge + unified data structure	• WIE • LMS
Internalization	Measurement tool to evaluate knowledge understanding	Assessment and evaluation	• LMS

Figure 13 shows the proposed model where the synergy between the three models can revert huge impact on building knowledge in VLE. Where in technology part, LMS and WIE tools will be used. In Processes part SECI model will be applied. Lastly the over all model will be implemented in PDCA model.

6 Conclusion and Future Work

Numerous and valuable research articles examine the concept of KMPs in the VLE and their role in organizing, processing, creating, sharing, and exchanging knowledge and other processes. The analyzed articles proved that KM promotes culture change and stimulates innovation by supporting freedom of thought. It also improves the exploitation of the expertise and skills possessed by the human element. KM helps organize, coordinate, and integrate processes in a way that leads the organization to achieve its objectives. On the other hand, all these studies confirmed the importance

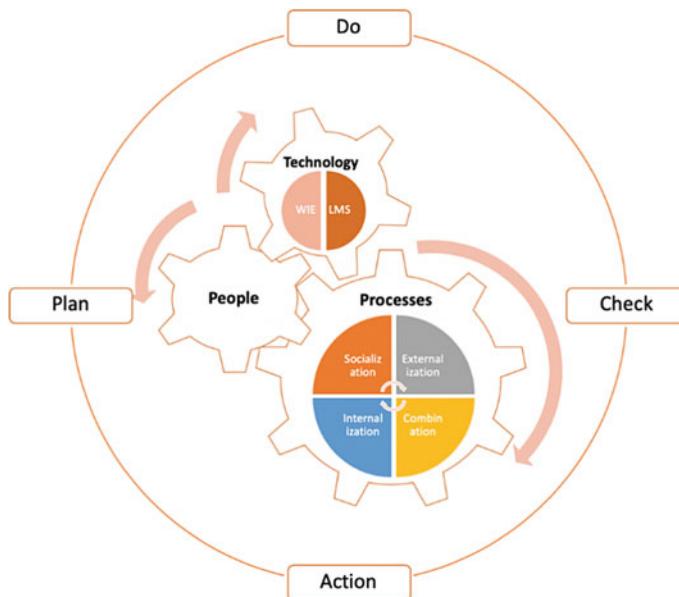


Fig. 13 Proposed model

of e-learning and VLEs in general in raising the performance of the learner and increasing his/her experiences. E-learning is an extension of the concept of learning, going beyond the boundaries of traditional classroom walls and moving toward an environment rich with multiple sources, where interactive distance learning techniques have a key role in reshaping the role of the learner and the teacher. In this systematic review, information was collected on the role of KMPs in VLEs, including the concepts of e-learning, KM, and the VLE. The study also included the extent of the integration between KM and the VLE and highlighted the impact of this integration and its advantages on the student, the instructor, and the organization. The requirements of KMPs in this type of learning environment and issues facing VLEs were also mentioned.

All the research questions were answered, which included the classification of databases and the most commonly used methodologies to illustrate the concept of the study as well as a presentation of the most searched KMPs in the VLE in the process of creating knowledge. One of the questions addressed the most widely used and valuable model of effective KM in VLEs. The countries that mainly addressed the topic and where case studies had been performed were reviewed. The subject of research is still under study and the focus of attention of many researchers. We hope that we have contributed somewhat in this area. The limitations of the research are that we addressed KM in VLEs only and did not address social networking environments, for example, or other virtual societies, for instance, the economy or politics, as the information on them may be unpublished or unshared.

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Online Social Networks Adoption in Micro Small and Medium Enterprises: An Empirical Evaluation Using the Task-Technology Fit Model



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Abstract The purpose of this paper is to investigate the factors that have an impact on online social networks (OSN) adoption, and how OSN adoption in turn affects the organization's performance of micro small and medium enterprises (MSMEs) in Palestine. The quantitative approach was used, and 115 questionnaires were collected from the target companies. The data was analyzed by using a structural equation modelling (SEM) approach through partial least square (PLS) software. Results show that there is a positive relationship between relative advantage, compatibility, and task on the technology fit. Also, there is no relationship between the complexity on the technology fit. And, technology fit positively affected the adoption of the online social network, in addition, the adoption of online social network positively affected the performance of MSMEs. This study recommends enhancing the benefit of adopting online social networking applications, fostering compatibility and efficiency, identifying the expected tasks of staff members on social networking sites because of its positive impact on the performance of MSMEs.

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Keywords Online social networks · Micro small and medium enterprises · Adoption · Organization's performance · Palestine

1 Introduction

The idea of online social networking sites as a means of communication and marketing among Micro Small and Medium Enterprises (MSMEs) has spread widely in Palestine as well as in the world in the last few years [1, 2]. Organizations have achieved considerable growth and popularity among those seeking services which are compatible with the global technological development [3, 4]. As a result of this development, significant changes have taken place in the working mechanisms, activities, and performance of businesses, which in turn has made these businesses more capable of keeping up with the development the world is witnessing in terms of innovation and inventiveness [5–7]. This development has been accompanied by the appearance of online social networking applications, which have become more common in the current century. According to some Palestinian statistics, the percentage of users of these online social networking applications reached 37% out of the internet users in Palestine [8].

Social media networking sites have become of growing interest on the part of businesses as they have opened the door wide to promote and communicate with a groups of customers [9–11]. Many types of organizations have been able to utilize optimally the free services provided by social media networking sites [12, 13]. These sites have been used to promote products, services, trademarks through creating posts, setting notifications, posts, messaging and comments. According to the literature, many businesses have succeeded in adopting the applications of online social networking sites, as they do not require high technical skills, special infrastructure, and they are cost-efficient [3, 9, 14]. Facebook is a good example of those applications which has gained wide popularity in societies. According to some statistics, 30% of the internet users in Palestine use this application efficiently to exchange pictures, share files and posts, and have immediate conversations [8]. Facebook is the main focus of this study, as it is the most widely used application by businesses in Palestine. Micro small and medium enterprises have been chosen because they are among the most important pillars of the Palestinian financial and economic organization [15]. According to the Arabic social media report, Facebook is the most widely used application in the Middle East [16].

Due to the wide technological development in the last decade, MSMEs have had a tendency worldwide to employ this development, mainly online social networks [4]. In Palestine, these media sites, especially Facebook, are widely used among individuals. This has made MSMEs paid attention to this, which in turn has increased sales, reduced costs, improved services, and enhanced businesses' relationships with customers. Employing online social networks applications has become a strategic goal for organizations to foster their performance [17]. The Palestinian economy is largely based on micro-enterprises where 99% of these enterprises are family-owned

ones [18]. Thus, this explains the fact that these enterprises heavily depend on OSN such as Facebook. As far as the researchers know, the factors which affect the adoption of online social networks and their impact on the performance of MSMEs have not been investigated [3, 4, 17]. Here stems the idea of this study bearing in mind that there are similar studies on the large companies in some developed counties. A key limitation of this research is that, the adoption of online social networks applications in the developing counties is still low compared to the adoption of these applications by large companies in the developed countries [19].

The objective of this paper is to study the factors which affect the adoption of OSN by MSMEs. Moreover, in this paper, the effect of adopting OSN on the performance of MSMEs will be investigated. The last objective of this paper is to identify the needs of MSMEs and to what extent they adopt OSN.

The remainder of the paper is organized as follow: Sect. 2 review of the literature, the research model and hypotheses presented in Sect. 3; Section 4 is devoted to research methodology; data analysis discusses in Sect. 5; the results of this study reported in Sect. 6; finally, the conclusion and recommendation concluded in the last section.

2 Research Model and Hypotheses

This study adapted the TTF model in a bid to determine the viability of OSN adoption as a marketing tool for MSMEs. Figure 1, illustrates the constructs described in the previous section.

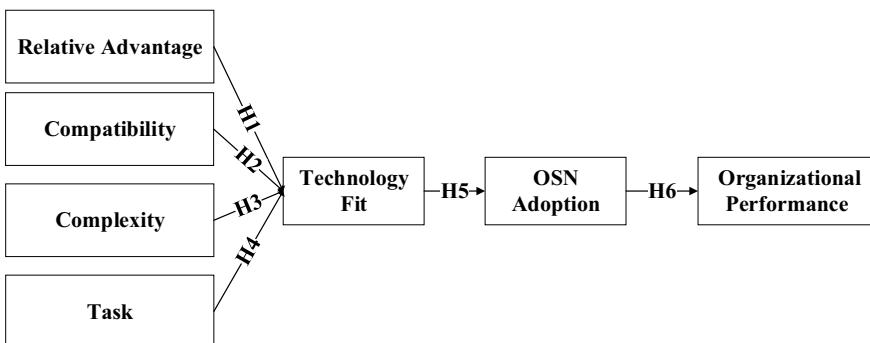


Fig. 1 The conceptual model

2.1 Impact of Technology Characteristics on Technology Fit

From the existing literature on the technological factors that influence IS adoption [20, 21], relative advantage, compatibility, and complexity have been proposed for measuring the technology aspect of the suitability of IS adoption. Further literature review suggests the existence of a relationship between these technological factors and the fit construct [20, 22, 23].

Al-Bakri and Katsioloudes [24] supported the significance of these three factors by revealing that complexity, compatibility, and relative advantage showed consistent significance in shedding light on IT adoption. Furthermore, Chong, et al. [25] suggested that relative advantage, complexity, and compatibility are the three innovation attributes among the five attributes of DOI which are applicable to EC adoption, while observability and trialability are not commonly applicable to IT innovation studies. Thus, in this study, relative advantage, compatibility, and complexity are projected for measuring the technological aspect of the fitness of OSN adoption by MSMEs.

2.1.1 Relative Advantage

Relative advantage refers to the advantages that the company receives owing to their adoption of different technologies [26]. The decision to adopt technology is first met with the primary concern of transitional costs, and the advantages achievable [27]. In this regard, relative advantage has also been evidenced to be the top factor in adopting IT in the earlier literature [28].

Organizations will get many benefits when adopting the online social network, such as informational benefits, and obtaining data input from customers and competitors easily, which helps to develop new businesses, support the existing ones, increase selling operations, increase the number of connections, and enhance the customer relations management [16, 29]. Thus, the relative advantages that OSN adoption is considered to provide a more positive impact on the probability of organizations to use the technology. Additionally, the impact of relative advantage on the fitness of information technology has been examined in different contexts [20, 23, 30, 31]. Furthermore, relative advantage is considered one of the factors that influence OSN fitness to MSMEs; therefore, this study supposes that:

RH1 Relative advantage positively influences the fitness of OSN adoption.

2.1.2 Compatibility

Compatibility is described as the level of fitness of a specific technology to the company's existing procedures and processes via its experience [26]. This study considers compatibility as the level to which OSN applications are compatible with the company's current practices, like its value chain relationships and its processes.

In this regard, the adoption of new technology calls for the adoption of new skills and methods for its correct implementation because incompatibility would prevent its adoption and hinder innovation within the company. The compatibility variable is known to be one of the most significant drives of OSN adoption when compared with the rest of the innovation predictor factors [16, 32]. Furthermore, several research studies have examined compatibility as a factor to measure task–technology fitness [22, 30]. The study by AlAjmi et al. [33] observed the relationship of the expected compatibility of E-learning based on cloud computing with the systems' fitness for task characteristics. Compatibility effects on OSN adoption fitness are investigated in this study, leading to the second hypothesis:

RH2 Compatibility has a positive influence on the fitness of OSN adoption.

2.1.3 Complexity

Complexity is the associated challenges with the learning, understanding, and use of technology. IT diffusion has been suggested to be easier for ideas and thoughts which can be easily understood and applied, including the required new skills for the application [26]. Ihlsoon Cho [27] revealed that the challenges related to the understanding and application of new technology may result in resistance, slower value recognition and fear of failure.

Numerous studies have investigated complexity as a factor that has a negative influence on IT adoption [34–36]. As per Goodhue and Thompson [37], complexity is a factor of the TTF; Lee et al. [22] further investigated complexity as a contributing factor to the determination of the fitness of technology for specific applications. In this study, the effect of managers' perception of complexity on the fitness of OSN from the MSMEs perspective was investigated; hence, the third hypothesis was proposed as follows:

RH3 Complexity has a negative influence on the fitness of OSN adoption.

2.1.4 Impact of Task Characteristics of Social Media on Technology Fit

Task characteristics are the task requirement (ability or behavior requirements) within an organization [20, 38, 39]. In this study, the task construct evaluates the requirements and actions performed by MSMEs when providing e-marketing services via OSN. This implies the examination of the computing needs of MSMEs towards OSN services implementation. The establishment of online social media services demands the upgrading and implementation of the MSMEs system to meet offline task demands. This research, therefore, proposes the following hypothesis:

H4 Task characteristics significantly affect the task technology fit.

2.1.5 Impact of TTF of Social Media on OSN Adoption

TTF can be expected to positively affect user attitudes toward technology adoption [20, 37]. Moreover, the outcome of the review of 43 UTAUT related research by Williams et al. [40] suggested the positive impact of TTF on the intention to adopt different technologies. As per Yen et al. [41], the behavioral intention of users to adopt wireless technology is a function of the fit between the task and technology. Technology, according to Chen et al. [42], can only be successfully adopted if it can completely fit with the intended tasks. This study suggested that a higher level of TTF can encourage the adoption of OSN applications by users; hence, it is hypothesized that:

H5 Task technology fit positively influences the intention to adopt OSN applications.

2.1.6 Impact of OSN Adoption on Organizational Performance

Several studies have evidenced the capability of technology to improve business activities and performance [43, 44]. According to some studies, there are several benefits of corporate adoption of social media; a positive relationship has also been identified between corporate performance and social media adoption [14, 45, 46]. As per Rodriguez et al. [47], social media positively influences customer-related activities and impacts sales performance. Similarly, another study by Parveen et al. [48] found the adoption of social media to strongly influence the performance of organizations in a positive manner, especially in the form of cost reduction, enhanced access to information, and improved customer relations. These studies agreed with the previous literature on technology adoption where technology adoption has been found to positively impact organizational performance in both financial and non-financial terms [14]. Hence, the last research hypothesis is postulated as follows:

H6 MSMEs' social media adoption has a positive effect on their business performance.

3 Research Methodology

3.1 Sampling and Data Collection

A quantitative research method was adopted in this study. The study participants were Palestinian managers of micro, small, and medium enterprises (MSMEs) under various sectors, like the business, services, industrial, and agricultural sectors. This study adopted the definition of the Palestinian Central Bureau of Statistics (PCBS) for MSMEs because it has been used by several past studies in Palestine [49]. Therefore,

for clarity, in this study, MSMEs are defined as micro firms that employed 1–3 workers; small firms, 4–19 workers; and medium firms, 20–49 workers.

According to the statement of the Chamber of Commerce at Tulkarm 2019, the MSMEs in Tulkarm region ($N = 1700$) were selected as the population of the study, and the sample of the study were ($n = 170$). Totally 170 surveys were randomly distributed, the total usable samples gathered were 115 surveys. Regarding the sample number, at least 100 samples are needed to perform Structural Equation Modelling (SEM) analysis [50]. Moreover, the sample size, according to the smart PLS path modeling, must be at least 30–100 cases [50]. Therefore, 115 respondents were enough for the analysis.

3.2 Measurements

The exogenous variables investigated in this study covered the relative advantage, compatibility, complexity, task, technology fit, and OSN adoption. The endogenous variable is the organizational performance. Table 1, showed the observed variables which represent the latent variables, with each construct consisting of numerous items that are measured on a five-point Likert scale (ranging from 1 = ‘strongly disagree’ to 5 = ‘strongly agree’). The utilized items were all extracted from previously validated scales used in innovation adoption researches (adapted to cover social media use where necessary). A minimum of three items was used per construct to ensure proper reliability [51]. For the sake of the non-English speaking respondents, the items were also translated into Arabic language to ease understanding.

Table 1 Constructs for the study

#	Name	Source of measurement items	Items
1	Task (TAS)	[30, 38]	3
2	Relative advantage (RLA)	[52–54]	5
3	Compatibility (COM)	[17, 26, 54]	5
4	Complexity (CMX)	[17, 53, 55]	5
5	Technology fit (FIT)	[30, 37, 38]	4
6	OSN Adoption (AD)	[17, 56]	6
7	Organizational performance (OP)	[4, 57]	5
Total items			33

Table 2 sample characteristics

Sample characteristics		Frequency	Percent (%)
Gender	Male	74	64
	Female	41	36
Age	Under 30 years	60	52
	Between 30–40 years	41	36
	More than 40 years	14	12
Education	Secondary school	27	23
	Diploma	26	23
	Bachelor	57	50
	Master and above	5	4
Number of employees	1–3	54	47
	4–19	40	35
	20–49	21	18
	Above 49	0	0
Experience	1–5 years	47	41
	6–10 years	29	25
	11–15 years	26	23
	Above 15 years	13	11
Sector	Business	35	30
	Services	63	55
	Industrial	15	13
	Agricultural	2	2

3.3 *Instrument Validation*

The developed questionnaire was tested on five people randomly selected from the target population. They were asked to ascertain the clarity of the instructions and questions, as well as to comment on the structure of the questionnaire and how long it requires to be complete. The selected participants agreed to the clarity of the questionnaire and its ease of completion; thus, there was no need for further modifications.

Table 3 Descriptive statistics for constructs

Construct	TSK	RLA	COM	CMX	FIT	AD	OP
Item	3	5	5	5	4	6	5
Mean	3.892	4.066	4.020	2.904	4.058	4.023	4.193
Standard deviation	0.689	0.579	0.543	0.948	0.585	0.589	0.533
Skewness	-0.086	-0.72	-1.04	0.072	-0.93	-1.32	-1.55
Kurtosis	-0.673	1.208	2.128	-0.65	1.502	2.306	3.224
Cronbach's alpha	0.703	0.801	0.788	0.859	0.750	0.850	0.783

4 Data Analysis

4.1 Descriptive Statistics

Table 2 presented the respondents' characteristics while Table 3 is a tabulation of the constructs' descriptive statistics. From Table 3, it was evident the mean of the entire constructs was in the range of 2.904–4.193 while the standard deviations were in the range of 0.533–0.948. This is an indication of a narrow spread of the values around the mean. Regarding the skewness and kurtosis values, the values of the skewness ranged from -1.554 to 0.072 while the kurtosis values ranged from -0.673 to 3.224. According to the rule of thumb established by Byrne [58], the values of the skewness and kurtosis for any normally distributed data must range from ± 3 to ± 7 , respectively. Hence, the data in this study was considered normal and suitable for further analysis.

The internal consistency of the measurement instrument was also assessed using Cronbach's Alpha. The analysis showed that the whole constructs achieved Cronbach's Alpha values of more than 0.70, showing a good level of internal consistency [59]. Such values confirm a good correlation among the set of responses to the items that measured the studied constructs [60].

4.2 Model Analysis

Partial least squares (PLS) was utilized to analyze the data and verify the validity of the model. There are two basic procedures in the PLS which are measurement model assessment and structural model assessment [51, 61]. The assessment of the measurement model requires the investigation of the constructs' reliability and validity while structural model assessment requires the verification of the models' hypotheses.

4.2.1 Measurement Model

This stage requires the assessment of the measurement scales to verify their validity and reliability. During this stage, all items are considered as reflective indicators; hence, item loading is also considered. The measurement model was revised by continuously discarding items with loading <0.6 [61]; hence, CMX4 was dropped. The reliability of the reflective measures was evaluated by using three indicators which are the internal consistency, Cronbach's alpha, and composite reliability [51, 61].

The item loadings for all the constructs' indicators, as shown in Fig. 2 and Table 4, were all above the lowest limit of 0.60 [62], indicating a satisfactory level of internal consistency. Regarding composite reliability, all the values were >0.7 [61, 63] as presented in Table 4. They also presented Cronbach's alpha values which are higher than the minimum criteria of 0.6 as shown in Table 4 [64]. Therefore, the reliability of the measurement model was reasonable. Concerning the convergent validity, the average variance extracted (AVE) values were above the lowest level of 0.50 [61]; this indicates that more than 50% of the variance of the items for each construct were shared among the items as shown in Table 5. Regarding discriminant validity, the observed square root of AVE for each construct in the research model was greater than the inter-correlations of the construct with other constructs as shown in Table 5 [65]. This implied that each construct was different and captured the non-represented phenomena by the other constructs. Therefore, the measurement model showed a satisfactory level of validity and reliability.

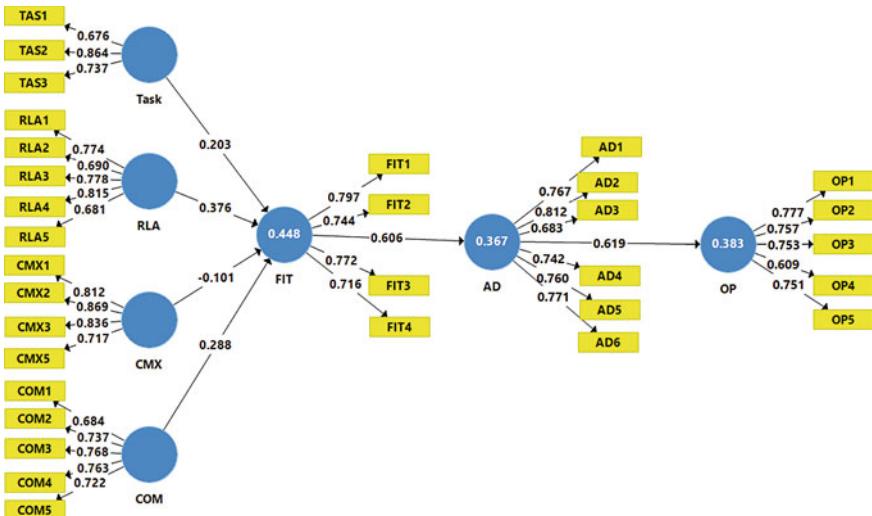


Fig. 2 Measurement model

Table 4 Measures: reliability and validity

Contract	Items loading	AVE	CR	Cronbach's alpha
Task (TAS)	0.676	0.582	0.805	0.701
	0.864			
	0.737			
Relative advantage (RLA)	0.774	0.562	0.864	0.806
	0.690			
	0.778			
	0.815			
	0.681			
Compatibility (COM)	0.684	0.541	0.855	0.788
	0.737			
	0.768			
	0.763			
	0.722			
Complexity (CMX)	0.812	0.657	0.884	0.832
	0.869			
	0.836			
	0.717			
Technology fit (FIT)	0.797	0.574	0.844	0.753
	0.744			
	0.772			
	0.716			
OSN adoption (AD)	0.767	0.573	0.889	0.850
	0.812			
	0.683			
	0.742			
	0.760			
	0.771			
Organizational performance (OP)	0.777	0.536	0.851	0.781
	0.757			
	0.753			
	0.609			
	0.751			

Table 5 Discriminant validity based on the Fornell-Larker criterion

	AD	CMX	COM	FIT	OP	RLA	Task
AD	0.757						
CMX	-0.011	0.811					
COM	0.656	-0.034	0.736				
FIT	0.606	-0.094	0.542	0.758			
OP	0.619	0.033	0.563	0.509	0.732		
RLA	0.551	0.007	0.504	0.559	0.480	0.750	
Task	0.296	0.067	0.300	0.354	0.396	0.191	0.763

4.2.2 Structural Model

The assessment of the structural model was based on the significance of the path coefficients which typifies the strength of the relationships that exist between the dependent and independent variables. The R^2 value is a reflection of the level of variance explained by the independent variables. For the dependent variables (Fit, ONS Adoption, and Organizational Performance), the R^2 values were 0.448, 0.367, and 0.383, respectively. These values revealed that the task, relative advantage, compatibility, and complexity factors explained about 44.8% of the fitness of OSN applications, while about 36.7% of the OSN adoption was explained by Fit of OSN applications. Also, 38.3% of the organization's performance was contributed by adoption of OSN. Additionally, an estimation of the significance of each path was done via a PLS bootstrapping method using 500 resamples to obtain the t -values [66]. The outcome of the hypotheses testing was presented in Table 6, where hypotheses H3 was rejected and the rest were accepted.

Table 6 Hypotheses results

H#	Relation	Original sample (O)	T statistics (O/STDEVI)	P values	Result
H1	RLA → FIT	0.376	4.886	0.000	Significant
H2	COM → FIT	0.288	3.238	0.001	Significant
H3	CMX → FIT	-0.101	1.125	0.251	Not significant
H4	TAS → FIT	0.203	3.112	0.002	Significant
H5	FIT → AD	0.606	7.362	0.000	Significant
H6	AD → OP	0.619	7.132	0.000	Significant

5 Discussion

Regarding the hypotheses in the above structural model, following are the path analysis results:

- H1: Relative advantage (RLA) has positive effect on technology fit (FIT)
The path coefficient = 0.376, t -value = 4.886, p -value = 0.000. Regarding the first research hypothesis (H1), the results display that the RLA has a positive effect on the FIT, the results in Table 6 showed that this hypothesis is supported in the proposed study model. The statistical result of the RLA in predicting the FIT showed that the t -value was 4.886 and the p -value was 0.000. It means when the prediction of FIT, the regression weight for the RLA is notably different from zero at the 0.000 level. Furthermore, the path coefficient for this relation was 0.376, which represents a positive relationship, that when the RLA rises up by 1 standard deviation, the FIT will rise up by 0.376 standard deviations. For that, H1 considered supported.
This result can be interpreted because using online social networks in organizations will impact and encourage these organizations to use social media in their operations by using and adopting the newest technologies. This result is in line with other results found in the literature, which discussed the importance of RLA in adopting any new technology [16, 20, 30].
- H2: Compatibility (COM) has a positive effect on technology fit (FIT)
The path coefficient = 0.288, t -value = 3.238, p -value = 0.001. Regarding the H2, the results display that the COM has positive effect on the FIT, the results in Table 6 showed that this hypothesis is supported in the proposed study model.
The statistical result of the COM in predicting the FIT showed that the t -value was 3.238 and the p -value was 0.001. It means when the prediction of FIT, the regression weight for the COM is notably different from zero at the 0.001 level. Furthermore, the path coefficient for this relation was 0.288, which represents a positive relationship, that when the COM rises up by 1 standard deviation, the FIT will rise up by 0.288 standard deviations. For that, H2 considered supported.
This result can be interpreted because using online social networks in organizations are highly compatible with the organizational infrastructure that is depending on the technologies and the internet. This result is in line with other results found in the literature, which discussed the significant of COM factor in the technology fit in organizations [19, 20, 30].
- H3: Complexity (CMX) has a negative effect on technology fit (FIT)
The path coefficient = -0.101, t -value = 1.125, p -value = 0.251. In testing the H3 related to the relationship between CMX and FIT, it was found that there is no direct significant relationship between CMX and FIT as stated in Table 6; the path coefficient = 0.101, t -value = 1.125, p -value = 0.251. Thus, H3 is rejected.
This result is in line with those published by some other researchers [20, 30].
- H4: Task (TAS) has a positive effect on technology fit (FIT)
The path coefficient = 0.203, t -value = 3.112, p -value = 0.002. Regarding the H4, the results display that the TAS has positive effect on the FIT, the results in

Table 6 showed that this hypothesis is supported in the proposed study model. The statistical result of the TAS in predicting the FIT showed that the *t*-value was 3.112 and the *p*-value was 0.005. It means when the prediction of FIT, the regression weight for the TAS is notably different from zero at the 0.005 level. Furthermore, the path coefficient for this relation was 0.203, which represents a positive relationship, that when the TAS rises up by 1 standard deviation, the FIT will rise up by 0.203 standard deviations. For that, H4 considered supported. Task refers to the task requirements and examine computing needs in the organization to implement e-government services. Which means to update the organization's e-services to match the task requirements. That means when determining suitable and a good task requirement, the technology will be more useful for the organization's success and its e-services. This result is in line with other results found in the literature [20, 30].

- H5: Technology fit (FIT) has a positive effect on OSN Adoption (AD)
The path coefficient = 0.606, *t*-value = 7.362, *p*-value = 0.000. Regarding the fifth research hypothesis (H5), the results display that the FIT has a direct positive effect on the AD, the results in Table 6 showed that this hypothesis is supported in the proposed study model. The statistical result of the FIT in predicting the AD showed that the *t*-value was 7.362 and the *p*-value was 0.000. It means when the prediction of AD, the regression weight for the FIT is notably different from zero at the 0.000 level. Furthermore, the path coefficient for this relation was 0.606, which represents a positive relationship, that when the FIT rises up by 1 standard deviation, the AD will rise up by 0.606 standard deviations. For that, H5 considered supported. This result can be interpreted that using online social networks considered one of the technologies that is completely depending on the technology infrastructure existed in the organizations. For that, the reason for adopting online social networks in organizations, will be more encouraging when the existing technology in the organization was completely fit and continuously were updated, which can be more useful in marketing, announcing, and reaching more customers. This result is in line with other results found in the literature [20, 38].
- H6: OSN Adoption (AD) has a positive effect on organizational performance (OP)
The path coefficient = 0.619, *t*-value = 7.132, *p*-value = 0.000. Regarding the H6, the results display that the AD has a direct positive effect on the OP, the results in Table 6 showed that this hypothesis is supported in the proposed study model. The statistical result of the AD in predicting the OP showed that the *t*-value was 7.132 and the *p*-value was 0.000. It means when the prediction of OP, the regression weight for the AD is notably different from zero at the 0.000 level. Furthermore, the path coefficient for this relation was 0.619, which represents a positive relationship, that when the AD rises up by 1 standard deviation, the OP will rise up by 0.619 standard deviations. For that, H6 considered supported. This result can be interpreted that using online social networks has a strong impact on the performance of organizations, in terms of cost marketing reduction, reach a huge group of future and current customers at minimal cost, enhancing customer

information and relationships, and enhancing information accessibility. This result is in line with other results found in the literature [43, 45, 67].

6 Conclusion

The results of this study provide several theoretical and practical contributions. From the theoretical side, this study added a piece of good information to the literature about some factors that are affecting the adopting OSNs in the organizations, and how can this adoption increasing the organization's performance. Furthermore, this study result has an important implications and value for MSMEs in Palestine and in the other similar countries, in order to develop more suitable strategies for adopting OSNs' as a communication and a marketing tool among their employees and customers. Understanding the technology factors that are affecting the adoption of OSNs and working on developing and updating them, will help the employees to better make a success online relationships between themselves and between their customers. For that, making a good connection between the employees themselves, and a good relationship between employees and the customer will affect the organization's performance through increasing sales, reaching more customers, enhancing profits, and marketing products in effective ways. Thus, this study tries to investigate the suitable technology factors that are affecting the adopting of OSN, in order to increase the performance of the organization. Finally, the researchers recommended:

- The relative advantage of adopting online social networks should be enhanced because of organizations' tendency to use modern technology.
- Compatibility between online social networks and modern technology should be fostered.
- Staff members should be provided with the necessary training of using online social networks as this has a positive impact on the information technology environment.
- Identifying the tasks expected of social media for staff members since this has a positive effect on the efficiency in the electronic environment.
- The existence of technology fit in using online social networks lead to positive results in adopting these sites.
- Adopting social media networks positively affects organizational performance.

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Comparison of e-Learning, m-Learning, and Game-Based Learning Applications for Introductory Programming Courses: An Empirical Evaluation Using the TAM



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Abstract Despite the growing need for IT graduates, the retention rate in software-related undergraduate programs is still a major concern. This stems from the difficulty and complexity of programming concepts for a large number of students. To handle this situation, this research introduces the “PROBSOL” application that is offered in three different platforms, namely e-learning, m-learning, and game-based learning for teaching introductory programming (IP) courses. To measure the students’ actual use of the three platforms, this research adopts the technology acceptance model (TAM). The three conceptual models related to each platform were validated by using the partial least squares-structural equation modeling (PLS-SEM) technique based on data collected from 204 students enrolled in an IP course. The results revealed that the students’ behavioral intention to use the three different platforms is positively influenced by the ease of use and usefulness of these platforms. The results also pointed out that the actual use of these platforms is significantly affected by the students’ positive intentions towards using the platforms. More interesting, the predictive power of the e-learning conceptual model is shown to be much higher than those of m-learning and game-based learning.

Keywords E-learning · M-learning · Game-based learning · Introductory programming · TAM

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1 Introduction

Learning to program is considered as a difficult and challenging skill for novice programmers to acquire in introductory programming (IP) courses [1, 2]. As a consequence, high attrition rates (dropout and failure) were reported in computer science and related disciplines [3–8]. Some studies concluded that the traditional method employed in the teaching and learning process of the IP course concentrates more on syntax and semantics of the programming language instead of paying equal attention to problem-solving skills [9–13]. Moreover, de Raadt et al. [14] reviewed forty textbooks used in the IP courses and determined that six out of forty books consistently applied problem-solving aspects throughout the different topics, and most of the other books focused more on programming language syntax and semantics. On the other side, Winslow [15] argued that novice programmers should concentrate equally on programming language syntax, semantics, and problem-solving strategies. Therefore, it is suggested to design the teaching materials of the IP course in a way that concentrates equally on programming knowledge (syntax and semantics) and problem-solving practices throughout the teaching topics of the course.

This study introduces the “PROBSOL” application used in delivering the instructional activities of the IP course. The purpose of the application is to augment the problem-solving skills of novice programmers. The application is based on the pseudo-code technique. The application covers all the teaching topics of the IP course. The “PROBSOL” application was developed and offered in three different learning systems (game-based learning, e-learning, and m-learning) to facilitate the learning process of novice programmers in the IP course. The game-based learning and e-learning applications were offered through web-based platforms. The m-learning application was offered through a mobile App.

The main objective of this research is to evaluate the students’ actual use of the three different applications in the IP course. In doing so, this study adopts the technology acceptance model (TAM) [16]. The selection of TAM in this study refers to the fact that this model is one of the most cited models in the technology acceptance domain. To validate the model across the three different applications, the partial least squares-structural equation modeling (PLS-SEM) technique has been employed based on data collected from students enrolled in the IP course.

2 Research Model and Hypotheses Development

This research adopts the TAM [16] to evaluate the actual use of e-learning, m-learning, and game-based learning applications. It is suggested that TAM offers robust empirical support for its two main factors, including “perceived ease of use (PEOU)” and “perceived usefulness (PU)” to evaluate the users’ acceptance of a certain technology [17]. In the domain of educational technology, TAM has been validated across a number of technologies, such as m-learning [18, 19], e-learning

[20, 21], cloud computing [22–24], wearable technologies [25], and social media [26, 27]. To understand the students' actual use of the three different applications, it is presumed that behavioral intention is affected by both PU and PEOU. It is also postulated that PU is influenced by PEOU. Further, it is suggested that the actual use of the three applications is affected by the behavioral intentions of students. The definitions of the factors and the suggested hypotheses under these factors are described under the following subsections.

2.1 Perceived Ease of Use

Perceived ease of use (PEOU) is defined as “the degree to which a person believes that using a particular system would be free from effort” [16]. Through the use of various technologies, earlier studies found that PEOU had significant positive impacts on both PU and behavioral intention (BI) [28–30]. Therefore, this research posits the following hypotheses:

- H1:** PEOU has a significant positive effect on PU.
- H2:** PEOU has a significant positive effect on BI.

2.2 Perceived Usefulness

Perceived usefulness (PU) refers to “the degree to which a person believes that using a particular system would enhance his or her job performance” [16]. A number of research studies concluded that PU had a significant positive influence on behavioral intention [31–33]. Based on that, this study suggests the following:

- H3:** PU has a significant positive effect on BI.

2.3 Behavioral Intention

Behavioral intention (BI) refers to the user's intent to perform a specific behavior [16]. BI has a strong relationship with the actual use of a specific technology [34]. Prior studies in the domain of technology acceptance indicated that BI had a significant positive association with the actual use of technology [35, 36]. Thus, this research presumes the following:

- H4:** BI has a significant positive effect on actual use.

3 Research Methodology

3.1 Context and Subjects

The data were gathered through an online survey. The target participants were the university students enrolled in the IP course offered at Al Buraimi University College in Oman. As the study focus is on the actual use of the three different applications in the IP course, all the participated students have experienced the use of the three different applications in their programming activities. Figures 1, 2, and 3 depict examples of the three different applications. The data were collected between December 2018 and April 2019. In total, 215 students have successfully filled out the survey. Of that, 11 responses were eliminated due to the large number of missing values, and therefore, 204 valid responses were retained for the final analysis. Table 1 shows the participants' characteristics. There were 57.4% females and 42.6% males. The majority of the participants are aged between 18 and 22 years old, with 78.9%. Most of the participants are specialized in information systems, with 53.9%. This is followed by those who specialized in computer science, with 31.4% and software engineering with 14.7%. It is imperative to report that 52.9% of the participants have prior experience in programming. Most of the students prefer using the m-learning application, with 64.7%.

PROBLEM SOLVING SKILLS : PROBSOL APPLICATION [Log In]

1: Algorithm 2: Basics 3: Input/Output 4: Selection 5: Repetition 6: Functions 7: Arrays GAME DownLoad

Problem Analysis Algorithemic Model (PAAM)
ARRAYS: 1/3

Problem is to write a program that reads five integer numbers in an array and then print these numbers along with its sum.

INPUT	PROCESS	OUTPUT
Enter Number 1 Enter Number 2 Enter Number 3 Enter Number 4 Enter Number 5	i[0] i[1] i[2] i[3] i[4]	Number 1 Number 2 Number 3 Number 4 Number 5 Sum is

PSEUDO-CODE

Random Steps:

```

Set count, sum to 0
Start
Print sum
do
Read the number Num, Store Num to item[count]
Calculate sum, Increment count by 1
while (count < 5)
Set count to 0
Do
Print item[count], Increment count by 1
Stop
While (count < 5)

```

Right Steps:

(Instruction: Select any line/step from the first List Box and move it to the second List Box and make all its lines into correct steps of sequential order, using the Arrow Keys.)

Next Question Check Solution

Problem Solving Skills > Topic 7: Arrays

Fig. 1 E-learning (E-PROBSOL) application

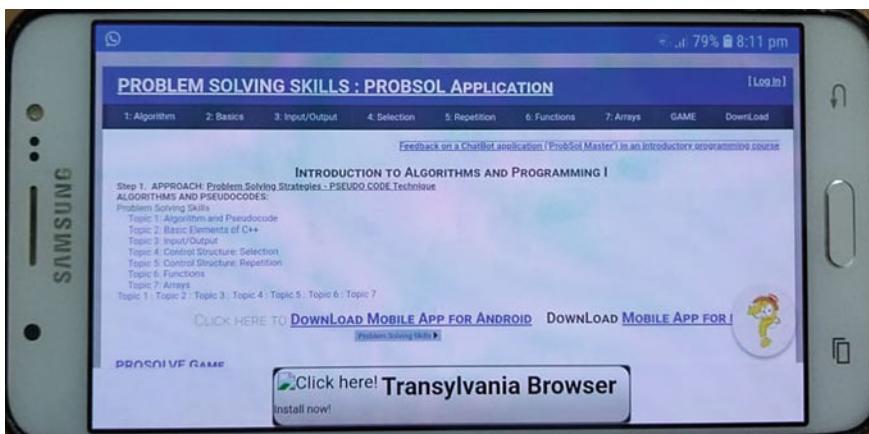


Fig. 2 Mobile learning (M-PROBSOL) application

PROSOLVE GAME

LEVEL 7

Write a C++ program that reads five integer numbers in an array then print these numbers and their sum.

Random Steps:

```

Do
While (count < 5)
do
Set count, sum to 0
While(count < 5)
Stop
Set count to 0
Print sum
Print item[count], Increment count by 1
Read number num, Store num to item[count], Calculate sum, Increment coun
Start

```

Instruction: Re-arrange the above given random steps into correct steps of sequential order by moving the lines (steps), up or down using the arrow Image-Buttons at right side of the list box.)

Number of Clicks:

Next Question
Get POINTS
Total POINTS:

Fig. 3 Game-based learning (PROSOLVE) application

3.2 Research Instrument

The research instrument consists of two parts. The first part involves the students' demographic characteristics, their programming experience, and preferences. The second part involves the indicators set out to evaluate the factors in the three different theoretical models. These indicators are measured using a five-point Likert scale, with values ranging from "1 = strongly disagree" to "5 = strongly agree". The indicators for PEOU and PU were adapted from Davis [16]. The indicators for BI and actual

Table 1 Participants' characteristics

Characteristics	Values	Count	Percentage (%)
Gender	Male	87	42.6
	Female	117	57.4
Age	18–22	161	78.9
	23–28	27	13.2
	Above 28	16	7.8
Major	Information systems	110	53.9
	Computer science	64	31.4
	Software engineering	30	14.7
Programming experience	Yes	108	52.9
	No	96	47.1
Preferences	M-learning (M-PROBSOL)	132	64.7
	E-learning (E-PROBSOL)	33	16.2
	Game-based learning (PROSOLVE)	39	19.1

use were adapted from Mohammadi [34]. The constructs and their corresponding items under the three different applications are detailed in the Appendix.

3.3 Data Analysis

To analyze the three different theoretical models, the partial least squares-structural equation modeling (PLS-SEM) approach is employed via the SmartPLS V.3.2.8 tool [37]. The dynamic use of PLS-SEM in the domain of IS makes it an effective approach, specifically when used for exploratory studies [38]. This research follows the procedures for using the PLS-SEM in the IS domain [39]. In that, the PLS-SEM has a dual-stage analytical method, namely the measurement model (i.e., “outer model”) and structural model (i.e., “inner model”) [40]. The reason behind the use of PLS-SEM in this research stems from its capability in providing the concurrent examination of both measurement and structural models, which in turn, will account for more accurate findings [41].

4 Results

4.1 Measurement Model Assessment

The measurement model refers to the relationship between the factors and their indicators. Its assessment involves estimating the reliability [i.e., Cronbach's alpha (CA) and composite reliability (CR)] and validity (i.e., convergent and discriminant validities) [42]. Concerning the reliability, the findings in Table 2 designate that the values of CA were all above the threshold value of 0.7 across the three models [43]. Similarly, all the CR values were above the cut-off value of 0.7 [44]. Given these results, the reliability is confirmed.

In terms of convergent validity, it is suggested to calculate the factor loadings and average variance extracted (AVE) [38]. As per the readings in Table 2, the factor loading values across the three models were all above the suggested value of 0.7. The findings also exhibited that the AVE values were all above the recommended value of 0.5. These findings provide sufficient evidence in which the convergent validity is fully established.

With respect to discriminant validity, Henseler et al. [45] suggested testing the Heterotrait-Monotrait ratio (HTMT). According to the results in Tables 3, 4, and 5, all the HTMT values were less than the suggested value of 0.85, which in turn, indicates that there were no concerns in testing the discriminant validity across the three models. Thus, the total validity is confirmed in this research. In line with the reliability and validity testing results, the three measurement models are established, which undoubtedly leads to the assessment of the structural models.

4.2 Structural Model Assessment

The structural model describes the association among the constructs in the conceptual model. Its assessment requires estimating the path coefficients through a bootstrapping procedure of 5000 re-samples and the coefficient of determination (R^2) [42]. Concerning the path coefficients, Table 6 illustrates the path coefficients, t -values, and p -values for each hypothesized relationship across the three conceptual models.

H1 shows that PEOU has a significant positive impact on the PU of e-learning ($\beta = 0.850, t = 37.934$), m-learning ($\beta = 0.873, t = 47.514$), and game-based learning ($\beta = 0.816, t = 26.696$). H2 reveals that PEOU has a significant positive effect on the behavioral intention to use e-learning ($\beta = 0.490, t = 5.815$), m-learning ($\beta = 0.420, t = 4.385$), and game-based learning ($\beta = 0.452, t = 8.927$). H3 indicates that PU has a significant positive influence on the behavioral intention to use e-learning ($\beta = 0.390, t = 4.312$), m-learning ($\beta = 0.492, t = 5.180$), and game-based learning ($\beta = 0.488, t = 9.584$). H4 suggests that behavioral intention has a significant positive impact on the actual use of e-learning ($\beta = 0.895, t = 57.724$), m-learning ($\beta =$

Table 2 Reliability and convergent validity results

Constructs	E-learning model						M-learning model						Game-based learning model					
	Indicators	Loadings	CA	CR	AVE	Indicators	Loadings	CA	CR	AVE	Indicators	Loadings	CA	CR	AVE			
Actual use	AU_E1	0.933	0.845	0.928	0.866	AU_M1	0.956	0.906	0.955	0.914	AU_G1	0.909	0.777	0.900	0.818	AU_G2	0.900	
	AU_E2	0.928				AU_M2	0.956											
Behavioral intention	BL_E1	0.900	0.908	0.942	0.844	BL_M1	0.854	0.878	0.925	0.804	BL_G1	0.918	0.902	0.939	0.836	BL_G2	0.912	
	BL_E2	0.930				BL_M2	0.908											
Perceived ease of use	PEOU_E1	0.905	0.900	0.938	0.834	PEOU_M1	0.894	0.843	0.906	0.762	PEOU_G1	0.882	0.850	0.909	0.770	BL_G3	0.914	
	PEOU_E2	0.929				PEOU_M2	0.888				PEOU_G2	0.905						
Perceived usefulness	PEOU_E3	0.905				PEOU_M3	0.835				PEOU_G3	0.845				PU_G3	0.906	
	PU_E1	0.933	0.905	0.941	0.841	PU_M1	0.935	0.911	0.944	0.849	PU_G1	0.923	0.906	0.941	0.841			
	PU_E2	0.917				PU_M2	0.918				PU_G2	0.923				PU_G3	0.906	
	PU_E3	0.900				PU_M3	0.911				PU_G3	0.906						

Note AU = "Actual use", BI = "Behavioral intention", PEOU = "Perceived ease of use", PU = "Perceived usefulness", CA = "Cronbach's Alpha", CR = "Composite reliability", and AVE = "Average variance extracted"

Table 3 HTMT results for e-learning

	AU	BI	PEOU	PU
AU				
BI	0.822			
PEOU	0.834	0.807		
PU	0.841	0.785	0.840	

Table 4 HTMT results for m-learning

	AU	BI	PEOU	PU
AU				
BI	0.722			
PEOU	0.776	0.786		
PU	0.769	0.756	0.795	

Table 5 HTMT results for game-based learning

	AU	BI	PEOU	PU
AU				
BI	0.778			
PEOU	0.826	0.770		
PU	0.759	0.747	0.729	

0.826, $t = 37.875$), and game-based learning ($\beta = 0.820$, $t = 23.951$). Thus, all the hypotheses were supported across the three conceptual models.

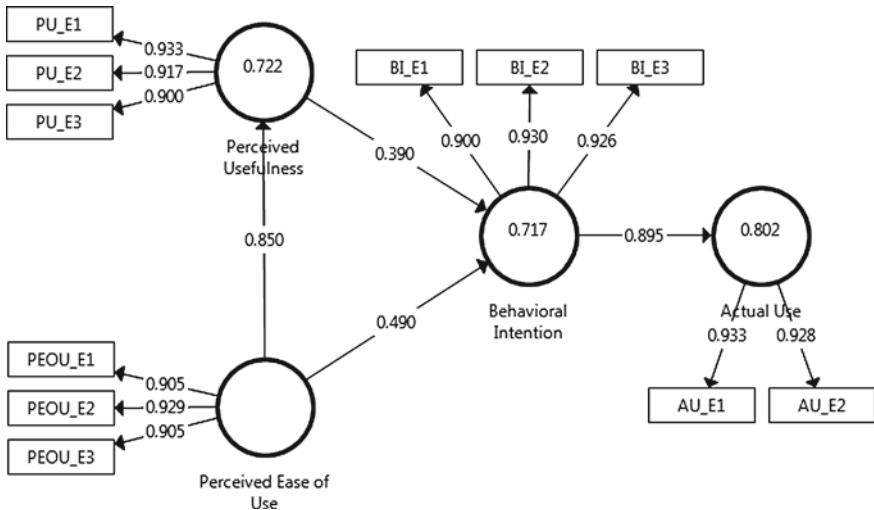
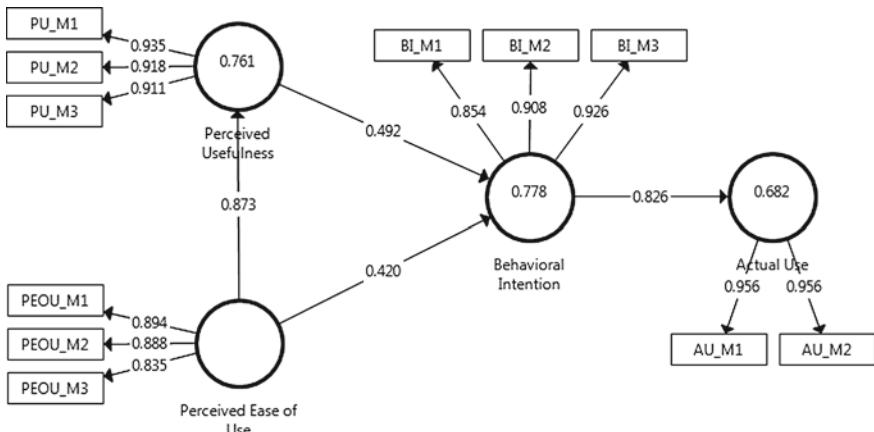
In terms of the (R^2), the results in Figs. 4, 5, and 6 indicate that the direct effect of behavioral intention and the indirect effects of PU and PEOU explain 80.2%, 68.2%, and 67.2% of the variance in the actual use of e-learning, m-learning, and game-based learning, respectively. This indicates that the predictive power of the e-learning conceptual model is much higher than those of m-learning and game-based learning.

5 Discussion

The present study introduced an application named “PROBSOL” and employed this app in three different learning platforms (e-learning, game-based learning, and m-learning) to facilitate the learning process of novice programmers in an IP course. The game-based learning and e-learning applications were offered through web-based platforms, while the m-learning application was offered through a mobile application.

Table 6 Hypotheses testing results

Hypothesis	E-learning model				M-learning model				Game-based learning model			
	Path coefficients	t-value	p-value	Remarks	Path coefficients	t-value	p-value	Remarks	Path coefficients	t-value	p-value	Remarks
H1: PEOU → PU	0.850	37.934	0.000	Supported	0.873	47.514	0.000	Supported	0.816	26.696	0.000	Supported
H2: PEOU → BI	0.490	5.815	0.000	Supported	0.420	4.385	0.000	Supported	0.452	8.927	0.000	Supported
H3: PU → BI	0.390	4.312	0.000	Supported	0.492	5.180	0.000	Supported	0.488	9.584	0.000	Supported
H4: BI → AU	0.895	57.724	0.000	Supported	0.826	37.875	0.000	Supported	0.820	23.951	0.000	Supported

**Fig. 4** PLS algorithm results for e-learning**Fig. 5** PLS algorithm results for m-learning

The study evaluated the students' actual use of the three different applications based on the TAM [16]. The PLS-SEM technique was used to test the proposed model. The study hypothesized that PEOU would have a positive and significant effect on PU. The results indicated that PEOU has a significant positive impact on the PU of e-learning, m-learning, and game-based learning applications. Previously, Arpacı et al. [46] investigated the impact of knowledge management practices on the acceptance of Massive Open Online Courses (MOOCs) by university students. Their findings indicated that PEOU has a positive and significant impact on the PU of MOOCs. In the same vein, Arpacı et al. [47] used TAM to explain the organizational

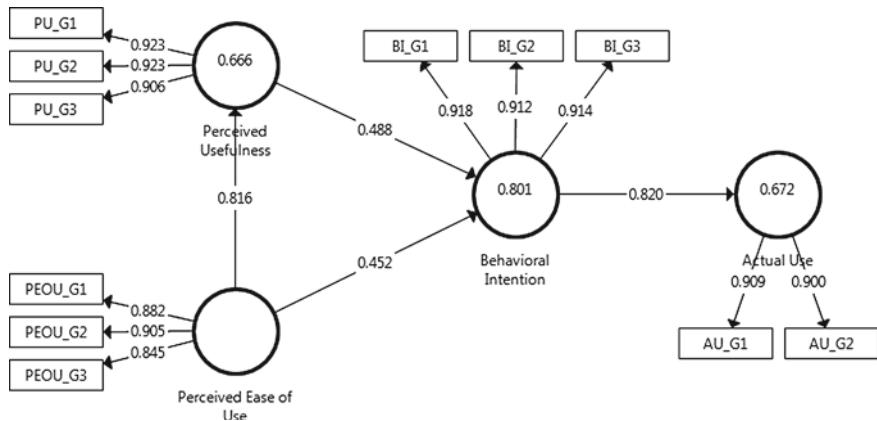


Fig. 6 PLS algorithm results for game-based learning

adoption of smartphones. Their results indicated that PEOU has a strong significant impact on the PU. This means that the usefulness of the three different applications would be increased if the students realize that these applications would be free from efforts and easy to use.

The study hypothesized that PEOU would have a positive and significant effect on BI. The results indicated that PEOU has a significant positive effect on the behavioral intention to use the three platforms. Previously, Park et al. [48] used TAM to explain students' behavioral intention to use m-learning. Their results confirmed the applicability of TAM in explaining students' acceptance of m-learning and indicated that PEOU has a significant impact on the students' behavioral intentions. This indicates that the higher the easiness of the three different applications, the higher the students' behavioral intention to use these applications in programming practices.

The study hypothesized that PU would have a significant positive effect on BI. The results indicated that PU has a significant positive influence on the behavioral intention to use the three platforms. Likewise, Arpacı et al. [49] used TAM to explain engineering students' intention to use a game-based programming environment. Their results indicated that PU has a significant impact on the students' intention to use the game-based programming environment. This indicates that the higher the usefulness of the three different applications, the higher the behavioral intention to use these applications in programming courses.

This research hypothesized that the BI would have a significant positive impact on the actual use of the three applications. The results derived from this study supported the proposed hypothesis and confirmed those observed in previous relevant studies [35, 36]. This indicates that the actual use of the three different applications would be increased if the students have positive intentions toward their use.

6 Conclusion

6.1 Research Implications

Despite the increasing need for graduates in the IT field, the retention rate in software-related undergraduate programs is still a major problem [49]. A remarkable number of students are changing their majors after they took the first programming course since programming is a complex and difficult activity. Given this situation, the present study introduced the “PROBSOL” application that is offered in three different platforms, namely e-learning, m-learning, and game-based learning for teaching IP courses. Using online applications does not only attract students’ attention but also provide them with ubiquitous access to learning materials and objects at “anytime anywhere” settings. However, the decision to populate these applications and integrate them in educational settings requires to test users’ acceptance. This study, therefore, focused on the acceptance of e-learning, m-learning, and game-based learning applications in IP courses.

The study applied TAM to investigate the key factors predicting the students’ intentions and actual use. One of the main implications of the findings was confirming the applicability and predictive power of the TAM for the acceptance of e-learning, m-learning, and game-based learning applications. More interesting, the predictive power of the e-learning conceptual model was much higher than those of m-learning and game-based learning.

6.2 Limitations and Future Work

While it is believed that the current study has exerted promising results concerning the use of the three different applications, it also posits some limitations which need to be considered for future examinations. First, the main limitation of this research is the relatively low response rate. What is furtherly needed is to evaluate the use of the three applications across a large sample size. Second, this research evaluated the use of the three applications using data collected from one academic institution. To further generalize the results, this research encourages testing the use of the three applications using samples from several academic institutions. Third, the data collection was restricted with the use of questionnaire surveys. Future investigations might consider the use of other methods, such as focus groups and interviews to further strengthen the results and interpret the relationships among the factors in the research model.

Appendix: Constructs and Items

E-learning (E-PROBSOL)

Perceived Usefulness

PU_E1. E-learning enhances my efficiency.

PU_E2. E-learning enhances my learning productivity.

PU_E3. E-learning enables me to accomplish tasks more quickly.

Perceived Ease of Use

PEOU_E1. E-learning is easy to use.

PEOU_E2. E-learning is convenient and user-friendly.

PEOU_E3. E-learning makes it easier to avoid future academic difficulties.

Behavioral Intention to Use

BI_E1. I intend to increase the use of E-learning.

BI_E2. It is worth recommending the E-learning for other students.

BI_E3. I'm interested to use the E-learning more frequently in the future.

Actual System Use

AU_E1. I use the E-learning on daily basis.

AU_E2. I use the E-learning frequently.

Mobile learning (M-PROBSOL)

Perceived Usefulness

PU_M1. M-learning enhances my efficiency.

PU_M2. M-learning enhances my learning productivity.

PU_M3. M-learning enables me to accomplish tasks more quickly.

Perceived Ease of Use

PEOU_M1. M-learning is easy to use.

PEOU_M2. M-learning is convenient and user-friendly.

PEOU_M3. M-learning makes it easier to avoid future academic difficulties.

Behavioral Intention to Use

BI_M1. I intend to increase the use of M-learning.

BI_M2. It is worth recommending the M-learning for other students.

BI_M3. I'm interested to use the M-learning more frequently in the future.

Actual System Use

AU_M1. I use the M-learning on daily basis.

AU_M2. I use the M-learning frequently.

Game-based learning (PROSOLVE)

Perceived Usefulness

PU_G1. Game-based learning enhances my efficiency.

PU_G2. Game-based learning enhances my learning productivity.

PU_G3. Game-based learning enables me to accomplish tasks more quickly.

Perceived Ease of Use

PEOU_G1. Game-based learning is easy to use.

PEOU_G2. Game-based learning is convenient and user-friendly.

PEOU_G3. Game-based learning makes it easier to avoid future academic difficulties.

Behavioral Intention to Use

BI_G1. I intend to increase the use of Game-based learning.

BI_G2. It is worth recommending the Game-based learning for other students.

BI_G3. I'm interested to use the Game-based learning more frequently in the future.

Actual System Use

AU_G1. I use the Game-based learning on daily basis.

AU_G2. I use the Game-based learning frequently.

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The Future of E-Commerce Systems: 2030 and Beyond



Aisha Mohdhar and Khaled Shaalan

Abstract The sophistication and efficiency of systems is undeniably advancing. As businesses evolve, questions on its past performance is beside the point but its anticipated functions and relevance in the future. With the use of software in commerce at the core of every business today, the overlook of how omnichannel transactions operates is an awe with the 4th industrial revolution and its societal impact. This chapter explains how commerce has currently evolved in the advent of technology elaborating on the current state and challenges of systems, its architecture, and the innovations of cyber physical systems in electronic commerce. It further expounds on the application of omnichannel systems in communication through the fifth-generation network, in transaction through blockchain and in composition through Social Internet of Things. We believe that this study will benefit all stakeholders in commerce from governments, supply chain organizations and consumers to understanding the forthcoming drivers of omnichannel systems in the 4th industrial revolution, its prospects, and its anticipated challenges.

Keywords E-commerce · Cyber physical systems · Industry 4.0 · Omnichannel · Technology acceptance model (TAM)

1 Introduction

The attributing factors of innovating commerce from its core trading such as the lack of specialization (coincidence of wants), storage, locality and medium of exchange [1–4] make the future of commerce as progressive as its evolution. Moldable through every innovative era, Commerce from its basics of barter to highly sophisticated global electronic transactions, soars in the generation in which it exists.

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Today, the involvement of software applications in commerce is in every part of the human livelihood coupled with rapid changes, it impacts not only functions and activities of the commercial system but sways its values across societal, political, cultural and legal ways, hence being very significant.

This wave of high performance technology centric commerce does not only impact established physical commerce organizations, but thru all domains in the supply value chain where innovative omnichannel [5] systems interoperate hardware and software solutions across brick and mortar channels, mobile technology and social media across the electronic commercial ecosystem. It involves entrants (startups) who want to break even to the market, technology solutions providers who need to understand the impact of different solutions integrating with organizations, end users who are interacting with the systems and government, network regulators who are setting policies on the application and usage of network technology for their day to day business functions.

Advancing with virtual consumers and businesses, it is evident that innovations in electronic commerce will take precedence in omnichannel systems demanding technologies in hardware and software interoperability.

E-commerce (EC) a fairly simple concept in explanation, where a commercial transaction of goods or services occurs electronically through systems application capabilities over an internet medium is now at the core of everyday businesses. As early as the 1960, when businesses exchanged information between each other through Electronic Data Interchange (EDI) [6] to the late 80s where Graphical User Interface (GUI) coupled with commercial opportunities on the network sprouted online merchants, e-commerce has stimulated demand in advancement of innovative hardware and software applications.

Meeting this demand is the fourth industrial revolution also known as industry 4.0 [7] which has grown e-commerce to real-time engagement. With its smart digital dynamics, industry 4.0 has eased consumer reach in applications and devices to their comfort. Industry 4.0 adoption in commerce has advanced the supply chain to diverse Cyber Physical System (CPS) [8] capabilities that allow real time computations and convergence of multiple systems across network channels. This advancement allows the tight coupling of the CPS with organizations functional capabilities such as information management, monitoring and controls which provides organizations with essential attributes in operating, collecting consolidating as well sharing information across the chain.

CPS is described as a combination of distributed cyber and physical systems which are controlled and monitored as per the user requirements [9, 10]. As a powerful source today for the most critical resources such as healthcare, energy, food, and transportation channels; CPS is a gateway to establishing a complete chain in omnichannel systems.

CPS innovations are currently integrated with Supply Chain services to innovate management of across its systems. Figure 1 shows the continuum of CPS as part of core technologies that have enabled organizations productivity in different time periods across the supply chain in organizations.

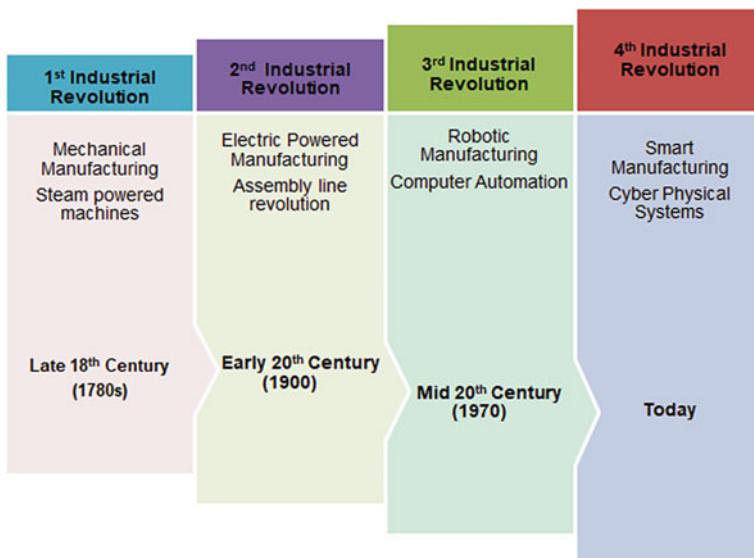


Fig. 1 Industrial advancements

At a time when information interchange is programmed and electronic commerce takes precedence over brick and mortar in commercial exchange; attention is needed to understand the drivers to the development in e-commerce systems to cater and meet the requirements of the industrial revolution. An analysis of the advancement of e-commerce channel solutions is essential to defining the future connection, transaction, and usage of omnichannel systems. Section 2 of this chapter explains using Technology Acceptance Model (TAM) to understand the current state of e-commerce systems architecture and how it applies to users in customer engagement and businesses towards achieving progressive technology. Section 3 elaborates on the current challenges facing e-commerce systems especially in the wake of COVID19 Pandemic and addressing ways to mitigate them. Section 4 discusses the technology advancements anticipated to revolutionize e-commerce systems in on how they communicate through the fifth-generation networks, transact through blockchain and interact through Social Internet of Things among systems and with consumers. Section 5 discusses the anticipated challenges brought by the advancements of technology suggesting ways on how to mitigate them. Section 6 concludes the study on the evolution of e-commerce systems.

2 Current State of E-Commerce Systems

An innovative systems milestone has the ability to transform, re-invent or create new business model at the peak of demand. As an enhanced Information Systems (IS)

platform which is able to capture, process and distribute information [11], integrate systems [12, 13] to streamline data and support key functionalities so as to have an operational and workflow efficiency [14]; e-commerce platforms provide additional functions that are beyond IS capabilities such as integrated decision making capabilities that allow organizations to understand customer data for customization and personalization of products and services. In this section we present the state of e-commerce systems and essentially understanding on how its architecture is applied and how the systems are perceived as functional in everyday usage to appreciate the technology drivers behind commercial systems advancements.

2.1 TAM in E-Commerce Systems Architecture

In any system engineering, the software architecture is essential to the organizations growth. Software architectural requirements can be functional which develop from organizational objectives and are determined by functionality and services of the system user needs or non-functional which are the system qualities which describe how rather than what a system should do [10].

Before looking at progressing technologies in the e-commerce arena we first turn to the Technology Acceptance Model (TAM) to provide for a theoretical framework for explanation of the adoption of progressive innovations. The Technology Acceptance Model (TAM) will be explained to provide determining factors for ease of use in e-commerce.

Over the years the adaptation of adopting new technologies has been studied in variety of fields [15]. In its originality the conceptualization of TAM [16] explains how the adoption of new Technology systems by users in context of their work.

With the Perceived Usefulness (PU) and the Perceived Ease of Use (PEU) being the main drivers of TAM, the attitude towards usage and acceptance lead to behavioral intention and ultimately actually using e-commerce systems. In their study Mezhuyev et al. [17], reflect on how Software Engineering research has proved that TAM goes beyond the explanation of an information system or software acceptance but the processes that the systems are involved under them.

As complex the architecture of e-commerce systems, segmentation of services is essential to understanding the variance in use of technology. A typical e-commerce system architecture integrates numerous software systems. Figure 2 shows how in its simplicity as viewed on the front end, e-commerce back end architecture is technically complex involving several functions which are diverse in application components, processes, and seamless interaction for information flow in real time. They include:

- (1) *Consumer services* that support the organizations pre-sales, sales and post-sale activities. Software systems providing these services enable organizations to capture, segment, analyze and manage customer information. Example: A Customer Relationship Management system (CRM) integration would handle

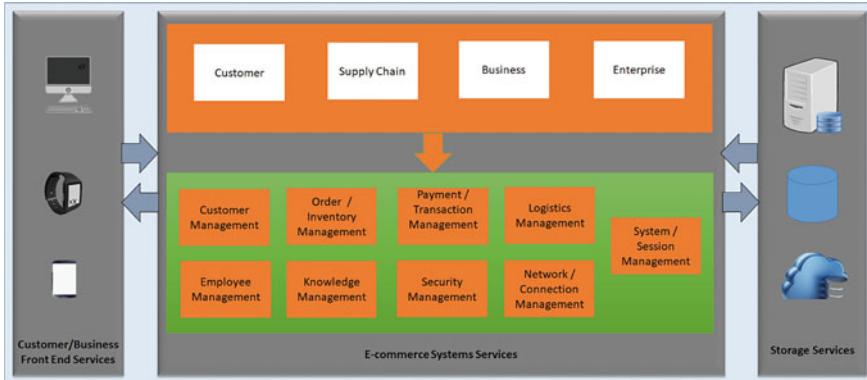


Fig. 2 Typical e-commerce systems architecture

customer registration details, customizable preferences of goods and services, customer status and behavior and transaction history.

- (2) *Supply Chain services* that support the organizations order fulfillment. Software systems providing these services enable organizations to monitor inventory, track the location and status of merchandise and manage orders in real-time. Examples include Merchandizing System, Order Management System, and Distribution Logistics System.
- (3) *Business services* that support the organizations value proposition [18]. Software systems providing these services enable organizations to strategize important elements through various analytical techniques of their offerings whether it is a product or service to meet the needs of the end consumer. Example: A Payment Management System integration will not only allow payment of goods and services online but connect to various payment systems, calculate value added tax (VAT), various taxable deduction systems as per the goods/services or country specific regulations, shipping costs and discounts. E-commerce has soared with its electronic payment system solutions that process payment at the convenience of both business and customers, reduce transaction costs and enable business to broaden their market. Software solutions provide various payment systems [19] in use today such as the credit card, debit card, smart cards, e-wallets, net banking, mobile payment, digital currency e.g. bitcoin and other custom payment solutions e.g. amazon pay that organizations provide.

Other key business services systems include Knowledge Management Systems (KMS), Point of Sale management (POS) system, Catalogue Management System, and Employee Management System (EMS).

- (4) *Enterprise services* that support the organization integration and workflow. Software systems providing these services enable organizations to connect and integrate platforms to work together in an efficient, secure and faster way for

seamless business processes. Examples include security applications, network connectivity applications and database management systems (DBMS).

With the integration of segments in e-commerce systems an understanding of variables that mediate and those that influence behavioral intention and action is vital to technology acceptance. In the e-commerce segment TAM has been reviewed [20, 21] and models have been simplified, extended or combined in assessing perception in adoption [22, 23] of online shopping experiences, verifying user experiences, understanding consumer behavior [24] as well as analysing payment specific to mobile payment (m-payment) with an extended Unified Theory of Acceptance and Use of Technology (UTAUT) model where performance expectancy was seen as the best predictor in understanding the behavioral intention in m-payment systems [25].

As omnichannel systems evolve, external variables towards attitudes and behavioral intentions to be used with minor effort [16, 26] is a determining factor to reflect on perceived ease of use and perceived usefulness of technologies in the 4th industrial revolution to explicate acceptance with systems architecture.

2.2 *Current E-Commerce Systems Application*

Currently technologies such as Mobile Phones and wearables, Artificial Intelligence and Internet of Things have advanced design solutions of e-commerce systems and its applications to provide the supply chain with ultimate business integrations and end user experiences throughout the omnichannel systems at its time.

The use of mobile phone technology has made a big impact in commerce, this is due to the demand and comfort of users to interact with mobiles. E-commerce systems are ensuring that software applications are designed across multiple platforms prioritizing a mobile-first design [27, 28] approach to give end user an accessible, fast and responsive experience. Through wearables, such as smart watches and glasses, E-commerce organizations are able to autonomously synchronize data to not only attract customers but also have businesses identify customer needs and push products and services. Wearables provide a personal and intimate ability for businesses and customers which are highly advantageous depending on their specialized functions, anatomy and function [29].

As Artificial Intelligence (AI) and Internet of Things (IoT) dominates the CPS ecosystems autonomous services, e-commerce has seen transformations beyond changing the way commerce works by enabling a socio-technical [30, 31] approach to interaction, data analysis and information dissemination which are able to identify and solve problems beforehand.

E-commerce systems are universally operated hence, end-to-end delivery is fundamental [32]. IoT through location-based technology has intelligently enhanced delivery. Systems are not only able to identify customer location for a timely and intact delivery but are now responsive to customer expectations by communicating through connected devices, such as electronic chips and sensors in real time. Such

innovative technology has created transparency where stakeholders across the e-commerce supply chain can connect and communicate [33] effectively. Through chips and sensor technologies, IoT is making an impact in managing inventory in the supply chain. Software applications in mobile phones and computer systems cannot only track inventory but send notifications and detailed description of products, such as manufacture details of the product, expiration, depletion, and managing restocking e.g. the dash button [34]. Enabling technologies such as high speed internet connectivity, advancement of Global Positioning Systems (GPS) in area location accuracy and interoperability of devices such as IoTs, e-commerce systems are currently deploying systems integration and interoperability of drones [35, 36] and autonomous vehicles [37] for efficiency in delivery potential in the future of commercial supply chain system.

Consumer and business services are also currently being enriched by CPS innovations to enhance user experience and enable synchronization of information. Artificial Intelligence is seen to dominate this area through Augmented Reality (AR) [38, 39] where consumers are able to experience a realistic 3D shopping experience through visualization of products in real size. Intelligent agents are integrated in e-commerce systems to listen through the networks channels and hardware devices on various platforms to consumers brand sharing content giving organizations the ability to gather information and push products accordingly. Chatbots are also programmed to engage and guide visitors in an e-commerce platform to cater to the universal demand hence can be deployed to function around the clock [40].

Figure 3 outlines a typical e-commerce systems application through Artificial Intelligence. The systems can interact, learn, and understand chat conversation between persons Max and Lina. Natural language processing a domain of AI, is able to listen to conversation by identifying key words on brand products or services and market product based on the conversation and/or sentiment analyzed and search through its data or knowledge based systems for product identification which is then push marketed to the consumer.

Organizations are now seeing software systems playing multiple roles in e-commerce where a differentiating task or capability of legacy systems that are assigned to serve independently for specific purpose creates challenges to the organizations interoperability. Combined with CPS, through Internet of Things and Artificial Intelligence, the demand of systems engineering to design autonomous [37] systems that are societally significant, accepted and can integrate with not only hardware but differentiating software systems is a challenge.

3 Current E-Commerce Systems Challenges & Constraints Revealed in the Covid 19 Pandemic

As the Pandemic hit, the choice of consumers restrained into lockdowns or restricted movements, lit on the attributing factors of shopping through e-commerce platforms.



Fig. 3 E-commerce systems application through ai

As an only choice to many for basic household necessities, organizations needed to amp up their technology, this meant for integrating to operate omnichannel systems or implementing standalone systems to meet the consumer demand on e-commerce platforms. This section elaborates on the current e-commerce system challenges through its innovations in software architecture, development and compatibility of technologies and security that illuminated during the pandemic and how organizations can mitigate them.

As seamless as the process of buying and selling online, e-commerce platforms can be a crippling risk to organizations when it comes to design flexibility, adaptability, and security across all systems. As a complex architecture, ensuring that seamless interaction between system functions, had e-commerce organizations like Amazon [41] one of the most highly functioning e-commerce systems scrambling during the pandemic, whereby, adaptability to user demand was seen as a major constraints.

Software being the driver in e-commerce systems, its overall development and complexity pose a major risk especially in today's interoperating environment. Legacy systems [42] whether of the shelf or custom built can handicap growth potential, hence the current state of omnichannel systems have to foresee potential challenges to be able to integrate, interoperate with other systems, infrastructure, industries, societies and economies. As the adoption of cyber physical systems increases with demand, policies, tools and practices of designing and building commercial software are changing. New entrants into electronic commerce have to consider long

term solutions to either replace their operational systems to cater for services or if applicable integrate to run the legacy systems in parallel with e-commerce platforms.

Development of usable and compatible systems considering human, social and organizational needs is a challenge in the current systems engineering. As demand grows in designing software in new dimensions of a social approach, Socio-technical systems [43, 44] design need to evolve. Engineers are currently facing various challenges in designing systems to meet this demand such include changes in alien technologies not known to engineers, keeping with turnover demand of software applications to integrate for customer liking and designing systems to work with several hardware. To mitigate, engineers have to realize the autonomy of e-commerce systems goals through systems resources and constraints as well as the overall customer demand where each individual system can control and action upon requirements while understanding the interdependency of individual systems and their progression. Knowledge based systems [45] algorithms advancements on the architecture ensures learned behavior to progress the evolution of commerce systems.

As technology seeks to reach everyone in this era of Internet of Everything (IoE), societies are yet to have gained trust and confidence in EC software on global payment security, delivery, security and management of data and privacy of online activities [46, 47]. This include emerging security areas, such as IoT infrastructure security, securing storage facilities on cloud technology, privacy of analyzed data and information by AI/deep learning applications as well as collection and usage of big data applications on consumer information. The need to consider the technical development of systems and how to secure them is essential. Bodeau [48] in explaining the basic principles of security engineering, highlights that: Effective systems security should not be restricted to individual system vulnerability that could increase risks at systems level, Policy formats should not be inconsistent and enforcement should not be restrictive throughout systems, Design long term systems security plan to cater for evolving systems architecture.

E-commerce software systems today have conflicting operations, challenged laws and policies especially operating internationally and undefined governing software relationships. It is vital for organizations and countries to define systems structures and leadership of systems that carry information ranging from trademarks, finances, logistics as well as detailed user and customer information. This is vital for national security to ensure effective execution of commercial systems capabilities and requirements, security policies, processes, and practices on every application area especially in the wake of a Pandemic, where essential orders halt as e-commerce organizations meet with regulations. localization of e-commerce systems and products have seen a faster delivery and satisfaction of customers than international shipping or systems bound by international laws which could not sell products across geographies as nations lockdown.

As a first on e-commerce platforms for many during the Pandemic, despite the system challenges, e-commerce is an essential pillar to cater to needs [49].

Studies on how TAM is applied to integration of systems and its compatibility in flexibility of design, adaptability, security and enhance actual system use to achieve ultimate functionality of systems is limited.

4 Future E-Commerce Systems

E-commerce systems architecture play a significant role in envisioning omnichannel systems of the future. As the basics of EC systems software architectural requirements, the current elements and quality of the systems are still prevalent. Interoperability and decentralization of systems will, however, require the relationships among systems to advance. As systems operations remain ubiquitous with unique innovative capabilities foreseeing advancements to supporting services developed to consumer, supply chain, business and enterprise systems is crucial.

Current e-commerce systems design automation, through IoT and AI capabilities such as, AR, Intelligent agents, wearables, machine learning, cognitive and autonomous computing advance, enhancements in e-commerce customer experiences and supply chain visibility foresees expansions across businesses. At the top of every organization list is to solve the issue of last mile approach i.e. the seamless process of end-to-end delivery in the supply chain.

Progression of systems expect autonomous systems to play a crucial role in delivery integrate and interoperate to cater to the supply chain demand. Operating in the fourth industrial revolution, the evolution of commercial systems demand interconnection, information transparency, technical assisting systems and decentralized decision making for sustainability of electronic commercial systems. Hence, envisioning commercial innovative solutions requires seamless and interoperable solutions which are accepted throughout the commercial ecosystem. This intern demand high network connectivity speed, scalable communication between systems and devices in storage and architecture as well as decentralization of transaction process.

Figure 4 describes a typical progression of e-commerce systems interoperability. A sensory detection of wearbles (smart watch) would detect Person A's low heart rate and share information to a medical application on a mobile phone. The mobile phone communicates to check availability of medication on the SMART medical cabinet. On detection of none/low medication, the SMART medical cabinet requests medicine replenishment on blockchain platform from a health practitioner (medicine providers). The figure outlines how systems can share information without the inception of person A. Figure 4 further outlines how efficient digital transactions are, for systems are able to communicate and establish a commercial transaction through blockchain. Lastly, the communication of information from medicine providers to the delivery with autonomous delivery systems capable of locating person A geographically through sharing information with the smart watch once the transactions is verified and approved.

This section introduces and explains how crucial advancements in the platforms of exchange through blockchain, interoperability of systems through Social Internet of Things and medium of exchange through 5G networks envision how e-commerce systems will be engaging in the supply chain, its user acceptance and most importantly its interoperability.

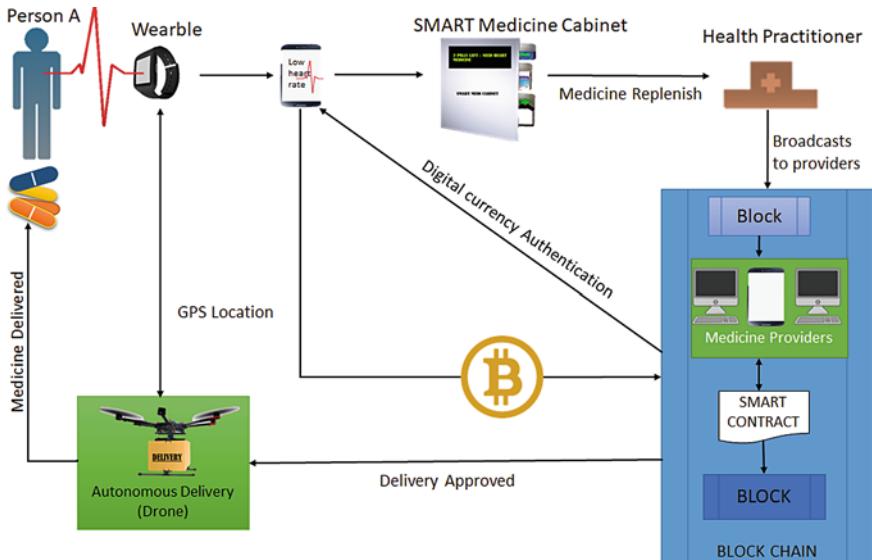


Fig. 4 Progressing e-commerce systems

4.1 E-Commerce Blockchain System

With change in digital dynamics of the supply chain, technologies in transactions such as digital currencies have e-commerce industries search and invest in advance platforms to gain competitive advantage and cater to the demand. E-commerce blockchain systems is seen evolutionary technology for provisioning virtual transactions.

With expanded markets of the global trade and highly sophisticated e-commerce payment systems, ensuring value for quantity and quality of goods is essential to mitigate concerns of exchange globally. Specialization, medium of exchange and locality are key attributes to growth of EC systems. This is due to flexibility in payment, transparency and authenticity of goods and services.

Blockchain [50] system technology is seen as a stepping stone to e-commerce and governmental [51] regulations on commercial policies especially in the advent of crypto/digital currencies in e-commerce. As the history edifies on the verse changes in commerce, crypto [52] currencies will exist parallel to fiat currencies in the future, thus cannot be overlooked.

Blockchain technology architecture [53] provides opportunities for redesign of systems. A software platform of digital assets, blockchain connects and records everything of value for businesses in enhancing a sharing economy, governance through transparency and publicly accessible technology, supply chain auditing through certifying the authenticity and locality of products and services as well management and control of hardware devices within the network [54]. The smart

contract, a software solution in blockchain, allows absolute record verification and security of all contracts and transactions.

Figure 5 outlines the transaction process in electronic commerce blockchain between the customer (Customer A) and the e-commerce organization (Store B). Customer A makes a request of purchase online. A block is generated on the request and broadcasted in the network. Information which serves as proof is added on the block at each stage an entity connects in the blockchain. The smart contract will then match the buyer and seller in the network. Store B receives order and sends the determined price of product to the contract. Customer A's money is immediately transferred to a smart contract. Store B sends proof of ownership to the smart contract and links it to the delivery channel of the product. Customer A receives the goods. A block is then added to chain with information of the whole transaction process. Store B receives money.

As online transactions gain momentum, the fast-track of digital currencies such as bitcoin [55] has gained traction beyond gaming platforms and the dark web.

Cryptocurrencies are an essential component in transaction on blockchain, hence of greater importance to understand on e-commerce platforms. Acquiring digital currency is the first part of blockchain transaction which can be done through digital wallets such as e.g. Bitcoin wallet applications available on web/mobile computing devices. Businesses realize its significance in the transaction exchange for goods in platforms which has facilitated the consideration in e-commerce systems design to cater for blockchain usage. Depending on the platform for transaction exchange, specific digital wallets or currencies will be listed to complete a payment.

The process of blockchain in e-commerce involves all elements of the transaction whether it is a product or service exchange. With the facilitation of automation, instant

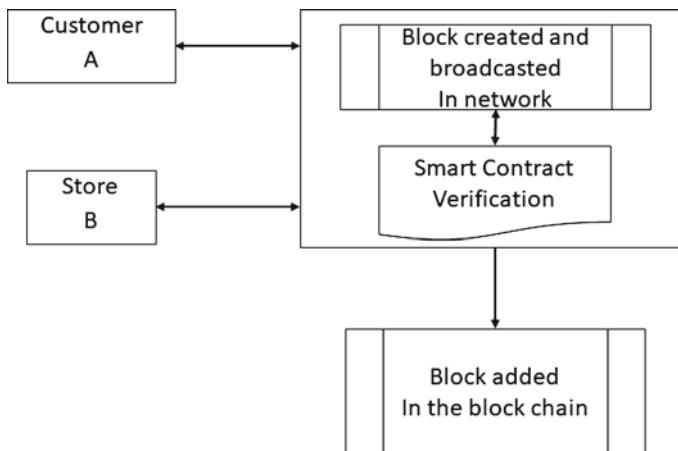


Fig. 5 E-commerce blockchain transaction process

transfer, the proof of work authentication, decentralization of transaction processes and the direct connection between the customer and the e-commerce organization; blockchain potentials electronic commerce systems to be secure, fast and an easy process.

Having a decentralized architectural approach, the progression of e-commerce's with blockchain expects complete automation of processes throughout the supply chain, utilization of smart contracts for ease in securing transaction, eliminating the need for third party contractors and easing governments and businesses from fragmented systems to defined policies.

4.2 *E-Commerce Social Internet of Things (SIoT)*

The expectation of a social environment of hardware, software, data stowage between organizations and its customers is the future of e-commerce.

With systems interoperability, organizations are opting for less storage capabilities in-house and source for reachable quicker and faster approaches which would be less costly. This has led to the emergence of the social relationship between the businesses from manufacturing through end-to-end customer delivery. In so doing, organizations allow their service platforms and its customers to access their system resources on demand through the internet. This is done without the organizations need to solely manage resources which range from high power mechanical operations through to day-to-day business applications.

This Social Internet of Things (SIoT) as described by Atzori et al. [56] aims at being the base for autonomous interactions among objects (service discovery and composition) towards benefiting the human user. In e-commerce SIoT benefits businesses through scalability of systems but also in securing customers such include:

- (1) *Delivery* which communication and movement of objects especially through autonomous channels such as drones from pickup to delivery will be enhanced to ease barriers such as geospatial and visibility issues as it communicates with other devices.
- (2) *Efficiency* in customer service as devices will be able to quickly exchange information and provide what is needed to the customer expectation.

With services such as cloud computing [57–59], Social Internet of Things (SIoT) is aimed to reduce computing power in e-commerce organizations with scalable architecture, computational power, and performance in the service by engaging customers and enhancing faster customer reach regardless of customer communication device, hence essential for customer retention and reducing cost.

4.3 E-Commerce 5G Connection System

Commerce today is bleak without sustenance of a platform of exchange. As technology is demanding speed in every domain, connectivity is key. With diverse applications and devices online, massive data sharing and connectivity, increase in smart consumer demands, foresee congestion of networks, thus the core network technology operating systems must be looked into.

The notion of “always on” [60] connection demands for faster speed and faster performance of not only e-commerce systems but any hardware and software integration with it. With the upscale in software defined networks and increase in mobile technology usage, 5G (5th Generation wireless network) [61] connection is the future of high performance of electronic commerce systems.

Unlike its current predecessors of 4G and 4G LTE, 3G and 2G connections; 5G promises to offer higher frequencies which can transmit faster connections and low latency thereby, can process high volumes of data with slight delay. This is key to not only communication but the whole supply chain system ranging from online catalogue browsing to autonomous vehicles for e-commerce delivery such as drones and driverless cars to smart connectivity with 5G driven IoT use cases [62].

The expansion of e-commerce systems expect automated and programmable open interfaces of tasks, configurations and policies on network equipment with the usage of Software Defined Networks (SDN) [63–65] in 5G connectivity. SDN allows the behavior of network equipment to be logically controlled in a centralized manner.

With these capabilities, evolution of electronic commerce platforms foresee an innovative exposure to faster connectivity, smart display of its platforms, enhanced Augmented Reality viewing, faster efficiency in application of robotics in manufacturing and advance communication on mission critical delivery systems such as autonomous vehicles on every connectable application and hardware device giving businesses a leverage in the supply chain.

With the fast track of digital dynamics during the Covid 19 Pandemic, the future of advancements in e-commerce systems is imminent. As discussed in this chapter, the innovations success are determinant on acceptance and actual use of systems.

Consumers appetite in data service create demand and strain on the current network topology. Network expansion is essential in determining user trust as efficiency of systems ease up e-commerce delays such include payments, risk of losing funds for e-commerce systems and faster communication for delivery as services expound.

As the push to technology centric domain is in demand with people moving online, familiarity to e-commerce system where users gain trust is critical. Unlike shopping cart models where users experience hidden charges or unaware of the fiat currency exchange platforms, as well as the details on information sharing makes the use of blockchain systems attractive. Blockchain ensures an open transaction platform where consumers are able to see movement of transaction for and between platforms of exchanges.

Popularity of SIoT devices are gaining acceptance with smart homes and smart technologies, with this the ability to store user knowledge is still a determining factor in usage behavior whereby, consumers deem them trustworthy by allowing network discovery and degree of interaction between objects for information collection and sharing among systems and IoT devices.

Future studies are essential on the variance of behavioral changes on users be it between business to business or business to consumer on omnichannel systems integrating or adopting to the new technologies and whether the determinants of ease of use to include integration, maturity and simplicity of systems will enhance usability.

5 Anticipated Challenges in E-Commerce Systems Progression

With the increase in complexity of systems and new areas of systems and systems engineering, evaluating the emerging innovative approaches of software architecture must be realized against the challenges it poses to e-commerce.

Willingness to share information and interconnectivity of devices is dissolving issues of discretion. As trust is established in accepting and using systems, privacy is the least of everyday e-commerce system usage concern but, the complexity of the future systems, its impact on critical infrastructure as well as engineers' knowhow and of systems.

As demand grows, critical infrastructure resources such as power/energy/electricity, transportation, systems security, and the overall societal impact will bear the burden of expansion of hardware and software complexity in systems. Utilization of energy resources to accommodate complex systems such as blockchain technology for e-commerce will significantly impact the power grid systems. With every communication established in the blockchain process to reach an agreement, utilization of computing and network power process is utilized. This will in the future burden the energy system as more and more organizations enter this marketplace. Alternate initiatives on the utilization of smart energy grids using solar and wind energy to accommodate for the increase in computing system processes need to be understood and implemented within individual governments and countries across the globe.

As e-commerce innovation develops, the transportation system whether it is through water channels, road systems or air channels would have to accommodate massive connectivity and delivery channels. It is essential that this critical infrastructure of communication have regulations and security protocols for efficiency across the supply chain. The expectation of 5G enabled autonomous delivery vehicles driverless drones, smart cars and smart airplane systems taking over delivery and distribution channels safeguarding each application layer in systems, security

protocols will have to be considered to safeguard breaching of systems and loss of data through malicious activities.

The ability of AI enabled e-commerce systems platforms to securely work with mass volumes of data which is a crucial component connecting consumers with organizations [66] without redundancy, incomplete capturing and failure in processing creates a challenge in EC. With AI capabilities such as machine learning advantaging businesses with technologies such as Conversation commerce; where virtual agents listen through the communication on networks and devices on brand sharing content of users on different platforms questions not only data security which allows for organizations to push for content based on agents' information gathering but also congestion of networks. This challenge broadly addresses governments and organizations alike at large who envision to have smart technologies in place running heavy data transmissions. E-commerce being data intense will be dependent on high network throughput in technologies such as 5G to sustain.

As systems evolve, a unified communication between SIoTs is expected to be autonomous hence raises concerns on whether the ability of machines collaborating with each other autonomously will dominate operations or override systems programed functions. This anticipated challenge of autonomous systems making over-riding decisions for efficiency of the system which might lead to human endangerment is a critical area of concern. Hence advancements in knowledge on integration and interoperation of systems engineering is an essential to management of systems interaction.

Advancement of systems solutions will always raise the question on impact of working roles where systems dominate the market. Societies in high adoption of technology countries will have to educate people on systems operations to avoid being economically impacted when system interoperability will render unskilled workers redundant in their jobs, such include customer care careers which are replaced with automated AI bots, retail associates replaced with Augmented reality to assist consumers in choosing and purchasing products online, warehouse boxing and packaging replaced with robots. Adapting in different software and hardware dimensions, the future will also scramble to define the roles of system engineers. The domain of systems and systems engineering (SoSE) demand experts in cyber physical systems to include robotics and integration capabilities to keep up with the complex software approaches and the changing requirements on every architectural tier of development in e-commerce.

6 Conclusion

E-commerce systems solutions offers a promising paradigm in delivering commercial solutions as it evolves. As a software-intensive system, taking into consideration the design principles of the fourth industrial revolution i.e. interconnection, information transparency, technical assisting systems and decentralized decision making,

e-commerce systems are integral in evolution of the way humans work as well as enhances global trading services.

E-commerce systems are the driver to the future software development, therefore, a broader view of how software applications will impact the everyday life adhering to legal frameworks, environmental protocols, infrastructure advancements, information management, societal concerns, technology knowhow and the shrinking geographical boundaries has to be realized.

With the world visioning for smart cities, efficiency of commercial technology is vital. Smart cities services and operations require sophistication of technologies from connectivity, storage to management across complex urban settings that meet the requirements of systems interoperability and functionality. Defined Technology Acceptance Models that cater to users in determining the value and acceptance of omnichannel systems and the technologies beyond online standalone stores is essential to ease electronic systems into our day to day commerce.

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Fit-Viability Approach for E-Learning Based Cloud Computing Adoption in Higher Education Institutions: A Conceptual Model



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Abstract Today, exists an innovative thinking amongst the educators and learners in the use of e-learning method in the Higher Education Institutions (HEIs) worldwide. Be that as it may, the E-learning framework requires immense up-front infrastructure with many establishments which isn't anything but difficult to be overseen. Cloud computing accompanies another advancement stage to overcome e-learning issues in a simple and cost-proficient way that HEIs can embrace to improve the nature of their scholarly services toward the end with the thought of an instructive innovation of educational technology. The fundamental point of this explorative study is to develop a conceptual model to examine the factors laid down by Information technology (IT) adoption theory that influencing the E-Learning Based Cloud Computing (ELBCC) by integrating fit-viability theory with the diffusion of innovations (DOI) theory's factors. The findings of this study demonstrated that the used scale measurement has met the criteria of reliability and validity. Further this study conveyed an integrated model for investigating Cloud Computing adoption for E-Learning in HEIs in Omani context in the Sultanate of Oman, and it provides the foundation for coming studies due to its infancy, and deep insight for cloud computing development, this is a hypothetical commitment. Moreover, this study builds up an empirical mechanism to explore influencing adoption features for the Omani HEIs perspective. In Composing, this is the first kind of an empirical study in Omani HEIs setting. At long last, the outcome will help the Omani HEIs to make sense of their preparation for E-Learning

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Based Cloud Computing, and what are the critical elements decision makers ought to consider prior to implementation.

Keywords E-learning based cloud computing · Cloud computing adoption · Fit-viability model · Diffusion of innovation · Educational technology

1 Introduction

The advancement of a society relies upon education by and large. Online or web based learning is considered as one of the best methods of education-for-all in the current age [1, 2]. E-learning alludes to ‘all channels that empower electronic learning and teaching, which are practical nature and expect to influence the development and improvement of comprehension with respect to individual experience, implementation, capacities, and knowledge of educators [3]. For ensuring a fruitful learning procedure, communication and knowledge systems, regardless of whether electronic or not, we have to use some specific channels [4]. Of late, various individuals in scholastics, especially those having a place in the pedagogy field, have built-up an extraordinary enthusiasm in Electronic based learning with most part with respect to cloud computing (CC) [5]. The development and improvement of social orders in communities and nations are extraordinarily impacted by Higher education institutions (HEIs) quality. Various Universities and Colleges have deserted past strategies utilized for teaching and received online or web based learning as new innovation has emerged [6]. These universities currently execute information and communication technology (ICT) which is called educational technology [7]. To ensure an effective online education delivery, Universities must have adequate IT infrastructure and make the correct ventures as these activities are hard to achieve during some significant breakdown, like SARS-CoV-2. In reality, there are some institutions which discover it extremely difficult to offer totally diverse kind of Information Technology (IT) facilities and hence students are then associated with users who are not directly connected with the institution [8]. At present, cloud computing technology offers a plan for educational institutions, an effective solution to the complexities concerning minimized IT costs are offered [9]. Presently, the HEIs are progressively executing cloud-based online learning, for example Cloud Zoom application. A recently directed exploration on E-Learning Based Cloud Computing (ELBCC) indicated that ELBCC technology has been actualized by forty-three HEIs in 2012. The results of the study show the tenth increase from research conducted in 2011, and it's evaluated that numbers will continue expanding over the years [9].

Today web is continually utilized by students, and they discover appropriate information through it [10]. These students are already the users of platforms based CC technologies as they use different social media applications and programs such as the Instagram, Twitter, Face book, Gmail, etc. [4, 11]. Subsequently, it has been demonstrated that solutions offered by ELBCC have a huge impact in the process of online

learning and these solutions are implemented and are concerned with the social theories of education, mainly in educational institutions [5]. Accordingly, HEIs directors, universally, are utilizing technologists to use ELBCC strategy. Henceforth, the significant goal of higher education institutions involves the adoption and implementation of online learning with special emphasis on cloud computing. Cloud computing has few advantages over the recently used technologies which are: quality retention, increased effectiveness, improved accessibility [8], economics, increased output, measurability, and diffusion of information worldwide [12]. Besides, the significant goals for online learning delivery are predominantly dependent on cloud computing adopting emergent IT infrastructures in HEIs and improving the accessibility of university' workers and students to guarantee better quality of education and valuable use of its assets [13]. Therefore, this study intends to examine this situation of the viewpoints associated with online education primarily dependent on cloud computing among the higher educational institutions. This paper will elaborate and present limitations and problems faced by the previously held researches on this subject. Moreover, the paper means to propose areas that require further exploration with the goal that education sector could be further enhanced. The investigations might end up being exceptionally helpful for specialists who are about to explore cloud computing based online learning within tertiary educational institutions. In addition, the study shows the deficiencies within the utilized methods of data for the better advancement in the teaching and learning sector. These gaps introduced critical areas that required to be highlighted in the upcoming analysis and results concerning the execution of cloud computing based online learning in advanced education sectors.

Through ELBCC, users are allowed to animatedly rescale or scale down their utilization of services which fulfill their needs by using a metering technique in which subscribers are only charged for real utilization [14]. Because of various hurdles, under-developed nations have commonly been deserted in the race of technology dissemination, its acceptance and application. These disruptive aspects to technology acceptance involve infrastructure, decision makers willingness, costs, governmental strategies, education, user unwillingness, and safety related issues [15]. The apparent gap between the economic conditions of developed and developing nations is mainly due to the inconsistency in technological development between the two as companies operating in under-developed countries neglect to embrace appropriate innovations [16]. Critical thoughts are being paid to ELBCC by international and national IT stakeholders, international companies and national governments along with cloud computer organizations such as IBM creating cloud centers functioning in various nations like South Korea, Vietnam, Brazil and India [17]. Cloud computing centers are firmly being built-up in under-developed nations by some other global cloud service suppliers like Amazon, Sales force, Dell, Microsoft and Parallels [17]. Under-developed nations could pave the way to success by progressively demonstrating enthusiasm in embarking cloud computing and they can also enjoy low beginning charges and flexible facilities offered by cloud [18]. Additionally, under-developed

nations can become as effective as the developed ones, as clouding is present everywhere and could be accomplished through the similar computing infrastructures, data centers and applications.

2 E-Learning-Based Cloud Computing and Academic Services Quality

E learning based cloud computing (ELBCC) offers the following benefits [19]:

1. Effective Computing and Sufficient Storage Space: A colossal measure of distributed computers and servers are utilized in cloud based e-learning with the end goal of computation and data storage, the presence of a number of clouds in a computer offered the capacity to do the computation effectively and to store enormous information and students can get to these cloud benefits through internet [20].
2. High storage space: By offering high storage space and high efficiency of computing, a remarkable help can be offered by this framework for cloud computing [21]. The node failure and uninterrupted connection can be automatically identified and analyzed by cloud computing system. Besides, the framework can also exclude an uninterrupted connection without disturbing the usual functioning of the system and servers.
3. Highly Secured Data: Data is stored with more security as it involves one or more data center and servers and the combined data is handled by the manager with actual shape and size, resources are assigned, load is balanced, software and servers are arranged, safety is managed, and consistent real time observation is carried out, this in turn guarantees the security of users' data to an incredible degree [22].
4. Virtualization Platform: Virtualization is considered as the foremost crucial and unique feature of cloud computing. Each application development which is surrounded by physical platform isn't connected with it. Data is handled, transferred and stored via virtualization. To develop a resource shared environment according to the demands, fundamental hardware is positioned with the servers, storage service and networking apparatus system of broad virtualization [23].
5. Classic Electronic Learning Services for Cloud Computing: Instructive exercises were doled out by the Instructors. In addition, customary addresses were moreover conveyed for enhancing the capacities of students. The course was taken by researchers to memorize from the sessions endorsing independent as well as collective learning [24], or they made the assignments given by the instructors by including their recommendations in them, in spite of the fact that agreeing to the arranged plan instructors responded to the questions inquired by the scholars at a time and also offered important education for imperative and troublesome questions. Moreover, multimedia system computing device may be utilized by Instructors and students may evaluate their claim learning, utilized

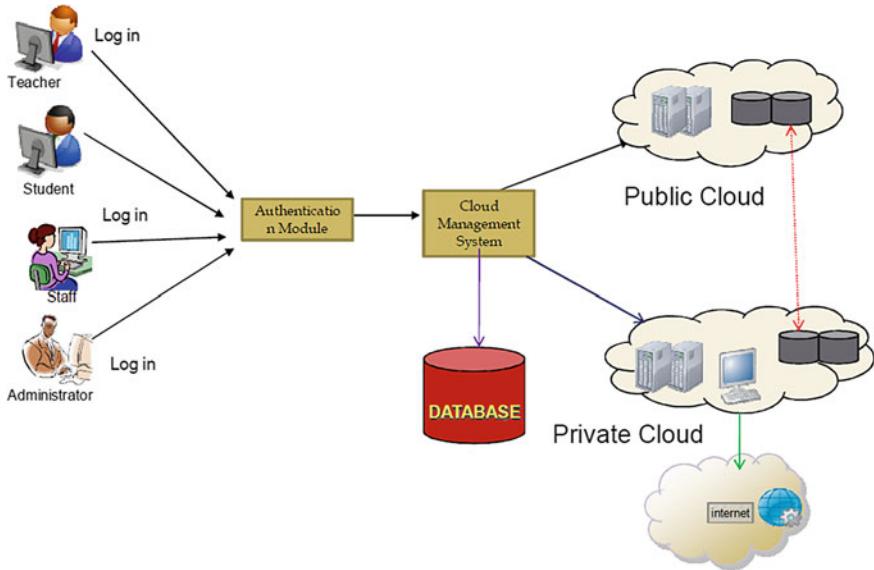


Fig. 1 Mode of the proposed architecture

strategies and critical learning approaches. Free online learning is carried out by the students after considering each division, they consult the internet and calculate their scores a short time later [25]. Instructors persuade all students to work whereas participating with each other to create the method of learning much easier and simpler. Collective learning not fair guarantees effective learning but too diminishes students' fear for group work and coordination. Besides, communication aptitudes are upgraded and abilities to legitimately express the views are also moving forward. Consequently, nowadays interactive sessions between Instructors and students are considered exceptionally critical. Figure 1 shows the interactive mode of the suggested plan [26] for ELBCC.

3 Theoretical and Conceptual Background

The economic conditions of a society are improved when people are more progressively open to grasp technology. However, the acceptance rate differs from territory to region because of different social concerns and cultural impediments. These concerns are commonly overlooked during the dissemination process of a new technology adoption. The dimensional character of technology implementation and improvement dissemination includes a distinction, in speed at which technology is accepted by various people and these distinctions can't be just connected with economic and technological aspects; social and cultural perspectives are likewise involved [27]. Current social and cultural conditions of the adopters should also be considered

during improvement dissemination and adoption as the ultimate success or failure of the technology adoption strategy may get influenced by these components [28]. There is a colossal contrast between the socio-cultural and economic condition of adopters of cloud computing in developed nations and those in under-developed nations.

All around the globe, different educational institutions refusing to fund allotments due to the existing universal economic decline. Along these lines, various organizations are focusing on methods that reduce their expenses to make progress in their errands [29]. Compelling cost-cutting techniques are offered by cloud computing and its flexible functional model which are required by the educational institutions. Because of these measures, the performance and effectiveness of educational institutions are not affected. Besides, new institutions as well as cash-strapped instructional institutions that are as yet experiencing the period of advancement can inspect the benefits and significance of measurability and furthermore impacts the price structure that enables HEIs to pay at their choice within the cloud computing model [29]. Due to the increasing costs of ICT foundation, setup and support, instructional system institutions are developing interest in the broad nature of cloud computing model, which may just require a trouble-free association between educational institutions and students at any time and at any place as compared to the existing system where the model can be accessed only by those who are present within campus. Higher education institutions as well as the academic leaders contribute more to the technological advancement and its rapid adoption globally. Though, educational institutions also develop such societies that involve people belonging to various social, cultural, and historic backgrounds. Socio-cultural variables that can affect cloud-computing adoption among the HEIs systems likewise to be figured out how to additionally upgrade the social orders present in HEIs [30, 31].

There are different hypotheses, for example the Technological-Organizational-Environment framework (TOE) [32] which involved additional variables for generating Diffusion of Innovations (DOI) [33]. Diffusion of Innovation (DOI) [33] as well as Technology Acceptance Model (TAM) [32] are concentrating on creating client activity models patterns towards an innovation adoption in a diversity of capacities and information systems. In the diffusion of innovation theory, it is stated that innovation reaches the public through bound communication channels over a specific time period and among a preferred system. Some concepts fail to study the activity factors that can influence the inclination of people to adopt an innovation, however this model closely focuses on concerns related to innovativeness. Hence, the need to triangulate this theory with another theory is felt. Although theories such as the theory of Planned Behavior (TPB) [34], TAM, and theory of Reasoned Action (TRA) are all purpose-related theories originated from psychological science, TAM was particularly modified in the light of TRA to be employed in the domain of information system. According to TAM, a user's willingness to utilize a system may depend on apparent utility and how simple it is to use [35]. Observed benefit has been described as the level to which someone who is using a system would enhance efficiency. Although efficiency will be enhanced by using a system, it is also vital to identify the complexities associated with the system. Subsequently, observed easy use is the degree to which someone believes that it will be easier to use a certain system and

it is important to determine this perceived ease of use as it will help people identify whether a system should be adopted or not [32, 36–38]. It was considered that TAM alone cannot be used for modeling cloud computing adoption and as it is not sufficient and lacks numerous options related to current technology acceptance as the concept was presented long ago in 1985 and we all acknowledged how technology has embraced various developments and changes till date. Davis initially designed the Technology Acceptance Model (TAM) in 1986, which is considered a popular model regarding the adoption of models and is concerned with the acceptance of the technology. The basic concept behind TAM is to generate a theoretical foundation for describing behavior related intents toward the utility of a system, effects of external variables, internal convictions and hence the use of real system [39]. TAM is an expanded version of the Theory of Reasoned Action (TRA). DOI is a model related to user adoption of technology by getting familiar with TRA [32, 36]. DOI uses this behavioral related intention relationship and also claims that perceived easy use and perceived utility are two major aspects that encourage a user to adopt a new technology [40]. TAM supported that actual and intention-based usages are impacted by external aspects via mediated impacts on observed easy use and observed usefulness [32]. Pragmatic easy use indicates the extent to which user believes that using a particular system would be trouble-free and easy to use, on the other hand, observed utility signifies the extent to which a user presumes that a particular system will help improve their efficiency [32]. In addition, an observed utility is affected by pragmatic ease of use, which in turn influences approach and intent and further willingness of a user to adopt an innovation.

3.1 Fit-Viability Model

Fit-Viability model (FVM) has been employed principally to control the adoption of another innovation [41]. Task—Technology Fit (TTF) model presented by Goodhue and Thompson [42] was utilized as an upgrade to build up a Fit- viability Model. Fit-Viability hypothesis emerged in 2001 for assessing overall adoption (e-commerce) in various organizations. Fit assesses ‘the degree to which a new technology is compatible with essential skills, structure, ethics, and traditions of an organization [41]. Then again, viability assesses ‘the degree of the additional capacity of recent applications, requirements of human resources, capital wishes and so on’ [41]. Match criteria is evaluated through innovation highlights evaluated through Department of the Interior theory [43, 44], while distinctive major measures for viability are economic, IT and company infrastructure standards.

3.2 *Diffusion of Innovation Theory*

Diffusion of Innovation Theory (DOI) founded by Rogers [43] first emerged in his book called ‘Diffusion of Innovation’ in which around 508 articles on diffusion analysis were presented for portraying the procedure of an innovation adoption among individuals and organizations. As per Rogers [43], there are four significant components which influence the spread of an innovation i.e. innovation, communication channels, time taken and a social system. Moreover, an organization or an Individual decides to either embrace or reject a new technology by relying on DOI model which involves five basic factors of innovations: relative advantage, compatibility, complexity, trialability, and observability impact. While carrying out this analysis, we picked three most significant attributes which ensure a constant adoption of innovation (Relative advantage, Compatibility, Complexity), as stated by Tornatzky and Klein [45] to evaluate what impacts these factors have on CBEL in HEIs in the country Oman, notwithstanding Fit-Viability (FVM) model towards further development.

This research intends to build up a model to embrace the methodology of ELBCC in Omani HEIs, towards the Quality of educational segments/administrations. The approach adopted during this research has empowered to recognize the internal structure aspects that will play a significant role in increasing the adoption rate of ELBCC and quality of educational facilities in HEIs. This analysis shows the development of the Fit-Viability Model that causes an increased execution of ELBCC while impacting the quality of educational facilities. Fit-Viability Model [46], Diffusion of Innovation theory [43] (as demonstrated in Fig. 1) were utilized while creating the proposed analysis model.

Information technology revolutions have diversely been leagued with Fit-feasibility theory by multiple studies. The acknowledgement of remote system technology helps the Fit-Viability structure expressed for instance, Liang [47], the characteristics reflecting the cloud aggregating acceptance and progression as an area of public division substitutes to apply e-government services were analyzed in the second exploration alongside the development of a research mode dummy laid on Fit-Viability model and dispersal of revolution [48]. The conclusion of the research declared the need to focus on factors linking the two dimensions; Fit and Viability, in making a proper decision to adopt cloud computing in an e-government sector. After the findings from ELBCC and technological and revolutionary traits, the model has been shaped in the two dimensions.

The Fit is termed as the commencing category of the plotted abstract structure summary because ELBCC is in desperate need of advanced education centers. To check if the new application is in accordance with profound potential, framework, merit, and intellect of the institution are totally monitored by Fit [44]. The DOI aspects obtained from Roger are applied in measuring and identifying the concussions of ELBCC [46]. DOI structure complexity, relative advantage, and compatibility factors proportional merits refer to the level of development that appears elevated than the best of its predecessors [49]. Humongous storage scope and the place of insight alongside easy access to any application from desired location or broadband

connection, by means of any suitable device, are the facilities ELBCC offers to cutting edge training focuses. Complexity could be defined as the degree of obstructions in achieving promotion [16, 50]. Unpredictability highlight of ELBCC enables to limit deterrents for scholarly focus and supremacy of IT and makes a technology fit for implementation ensuring imminent quality education services. The substitute debate obtained from DOI theory is compatibility, which identifies with the scope of a steady development recognized with the current values and associated to unification and experiences of prospect and educational adopters [16]. The propounded model depicts the compatibility of technology to transfer the diversified interfaces and information to the cloud and offer this technology fit for the HEIs.

The next factor applied for the utilization of the additional capacities of the requirements of advanced applications to its apex is viability [44]. As it is hugely powerful for mandatory conclusions and handles reduction in its price and their adjustment of readiness for IT, it builds various component for enhancing ELBCC technology of higher educational institutions. One of the crucial elements of suitability is decision making which determines the behavior of officials in supporting and executing the new technology. The development in decision making was reflected by viability before the adoption of ELBCC in the higher educational institutions. The number of financial and labor resources to implement and administrate cloud computing is termed as price reduction [47]. It's an additional significant issue reasonable for encouraging ELBCC in modern academic centers and furthermore displays the minimization of cost in internet access and the preservation of large information by availing the cloud.

The proposed model represents the viability of HEIs and management with ELBCC and explains their willingness before applying the cloud computing technology for untroubled adoption (Fig. 2).

E-learning despite everything relies upon the mentoring and investigation sectors of administration in an instructing perspective that is structured by a social order. The resourceful characteristics of modern technology have exerted an impact on capable adopters of the innovation factor. The logical foundation for the directive systems framework compiles law that is adopted in the organization mentoring culture and trade and academic surroundings. This foundation originates from the behaviorist outlook but emphasizes on task interpretation. The expansion of innovation findings has highlighted the value of Task, Relative advantage, compatibility, and complexity in configuring the inclination of administration to adopt advanced technology [51, 52]. Subsequently, we assumed that that:

H1: The HEIs-related tasks requirements emphatically impact positively influence ELBCC adoption.

H2: The fitness wellness of ELBCC impacts has a positive influence on HEIs' decision to receive adopt it.

H3: Relative advantage favorable position positively influences on the fitness of ELBCC to a HEIs' computing requirement needs for reception. adoption.

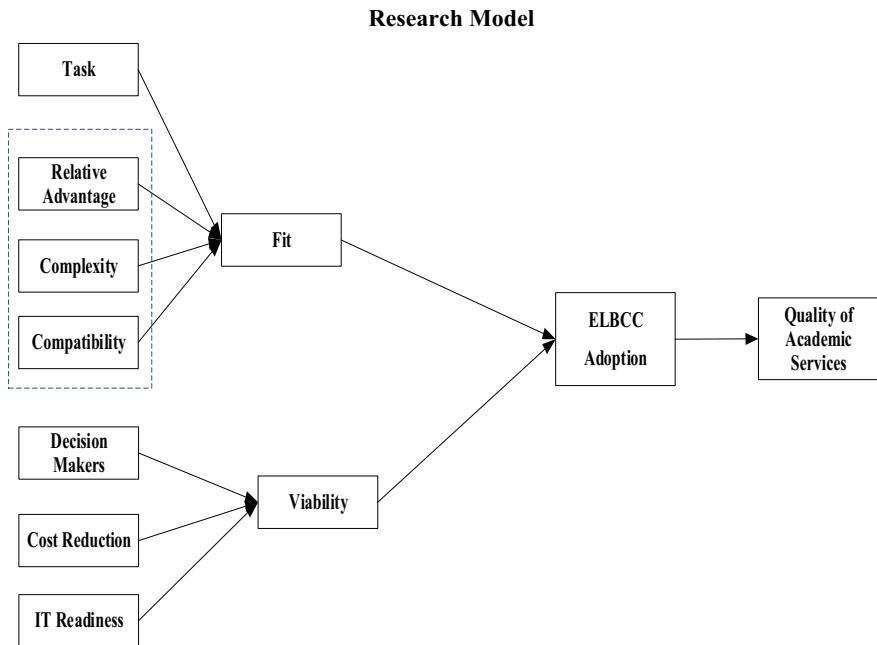


Fig. 2 Proposed cloud-based e-learning

H4: Compatibility positively influences emphatically effects on the fitness of ELBCC to a HEIs' computing needs for adoption.

In the process of this study, the fit identifies with accessing the breaking point to the advanced applications that are in accordance with the profound potential, framework, value, and tradition of the administration. It is determined by the differentiating and examining the influence of ELBCC by DOI characteristics originated from Rogers [43]. The fit debate is that the initial component of the planned and presumed form is summarized because the limit to that CBEL is according to the exact demands of higher academic centers and education departments. DOI structures the relative advantage, compatibility and presumes that:

H5: The fit of ELBCC to the HEIs task characteristics positively influences HEI's decision to adopt it.

Information technology's delicate nature has persistently been a priority to customers over the years in sectors like e-commerce and currently net banking [53]. A portion of the technological issues that have compelled problems pertaining adoption and innovation of cloud computing are information safety, knowledge gap and IT willingness. Since cloud computing technology lays its foundation on internet technologies, persistent security issues hurdle its adoption. However, price minimization and modern safety algorithms with information technologies (IT) willingness hired in cloud computing are termed as major distinguishing factors of cloud computing [54] which will influence its adoption. Likewise, the advertisers are prepared to

screen and manage utilitarian practices with the implementation and utilization of cloud information. To brighten the outcome with quality management, those ranges are very essential for key arrangement and to sort out multiple cloud-based trading arguments. we have a scope to presume that:

H6: Top management support positively influences on the fitness of ELBCC to a HEIs' computing needs for adoption.

H7: Cost reduction positively influences on the fitness of ELBCC to a HEIs' computing needs for adoption.

H8: IT readiness positively influences on the fitness of ELBCC to a HEIs' computing needs for adoption.

Viability model is exclusively being utilized to cater and has been inclined to the implementation to management for successful cost diminishing for a substitute to technology for cloud computing and in obtaining right call and decision-maker to adopt cloud computing in an e-government sector and it is propelled by economic, managerial and groundwork factors for example decision-maker's assistance, reduction in price and IT willingness factors.

The proposed ideal model establishes its framework on the Fit, viability, and adoption of cloud-based E-learning, which emphasizes the formality, integrity, control, and pro-activeness together with the Fit model of technology factor for knowledge, making the model broadly at risk for the selection of E-learning in universities and high schools. Data integrity refers to the integrity of information, it assures the reliability of data, and it handles mistakes or data safety issues rising due to students' and personnel's use of cloud computing technology [55]. The information formality pertains to the deliberate obsession with prescriptive data, instead of the accidental sources that signaled formal management and revitalization of the Data before the adoption of IT technology cloud by higher education institutions. The information form, management of information, information initiative and the integrity of information are the four information attitudes and vitality factors utilized in this study, guiding colleges and universities to adopt e-learning online and subsequently hypothesize that:

H9: The feasibility viability of ELBCC has a positive influence on HEIs' decision to adopt it.

Most universities have figured out the potential advantages of using cloud computing for budgetary reasons and next level advanced academic and data sharing services [56]. The offered optimist model relies on the educational service standard with the ascending use of cloud computing, a few academic institutions are announcing cloud computing technology into their university frameworks prospecting and providing progressively reliable and versatile academic services. Current cloud computing benefits for e-learning are recognized as being frugal with advanced data safety, virtualization, compact Data preservation, and the possibility of supervising data accession.

The benefits of cloud computing for e-learning and the advantages of cloud computing adoption are additionally underscored and discovered that it is efficient

with enriched performance, presents prompt software updates, and enhances the compatibility of record configuration. Besides, it gives numerous benefits to students and professors such as correspondence courses, assessment, projects, forums and e-learning materials, narrations, and resource control in educational services. Along these lines, this study assumes that the implementation of e-learning based cloud computing characteristics of cloud computing progressively influences the plan of higher education center in Oman to ensure standard of educational services.

H10: ELBCC adoption has a positive impact on quality of academic services in HEIs.

4 Methodology

The application of quantitative knowledge is ceased within the perspective of philosophical hypothesis, which generated confirm outcomes, effect, or result. We intend to utilize this recommendation amidst the study to authorize the kinship in our model among the free-lance variables pertaining to cloud computing adoption, dispersal, fit-viability, and adoption; alongside the subordinate factors of intention to adopt and intent to apply cloud computing advancement recognition. A research proposition that emphasized quantitative information in the study has been gathered for this research as a product. It will empower us to innovatively and responsively measure the reaction of a humongous sample across multiple universities/colleges in the reigns of Oman in an exquisitely proficient and ideal gesture [57]. The researcher [57] proposed that evidence of the interlink amongst variables will solemnly be investigated in an extensively empirical correlation scrutiny format using quantitative knowledge. Prefatory knowledge for examining the suggested model was gathered by means of a survey distributed online through the Survey Monkey tool. Preliminary studies of precedent five years on the dispersal of innovation theory assisted to design a survey tool through supported literature [39, 58] TOE [16] and adoption of ICTs and e-commerce in progressive States [65]. Propositioned definitions were applied to create questionnaire measures for models that lacked suitable measures from the remaining literature such as the quality of academic services material.

The tool comprehends the extensive focus research in concern to cloud computing adoption. It was Distributed into sub-division where each subsection has expertise in questions pertaining to the diversified elements in our suggested analysis model and hence generated the upcoming hypothesis that was backing the proposed conceptual and speculative models. Filtering the survey tools into these unique parts grants for a lucid comprehension of why the queries were being raised and their part in evoking solutions and supportive terms that may assure the validity and reliability of the approaching model to answer our analysis questions. The urge to adopt and apply cloud computing was by inquiry and defect measured in a chunk of the instrument employing a five-point Likert scale (range one = strongly condemn to five = strongly ap-prove).

Explanatory statistics are hired in the aggregate research to inspect info. However, for this study which focused on the development and authorization of the model and instrument, this information wasn't confined within the study. Tool durability was examined using Cronbach's Alpha. Alloy reliability tests as Pearson correlation analysis using the SPSS applied mathematics tool authorized the sizing and structural factors of our model. The products from this precedent analysis were applied to validate the indicators mass and Containers for everything employed in our equipment and locate coefficients amidst freelance and contingent factors. The instrument validity was furthermore examined through focused and discriminant validity.

5 Results

5.1 Preliminary Study Results

A pilot survey was assigned amidst academics/decision-makers/IT engineers in an attempt to validate the survey items designed above for the info gathering in HEIS in the Sultanate of Oman. Forty out of One hundred people who were mailed and invited to fill the survey, submitted their response with a percentage of forty. This survey was monitored online and through paper strategies to various higher institution institutions in Oman. Out of 10 people received the survey form at a conference, only a couple of persons filled and re-submitted the form at the end of the conference, response rate resulting 2 out of 100 respondents. This proves that a physical survey would force procrastination and energy for the respondents to fill them and resubmit them to the research team. The benefits of the internet survey were transparently the prompt response of the attendants. The researcher however sent out consecutive email reminders to stimulate the response rate mentioned above. Our remote study reliability data is inclined on thirty-nine concluded questionnaires ($N = 39$).

5.2 Survey Instrument Validity and Reliability

It is mandatory to authorize the survey items to assure that the materials of the questions are transparent and free from doubtfulness. The approach of the study is to impose various insights from multiple experts within the faculty to ensure that the study is practicable, examine the information gathering methods to be used, and ponder over how the information is examined and gathered [66]. Experts authorize the survey items for this research prior to the pilot study that provided ideas for improvement within the framework of numerous questions similarly as the compensation of doubt.

In accordance with the modifications imposed by the advisors and the respondents to the online survey, the material validity of the equipment was formed. It is also

Table 1 Reliability statistics

Construct	No. of items	Cronbach's alpha
Task	4	0.911
Relative advantage	6	0.924
Complexity	5	0.897
Compatibility	6	0.815
Fit	5	0.927
Organizational	6	0.949
Economical	5	0.960
Infrastructure	6	0.932
Viability	3	0.916
Adoption of E learning based cloud computing	5	0.916
Academic service quality	4	0.969
All item	55	0.919

prominent that almost the entire questionnaires for the study were based on former studies on Fit-Viability theory, dispersal of innovation theory, and E-learning adoption in progressive countries, practicing the validity and durability of the additionally established things [54, 59].

Cronbach's alpha reliability observed statistics to identify the durability of our instrument and assuring that the questions used were weighing the qualities of the concept. The Cronbach's alpha could be regularly in accordance to statistical scaling used for determining the inner reliability of a survey equipment to ensure results from measurements are coherent in generating alike products time to time. Applied the statistical package for the social sciences (SPSS) to inquire the response from our findings.

Table 1 illustrates the Cronbach's alpha values for each hypothesis and the intervening correlation values when items marked for eradication by the SPSS statistical equipment to stir up the Cronbach's alpha values were removed [58]. Directed that the major correlation among items for a measurement scale gives information relating the dimensionality of the size. Additionally, it was claimed that the mean intertwined correlation contradicts from a dependent estimate as a consequence it is not affected by scale length and therefore provides a transparent measure of item similarly. A mean correspondence among items of less than 0.3 indicates feeble bond with others in measuring alike construct, whereas inter-item correlation greater than 0.9 warns issue of multi-collinearity. In the meanwhile, a Cronbach's alpha worth of 0.7 or higher depicts smart infra consistency of items in the scale [60]. In accordance with [60], a Cronbach's alpha worth higher than 0.9 is great, larger than 0.8 is fine, bigger than 0.7 satisfactory. Greater than 0.6 is questionable, bigger than is 0.5 below average and lesser than 0.5 is unacceptable. A number of inter-item correspondences were observed to be smaller than the proposed worth 0.3 thus they were uninvolved in the study. No items were qualified for elimination due to low equivalency with

the contrary items during the measurement of complexity and produced apparent constructs.

As the evaluated Cranach's values are higher, we preceded these objects and regulate the durability statistics again in SPSS to encourage higher Cronbach's alpha values and enhance the reliability of our model equipment (Table 1).

6 Conclusion

The inference arrived during this explorative study leads to an evolutionary and conceptual representation of E-learning due to the acceptance of cloud computing in developed tutoring centers or higher education institutions in the Sultanate of Oman. The research included elaborated theory of revolution and acquaintance and advantage of technology with the origination of students practicing cloud aggregating system. A survey was done among 39 participants in the CBEL and examined by calculable data. Fit-viability theory and the DOI are the two major theories laying the foundation of the research proposed form in the aspect of acceptance of modern technologies along with standards for the theory of educational services. the presented adoption representation consists of 10 hypotheses to display the role of Fit, inspired by the characteristics of technological factors borrowed from the DOI theory, comparably relative benefits, accordance and complication; maintenance is affected by frugal, management and infrastructural components, such as cost minimization, decision-making ability and computer inclination factors from Fit-viability theory. All have an amiable relationship with higher education systems aiming to accept ELBCC targeting the quality of educational services.

The products of global research are likely to play a part in the formation of a reliable specific miniature that can survey the practice of cloud computing and similar technologies, applications, feasibility and educational practice of the education system. The articulation of the research representation is laid on essential approvals of concepts from divergent IT research work committed at multiple administrative scales. Consequently, the verification of the design suggested in this depiction is binding.

The hypotheses of research representation are likely to be embraced by HEIs in Oman willingly. The supplementary intention of this investigation is to compile data for the launch of ELBCC which is inspired by the characteristics of many institutions, pleasant motivation, communal influence and contemplation of conduct. Ultimately the processing research findings are expected to pitch into scholastic exquisite service examples pertaining to the idea of developing States. The most important aspects influencing the adoption of ELBCC among HEIs in Oman should be examined by the proposed model. In under-developed nations, enough research has not been carried out by using FVM and DOI theories for designing and combining constructs to describe the organizational acceptance of cloud computing based online learning and quality of educational facilities. A fresh outlook is presented by the triangulation of two theories along with presenting the effects of background-related and economic

factors; furthermore, understanding of views, dissemination, acceptance, quality, technology, and adoption of cloud computing-based online learning in HEIs in Oman is also provided. This learning was not extended to cover more respondents in order to validate the proposed model, as it focuses on focused group of respondents as initial study. Future research on this same topic would focus on the second stage of this model development.

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Energy Management Based on Internet of Things



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Abstract These years, the control of energy consumption and the use of renewable energies are becoming more important. In addition, there is a strong transition from a model where production is planned and predictable to another decentralized model that is difficult to predict and that energy management in distributed environments is really difficult, which requires the integration of new techniques such as information and communication technology (ICT), and artificial intelligence. However, with the Internet of Things (IoT), devices can communicate and exchange data with each other. The IoT paradigm promises to increase visibility and awareness of energy consumption through smart sensors and meters in machines and production lines. The connected objects are designed to collect and analyze data in real-time. They thus make it possible to monitor and manage the use and consumption. As a result, real-time energy consumption data from production processes can be easily collected and analyzed to improve the decision making. In this context, this document contributes to an understanding of the energy production management practices made possible by the IoT technic. This technic presents an element of an open system that is always in permanent interaction with other systems. For this, the presence of interoperability is essential in this technic for adapting to other systems already existing or still to be created. In addition, energy managers can adapt the adoption of IoT in a benefit-oriented way, by addressing energy management practices more aligned with the business, data and systems maturity and the information tools available. Finally, this work can be considered as an information platform for designers and installers in the field of intelligent energy management.

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Keywords Internet of things · Energy-efficient production management · Energy consumption awareness · Energy management practices · Framework · Decision making · Interoperability

1 Introduction

Energy conservation usually means less energy consumption due to behavioral rather than technological changes. The application of energy conservation methods produces the same environmental benefits as those obtained by reducing the use of energy by energy-efficient products and materials.

The concept of energy efficiency refers to a decrease in energy consumption due to technological rather than behavioral changes. Most appliances or other types of appliances use energy to operate. Except for solar devices, this equipment is connected in one way or another to a direct energy source. Energy-efficient devices or products provide equivalent performance while consuming less energy.

Today, energy-efficient manufacturing solutions have several benefits for manufacturing companies: cost reduction despite rising and volatile energy prices, building a good reputation through compliance with government and international environmental regulations, and adaptation to changing consumer perception of green products [1]. Driessen et al. [2] have defined green products as products that consume as little energy as possible. As a result, best practices to reduce energy consumption during production are becoming increasingly important for today's manufacturing companies. In many companies, energy management practices at the production level suffer from a lack of awareness of energy consumption behavior. Energy savings should be achievable both by improving the energy efficiency of certain production processes, as well as by the use of energy monitoring systems and innovative management approaches [3].

New emerging technologies, such as the IoT, are advancing the monitoring of production processes in real-time. IoT plays a key role in monitoring energy consumption [4]. IoT technology (e.g. Smart Meters and sensors) makes energy consumption models more aware by collecting energy consumption data in real-time.

The IoT relies on the implementation of a multitude of new sensors, actuators, and intelligent systems that communicate with each other. The rise of the IoT is at the crossroads of three techno-industrial developments:

- The record penetration of smartphones, these new universal remote controls, and the emergence of cloud services;
- The dramatic drop in production costs for sensors and actuators;
- The emergence of new long-distance and low consumption communication networks.

The energy sector is currently exploring the possibilities offered by the IoT. But for this sector, network intelligence is not a completely new phenomenon. The electrical networks already have information retrieval capacities for their monitoring and

control, but these are still limited. However, the meeting of IoT and Smart Grids opens the way to data collected from all points of the network and in real-time. Some data previously collected in an aggregated manner over large geographic areas could now be collected on a more local scale, near production or transmission points, and at a reasonable cost. It is also the massive accumulation of this data and its processing that is possible today. Hourly readings from 38 million Linky meters generate more than 300 billion measurements each year [5]. Taking advantage of such volumes was not possible with available technologies even 10 years earlier. Then, the instrumentation of each link in the distribution network is concerned:

- Optimization of production: to control a production facility and improve its performance, especially if it is a renewable source;
- Network supervision: remote detection, localization, and repair of a fault;
- Counting of consumption: to invoice as accurately as possible or optimize;
- Demand control: to increase network flexibility;
- Optimization of consumption: thanks to the energy savings made possible by intelligent systems;
- Optimization of the use of storage: to maximize its lifespan, its autonomy, and its use.

The IoT could significantly improve the efficiency of their operations and the management of their assets. The main challenge lies in the integration of existing information systems and the IoT. Finally, among the expected benefits of this integration, they cite in order of importance:

- Improved long-term planning,
- The best visibility within the organization,
- Prevention of security risks and optimization of fault management.

Given the importance of electrical energy management, we thought of carrying out this work, which is a detailed study of this subject using the IoT technics. The latter makes all household appliances into a harmonious group that communicates with each other by relying on physical means such as computer networks and well-developed programs. Each element of the group is responsible for specific tasks and cooperates with the rest of the elements to achieve the main objective which is intelligent and ideal management of electrical energy. Finally, it is interesting to recall the importance of this work for experts in electrical energy as well as for students and professors in research.

The remainder of this paper is organized as follows. Section 2 presents the research methodology. Section 3 explains the energy management. Section 4 explains the energy management methods. Section 5 details the IoT in electrical networks. Section 6 clarifies the IoT for consumers. Section 7 provides the benefits of implementing smart grids. Section 8 details the theoretical framework and conceptual model of the IoT. Finally, Sect. 9 concludes the paper.

2 Research Methodology

Figure 1 presents the research methodology adopted in this study. First, a systematic review of the literature on concepts and theoretical frameworks on energy management practices and the IoT paradigm was carried out. This included a critical assessment of IoT factory definitions, technologies, and applications. To this end, several keywords were used in the research process, such as “energy management practices”, “energy efficiency in production”, “energy monitoring”, “awareness of the consumption of energy”, “real-time energy data”, “smart meters”, “IoT technology” and “IoT and energy efficiency”. Similar articles were found using search engines, including Google Scholar, Web of Knowledge, Elsevier, and Scopus. Second, given the nature of this research paper, a qualitative research approach based on semi-structured interviews was used: the interview format offered a level of structure to cover certain main topics but left some flexibility by allowing follow-up questions to provide clarification. Namely, a group of energy management experts was interviewed who are in regular contact with and provide services to their customers, such as storing customer data in the cloud and analyzing that data [6]. Two other interviews were conducted with industry professionals. Two of them were IoT technology experts; they were asked about IoT technology and its applications for energy management. Next, respondents were asked to answer different questions to highlight the status of smart meters, sensors, and the applications they offer to customers. In addition, they were asked to define their customers’ energy management practices after installing smart meters and collecting and analyzing energy data. These questions were guided by the literature review carried out in the first stage and gave an overview of current sustainable practices. The rest were energy management consultants, asked about current energy management practices, and the energy data embedded in production decisions at the production level. The following section has been reserved to present the technology of the IoT and its interventions on energy management. The

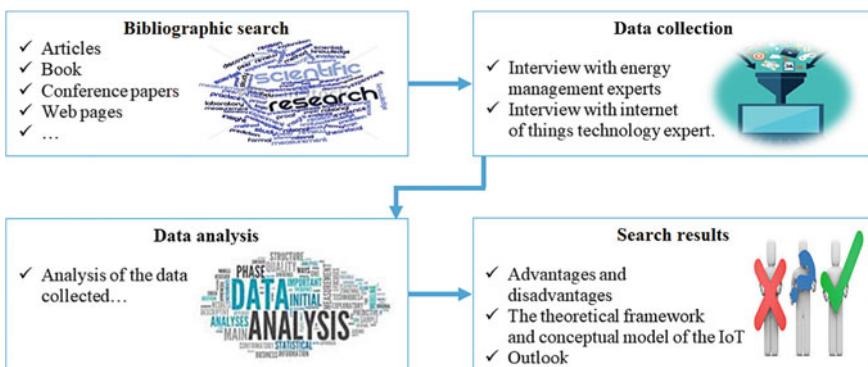


Fig. 1 Research methodologies

last section was devoted to describing the results of our research in the form of the advantages and disadvantages of intelligent energy management.

2.1 Inclusion and Exclusion Criteria

The inclusion criteria present the characteristics that the suspect subjects must mandatory possess or satisfy to have included in the domain of the study. Inversely, the exclusion criteria present the characteristics that must no-possess or satisfy to have included in the domain of the study. For this work, we will provide examples of what you will stick to or avoid (Table 1).

3 Energy Management

Adequate and ecological management of resources combined with the reduction of environmental impacts can promote economic development [7]. Renovation or construction projects provide multiple possibilities for applying energy-saving measures. In the case of renovation projects, the larger and more complex the planned work, the more opportunities there are to improve energy efficiency. About construction projects, the range of possible energy-saving measures is very wide.

Facility managers should look beyond the immediate scope of the project to find opportunities to reduce their energy use. When an energy-saving measure is implemented, the aim should be to optimize the planned savings and maintain them throughout the project and even beyond. Often, planned energy savings fail due to poor operating and maintenance methods. For example, energy-efficient products installed as part of renovations are sometimes replaced by less efficient products when they reach the end of their useful life [8]. One of the ways to avoid this problem is

Table 1 Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
This work should mainly be based on two subjects which are energy and IoT	Fossil energy sources are not concerned with this study
Research in this work should focus on recent works and new technology applications	/
Giving the importance and priority of renewable energy	/
Prioritize that provide for experimental works	/
It is necessary to present the architecture and essential elements of the studied system	/

to put in place an energy management plan with guidelines to ensure that energy conservation is practiced continuously [9].

A long-term energy management plan helps facility managers to define energy-saving measures, to include them in their planning, and to integrate energy efficiency into the daily activities of the organization [10]. One of the elements of an effective energy management plan is the grouping of energy efficiency projects aimed at maximizing their profitability [11].

Three ingredients are essential to the effective management of the energy-efficient components of a project.

- **On-site management team:** implementing energy-saving measures is a complex process encompassing many activities. The existence of a competent management team responsible for energy-saving measures is essential to the success of the project. The team should meet very early in the project and establish a schedule of frequent meetings to take stock of the progress of the work. The team should also include experts in technical and other fields to reflect the views of administration and operations.
- **Expert assessment:** when incorporating energy consumption reduction into a project, a large number of technical experts are needed, as different skills may be required, depending on the stages. Sometimes energy-saving measures include improving the building envelope to reduce the transmission of heat by air infiltration, with the consequence that ambient air pollutants are trapped in the air. Interior and harm the health and well-being of the occupants. One should be very vigilant throughout a project to avoid this kind of situation from happening.

Depending on the scale and complexity of the project, a facility manager may have to turn to outside resources specializing in the following areas: energy consumption studies, cost analysis and economic analysis, architectural design and systems design, technical aspects, indoor air quality analysis, construction methods, commissioning, staff training, maintenance and monitoring, and coordination of activities.

- **Energy Outsourcing:** Energy service companies are private companies that provide energy services. These companies provide technical expertise during the planning and implementation of a project and can also help manage the financial aspects and minimize risks. Energy outsourcing is a way to introduce energy efficiency measures into projects and reduce operating costs with a minimal initial investment. Energy service companies offer a full range of skills, as well as the capital to implement the project. Payments are based only on energy savings achieved through improvements to the building. Most of the technical and financial risks, and those related to maintenance, are the responsibility of the energy service provider.

Regardless of the importance of the participation of energy service professionals in the project, facility managers must know the principles and solutions for energy efficiency. These notions will be at the heart of the development and implementation of a long-term energy management plan [12].

An energy management system minimizes energy consumption while optimizing comfort in a building [13]. By regulating and programming, this device reduces costs and polluting emissions [14].

The regulation automatically maintains, at the desired value, a physical quantity (temperature, pressure, humidity, etc.) subject to variations. To do this, it measures the actual value, compares it with the set point, and acts on the variable of adjustment (temperature, for example) to reduce the difference. This therefore requires:

- A detection device (temperature, humidity, twilight sensors, presence detectors, etc.);
- A regulator (to compare and transmit a correction signal);
- An adjustment device (thermostatic valves, three-way valve for heating or air conditioning, etc.).

The programming adapts the operation of the facilities to the use of an intermittent building, either by manually or automatically stopping these facilities during a vacancy or by modifying the values of the set points in the case of thermal use (night idle). The programming bodies are, for example:

- **Timers:** switch equipped with a time clock cutting off the power to the equipment after a predetermined time;
- **Programming clocks:** system shutting down all or part of an installation of equipment at scheduled times. Local exemptions may allow the equipment to be put back into service manually;
- **Among these clocks:** some are equipped with computers allowing them, in particular for heating, to stop and restart the installation according to climatic conditions and the “state” of the building.

Load shedding for electricity proposes a temporary shutdown of non-priority electrical equipment, in order to reduce the installed power of the installation. This leads to limiting the subscribed power and, if necessary, to erasing certain non-priority uses during the hours when the electric kWh is the most expensive.

These management systems are designated by the term “home automation” in the residential sector and by “GTB” in the tertiary sector [15].

Finally, energy management is essential today because it allows real savings that should not be overlooked. This involves two actions [16, 17]:

- Decrease energy consumption by consuming better (examples: lower your heating, switch off the day before your electrical appliances, etc.);
- Substitute expensive energy with less expensive energy (example: self-consumption).

This energy management takes different forms, depending on whether or not the house produces its solar energy (for more information, see the section on Self-consumption of energy).

According to forecasting work, all the houses will be more and more positive energy, that is to say, that they will produce more electricity than that which they will

consume. They will also have to integrate, at a minimum, a system for measuring and managing their energy consumption (home automation).

3.1 Energy Management Without Solar Panel

Energy management without a photovoltaic panel makes it possible to [18]:

- Monitor consumption in real-time;
- Control devices remotely to reduce consumption.

Simply monitoring your consumption (via a home automation system) can save up to 23% on your energy bill.

It is also possible to act directly on electricity consumption, starting with the main energy consumption item, heating, which alone accounts for 50% of a household's total energy bill. Next comes the water heater (which represents 25% of the energy bill) and finally the large household appliances (washing machine, dryer, etc. ... (12.5%) and small household appliances (12.5%)).

Energy management even without a photovoltaic panel, therefore, helps to reduce your energy consumption. Indeed, you just have to go from 22 to 18 °C the radiators overnight (a drop of 4 °C) to get 7% savings on your heating bill.

Thanks to an energy management system, you can save up to 30%.

3.2 Energy Management with Solar Panels

Producing your electricity using photovoltaic solar panels to lower your energy bill is currently highly recommended in 2020, however, an additional energy management system is essential to achieve good energy self-consumption. Energy management with photovoltaic panels acts on two levels [19]:

- By reducing overall consumption, as described above
- By erasing daily consumption, that is to say by making energy consumption coincide with solar production (this is precisely the essential role of an energy management system)

Energy management with photovoltaic panels allows you to [20]:

- Monitor consumption, production and performance indicators in real-time
- Remote control of electrical devices
- Optimize its consumption to cover it with its energy production. For some energy management solutions, this is done automatically. For example, instead of operating at night, the launch of your water heater is shifted during the day, when the solar panels produce energy.

Up to 70% savings can be achieved with an energy management system. We recommend the Monabee brand, which is the manufacturer of energy management systems designed for solar self-consumption (intelligent energy management and optimization of solar self-consumption).

3.3 Integration of Energy-Saving Measures

Here is a procedure to follow which could be used to implement energy-saving measures. The chronology and the scope of the defined stages can vary according to the projects (Table 2).

4 Energy Management Methods

A large number of programs and management methods due to the many players involved (consumers, network managers, resellers, etc.). There are both long-standing programs (conventional management) and more recent programs based on advanced control methods.

All the management methods will be divided into two classes, depending on whether the control methods used are direct or indirect.

Table 2 Chronology and scope of defined steps may vary depending on the project

Step	Description
Defining the scope of the project	Understanding the project objectives and budget will help determine whether or not the project appears to offer opportunities for incorporating energy-saving measures. Acceptable cost recovery periods and the project schedule should also be established
Research	This step includes a preliminary assessment of the financial benefits to be included in the project of energy-efficient systems and energy-saving measures. At the study stage, we should roughly assess the amount of energy that can be saved and the costs associated with implementing these measures
Consumption study	It makes it possible to determine the precise model of energy consumption and indicates where in the building the modernizations proposed will make it possible to modify these models and the most advantageous saving measures. A comprehensive study will deal with aspects of energy conservation, energy efficiency, and energy-saving

Table 3 Groups of ILC

Group	Description
First group	These are the actions aimed at encouraging users to replace their old electrical devices and to use more energy-efficient solutions examples: use of low-consumption lamps, or incentive to reinforce thermal insulation, etc.). These methods are essentially based on financial aid to facilitate the penetration of new technologies
Second group	The user is asked to agree with suppliers to reduce consumption during certain periods of the day in exchange for financial assistance or bonuses. The methods are applied in particular widely to solve the problems associated with peak consumption during peak hours
Third group	This involves applying different rates during the day. France, Spain, the United States and a few other countries have implemented numerous programs along this axis. With these methods, information relating to the price of electrical energy is provided to users, who can then adapt their consumption behavior in order to make the most of variable tariffs. It is an indirect action, the result of which depends on the customer's sensitivity to high prices
Fourth group	These are methods based on the fact that on the electricity market the price of electricity is dynamic. These methods allow the user to face different prices on the electric market and to take responsibility for these purchasing decisions. The demand side bidding (DSB)

4.1 Indirect Load Control (ILC)

They encourage users (consumers or customers) to modify their energy behavior. The consumer manages his energy activities himself (choice of suppliers, subscription, electricity equipment, etc.), but network managers or operators cannot directly control user charges [21]. ILC programs can be grouped into four main groups (Table 3).

4.2 Direct Load Control (DLC)

These are control means/methods that allow network operators and also users to directly carry out load management actions to achieve well-defined control objectives. In general, the DLC methods applied in the residential-tertiary sector aim to control the consumption of air conditioning, heaters, water heaters, and lighting devices [22]. The classification of the management methods is based on various characteristics, such as the type of load, the calculation times required and the nature of the data to be processed.

4.2.1 Preventive Management Methods

They are based on programs aimed at establishing energy allocation plans in certain time slots in advance. The principle of these methods is to provide information, consistently and credibly, related to the energy that will be consumed in the future. Fluctuations in energy costs, changes related to uses, or even weather forecasts are the most used information. They meet the system load planning requirements. Based on this information, energy use actions and plans are developed using operational research techniques. Regarding the weather forecast, the management programs can retrieve the information remotely via dedicated communication lines. The most important forecast concerns the forecast of load curves. To do this, a wide variety of techniques are available: artificial neural networks (ANN), expert systems, learning systems like fuzzy systems [23], mostly based on databases. The effectiveness of preventive management methods strongly depends on the accuracy of the results and the ability to forecast to adapt to uncertainties. The use of optimization techniques is essential for planning energy allocations to achieve the desired level of performance. They are applied to find the optimal solution between possible energy allocation plans. These plans are normally defined using mathematical models or simulations. These plans vary according to various parameters such as the evolution of electricity tariffs (peak/off-peak hours, electricity market), direct requests from the supplier, additional resources, etc. The computation time of an optimal program depends directly on the number of variables to be solved. To take into account the constraints linked to the response time, the formulations of an optimization problem must be as simple as possible (the computation complexity is lower).

4.2.2 Real-Time Management Methods

The objective of these methods is to control the loads directly with a rapid intervention time, in real-time. These methods are applied in several fields such as lighting, door control systems, etc., whose control actions are determined based on future events.

Recently, new approaches have been proposed. First, these are direct methods based on the use of sensors (Sensor-based approach). This approach improves the quality of management services, to meet the needs of occupants, or to optimize the use of energy, taking advantage of the latest developments in the field of sensors.

Second, direct management methods rely on Multi-Agent (MA) techniques. These techniques are widely used to build an autonomous management system. They view the equipment and users of the system as a collection of agents. Each “agent” acts autonomously and intervenes with the others while respecting global constraints determined by the system.

5 IoT in Electrical Networks

The IoT plays an important role in many aspects of electrical networks such as network management, integration of renewable energy, and smart metering.

- **Network management:** the management of electrical networks is at the heart of the challenges of the IoT related to energy. The current infrastructure is the result of decades of investment waves. Consequently, the computer systems that compose it also come from the technological context of the time. The technological advances made possible by modern means, therefore, require the upgrading of these infrastructures. This is the subject of the ISO 61,850 standard which proposes a methodology for modernizing electrical stations. Standard 61,850 organizes the transition from “master-slave” protocols to “client-server” protocols. It fixes concerns about interfacing between different types of equipment and their proprietary protocols, which constitutes a major advance in terms of interoperability. It allows operational management savings but also gives much more flexibility to network managers by opening the way to multi-owner installations. The dynamics of the 61,850 standards are inspired by the “all over IP” wave that hit corporate networks ten years ago. But standard 61,850 also takes into account the business constraints that are specific to the world of energy. It is estimated that there are approximately 200,000 transformer stations and 30,000,000 source stations worldwide. Knowing that around 10% of electrical energy is lost in the networks due to the lack or absence of optimization of all resources, this gives a promising market potential.
- **Integration of renewable energies:** renewable energies are by nature intermittent. They induce new hazards that put the stability of the networks at risk, which induces the design of new solutions. Advances in the digital world are therefore a promising response for real-time management and the integration of renewable energies. These new solutions allow the emergence of various functionalities ranging from postponing the call for power to controlling the risk of service interruption. The challenge is both on the production side, with solutions capable of accurately predicting the production of renewable energies. This is, for example, what companies like Reuniwatt or Leosphère offer through forecasting algorithms combining meteorological information, characteristics of installed parks, and historical data. At the heart of these technologies, sensors and big data processing systems make possible new applications. On the consumption side, better knowledge of energy consumption with a finer mesh will allow tomorrow to better predict consumer demands. This is, among other things, one of the advances that could be made by individual load curves from Linky meters, or equivalent.
- **Smart metering:** the smart meter is the most visible link in Smart Grids for the general public. Tomorrow, these real connected objects, in addition to providing metering information, will offer new services to consumers [24]. It is the transition link between the subscriber and the electricity network. It is a privileged interface which, once connected, could offer users various functions such as real-time alerts or the study of consumption histories. However, few people with a smart

meter have filed complaints with these electricity suppliers, which show a very high satisfaction rate from users. In addition, the communicating meter will be compatible with the self-consumption of electricity.

- **Innovation:** Beyond the management of energy production and demand, there are other sources of innovation linked to Smart Grids, in particular around additional themes such as maintenance, training, awareness-raising, or the electric vehicle.

6 IoT for Consumers

The benefits of IoT are not limited to running networks and smart meters, but rather offer many benefits to the consumer of electrical energy.

- **Towards dynamic pricing for the benefit of the network:** the sensors installed throughout and at all points of the networks (from decentralized production equipment to the place of consumption) provide a whole series of functions: monitoring of the equipment present on the distribution networks, managing incidents, operations metering, and remote consumption readings. Companies are developing remote diagnostic platforms based on autonomous sensors that monitor equipment. If a fault is detected, an alert is sent through an IoT network. The user is then notified in real-time. In addition to its network of miniature, long-range wireless sensors, companies offer architectures with very low power consumption, energy recovery, on-board energy storage, and access to data via a secure web platform. By facilitating the exchange of information between network needs, the level of electricity prices, and the level of consumption, sensors open the way to active management of demand, in response to the integration of energies intermittent renewables and the proliferation of new uses. These exchanges will make it possible to balance the network more efficiently by knowing the elements calculated in real-time such as erasure capacities. The possibilities for adjusting consumption will also have to be assessed and then declared in real-time to those responsible for balancing the transport and distribution networks, the market then taking the form of an options market on the operating mode. of the current adjustment mechanism. This visibility of the instantaneous cost of electricity makes it possible to very precisely model the behavior of users, to extrapolate future demands, to better adapt supply to demand. The sensors installed on the equipment present on the distribution networks (overhead lines, underground cables, transformer stations, etc.) make it possible to monitor the use of the equipment and anticipate their failure (for example on wearing parts) and thus predict their future operation. The escalation of network data at the level of central information systems makes it possible to bring out typical fault diagrams and thus to make very reactive decisions for self-correction, or even self-healing (within minutes, even seconds, to prevent the spread of the fault on the network).
- **Connected home:** IoT innovations also abounds around the theme of the connected home. If consumers have so far focused on multimedia equipment for their homes (TV, Blue-Ray, Multimedia Box, etc.), the next revolution may

come from the world of energy. Enabling consumers to have a connected station at home that meets all their comfort needs, of which energy is the main component [25]. Other solutions exist, which offers individuals and social landlords to set up a social network making it possible to launch energy challenges to their friends or neighbors, thus encouraging them to achieve energy savings through a playful approach. The solution relies on sensors installed in private homes on their sources of consumption. The information from these sensors is then retrieved and processed through the IoT.

- **Smart heating:** heating accounts for the largest share of household consumption. Some Smart Grid players have understood this and are offering connected thermostats solutions that allow their owners to make substantial savings. Unlike many energy uses, controlling heating also gives users increased comfort, which makes connected thermostats one of the products most popular with consumers.
- **Smart appliances:** beyond heating, household appliances are a significant source of energy consumption since they represent around 22% of the consumption of a household. Also on this subject, Smart Grids players are mobilized. Tomorrow, our household appliances will be able to interact with the network to, as needed, delay their start-up, delay the achievement of one of the phases of a program (washing, pre-washing, spinning, drying, etc.) or automatically schedule a start at an optimal time. This intelligent management will allow the entire network to benefit from a new source of flexibility and therefore increase its capacity to integrate renewable and intermittent energies. To perform the functions described above, it is however necessary that all of our devices communicate using a common language. This is what several standardization initiatives are trying to make possible. The European Commission has launched a reference ontology on this subject called SAREF (for Smart Appliances REference ontology). This initiative has now been taken up by several other reference structures in the world of standardization such as the TC One M2M from ETSI and the TC 59x from IEC.

7 Benefits of Implementing Smart Grids

The benefits expected from the implementation of intelligent electrical networks are environmental, economic and societal.

- **Environmental benefits:** the global and local response of the electricity network to the challenges of climate change involves actions both in terms of electricity supply and demand. The objective is to meet ever greater and volatile demand, while drastically reducing CO₂ emissions. The implementation of an intelligent electrical network allows a consequent reduction in the impact of the supply of electricity on the environment by The level of investments made is commensurate with the interest shown in intelligent electrical networks. For example, the United States spends about 4.5 billion dollars on research. Venture capital companies, for their part, invested more than \$800 million in 2007 and 2008. In France, the Grenelle Environnement has laid the foundations for a large-scale public

investment policy in sustainable development, with 440 billion euros by 2020, including 115 dedicated to renewable energies.

- **Societal benefits:** beyond the environmental and economic aspects, an intelligent electricity network provides answers to the evolution of the basic needs of the society in energy and supports the overall energy policy of France. By enabling the share of renewable energies in the energy mix to increase, an intelligent electricity network makes it possible to reduce dependence on fossil fuels. It helps support sustainable growth, by meeting energy needs and their increase, especially that driven by the development of new uses. The issue of less energy dependence is also strategic. Dependency levels may increase if the energy mix does not change. Thus, it is estimated that by 2030 Europe may have to import up to 84% of its gas, 59% of its coal, and 94% of its oil [26]. Finally, an intelligent electricity network is an opportunity to ensure and improve the quality of supply and network security. Indeed, it perpetuates the development of remote reading and tele control of installed electrical equipment and optimizes maintenance, it improves the detection and localization of failures. In doing so, it can initiate automatic reconfigurations following an incident and becomes self-healing. All these improvements make it possible to ensure the quality of the current supplied and to reduce the frequency and duration of cuts. In particular, the means of managing demand and improving network efficiency make it possible to improve peak management and avoid major blackouts. These improvements make it possible to envisage a safer and more reliable network in the event of an incident, in one of the electricity. Faced with, in particular, large-scale climatic phenomena or the risk of a terrorist attack, securing electricity supplies makes it possible to meet increasingly strong demand from the community.
- **A response to societal expectations and benefits distributed across the chain of actors:** combined with the planned scarcity of fossil fuels and the imperative of energy security, the protection of air quality and the climate leads us into an inevitable movement of increased use of renewable energies, whether they come from the wind, the sun, land, or sea.
- **For the state and national public accounts:** creation of favorable conditions for energy efficiency, increased energy independence through the integration of renewable energies and reducing the tip, contribution to the security of electrical networks and more generally to cybersecurity, securing commercial outlets for national industrialists in the electricity sector, penetration of new energy technologies and support for national research, and contribution to the circular economy and the preservation of raw materials.
- **For consumers:** access to economically competitive and already existing energy efficiency solutions, promotion of virtuous behavior through more flexible pricing according to usage, voluntary modification of behavior while respecting privacy thanks to standardization and specific data protection legislation, and better control of renewable energy production and new uses.
- **For electricity distributors:** optimization of networks and their management according to the source of electricity production, harmonious integration of the use of electric vehicles and new electrical uses, and securing the balance of networks.

- **For energy carriers:** overall management of the production, transport, and distribution system, and anticipated management and modeling of available energy production capacities based on real and/or spontaneous demand.
- **For electrical manufacturers and manufacturers:** sustainability of high value-added jobs in the territory, support for the export of the know-how and excellence of the French and European electrical industry through the increasing interconnection of networks, and reinforcement of standardization and standards for the penetration of emerging economies.
- **For the University and research:** mobilization of researchers and academics around an application platform and real size for the crossing of technologies.

8 Theoretical Framework and Conceptual Model of the IoT

There is a set of ideal theories for accepting and adopting technology among them are the Technology Acceptance Model [27, 28], planned behavior theory (TPB) [29, 30], the unified theory of acceptance and use of technology (UTAUT) [31], Diffusion on Innovations [32] and the technology-organization-environment (TOE) framework [33]. However, there has been an evolution and effective acceptance of technology around the world since the second half of the twentieth century. This has resulted in improvements in social life and even self-expression [34]. TAM, as a search stream, is a widely deployed model for assessing technology acceptance in information systems due to its simplicity and understandability [35]. Its proponents said the key to improving usability was first to increase acceptance of information technology, which could be assessed by measuring future usage intentions [36]. The models are based on the theory of reasoned action (TRA) [37], a psychological approach that illustrates how an individual's belief system is involved in human behavior. TAM describes how perceived benefit and ease of use are the basis for accepting and adopting any new technology [38]. The utility also has more to do with user behavior than ease of use, suggesting that perceived ease of use may be a priori causation [27]. The perceived utility and usability also play a large role in user acceptance and use of technology. Subsequently, UTAUT unified theory was developed as a synthesis of previous research on technology acceptance, in which previous theories were developed to explain the acceptance and use of technology mainly through studies in psychology and sociology [39]. After that, these models/theories were applied mainly by different researchers to determine many views and variables related to mobile payment services, including confidence, intent to use, and user satisfaction, since more than half of the studies in this group aim to investigate These variables. With the advancement of mobile digital devices, the mobile internet, and the availability of applications, making mobile payment services acceptable to users has become a high priority issue. For example, TAM and UTAUT are widely used in various tasks [40], and the application of technology is studied at different levels [41].

TRA is a general framework and requires the identification of contextual beliefs that influence specific behavioral intentions [42]. Although TAM and UTAUT have

proven their worth in different areas of technology adoption [39], several studies have shown that other salient perceptions have a higher predictive value in explaining the acceptance of technology in specific contexts. For example, Lee and Larsen found that the perceived severity of the threat and the self-efficacy of the perceived response were the primary determinants of intention to install anti-malware software [43]. Hsiao showed that fear and mistrust were the key factors that helped explain the intention of adoption in an electronic market [44]. Baird et al. demonstrated that a complex set of contingencies influenced the adoption of electronic patient portals by healthcare providers [45]. In summary, although TAM and its successor, UTAUT, offer broad frameworks encompassing factors influencing technology adoption intent, research in specific contexts has shown that context-specific factors allow for better understanding, more contextualized, phenomenological factors in the respective contexts.

IoT technology is becoming widespread with the development of the energy management field. The emergence of these technologies can offer unique opportunities to students and academics by enabling ubiquitous communication [46]. However, in research and development, the literature on the development of theory in the field of IoT is very limited, Chaudhuri and Cavoukian published a framework for the confidentiality of IoT [47]. The high-quality theory is believed to enhance the knowledge of the researcher and other researchers in the field of theory. It can also serve to strengthen the capacities of practitioners to function effectively in the theoretical framework (Weber 2012), it describes several ways in which a theory could make new contributions to a discipline:

- The focal phenomena of the theory were not addressed by the previous theories;
- The theory can be considered new because it identifies or includes preexisting focal phenomena known in new ways;
- The novelty of the theory may arise due to the significant changes you make to the current theory.

Gregor identified taxonomy of theories based on an in-depth review of the existing literature and identified five ways in which the term “theory” was used (Table 4) [48].

Weber argues that the theories for analysis are typologies and not theories and that the theories for design and action are models but not theories lacking in certain characteristics important to a theory [49]. Second, he further asserts that the theories for explanation and theories of prediction may not be rigorous enough to constitute

Table 4 The five types of theory according to Gregor

Type	Theory
Type 1	Theories for analysis
Type 2	Theories for explanation
Type 3	Prediction theories
Type 4	Theories for explanation and forecasting
Type 5	Theories for design and action

Table 5 Parts of the dynamic phenomenon according to Weber

Part	Description
Part 1	Their constructions
Part 2	Their associations
Part 3	The states they cover
Part 4	The events they cover

theories. It aligns with the taxonomy on the theories for the explanation and the forecast of Gregor by affirming that the existence of a model is a primordial condition for the existence of a theory, but not a sufficient condition [48]. However, the existence of a theory is a sufficient condition for the existence of a model [49]. According to Weber, theories that have dynamic phenomena have four parts (Table 5) [49]. Each of the four parts encompasses the internal and external borders.

Most of the theoretical models developed are the variance of process models. Jaccard and Jacoby suggest that the development of the theory be approached from a process perspective indicating that the researcher could theorize about the event or the stages that would constitute the adoption of technology [50]. This approach was followed, which made it possible to identify associations, states, and events. Next, the Insights team (2017c, p. 19) states that IoT is the digital transformation of the business and that “... building the business case and leading IoT to solve business goals are the keys to success.” As indicated in the theoretical framework and the conceptual model, the priority areas must be identified, the challenges met and the confidence established to obtain the optimal benefits of an IoT system [51].

8.1 Architecture of the IoT and the Associated Model

Some researchers believe that the future generation of the Internet works, such as the nervous system of the human race that can see, share feelings, sensations, and other qualities available only in humans. Overall this is the ideal view of IoT technology [52, 53].

The structure of the IoT can be classified into two different types (Figs. 2 and 3). The first type is the human brain responsible for thinking and making decisions, and the brain is the center of all information and data (Fig. 2). It consists of three main parts: the brain (Processing and Knowledge Base: PKB), and a person’s spinal cord and nerve network can also be considered using distributing information, which can be represented by the Internet of Things. Generally, IoT transmits the message from the sensors to the corresponding control nodes and to the PKB, which receives and sends the message to the sensors to control “things” or to solve a specific problem. Although the functioning of relying on the IoT is similar to the nervous system of the human race, there is still an important difference in the ability to control or respond to external or internal stimulation in some cases.

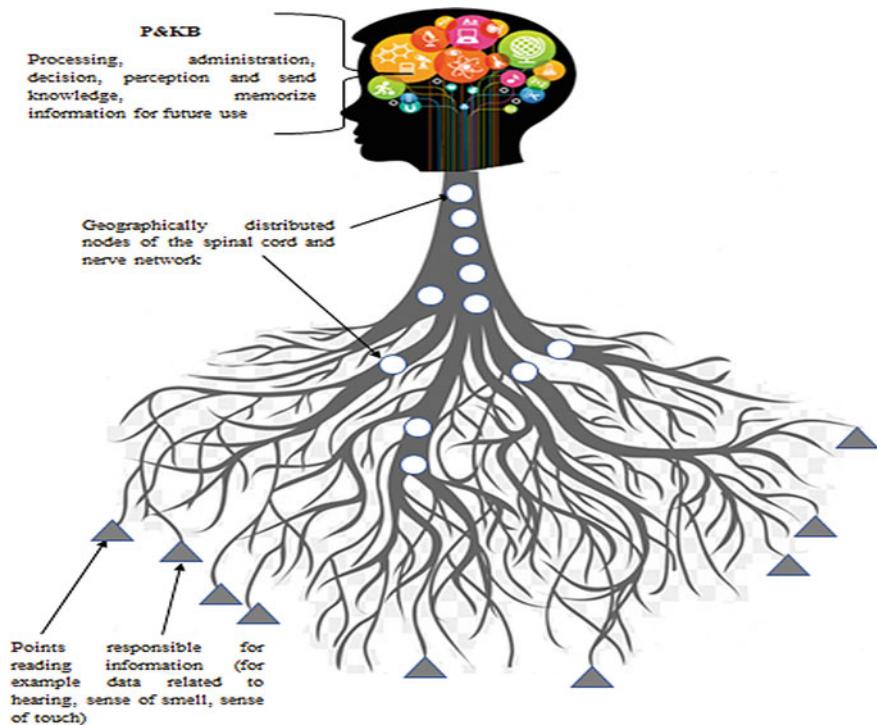


Fig. 2 Model

The second type of IoT is a modified P&KB model. Its distributed data center is located not only in P&KB but also in certain other rope nodes. In this model, whether the distributed control node operates as a distributed data node or not is determined by the requirements (Fig. 3).

Finally, there are great similarities between IoT operating and that of human thought due to the inspiration of this methodology from these natural creatures (Fig. 4).

8.2 Contributions of the Theoretical Framework

The knowledge acquired from this research on energy management based on the IoT and associated concepts led to the development of a theoretical framework to improve old knowledge and allowing new studies to be carried out on it. IoT, then it serves to explain this concept and the usage prediction that can guide practitioners during the adoption and implementation of IoT. A global contribution of this framework is the establishment of a theory on IoT for the adoption and implementation of IoT more particularly for energy management which is practically non-existent in the

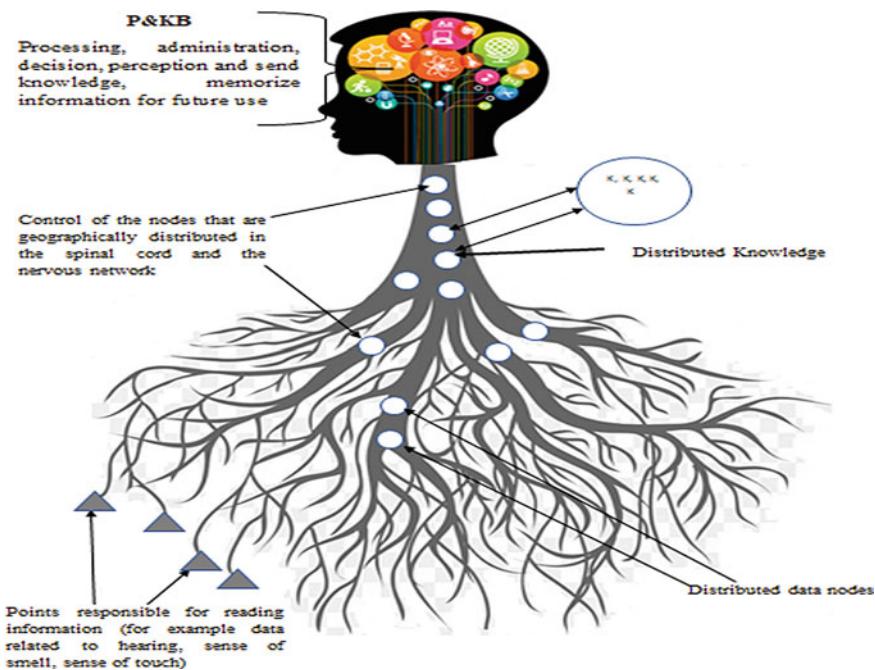


Fig. 3 Modified model

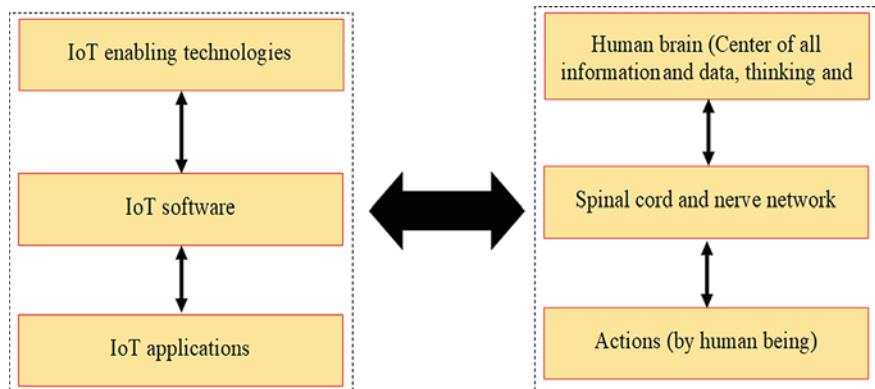


Fig. 4 Similarities between the IoT operation and human thought

literature. The challenges have been widely addressed and the benefits have been briefly discussed in the literature, but very few have addressed the importance of identifying priority (functional) areas of IoT to obtain optimal benefits specific to IT management of energy. Additional contributions from the components of the energy management and research framework are also discussed. If the IoT involves objects

communicating with objects, the human component cannot be removed from the model. Stakeholders are essential to the ultimate success of IoT.

Addressing priority areas and challenges leading to the adoption of IoT is essential and both must be carefully addressed before implementing IoT. This theory contributes to the knowledge of IoT, including priority areas, which guides practitioners and, more importantly, recalls that the challenges of privacy and security must be met to gain user trust and use successful IoT. Next, the theoretical framework and conceptual model contribute to the body of knowledge in the field of IoT, providing researchers with additional explanations and predictions based on the theoretical components, thus opening up opportunities for a diverse range of research. There is ample space to test this theory and the components of the theory should also be studied separately. Finally, researchers in the technology field could be inspired to expand and develop a journal and a theoretical framework with other components where research gaps may exist.

9 Conclusion and Perspectives

The IoT opens the way to a better knowledge of energy equipment so that intelligent objects are now able to facilitate knowledge of all energy infrastructures. For example, by analyzing sensor data, it is possible to assess the behavior of the equipment over time and predict breakdowns before they occur. These techniques make it possible to considerably reduce operating and maintenance costs, while allowing better integration of new sources of energy, in particular renewable, but also of new infrastructures, necessary within the framework of the country which continues to develop their electrification. However, IoT-based energy management reduces the energy bill, tracks consumption remotely and in real-time. It also makes it possible to shut down and switch on electrical devices remotely.

It is expected that soon IoT will be widely used as a network for connecting objects. IoT provides many possible applications. In the future, there will be many applications for electric power management, such as intelligent power control. The IoT system must be able to connect multiple heterogeneous devices across the Internet, which explains the urgent need for layered architecture.

In this paper, the smart power management is described using IoT in which objects, people, and cloud services are combined to facilitate application tasks. The main components are described taking into account the smart power management application. After an overview of IoT software platforms and enabling technologies, some challenges caused by IoT software and hardware immaturity are described. The main promises of an effective IoT system can be fulfilled when these problems are overcome, thus creating a safe, reliable, and easy to use IoT system and providing daily comfort for users. Then, by understanding the IoT systems and taking into account the priority challenges and theoretical framework presented in this document, the researchers and practitioners can learn about the uses and benefits of the rapidly

growing IoT technology. Finally, concerning the future and perspective works, theoretical studies can be conducted in laboratories that must be applied to know the actual results of the applications of this technology, as well as to make an actual comparison between different works to choose the best among them.

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Designing an Online Community Checklist Tool (OC2T) Based on Online Communities Implementation Framework Using Three-Tier-Architecture



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Abstract This research introduces an Implementation framework (IF) to evaluate the sustainability of online communities. The appropriateness and importance of the components in the IF are validated by four experts from the academia and industry. Based on these findings, a prototype called Online Communities Checklist Tool (OC2T) is developed and evaluated. A user acceptance test using the Perceived Usefulness and Ease of Use (PUEU) instrument conducted with fifteen developers' demonstrated overall feasibility and acceptability of the prototype. Results further reveal that the OC2T is beneficial in evaluating the sustainability of online communities. Finally, to sustain a successful online community, the present study aids by assisting organizations in their policy making through positive engagement of users involving online communities and to embark into OC2T components to prevent online communities from failing.

Keywords System design · Online communities · Checklist tool · Three-tier-architecture · Implementation framework

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1 Introduction

The models that predict constructs of individuals' acceptance are predominantly based on pre-adoption intention and behaviour rather than post-adoption. Although within the field of Information Systems (IS) a number of continuance models have been developed and tested for efficacy the capabilities of these models are limited because its underlying conceptualization of predicting acceptance behaviour underestimated social related influences [1]. The lack of social related influences in continuance participation models affects the sustainability of online communities. Moreover, many online communities that spring up fail due to the limitation and lack of attention given for social needs of individuals.

To overcome the mentioned limitations, a Continuance Participation Model (CPM) for online communities was presented and evaluated which is beyond the scope of this paper, but described elsewhere [2]. The model attempted to define the relationship between the Theories of Planned Behaviour (TPB) and Social Support (SST) alongside satisfaction and perceived value constructs towards the continuance participation intention and behaviour of online communities. By grounding the related constructs from the established models, the TPB model emerged to be the most appropriate model to explain on the continuance participation of online communities.

In IS, the TPB is heavily utilized and applied to study, explain and predict decisions of acceptance, adoption, and use of technology systems and other digital services [3456]. In addition, a related recent study integrating TPB and perceived value construct conducted by Al-Debei, Al-Lozi [5] on Facebook explained on the continuance use of online communities. Furthermore, the Satisfaction construct from the IS Success Model extends the TPB to explain continuance participation in online communities.

From the assimilation of observation, discussion and extensive literature review undertaken it is apparent that the inclusion of Social Support constructs contributes to the positive engagement of users in their online community which strengthens the reliability of the continuance participation model. Evidently, behavioral science and individual psychology also suggest that Social Influences and Personal Traits are potentially important determinants of adoption of a new system [7, 8]. For this study, the integration of the Social Support constructs from the Social Support Theory namely the Emotional and Informational constructs were considered for examining the Continuance Participation Intention and Behaviour constructs.

The addition of these two constructs with the integration of the Theory of Planned Behaviour, Perceived Value and Satisfaction construct were seen to be significant and has the potential to influence the continuance participation of online communities. The constructs contributing to the model is identified based on extensive literature review and Average Congruency Percentage (ACP) verified and validated by three panels of experts [2].

This study was established on a positivist approach in which a quantitative methodology was used to investigate the correlational paths [9]. Using a probability sampling

method, data was collected from 385 users of social networking sites (SNSs) with a minimum of two years of experience [10]. Hypothetical relationships were examined using Structural Equation Modeling (SEM) based on the Partial Least Squares (PLS) [11, 12]. The study findings indicate that the CPM achieved an acceptable fit with the data and specifically 9 out of 10 hypotheses were met [13].

The empirical evidence also reveals that social support constructs measured by informational and emotional support exert significant effects on the intention and behaviour as well as exerts positive effects on perceived value and the intention to continue participating in online communities.

Subsequently, this research introduces an Implementation framework (IF) to evaluate the sustainability of online communities. The appropriateness and importance of the components in the IF are validated by four experts from the academia and industry [13]. Based on these findings, a prototype called Online Communities Checklist Tool (OC2T) is developed and evaluated. A user acceptance test using the Perceived Usefulness and Ease of Use (PUEU) instrument conducted with fifteen developers' demonstrated overall feasibility and acceptability of the prototype.

Results further reveal that the OC2T is beneficial in evaluating the sustainability of online communities. The structure of this study is presented as follows: section two discusses related literature review leading to the development of OC2T. Section three discusses the design principles required to develop the OC2T system. Section four explains the methodology adopted in the study. Section five provides research findings and analyses. Finally section six presents discussion of research limitation and conclusion of study.

2 Literature Review

2.1 Continuance Participation Model (CPM)

The extensive literature and analysis conducted in [2] contributed to the development of CPM. The CPM consists of the constructs from the Theory of Planned Behaviour (Attitude, Perceived Behavioural Control and Subjective Norms), Social Support (Emotional and Informational), Satisfaction and Perceived Value as the independent variables and Continuance Participation Intention and Continuance Participation Behaviour as the dependent variables [5, 141516].

Each of the independent variable has been tested and reported to influence the continuance participation intention and behaviour and therefore is crucial for ensuring the sustainability of online communities [2, 17]. Figure 1 depicts the CPM with supporting constructs and relationships.

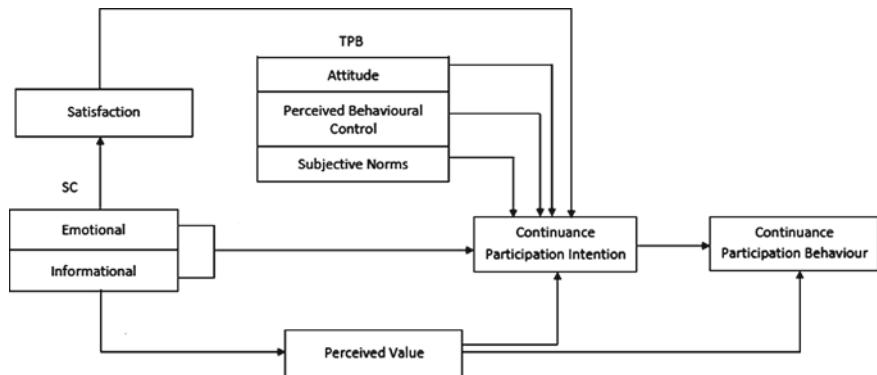


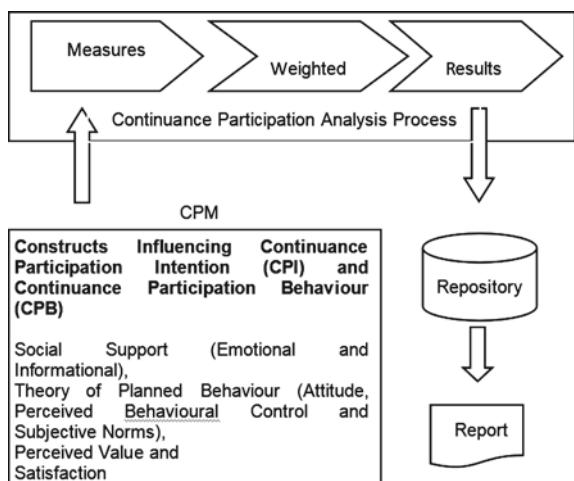
Fig. 1 Continuance participation model

2.2 Implementation Framework (IF)

The Implementation Framework (IF) provides an abstract view on the pertinent components required for ensuring the sustainability of online community sites. This framework collaborates with the findings which contributed to the development of CPM, as shown in Fig. 1. The purpose of this framework is to enable online community developers to evaluate the sustainability of online community sites as well as be informed on the components required for successful online community sites.

The IF is as depicted in Fig. 2. This framework is an integration of the constructs influencing the Continuance Participation Intention and Behaviour of the CPM (refer to Fig. 1) and Continuance Participation Analysis Process which consists of the measures, weighted checklist [18] as well as assessment of results [17].

Fig. 2 Implementation framework (IF)



2.3 *Online Community Checklist Tool*

The Online Community Checklist Tool (OC2T) is a prototype developed based on IF. Since the IF is developed based on validated CPM and literature review with the appropriateness and importance of its components verified by social commerce experts (partly the users) hence it is considered that the prototype is developed after performing initial analysis where user requirements are gathered [13, 17]. The prototype is developed in accordance with the processes proposed by Sommerville [19]. The section to follow discusses the initial analysis process, functional specifications, system architecture and software design of the prototype.

3 Design Principles

3.1 *System Architecture*

The system architecture of OC2T is based on three tier architecture. Three-tier is a client-server architecture in which the Presentation Layer, Application Layer and the Data Layer are maintained independently. In a web based application, the presentation layer is content rendered by the browser. For OC2T, the content is generated both statically and dynamically depending on the functions. Figure 3 illustrates the three tier architecture of OC2T.

The presentation layer is the user interface of the application. Users of the OC2T can access the application through the web browser on their computer. The web browser supports Hyper Text Markup Language (HTML).

3.2 *Software Design*

The use case diagram represents the specific flow of events in the prototype. For OC2T, the main actor is the web developer. Figure 4 shows the use case diagram for OC2T. Users of OC2T are able to login, update password, take checklist as well as view present and past results.

The overall content and navigation structure of OC2T is as depicted in Fig. 5. Referring to Fig. 5, users of the prototype in this case the web developers will first have to login into OC2T. They will then proceed to take the checklist or update their login password details. Following that, results are displayed for present and future viewing so appropriate decisions can be taken.

Fig. 3 System Architecture for OC²T

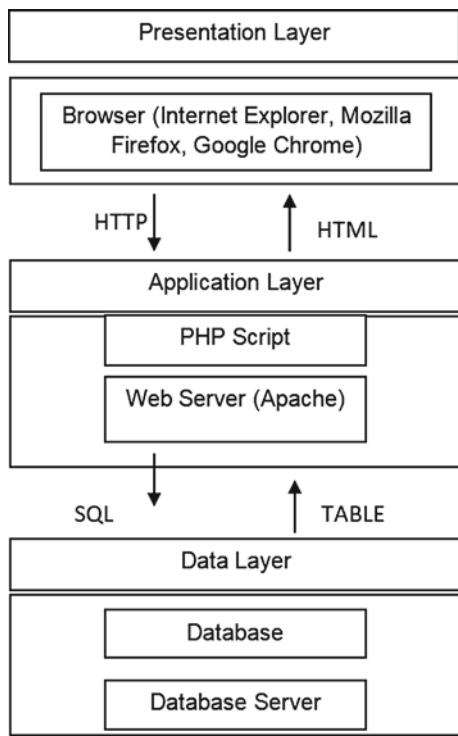


Fig. 4 Use case diagram

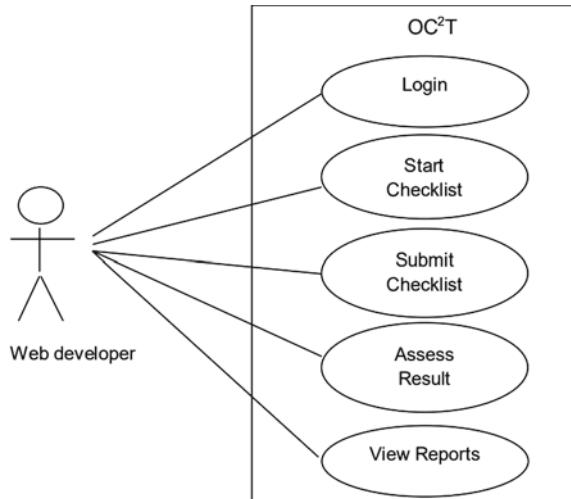
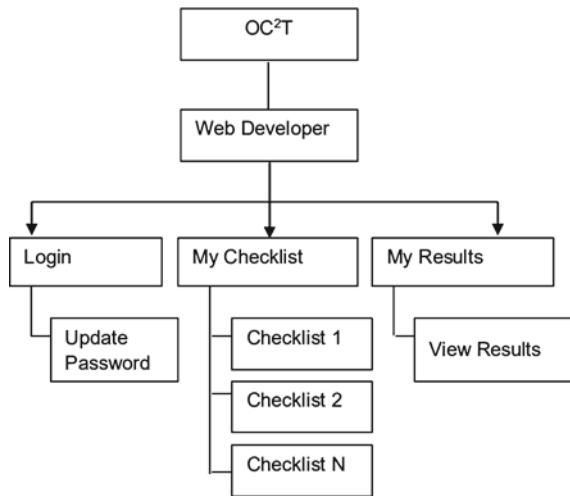


Fig. 5 Content and navigation structure of OC2T



3.3 Technology Platform

As per the requirements of OC2T, it requires a web server which accepts the HTTP requests from the web browser. For that purpose, the Apache web server was used. The XAMPP tool was used to setup a web server locally. XAMPP is a free and open source cross-platform web server solution stack package consisting mainly of the Apache HTTP Server, MySQL database and interpreters for scripts written in the PHP and PERL programming languages. A database engine is required to store the information related to OC2T. The MySQL database engine was used for the development of OC2T because it is highly compatible with Apache server. Moreover, the fact that MySQL is free and reliable makes it an appropriate choice. The programming language used for the development of web pages of OC2T is PHP. As PHP is open source, easy to use, fast and customizable, it is a good choice for developing web pages. In addition, HTML5, CSS and JavaScript were used for developing the graphical user interface while Ajax and jQuery were used for the purpose of results simulation in OC2T.

4 Methodology

A total of 15 respondents participated in the online survey developed using google forms. According to Faulkner [20], studies to evaluate a prototype of a novel user-interface design reveals severe errors quickly and therefore often require fewer participants. Literature suggests that three to twenty participants provide valid results [21] hence the 15 respondents. The respondents come from two IT companies dealing with web development of which two of them are also the expert reviewers involved

Table 1 Demographics of respondents

Demographic	Group	Frequency	Percentage (%)
Gender	Male	14	93.3
	Female	1	6.7
Age	18–24	0	0
	25–34	6	40
	35–44	9	60
	45 or above	0	0
Designation	Junior developer	1	6.7
	Senior developer	12	80
	Webmaster	2	13.3
	Other	0	0

in the expert review process. The participating companies are VICT Systems and DXC Technology. Seven developers from VICT Systems and 8 developers from DXC Technology participated in the user acceptance test, conducted via an online survey. The system is first downloaded and installed on individual machines. This requires the installation of XAMPP, php files as well as sql. Then, they were required to explore and use the OC²T. When this task is completed, they were requested to answer the online survey based on their usage experience of OC²T.

Additionally, four experts from the industry and academia also participated in the expert review. The experts from the industry come from IT background and are involved in software development projects and the managing of web. In addition, they have experiences developing and managing social commerce sites where requirements come from the clients themselves. As for the academics, they are actively involved in social commerce domain of research, evaluation of usability and interface design as well as evaluation of usability and user experience study.

The questions in the expert review form are first pilot tested by two academics and were found to be well-structured and understandable. Next, all the four expert reviewers were met for their valuable input. The reviewers were first briefed on the content of the expert review form as well as the flow of the research. Following that, they are required to complete the questionnaire. Both these processes were diligently done and took slightly more than an hour per reviewer. The basic demographic of these respondents are as listed in Table 1 with a response rate of 100%.

5 Results

5.1 Results of Implementation Framework (IF)

Reviewer 1 who is a senior web developer found the CPM, IF, its components and subcomponents to be systematic clear and comprehensive. The summary feedback of

the first reviewer with regards to all three sections of the expert review questionnaire were (i) the Continuance Participation Model carries a set of constructs which are significant pointers for continuance participation of online communities therefore the components of the construct known as measures should carry equal weight, (ii) the subcomponents of constructs referred to as checklist items are able to guide web developers on the vital features required when developing online community sites and (iii) the simulations provided for processing the end results to identify the sustainability of developed online community sites are commendable. The feedback obtained from reviewer 1, particularly on (i) is noted and considered during the prototype development.

Reviewer 2 who is a system testing manager respondent alike to that of reviewer 1 but had the following feedback to add, (i) the IF is significant in improving the quality and sustainability of online community sites, (ii) fresh and novice web developers will benefit from the proposed framework through the prototype implementation and (iii) experienced designers can also benefit from the proposed framework by suggesting the vital pointers required to their clients for ensuring continued usage of online communities. The feedbacks obtained from reviewer 2 were positive and no major improvement on the framework was required.

Reviewer 3 who is a senior lecturer from Universiti Teknologi Malaysia gave comprehensive feedback and the overall feedback was (i) the category weight assigned to the constructs during the simulation process has to be justified, fixed and must come from the researcher, (ii) the Importance-Performance Map Analysis (IPMA) [12] should be considered for deriving the category weight at the same time extending the results of PLS-SEM and (iii) the prototype development which is a follow up from the implementation framework is vital provided it has a strong justification with regards to the category weight assignment. From the feedback obtained from reviewer 3 on (ii) and (iii), the IPMA was used for the assignment of category weight.

Reviewer 4 who is an associate professor from the International Islamic University Malaysia found the proposed framework useful for web developers particularly those involved in developing social commerce sites such as Facebook that requires social involvement from users. However, the reviewer also provided the following feedback for improving the research model, (i) before adopting the proposed model, developers should have basic knowledge on the social perspective factors that are crucial when developing online community sites. It is only then, they will be able to perceive the model as well as utilize the tool at optimum level and (ii) the proposed model is an excellent guidance for novice developers and should be made mandatory when user requirements for clients are gathered.

The feedback obtained from reviewer four was only minor and therefore no major improvement was needed on the proposed model. The expert review process was ended with the fourth respondent since it has reached the saturation point. In summary, the findings of expert reviews on all the four reviewers show that they are agreeable to the sequence and content of the entire proposed model together with its components and subcomponents.

5.2 Results of Prototype

There were two main steps involved in this phase; (i) all the targeted respondents were asked to perform testing on the prototype and (ii) to complete the online survey form based on their experience of usage on the prototype.

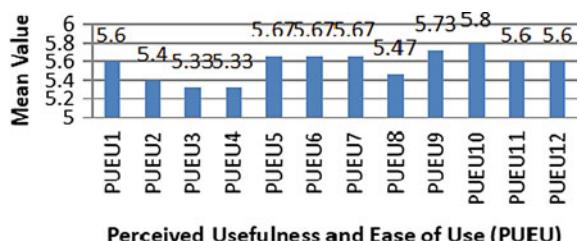
This research implemented the user acceptance test based on the Perceived Usefulness and Ease of Use (PUEU) instrument by [22] which has been based on the Technology Acceptance Model (TAM) [23, 24]. Perceived usefulness and perceived ease of use are hypothesized to be fundamental determinants of user acceptance and system use [22, 25]. To analyze the PUEU test, descriptive analysis (mean, standard error) using SPSS was carried out. For the discussion of descriptive analysis in this research, item rated with scale 6 which denotes ‘Agree’ and scale 7 which denotes ‘Strongly agree’ show that the item measured is highly useful as ratings of 6 and 7 in Likert scale has synchronous meaning of high usability [26]. The questions of the survey are divided into two parts. The first part is on demographics while the second on prototype perceived usefulness and ease of use.

To measure OC²T, the perceived usefulness and ease of use of each item in the survey are determined based on the agreeable level of the respondents using the Likert scale from (1) Strongly disagree to (7) Strongly agree. The seven-point Likert scale was used for the usability study as it appears to be more suited to electronic distribution of usability survey [26]. The Likert scale score reflects the level of agreement on agree-disagree scale. Many types of benchmarks are used to judge the level of agreement obtained for Likert scale scores however literature suggest that an average score of 75% is rated as high usability [27, 28]. For the purpose of this research, a threshold value of 75% is therefore used as a benchmark.

5.3 Usability Test Survey

Participants rated the usability of the system positively. PUEU scores obtained from all the 15 participants' responses for all the twelve evaluation questions surpassed the average score of 75% indicating a high overall usability. Figure 6 depicts the mean scores obtained by all twelve items. The average mean scores are all above 5

Fig. 6 Mean scores for PUEU



(somewhat agree) indicating that the overall respondents agree with the perceived usefulness and ease of use of the system.

Figure 7 reports on the standard deviation where the scores are closely clustered around the mean value indicating data is well dispersed and reliable.

Distributions of data are considered to be of low-variance if the coefficient of variation, CV calculated by dividing the scores of standard deviation and mean ($CV = \text{standard deviation}/\text{mean}$) is lesser than 1 ($CV < 1$). Table 2 lists down the CV on all twelve items evaluated. As the CV score for all the twelve items are below 1, it can be concluded that the data are well distributed. The agreement level for each of the item tested are also summarized in Table 2. In general, the level of agreement for the usability test conducted with 15 respondents is more than 75% and therefore demonstrates a high level of agreement. This shows that the IF is perceived useful and easy to use. Additionally, some positive remarks were given by the respondents on the practicality of the prototype. These include the ability to view past reports as well as obtain results on the significance level of sites to.

Fig. 7 Standard deviation for PUEU

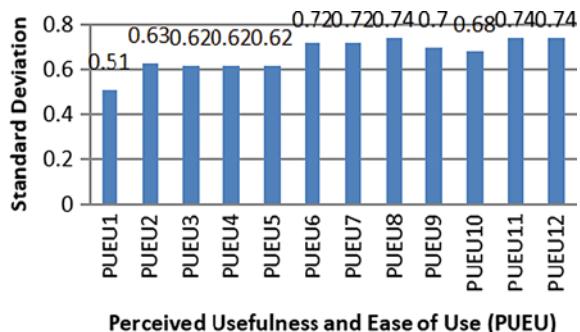


Table 2 Coefficient of variation and agreement level for PUEU

	CV	Agreement level (%)
PUEU1	0.09	100
PUEU2	0.12	93
PUEU3	0.12	93
PUEU4	0.12	93
PUEU5	0.11	93
PUEU6	0.13	100
PUEU7	0.13	100
PUEU8	0.14	100
PUEU9	0.12	100
PUEU10	0.12	100
PUEU11	0.13	100
PUEU12	0.13	100

6 Conclusions and Discussions

Drawing on the theories of planned behavior and social support as well as satisfaction and perceived value constructs, this study introduces an Implementation framework (IF) to evaluate the sustainability of online communities. The IF provides an abstract view that emphasizes the pertinent components required for ensuring the sustainability of online community sites. The IF consists of the continuance participation analysis process (measures, weighted checklist, results) applied on the validated CPM.

This framework serves as the implementation of the proposed model and is an integration of the constructs influencing the Continuance Participation Intention and Behaviour of the CPM, and Continuance Participation Analysis Process. The purpose of this IF is to guide web developers' in online community web developments, measure the sustainability level online community sites as well as assist web managers in organizing and handling their online community sites. The weighted checklist method is applied on the continuance participation analysis process to generate results. The framework was reviewed by four expert reviewers from the social commerce domain. The framework serves as a guideline for both researchers and practitioners on the vital components required for ensuring continuance participation in online communities.

Subsequently, a prototype named OC²T is developed to validate and to test the efficacy of the IF. The system architecture of OC²T is based on a three tier architecture comprising of presentation layer, application layer and data layer maintained independently. The data layer is implemented using database and database server, the application layer is implemented using PHP script and Apache Web Server while the presentation layer is implemented using browsers such as Internet Explorer or Google Chrome.

Findings from the deployment of OC²T to 15 respondents are positively inclined to IF and was reported perceived useful. The OC²T was tested using the PUEU test and resulted in positive engagement. The PUEU usability test was conducted on fifteen respondents who are web developers. The results of the study indicate that social support theory alongside with its constructs, informational and emotional, theory of planned behaviour alongside with its constructs, attitude, perceived behavioural control and subjective norms, satisfaction and perceived value constructs are key determinants in driving continuance participation intention and behaviour in an online community in the context of Web 2.0 technologies. The results also show that the measures associated to these constructs contribute to the continuance participation of online communities in ensuring the sustainability of online community sites.

The lack of guidelines in the development of online community sites in ensuring continuance participation and the sustainability of online communities are vital issues to online community developers [5, 16]. This is evident because documents reporting on the development or the design of popular social networks are yet to be published [29].

With thousands of social networks springing up it is crucial to establish a guideline for ensuring the sustainability of online communities [5]. The present study therefore aids organisations in their policy making through positive engagement of users involving online communities. To guarantee post-continuance participation of users, organisations must look to the constructs specified in the model to satisfy online communities' continuance usage. This is because users are concerned about the value and benefits they perceive from within the online community and these values indicate their willingness to continue participating in online communities. It is vital for web development companies to be aware of the components required for ensuring the sustainability of online communities. This is evident as consumers are more inclined to perform transactions online especially considering the current pandemic, such as the Covid-19. The authors believe that the OC²T will act as a significant checklist tool for studying the status of the developed online community site.

6.1 Theoretical Implications

In terms of theory building, this study aims to develop a new theory through the integration of a social psychology theory, mainly social support constructs, by extending the standard Theory of Planned Behaviour to study the constructs that influence continuance participation in online communities. To be specific, this study addresses the post-adoptive intentions and behaviour of online communities mediated by the Web 2.0 technologies. Online communities hosted by the Web 2.0 platform, such as the Facebook, LinkedIn and TripAdvisor, though are swiftly expanding, yet still lack theory-driven empirical research in information systems domain investigating the post-adoption issues from a behavioural and social perspective.

This study is significant as the decision to continue or discontinue participating in online community is heavily dependent on the post continuance intention and behaviour of the users. This study, through its hypothesized model also known as CPM, combines the TPB and social support theory through its two dominant constructs; informational construct and emotional construct and adds the perceived value and satisfaction constructs. The results show that nine out of then tested hypotheses are supported and thus mean that the model makes a significant contribution to the online community literature as a theory model. The addition of the social support constructs contributes by improving the standard Theory of Planned Behaviour constructs in driving continuance participation in online communities.

6.2 Practical Implications

From a practical perspective, to sustain a successful online community, the present study aids by assisting organisations in their policy making through positive engagement of users involving online communities. To guarantee post-continuance participation of users, organisations must look to the constructs specified in the model to satisfy online communities' continuance usage. This is because users are concerned about the value and benefits they perceive from within the online community and these values indicate their willingness to continue participating in online communities.

7 Limitation and Future Work

Although the findings provide significant insights, a number of limitations should be acknowledged. The OC²T was developed based on the findings from experts involved in web development but not necessarily related to the development of online communities. Future research should involve testing of the OC²T with respondents that have vast experience in developing online community platforms such as Facebook, Twitter, Instagram and other online community sites. Additionally, prior to the development of the OC²T, requirements gathering was skewed towards popular social networking sites and only involved respondents who were based in Malaysia. Finally, this study model should further be tested with other behavioural constructs that can potentially influence the continuance participation of online communities.

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Knowledge Management in Startups and SMEs: A Systematic Review



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Abstract Even though startups have limited human and financial resources, they can utilize these resources for success and overcome the obstacles against knowledge management (KM) usage. This paper conducts a systematic literature review of KM in startups and small and medium enterprises (SMEs). This systematic review answers three research questions including the critical success factors and barriers affecting the usage of KM in startups/SMEs, the various KM tools/practices/systems adopted for usage by startups/SMEs and how the performance of startups/SMEs are affected by the use of KM. We aims to provide a thorough analysis of 28 research papers (out of 2123) published in reputable journals and conference proceedings throughout the past 10 years, from 2010 to 2020. The impact of KM usage on the performance of startups/SMEs demonstrated across all collected studies included looking at different domains such as market, organizational, economic, technological, financial and human performance. The review investigates the different KM techniques and technologies gathered from the reviewed literature and recommends the most suitable KM solutions. The paper also accentuates how the use of KM approaches plays a vital role in contributing to the overall growth of startups/SMEs, while also enhancing their efficiency, performance and scalability.

Keywords Knowledge management in startups · Small and medium enterprises · Market, organizational, economic, technological, financial and human performance

1 Introduction

A startup is a newly formed company or enterprise attempting to close a gap in the existing market and solve a problem where the solution is not clear. They usually have limited resources so they might need support from other organizations in order

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to get off the ground, start growing their business and solidify their position in the market [1]. It is also hard to pinpoint the moment when a startup is no longer one or if a company is considered as a startup or not. Some people [2] claim that this is the case when the company reaches some specific size of employees, go public or starts making profits. Others [3] claim that this happens when a startup finally has a live sellable product, a solid plan to gain profits, a reproducible business model with a decent growth rate. Startups are in constant search of the perfect business model that suits their operations, and there is much uncertainty and turbulence in their operating environment [4]. That is why they need to utilize their limited resources to the maximum. A vast portion of these resources are individuals such as employees and managers who try to use the other tools to maximize the chances of the company's success [5]. One of the methods to achieve this is by applying knowledge management [6]. It has been shown [7] that knowledge management has a significant influence on how the organizational structure [8, 9], culture and vision of the company diffuse through the organization. Knowledge management practices [10] can drastically improve the chances of a startup to survive and uplift the business performance, especially since a considerable number of startups fail. Startups can utilize KM to advance important innovations across environmental, business, financial, and social domains. Moreover, KM allows for sharing knowledge between stakeholders and customers which helps startups to accomplish sustainable environmental, social and business goals [11].

This paper assesses the usage of knowledge management in startups/SMEs by carrying out a thorough, detailed analysis of the obtained research articles. The research questions addressed in this systematic review paper are:

- 1) What are the factors and barriers that impact the usage of knowledge management in startups/SMEs?
- 2) What are the KM tools/practices/systems implemented in startups/SMEs?
- 3) How is the performance of startups/SMEs influenced by the use of knowledge management?

The remainder of the review is split as follows: Sect. 2 containing a literature review, research methodology discussed in Sect. 3. A statistical descriptive initial analysis of the reviewed articles is portrayed in Sect. 4. Section 5 demonstrates the findings and results achieved from the in-depth analysis of the articles reviewed. Finally, the review is concluded in Sect. 6.

2 Literature Review

2.1 Startups

Startups are newly established business organizations aiming to fulfill a need or gap in the marketplace. It is hard to determine when a startup is no longer one as there

is no specific measure to classify a company as a startup. The lifespan of a startup or a small enterprise can be split into three phases: existence, survival and success [12]. The first phase is *existence*, where the main target of the company is to obtain customers and deliver their product or service. While limited resources and capital at this point, the fundamental objective is to secure enough interested customers to provide the product/service well enough to potentially expand that pilot launch to a greater sales base [13]. There is very minimal to nonexistent formal planning as the owner is the one who performs all the essential tasks directing the ship, so he should be competent. Many startups run out of funds before becoming viable businesses. The companies that manage to go through this phase successfully move to the next stage; *survival*.

In the survival phase, the company has now been proven to be a viable business having enough customers while providing a product or service to keep these customers satisfied. The focus in this stage is to generate enough profits to stay in business and grow the business financially [11]. There is a minimal amount of planning, mainly in the form of forecasting cash flow. During this phase, the company could grow enough to move to the next stage, or it could remain surviving for some time then go out of business if the owner retires or slows down the pace.

The third and last phase is *success*. Now, the employees increase and the owner is no longer doing most of the most as the company starts creating specialized departments. The main decision at this point is to decide whether to keep the company stable making profits or to advance and expand the activities [12]. The company is now growing and transforming into a permanent organization.

2.2 Knowledge Management in Organizations

Knowledge management can be defined as the systematic management of the knowledge resources of an organization in order to create value that meets the strategic requirements [14–17]. It entails the processes used, strategies employed, storage systems, sustainability measures, sharing, assessment, creation and refinement of knowledge [18]. Therefore, knowledge management has a strong link to the goals of an organization as it aims to create and enhance the organization's value [19]. Knowledge management in this context includes the different forms of knowledge, generating relevant knowledge, providing appropriate knowledge to individuals who need them, storing in accessible manner, constantly refining knowledge obtained, and managing all the mentioned points to improve the overall organization's performance.

Implementation of KM in an organization has some key knowledge processes (Oe and Mitsuhashi 2013) including:

- Knowledge identification includes identifying forms of external knowledge in order to describe and analyze the knowledge environment of the company.
- Knowledge acquisition entails determining the forms of competency that should be acquired by the company through relationships with suppliers, customers or

even competitors. There is also a focus on generating and advocating new products or services, new skills and more efficiency in total operations.

- Knowledge distribution and sharing involve spreading the already existing knowledge throughout the organization for everyone to use and benefit from.

It has been shown that business process management should be integrated with knowledge management in organizations since it has a positive effect on the overall performance and success. Since the main idea of a startup is to execute the customer's requests, KM is essential to facilitate this process and give the best advantage to the customers [13]. Also, knowledge does not conform to specific business limits or borders so knowledge processes aid with modeling business processes. That is why business processes are integral to KM as it reaches its best levels of efficiency when following a structured model. Moreover, measuring the knowledge contributes a lot to the success of KM by providing a base central pivot for factors or barriers affecting the overall process [7]. All in all, knowledge management follows an exhaustive approach where every single part of the business process modeling has to be considered as they affect the overall success [20].

Multiple research papers portray some factors that affect the usage of KM practice in startups/SMEs either positively or negatively [4]. They are mostly surrounding the specific nature of knowledge in startups as they are primarily human impacted and having financial resources. There are also several tools available for startups to integrate KM usage into their business considering their limited funds such as low cost knowledge management systems (KMS), easy to use interfaces that don't require advanced skills and interfaces to advance socialization within teams and groups.

The articles collected for this systematic review will be discussed in detail in the upcoming sections. The review aims to discuss the factors and barriers affecting KM usage in startups. It also portrays how KM usage helps in several domains such as financial, economic, organizational, and market areas and the significant effect that has on the startup's performance.

2.3 Technology Acceptance Models

The technology acceptance model (TAM) is employed to attempt predicting how the users accept the new technology introduced. Since knowledge management systems (KMS) in startups/SMEs use several technologies, applying technology acceptance models within the organization is beneficial. TAM has two fundamental determinants which are the perceived ease of use and perceived usefulness, that need to be considered when adopting the different technologies in KMS [21].

In organizations such as startups/SMEs, TAM is usually combined with other theoretical models generating hybrid acceptance models. For instance, there is the Task-Technology Fit Model (TTF), which is concerned with measuring the ability of the technology to support the tasks performed in the organization. The four main pillars of TTF are technology characteristics, task characteristics, task-technology

fit, and performance. TTF and TAM combinations are commonly used in ecommerce applications [22].

3 Research Methodology

An extensive literature review is the first step to be done when doing any study or research. It acts as the basis for gathering the needed information and related knowledge about the topic of interest. This allows the researcher to improve the previous research funding based on new evidence acquired, advance concepts, identify research gaps and determine future research aspects. A systematic review is a review that aims to perform comprehensive identification, appraisal and synthesis of studies or research articles that are relevant to a specific topic [23–30] provide guidelines on performing a systematic literature review which were followed generally with some changes to develop this report. In this systematic review, there are several stages including determining inclusion and exclusion criteria for filtering the gathered papers, detailed thorough search for papers related to the research questions, evaluating the quality of the papers found and performing an exhaustive analysis to answer all research questions. Details regarding all these stages will all be demonstrated in the upcoming sections.

3.1 *Inclusion/Exclusion Criteria*

The articles and research papers that will be analyzed in this review meet the inclusion and exclusion criteria shown in Table 1.

Table 1 Inclusion and exclusion criteria

Criteria Inclusion	Criteria exclusion
Should involve knowledge management in startups	Papers with focus on knowledge without with insignificant reference to startups/SMEs
Should involve knowledge management in SMEs	Papers focusing on startups/SMEs without mention of knowledge management
Only journal articles	Dissertations, textbooks, unpublished papers and non-English
Should be written in English	Papers with focus on knowledge without with insignificant reference to startups/SMEs

3.2 Data Sources and Search Strategies

The articles analyzed in this systematic review were gathered through a detailed search of research papers from the databases: IEEE, Springer, ACM Digital Library and ScienceDirect. The search took place in April/May 2020 spanning the last ten years (2010-2020). The search keywords included “knowledge management”, “KM”, “knowledge creation”, “knowledge acquisition”, “knowledge storage”, “knowledge adoption”, “knowledge exchange”, “knowledge transfer”, “knowledge sharing” or “knowledge reuse”, combined with “startup*”, “start-up*”, “SME*”, “small firm*” or “small business *”. The search using the mentioned keywords retrieved 2123 results. There were 278 duplicate articles, which were removed using Mendeley Software, leaving a remainder of 1845 articles. The next step involves going over the title and abstracts of the articles for initial screening, which resulted in excluding 927 articles that weren’t focusing on knowledge management in startups/SMEs. Further screening was done on the remaining 918 articles by using the inclusion/exclusion criteria shown in Table 1, which resulted in the exclusion of 890 articles. At the end, there were 28 articles that met the inclusion/exclusion criteria to be included in the upcoming analysis. The search process with the intermediate screening steps followed the guidelines of the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) [31]. The PRISMA chart explaining this procedure is demonstrated in Fig. 1.

3.3 Quality Assessment

Evaluating the criteria used in the inclusion and exclusion is an important step. That is why an evaluation checklist with 5 criteria was created and used to appraise the selected articles’ quality. In this case, the 28 articles that successfully passed all the filtering steps are the input to this assessment. [32] demonstrated a quality assessment that inspired the evaluation checklist used here.

Each question in the checklist was given a score out of three: Zero points is equivalent to the criterion not being met in the article, half a point is equivalent to the criterion being partly covered by the article, and one point is equivalent to the criterion being fully covered by the article. After calculating the criteria for all the articles, their sum is calculated which represents the overall estimate of the degree of the article’s relevance. Therefore, the total score an article gets is in between zero and five, where five means very relevant and zero means irrelevant. The higher the score is, the higher the degree that the article in question is relevant to the research conducted. Five evaluation criteria were employed to evaluate the papers:

1. Mention of knowledge management techniques
2. Explaining startups/SMEs
3. Clear demonstration of applying knowledge management in startups/SMEs
4. Providing evidence/studies/models of KM in startups

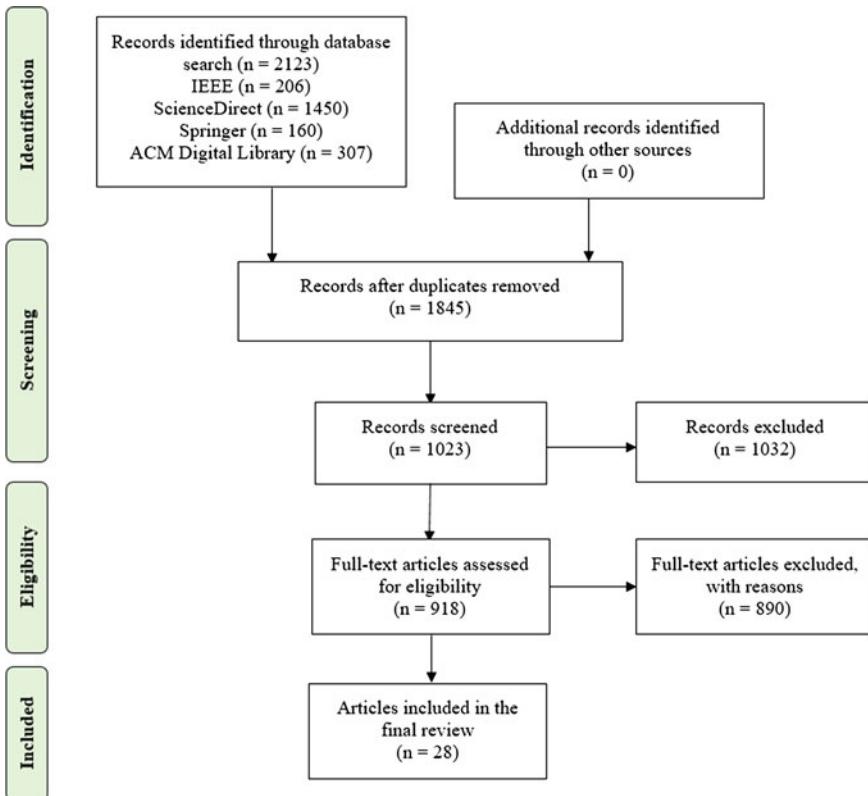


Fig. 1 PRISMA flowchart for the selected articles

5. Ideas introduced are cohesive and comprehensive?

The results of this quality assessment for the 28 articles are demonstrated in Table 2. It can be seen that all articles obtained high scores, thus confirming their relevance to the research topic and successfully passing the assessment. Therefore, all 28 research articles are eligible to be used in the rest of the exploration and analysis in the review.

3.4 Data Coding and Analysis

The analysis process counts on the quality of the coded features including (a) knowledge management components, (b) startups, (c) SMEs and (d) KM in SMEs. Through the analysis phase of the articles, any papers not clearly describing the usage of knowledge management in startups/SMEs were disregarded from the review. All obtained research papers were analyzed manually.

Table 2 Quality assessment results

Resource	C1	C2	C3	C4	C5	Relevance Factor	Percentage (%)
S1	1	1	1	1	1	5	100
S2	1	0.5	0.5	1	0.5	3.5	70
S3	1	1	1	0	1	4	80
S4	0.5	1	1	1	1	4.5	90
S5	1	1	0	1	1	4	80
S6	1	0.5	1	0.5	1	4	80
S7	1	1	1	1	0.5	4.5	90
S8	0	1	1	0.5	1	3.5	70
S9	1	1	0.5	1	1	4.5	90
S10	1	1	1	0	0.5	3.5	70
S11	1	0	1	0.5	1	3.5	70
S12	1	1	0.5	1	0.5	4	80
S13	1	1	1	1	0	4	80
S14	1	0	1	1	1	4	80
S15	1	1	0.5	1	0	3.5	70
S16	1	1	1	0.5	1	4.5	90
S17	0	1	1	1	1	4	80
S18	1	1	1	1	1	5	100
S19	1	1	1	1	0.5	4.5	90
S20	1	0.5	1	1	1	4.5	90
S21	0.5	1	1	1	0.5	4	80
S22	1	1	0	0.5	1	3.5	70
S23	1	1	1	1	1	5	100
S24	1	1	1	0.5	0	3.5	70
S25	1	0.5	1	1	1	4.5	90
S26	0	1	0.5	1	1	3.5	70
S27	1	1	1	1	0.5	4.5	90
S28	1	0.5	1	0.5	1	4	80

4 Results

This section aims to demonstrate an initial analysis describing the features of the selected 28 articles that are dealing with the topic of knowledge management in startups/SMEs. For this, four viewpoints were identified:

1. Papers over time
2. Papers by methodology
3. Papers by journal subject area

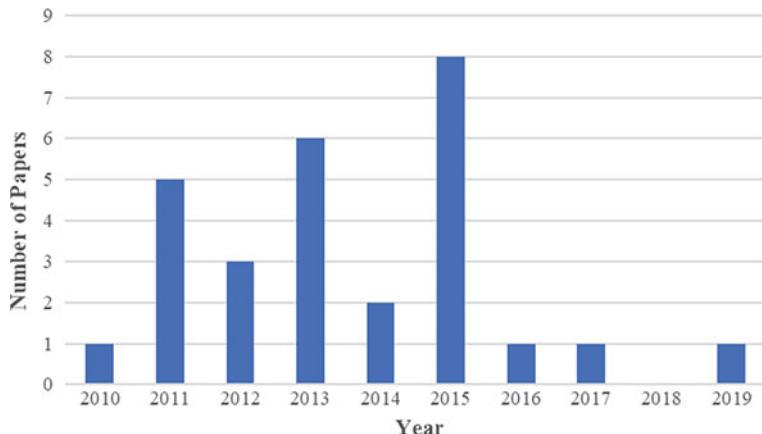


Fig. 2 Papers' distribution over time

4. Papers by topic area

4.1 *Papers Over Time*

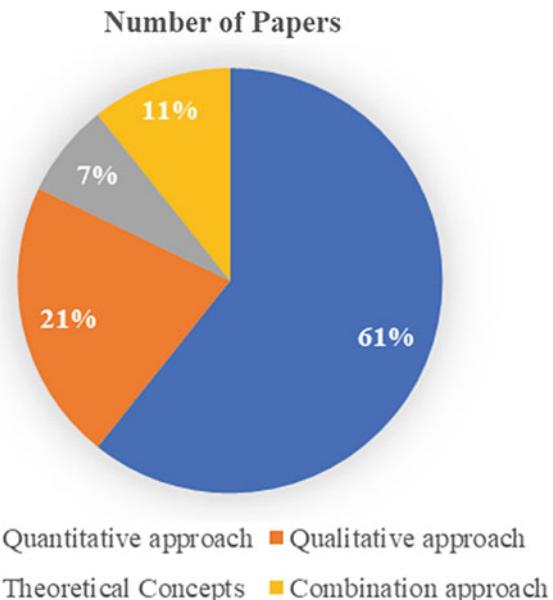
Figure 2 shows how the 28 articles are distributed over time. A significant amount of articles in 2015 with a total of 9 articles. This is closely followed by 6 papers in 2013 and 5 papers in 2011. The other 8 papers were found in the remaining years (2010, 2012, 2014, 2016, 2017, and 2019).

4.2 *Papers by Methodology*

Figure 3 demonstrates the methodology utilized in the research articles, the majority (17 papers) used quantitative approaches while less articles used either qualitative techniques (6 papers), theoretical concepts (2 papers) or a combination of these approaches (3 papers). The seventeen articles using quantitative approaches include 2 mathematical models and 15 surveys. The various methods of collecting information in the surveys included 2 through phone calls, 10 through interviews, 3 through online forms and 2 through emails. This shows that interviews are the preferable method for gathering information as the face to face factor facilitates the information gathering process in comparison to the other modes.

The six articles using qualitative approaches include 4 empirical studies and 2 literature reviews. Whereas two papers discussed theoretical conceptual information and the remaining three papers included a combination of both the quantitative and qualitative approaches.

Fig. 3 Papers' distribution by methodology



4.3 *Papers by Journal Subject Area*

The 28 articles were grouped and distributed among five journal subject areas showing the subject area under which each article was found from its corresponding journal. The grouping as shown in Fig. 4 followed: 7 papers in Engineering, 10 papers

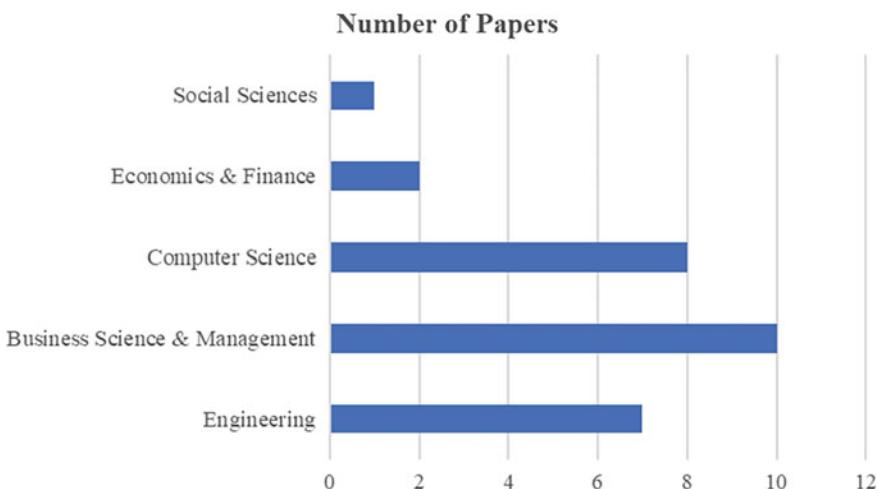


Fig. 4 Papers' distribution over journal subject area

in Business Science and Management, 8 papers in Computer Science, 2 papers in Economics and Finance and 1 paper in Social Sciences. This shows that knowledge management in startups/SMEs spans over a mix of methodologies and approaches from various research subject areas.

4.4 *Papers by Topic Area*

In this section, the selected articles were further investigated and categorized into three main topic areas as shown in Table 3. The three topic areas are:

- 1) Factors and barriers affecting knowledge management adoption in startups/SMEs (8 articles amounting to 29%)
- 2) KM tools/practices/systems adopted by startups/SMEs (11 articles amounting to 39%)
- 3) Impact of use of KM in startups/SMEs performance (9 articles amounting to 32%)

Figure 5 shows a pie chart further illustrates the distribution of papers by topic area.

5 Discussion

5.1 *RQ 1*

What are the factors and barriers that impact the usage of knowledge management in startups/SMEs?

Several surveys [33, 39] were carried out to study how a person's skills, education and his social relationships can affect their capability to establish a startup. These elements are crucial factors that can strongly influence a person's decision to become a startup owner. The results confirmed this hypothesis by showing that the probability of a person being involved with a startup is directly proportional to that person's level of knowledge and how much they were exposed to external sources of knowledge. This concept was further shown in another paper [38] that discussed the fundamental building pillars of creating and growing a high tech startup including the product/service initial idea, technical expertise from the owner, resources (funds, partners, tools, etc....), social relationships between other the owners and other people in their professional networks and a possible target customer base. From these studies, we can say that the first step in the direction of establishing a startup is opportunity recognition, where the core business ideas of the startup are recognized with initial knowledge.

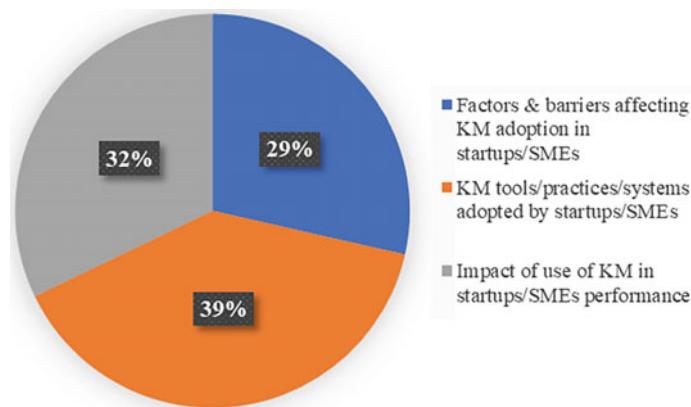
Table 3 Papers by topic area and relevance

Topic area	Article	Relevance
Factors and barriers affecting knowledge management adoption in startups/SMEs	[33]	Human and cultural factors
	[34]	Economic and geographical factors
	[35]	Human and cultural factors
	[36]	Human, cultural and managerial factors
	[37]	Managerial, organizational and human factors
	[38]	Human, managerial, organizational and economic factors
	[39]	Human, cultural and managerial factors
	[40]	Managerial, technological and organizational factors
KM tools/practices/systems adopted by startups/SMEs	[41]	Intranets, learning management systems and databases
	[42]	System design cycles, databases and teams
	[43]	Databases, teams and collaborative technology
	[44]	Social networks
	[45]	Mapping techniques and collaborative technology
	[46]	Customer relationship management system
	[47]	Databases, UI prototypes, UML diagrams (class, use case, etc....)
	[48]	Collaborative technology and system portals
	[49]	Databases, knowledge infrastructures and data warehouse
	[50]	System portal, databases and mobile application
	[51]	Teams, social networks and project management techniques
	[52]	Economic, financial, human and organizational performance
Impact of use of KM in startups/SMEs performance	[53]	Economic, financial, market, technical, human and organizational performance
	[54]	Economic and financial performance
	[55]	Economic, financial, market, technical, human and organizational performance
	[56]	Economic and financial performance

(continued)

Table 3 (continued)

Topic area	Article	Relevance
	[57]	Economic, financial, market, technical, human and organizational performance
	[58]	Human, economic and financial performance
	[59]	Economic, financial, market and technical performance
	[4]	Economic and financial performance

**Fig. 5** Papers' distribution by topic area

Proximity was found to have an effect on how knowledge is acquired in startups [36]. Relationships between different employees or members of a startup usually involve trust based on kinship and friendship. This allows for more interactive learning leading to more innovative results with improved performance. Having this sense of social proximity with real social bonds between people enable much more effective learning and knowledge sharing compared to pure business relationships that easily shatter at the sight of the first problem.

Amidst the several papers studying knowledge use in startups/SMEs, there is an acknowledgement that knowledge is obtained from the tacit and explicit learning experiences of involved people. A dominating example was decision making as it was shown to depend almost entirely on the already existing knowledge and skills of the startups' owners [5]. These papers show how startups/SMEs profit from the owners and managers understanding the essential knowledge sources that can be obtained from outside their own knowledge and experience, further emphasizing the importance of social interaction and communications to look for that external knowledge [35]. The owner of the company is still very much integral to the knowledge management process as his view serves as a guiding beacon to explain the routines employed for organizational knowledge in the context of their business.

Some patterns influencing the decision making in a startup [35] include misidentifying the problem at hand, owners/founders not trusting themselves enough to lead the team, no clear purpose identified, mismanagement of the limited human and financial resources available, depending too much on one's previous experiences without proper utilization in the context of the current business, owners' failure to properly communicate decisions to the team or lack of risk management planning.

Looking at what forms a knowledge base for a startup/SME, it is mainly the employees. Owners are very much aware of the fact that they need competent human resources to nurture and retain their knowledge base as the startup's future would not be very long without these people [40]. Moreover, integrating different resources like human and technological and apply them to commercial ends is a major decider of the startup's absorptive capacity. The social capital [33] from either the employees or the knowledge acquired through their relationships and contacts allows startups to have access to much more information that matches their targets and aims, have higher potential to transform knowledge, profit from various swift forms of knowledge transfer and become more exposed to a wide array of perspectives potentially increasing the customer base in the targeted market [36]. So, it can be said that the strength of the relationships between the employees and teams in a startup has such a crucial role in constructing knowledge and paving the road for innovation.

Developing a business plan for the startup doesn't guarantee success, but a careful planning process has a crucial impact on whether the startup succeeds or fails [10]. Unfortunately, many people hurry this process to start developing the products/services right away and think about funding. This causes several issues in the future of the company which could have been avoided by proper planning. Typical mistakes in this stage [37] include unrealistic sales forecasts, overspending, under-spending, forcing ideas with not enough research to back them up, lack of risk analysis, or even scaling too quickly without seeing tangible progress.

In summary, factors influencing the use of knowledge management in startups/SMEs can be divided in these categories:

- Organizational/Managerial factors such as owners' decision making skills and how they communicate with the team members.
- Human and cultural factors such as people's skills, expertise and education.
- Geographical factors such as the proximity between people in the same industry such as customers and partners.
- Relational factors including knowledge sharing between employees, gathering external forms of knowledge and integrating them with already existing internal knowledge, and trust between team members.
- Technical/Technological factors such as the technical skills and expertise of the owners founding the startup serving as base infrastructure.
- Strategic factors such as business plan development, market research and revenue/profit forecasts.

5.2 RQ 2

What are the KM tools/practices/systems implemented in startups/SMEs?

A knowledge management system (KMS) is an information system employed to endorse startups and SMEs in the processes of knowledge creation, storage, sharing, retaining or application. In a survey conducted on a group of over ninety Chinese startup companies [44], the usage of social networks had a positive effect on the knowledge transfer process. The relationship between the company's size and the formality of the KM practices employed was investigated in from a study [47] on over twenty startups in several industrial domains. This showed how KM practices used in startup companies are mostly informal and not following any standards as they are just a collective effort of the collaborating employees. So, this shows how the size of a startup can influence how formal or informal the KM process is while understanding the level of integration between organizational and personal knowledge. [41] demonstrated the importance of the choice of a KMS in startups/SMEs allows the growth of the company through a study in Jakarta. Different forms of implementation of KMS included enlisting help from vendors and suppliers to enhance the business opportunities, and collaboration with enterprises using similar forms of KMS. Portals, forums and content management systems were also used as KMS [45] to allow for utilizing the technological assets to close the technical gaps and contributing to more seamless sharing of information and increased collaboration between team members. Another survey [51] on a sample of over fifty Swedish and Danish startup companies investigated the usage of technological tools to support the KM process such as intranets allowing employees to access more information and enhance their skills and education, collaborative management systems, and online databases for knowledge sharing, storage and transfer. Documents, active documentation systems, systematic planning with UML diagrams, data warehouses, central servers and embedded systems, prototyping [43, 46] were also found to support startups in employing their KM strategies.

In summary, the papers demonstrated an array of knowledge management systems and tools used in startups/SMEs. This shows that startups have an understanding of the importance of KM and strive to incorporate IT tools to support their techniques and further improve their business organizational process for creating, storing, sharing, retaining and applying knowledge. Figure 6 shows the most commonly used KMSs by startups/SMEs with their corresponding usage percentages amongst the surveys and studies reviewed.

5.3 RQ 3

How is the performance of startups/SMEs influenced by the use of knowledge management?

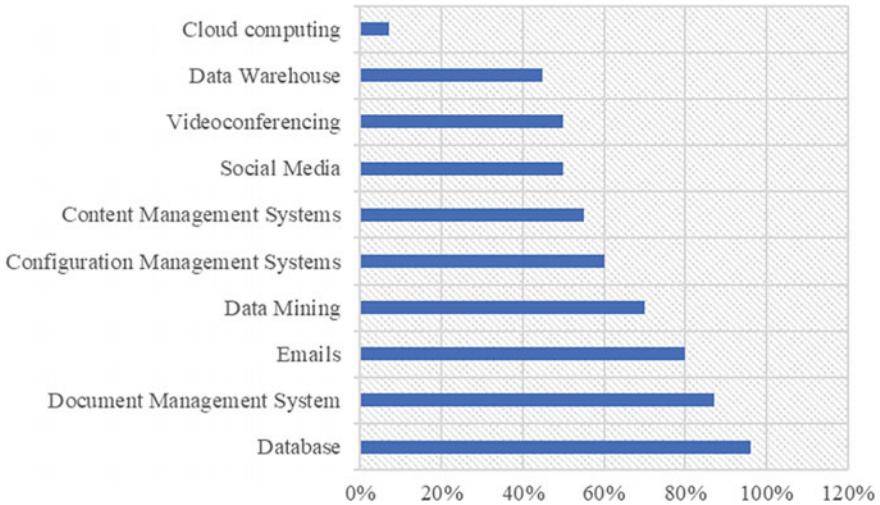


Fig. 6 KMSs used in startups/SMEs

Several papers investigate how the implementation of KM affects the performance of startups/SMEs in different areas such as market, financial, economic, technical, organizational and human performance. Carefully planned business models inspiring a functional knowledge management system [54] improves the performance of the startup significantly. Further studies on startups in rural regions in Europe [58] highlighted that startups that are not employing KM practices suffer from low performance and their growth is negatively impacted. Another survey involving almost 400 American startups [4] showed again that the owners' knowledge combined with the sharing of gained skills and expertise between the players in the same industry field has a major positive impact on the company's performance. A survey in a group of Taiwanese startup companies conducted by [52] demonstrated that the employment of KM has influenced the productivity of employees and enhanced the quality of services provided, thus leading to improved customer satisfaction and boosting the overall performance of the company. [53, 57, 60] also stress out that KM improves all the difference performance domains including financial, technical, market, human and organizational.

The findings from these articles confirm that adoption and usage of KM methodologies in a startup promote system and service quality. Moreover, the products' quality is positively correlated to customer satisfaction and the profits achieved. The advantages of adopting KM in a startup to grow and reach success have been highlighted and clearly proved that they lead to more successful scalable organizations. Figure 7 represents the impact of adopting KM practices in startups and SMEs by the level of importance on the different performance domains.

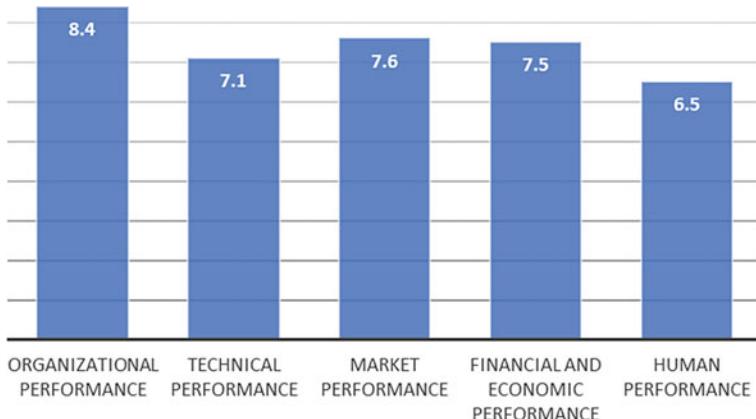


Fig. 7 Effect of KM usage on startup performance—importance level

6 Conclusion and Future Work

This paper presented a systematic review on knowledge management in startups and SMEs. This review tackles all the research questions through the analysis of the 28 articles investigated. The findings showed that the main factors impacting the adoption of KM in startups/SMEs include organizational, human, geographical, cultural, relational, technological and managerial factors. The results also showed the recommended knowledge management systems, tools and practices employed by startups including emails, forums, mobile applications, portals, management systems, social networks, intranets, data warehouse, databases, and data mining. As for practices, they include extensive documentation using UML diagrams, system design techniques, collaborative projects, effective team division, prototyping systems' interfaces, and other mapping practices for the knowledge involved. All these tools and practices support the startups in their different stages of creating, storing, transferring, sharing, retaining and applying knowledge in their business.

The research also demonstrated how KM has a very positive influence on the overall performance of startups/SMEs in many domains including financial, market, economic, technological, organizational, relational, human, and technical domains. All of these findings show that startups can subdue their limited funds and resources and make the best use of KM through multiple KM tools that are low cost and don't require a lot of experience, thus overcoming the financial and human barriers. Furthermore, KM implementation in a startup influences the performance of all these mentioned performance domains and boosts its growth allowing for future successful scalability. This allows startups and SMEs to experience new benefits and grow more efficiently with the guidance of KM.

As a limitation, the search process for papers used in this review were obtained from IEEE, Springer, ACM Digital Library and ScienceDirect. Therefore, there might be some other relevant articles from other sources that were not included. Future work

might involve including more repositories for gathering more articles. In addition, we might consider finding more articles with specified focus on startups or SMEs separately, combined with attempts to reach a clear differentiation in the employment of KMS in each organizational structure. A further analysis between the variety of KM implementations in different industry domains in both startups and SMEs may also be performed.

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Transforming the Environment of Education by Internet of Things: A Review



Sushobhan Majumdar and Manami Mandal

Abstract The application of IoT in the field of social science has changed the process of learning in recent decades. Nowadays technology has played an important role in the educational sector. Introduction of this technology in the educational sector can be categorized as a cultural paradigm. The objective of this study is to explore the roles of IoT in the educational sector. Side by side emphasis has also been given about the problems faced by the educational institutions in Kolkata for using this technology. For the analysis, in-depth interviews and observation methods have been followed. This study reveals that application of this technology is higher in the nongovernmental institutes than the governmental institute. This study also reveals several problems that have been faced by institutions in Kolkata i.e. lacks of funds, inadequacy of infrastructure, high ratio of students and teachers, improper uses of resources etc. This study has been done in Kolkata and can also be done in the other metro cities also. The methodology used for this study of IoT can also be applied in the other studies also e.g. ICT in education, uses of EDUSAT in education also.

Keywords Internet of things · Technology · Infrastructural development · Student teacher ratio

1 Introduction

Application of internet and associated technologies for learning can be categorized as Internet of Things (IoT). It is a relatively new concept which has flourished a few decades ago. The uses of this technology not only limited into the educational sciences but also in the area of social sciences. This technology has played a vital role in teaching and also in learning. The application of this technology has totally changed

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the traditional culture of learning and teaching [1]. There are two positive impacts of education. Firstly, it has introduced lots of infrastructural changes in the field of education and secondly it has linked educational sciences with the computer sciences [2]. IoT has played a vital role for teaching and learning at school level, college level, university level and so on, as both student and teacher has been benefited with this technology. The application of IoT is not only limited to the educational sciences but also in the field of architecture, computational intelligence, data mining etc. [3–5]. The term IoT was first introduced by Kevin Ashton in 1999. Various researchers have already attempted to find out the role of IoT in educational science [6]. Major key features in case of this technology is its privacy and security details because of its proper management and performance [7], but it also has lots of challenges [8–11].

Different models like Technology Acceptance Models (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT), Theory of Planned Behavior Model (TPB) were introduced by the various researchers in IoT and each model has certain advantages and also some limitations. The TAM model has been mainly used to assess the impact of certain variables whereas other two models have been mainly used for the IoT services [12].

The objective of this study is to explore the roles of IoT in the educational sector. Side by side emphasis has also been given about the problems faced by the educational institutions in Kolkata for using this technology.

Kolkata city is one of the major metropolitan cities in India which has been chosen as a study area. It is one of the largest cities in the world and it ranks third among the metro cities in India in terms of population and area. According to the latest census from the Government of India, the total population of Kolkata city is 4.5 million. Kolkata city is under the jurisdiction of Kolkata Municipal Corporation and Kolkata Metropolitan Development Authority (KMDA).

Kolkata city was the Capital of India till 1912. After 1912, it was shifted to New Delhi. Most of the growth and development (in terms of business, education, administration, culture etc.) of Kolkata city is mainly because of the colonizers who used this city for their business purposes.

From that period this city is one of the largest educational hubs of India because of huge infrastructural development in the educational sector e.g. school, college, university, technical colleges, research institute etc. It is also the cultural hub of West Bengal because of the presence of various religious communities and their cultural programs, festivals. Kolkata city is also the administrative headquarter in the eastern parts of India (e.g. defense, agencies etc.). This city also has good port facilities which help this city to be connected with the world. The port of Kolkata city is well developed because of its large hinterland which covers nearly 5000 km² area. Kolkata city is now the Capital of West Bengal. This city has also been experienced with the other infrastructural faculties (e.g. hospitality facilities, good transport and communication facility etc.).

2 Data and Methods

For the purposes of study both primary data and secondary data has been used. For the purposes of analysis, various techniques have been used.

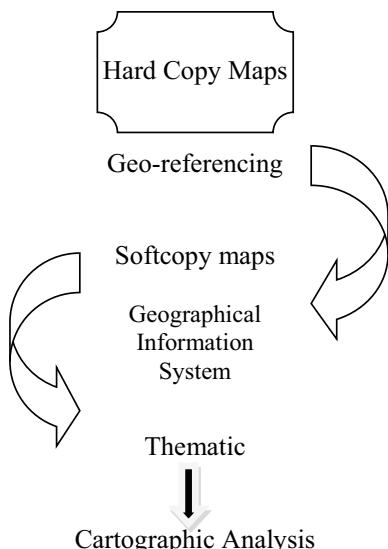
2.1 Data

For the purposes of study information has been collected from different sources like journals, periodicals, edited volumes etc. Secondary data has been collected from various sources (like National Library, Kolkata Municipal Corporation office, Indian Statistical Institute, research institutes etc.). Map of Kolkata Municipal Corporation has been collected from the Kolkata Municipal Corporation Office.

2.2 Methods

Data collected from the various sources have been transferred into excel file to convert it into softcopy. Maps collected from the various sources have been geo-referenced with the hardcopy topographic maps for the geo-referencing of the image. Therefore it has been put in the map for the purposes of analysis. For the analysis, in-depth interviews and observation methods have been followed (Fig. 1).

Fig. 1 Methodological framework for study



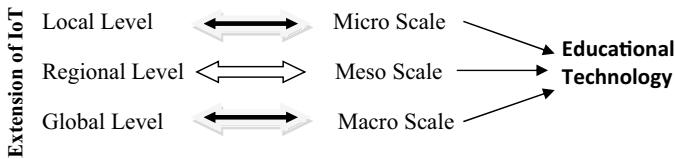


Fig. 2 Areal extent of IoT in education system

2.3 Techniques

For the purpose of analysis, various statistical parameters have been used. For the visual purposes and analysis some cartographic techniques have been used.

3 Results and Analysis

3.1 Role of Internet of Things in Education

Internet of things is a system which consists of various objects like electronic gadgets, software's, sensors, remote control devices etc. It also helps to meet the demand of the users without any age limits. It also helps to learn various types of learners. It also helps to exchange the ideas between the listeners and instructors.

By using this technology every device has been connected with the hub through the server or IP addresses. Through this technology all the devices have been connected from the local level to global level.

Figure 2 shows areal extent of IoT in the education system.

The applications of IoT in the field of educational sciences have been increased in recent decades mainly because of the internet facility. IoT technology helps to connect all the learners of remote places through networking system. The role of IoT in the educational sector can be explained in the following ways.

3.2 Smart Education System and IoT Technology

IoT has been played a vital role for constructing network through the internet based technology system (IBTA). The spheres of educational sciences have been totally changed because of the application of this technology in the subject of education. The domain of the educational sciences has been transformed into multidisciplinary from the interdisciplinary domain because of this technological development.

3.3 Smart Education and IoT

Uses of this technology in the educational sciences have been introduced a few decades ago. Recently the application of this technology has been increased day by day because of its multidisciplinary nature. Now educational sciences are connected with various disciplines like computer science, geography, economics etc.

3.4 Smart Classroom and IoT

In the smart classroom system the application of this technology is higher than the old classroom system. In the modern smart classroom system the applications of computer, camera and recorder is higher than the older one. This technology is also helpful for the learners for easy learning. By using this technology every student can be connected with the hub. Authority can store, analyze the data of the student for their future growth and development.

3.5 Smart Laboratory and IoT

In this smart laboratory system, students can easily perform the practical applications of theoretical knowledge. It also helps them to collaborate with the other field and also helps to remove their drawbacks.

It also helps the student to design a smart box and good interaction with the other learners. By using this technology students can get two opportunities like the facility of the internet system and practical application of theoretical knowledge.

3.6 Increased Learner's Pace

This technology also enhances the pace of learning among the learners. It is also fruitful for the better understanding of the contents. Because of its various applications (e.g. easy interactive sessions with the other learners and teachers), it increases the speed of learning. Another advantage of using this technology is it is helpful for learners of all ages because of the collaborative nature.

3.7 Increased Learning Efficiency

IoT can enhance the learner's efficiency by enhancing the quality and intellectuality of the learner's. By these technologies the concerned authority can easily store, process and analyze the data of each of the active learner's. Through this technology, all the devices can be connected with the various sub systems which are relatively faster than the older methods which help to increase the efficiency of the learners.

3.8 Reduced Redundant Cost

IoT can also be used for the reduction of costs for the study. It also helps to reduce the costs of expenditure of the authority. By using this technology the authority can easily reduce the hidden and unnecessary costs.

3.9 Hotspot Connection Using IoT

Hotspot connections are one of the new technological innovations has been developed mainly because of the advancement of the new technologies. Through the networking system every learner can be connected with the devices and computers under the same domain. It also helps to increase the speed of the learning through the high speed network system. Using this system every learner can learn at the same speed.

3.10 Management and IoT

To maintain the all technology that has been attached with the system requires proper planning and management (to maintain connection, implementation of new technologies etc.). So, it has been seen the implementation of the technologies require huge procedural techniques and management procedures.

3.11 Safety and Security Using IoT

This technology is also helpful to secure the data where it is stored. In this system, each student is registered with a specific barcode. If authority wants, it can fetch the data of each of the students with their all details e.g. qualification, previous marks, attendance etc.

3.12 Problems and Challenges Using IoT

Major problem of using IoT technology in school is lack of proper infrastructure. Lack of the infrastructure is one of the major problems of all educational institutions in Kolkata. The space for the classroom is not sufficient and the ratio of the students and teacher is high.

Lack of trainee teachers is also a problem of all medical institutions in Kolkata city. The ratio of students and teachers is also higher than the other cities in India which creates lots of problems. Uncertainty of the power supply is another problem in the educational institutions. Lack of funds is also a major problem for the implementation of IoT technology in the classroom condition. Very slow networking facilities are also another problem faced by the learners of all institutions.

4 Discussion

From the study it has been found that Kolkata is one of the largest cities in West Bengal and also in India. From this study it has been found that infrastructural facility is relatively higher in the nongovernmental schools than the government or government aided schools. There are no scopes of smart classrooms in the government or government aided schools, but in the nongovernmental school there are two or more classrooms having smart technology. The uses of internet of things technology are higher in the nongovernmental schools than the government schools. Though few schools have already made arrangements for the internet of things in classrooms. The student teacher ratio in the nongovernmental schools is less than the government and government aided schools.

5 Conclusion

Kolkata city has been experienced with different types of educational institutions like schools, colleges, universities etc. Present study shows that the uses of the internet of things are relatively higher in the nongovernmental institutions than the governmental institutions. There are lots of problems faced by the educational institutions in Kolkata i.e. lacks of funds, inadequacy of infrastructure, high ratio of student and teacher, improper uses of resources etc. Government has already taken many steps to minimize this problem but it is inadequate to solve these problems. This study has been done in Kolkata and can also be done in the other metro cities also. The methodology used for this study of IoT can also be applied in the other studies also e.g. ICT in education, uses of EDUSAT in education also. This study will throw new insight over the studies and applications of IoT in educational sciences and how the applications

of the IoT techniques can be increased in this education system which helps the country to achieve sustainability in education.

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What Impacts the Acceptance of E-learning Through Social Media? An Empirical Study



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Abstract An incredible volume of research was conducted to examine the students' acceptance of e-learning systems through the platforms of higher education institutions (HEIs). However, little debate was made concerning the exploration of the factors influencing the acceptance of e-learning systems via social media applications. Accordingly, this study extends the technology acceptance model (TAM) with social media practices, including knowledge sharing, motivation and uses, and social media features to understand the impact of these determinants on students' acceptance of e-learning systems. The partial least squares-structural equation modeling (PLS-SEM) along with the importance-performance map analysis (IPMA) are employed to analyze the theoretical model using survey data collected from 410 students. The findings indicated that knowledge sharing, motivation and uses, and social media features have significant positive effects on both perceived ease of use (PEOU) and perceived usefulness (PU). It is also essential to report that the e-learning system acceptance is positively affected by PEOU and PU together. Further,

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the IPMA results showed that PEOU was the most important influential factor of e-learning systems acceptance.

Keywords E-learning acceptance · Social media practices · TAM · PLS-SEM · IPMA

1 Introduction

The emergence of information technology has fashioned newfangled applications, such as “e-banking”, “e-commerce”, “e-learning”, and “e-health” [1]. E-learning is one of such applications that recently become very common in the educational domain [2]. The primary concern of these applications is to minimize the location and time restrictions [3]. These applications enable access to various resources without restrictions [4]. Inspired by their persuasive benefits, including cost-effectiveness in course allocation and organization, physical range, and student control, universities and colleges are embracing e-learning by employing an extended range of technology-based platforms [5]. It is emphasized that even if extensive funds are allocated, some institutions still fail to gain the expected advantages of e-learning systems [6]. This stems from the variations of the determinants affecting its usage and acceptance [7].

On the other side, social media has increasingly become prevalent with the growth of the second generation of “web-based communities” due to the increased cooperation and sharing among users through various applications such as “blogs”, “podcasts”, and “feeds” [8, 9]. For education, social media platforms afford an exclusive opportunity for instructors to feel the sense of community among the learners and motivate personal communications that can lead to the construction of new knowledge [10, 11]. These platforms offer a number of features such as creating online courses, registering, and monitoring the practices of students and instructors [12, 13]. With the prevalent use of e-learning through the Internet, e-learning through numerous platforms has provided a portable and flexible approach for students to acquire their basic knowledge from several resources [14]. Students can even interact with instructors and peers simultaneously through these platforms [15].

Based on the existing literature, much research was published to investigate the students’ acceptance of e-learning systems using the platforms of higher education institutions (HEIs) [7]. Nevertheless, little debate was made concerning the exploration of the factors affecting e-learning acceptance through social media applications in HEIs. In keeping with this, this research is an attempt to examine the students’ acceptance of e-learning systems through social media applications in HEIs. More specifically, this research aims to examine the impact of social media practices (i.e., knowledge sharing, social media features, and motivation and uses) on students’ acceptance of e-learning systems by extending the technology acceptance model (TAM) with these antecedents.

2 Research model and hypotheses development

The developed theoretical research model of this study is depicted in Figure 1. It is anticipated that students' acceptance of e-learning systems is influenced by "perceived ease of use (PEOU)" and "perceived usefulness (PU)". It is also suggested that both PEOU and PU are influenced by social media practices, including knowledge sharing, social media features, and motivation and uses. The description of each construct along with the proposed hypotheses are deliberated in the following subsections.

2.1 Knowledge sharing (KS)

Knowledge sharing (KS) refers to "the business processes that distribute knowledge among all individuals participating in process activities" [16]. Previous research revealed that KS has a significant impact on the acceptance of various technologies [17–20]. In this study, it is suggested that the higher the KS through e-learning systems, the higher the PU and PEOU of such systems would be. Therefore, the following hypotheses were suggested:

- H1a: KS has a positive impact on PU.
- H1b: KS has a positive impact on PEOU.

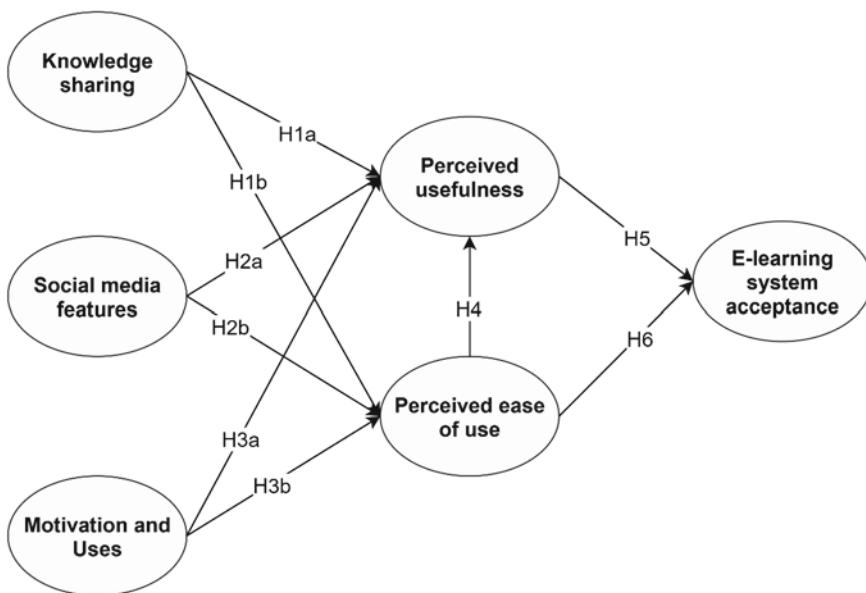


Fig. 1 Theoretical model

2.2 Social media features (SMF)

Social media platforms such as “Facebook”, “Twitter”, “Instagram”, “Snapchat”, “LinkedIn”, and “YouTube” are among many other platforms that allow the exchange of videos and photos, sharing resources, and interacting with others [21]. These features affect the students’ perceptions and academic performance either positively or negatively [22]. Concerning the learning through social media, prior studies pointed out that the PEOU and PU of social media provide sufficient opportunities for students to take part in online discussions, which in turn, leads to the acceptance of e-learning through the features that these platforms provide [23, 24]. Accordingly, the following hypotheses were suggested:

- H2a: SMF has a positive impact on PU.
- H2b: SMF has a positive impact on PEOU.

2.3 Motivation and uses (MU)

Motivation and usage (MU) of electronic educational systems play an effective role in influencing the students’ and educators’ ability to accept and use these systems [25]. Several studies conducted in the past have revealed that MU has a positive effect on the PEOU and PU of e-learning systems [26–28]. Further, the self-motivation and psychosocial needs of individuals could be useful in understanding the intention to accept e-learning systems [29]. Based on these arguments, the following hypotheses were suggested:

- H3a: MU has a positive impact on PU.
- H3b: MU has a positive impact on PEOU.

2.4 Perceived ease of use (PEOU) and Perceived usefulness (PU)

The technology acceptance model (TAM) presented by Davis [30] has become the most popular and influential model for predicting the acceptance of a specific technology and has acquired extensive experiential props in many studies [31]. Davis [30] suggested two main constructs for explaining the acceptance of any technology. These two constructs are “perceived ease of use (PEOU)” and “perceived usefulness (PU)” [30]. PEOU refers to “the degree to which a person believes that using a particular system would be free from effort”, whereas PU refers to “the degree to which a person believes that using a particular system would enhance his or her job performance” [30]. PEOU and PU were shown to have significant positive impacts on the acceptance of e-learning systems [7, 32, 33]. Hence, the following hypotheses were put forward:

H4: PEOU has a positive impact on PU.

H5: PU has a positive impact on e-learning system acceptance.

H6: PEOU has a positive impact on e-learning system acceptance.

3 Research methodology

3.1 Context and subjects

This research was carried out at the British University in Dubai in the UAE. The participants comprise both undergraduate and graduate students. The data were collected through a questionnaire survey using the convenience sampling technique. The time required to fill the survey was not more than 15 minutes. Out of 480 surveys distributed, a total of 410 valid responses were retained, with a response rate of 85.4%. Among the 410 valid responses, there were 230 females and 180 males. Further, 75% of the participants were aged between 18 and 29 years old. It is worth reporting that about 85.6% of the participants were frequently using social media applications like “Facebook”, “YouTube”, and “Twitter” on daily-basis.

3.2 Data analysis

The analysis of the developed theoretical model was undertaken using the “partial least squares-structural equation modeling (PLS-SEM)” using SmartPLS [34]. The aim of using PLS-SEM in this research stems from the exploratory nature of the developed theoretical model. We have followed the general guidelines for employing PLS-SEM in the IS domain [35]. As per the recommendations of Hair et al. [36], a two-step approach (i.e., “measurement model” and “structural model”) needs to be carefully followed for evaluating the theoretical research model. In this study, these two-steps were strictly followed.

4 Results

4.1 Measurement model assessment

In order to evaluate the measurement model, Hair et al. [36] suggested testing the reliability and validity. Reliability is basically assessed by two measures, namely “Cronbach’s alpha” and “composite reliability (CR)” [36]. The values of these two measures should be equal to or greater than 0.70 in order to be accepted [36]. As shown in Table 1, both reliability measures are ascertained.

Table 1 Reliability and convergent validity results

Constructs	Items	Factor loadings	Cronbach's alpha	CR	AVE
E-learning system acceptance	ELA_1	0.919	0.851	0.930	0.869
	ELA_2	0.945			
Knowledge sharing	KS_1	0.916	0.845	0.897	0.686
	KS_2	0.867			
	KS_3	0.781			
	KS_4	0.738			
Motivation and uses	MU_1	0.708	0.806	0.873	0.634
	MU_2	0.882			
	MU_3	0.843			
	MU_4	0.740			
Perceived ease of use	PEOU_1	0.838	0.793	0.865	0.618
	PEOU_2	0.708			
	PEOU_3	0.868			
	PEOU_4	0.720			
Perceived usefulness	PU_1	0.802	0.886	0.921	0.746
	PU_2	0.875			
	PU_3	0.894			
	PU_4	0.880			
Social media features	SMF_1	0.726	0.842	0.901	0.705
	SMF_2	0.900			
	SMF_3	0.925			
	SMF_4	0.936			

For validity assessment, both convergent and discriminant validities need to be confirmed [36]. In terms of “convergent validity”, the “average variance extracted (AVE)” and “factor loadings” need to be measured. In line with the recommended values [36], the values of factor loadings should be equal to or greater than 0.70, while the values of AVE should be equal to or greater than 0.50 in order to be accepted. The results in Table 1 indicate that the values of AVE and factor loadings are both accepted, and hence, the “convergent validity” is confirmed. Concerning the “discriminant validity”, the “Heterotrait-Monotrait ratio (HTMT)” of correlations needs to be tested [37]. A value of less than 0.85 should be ascertained. The results in Table 2 reveal that the HTMT values are considered to be satisfactory, and therefore, the “discriminant validity” is confirmed.

Table 2 HTMT results

	E-learning system acceptance	KS	MU	PEOU	PU	SMF
E-learning system acceptance						
KS	0.032					
MU	0.113	0.493				
PEOU	0.072	0.469	0.615			
PU	0.074	0.309	0.713	0.548		
SMF	0.076	0.503	0.628	0.717	0.616	

4.2 Structural model assessment

Table 3 and Figure 2 demonstrate the results of the structural model. It can be seen that all the suggested hypotheses are positive and significant. In that, KS is shown to have significant positive impacts on PU ($\beta = 0.601$, $p < 0.05$) and PEOU ($\beta = 0.594$, $p < 0.05$); hence, H1a and H1b are supported. Moreover, the results indicated that SMF have significant positive impacts on PU ($\beta = 0.382$, $p < 0.05$) and PEOU ($\beta = 0.232$, $p < 0.05$); therefore, H2a and H2b are accepted. Further, it can be observed that MU have significant positive effects on PU ($\beta = 0.797$, $p < 0.05$) and PEOU ($\beta = 0.505$, $p < 0.05$); hence, H3a and H3b are supported. In addition, the results reported that PEOU has a significant positive influence on PU ($\beta = 0.412$, $p < 0.05$); therefore, H4 is accepted. More interesting, the results exhibited that the e-learning system acceptance is positively and significantly influenced by PU ($\beta = 0.606$, $p < 0.05$) and PEOU ($\beta = 0.363$, $p < 0.05$); thus, H5 and H6 are both accepted.

Moreover, KS, SMF, MU, and PEOU together accounted for 74.5% of the explained variance (R^2) in PU. Further, KS, SMF, and MU together accounted for 62.3% of the explained variance (R^2) in PEOU. The direct effects of PU and PEOU

Table 3 Hypotheses testing results

H	Relationship	Path coefficient	p-value	Decision
H1a	KS → PU	0.601	0.000	Supported
H1b	KS → PEOU	0.594	0.000	Supported
H2a	SMF → PU	0.382	0.011	Supported
H2b	SMF → PEOU	0.232	0.035	Supported
H3a	MU → PU	0.797	0.000	Supported
H3b	MU → PEOU	0.505	0.000	Supported
H4	PEOU → PU	0.412	0.015	Supported
H5	PU → e-learning acceptance	0.606	0.002	Supported
H6	PEOU → e-learning acceptance	0.363	0.031	Supported

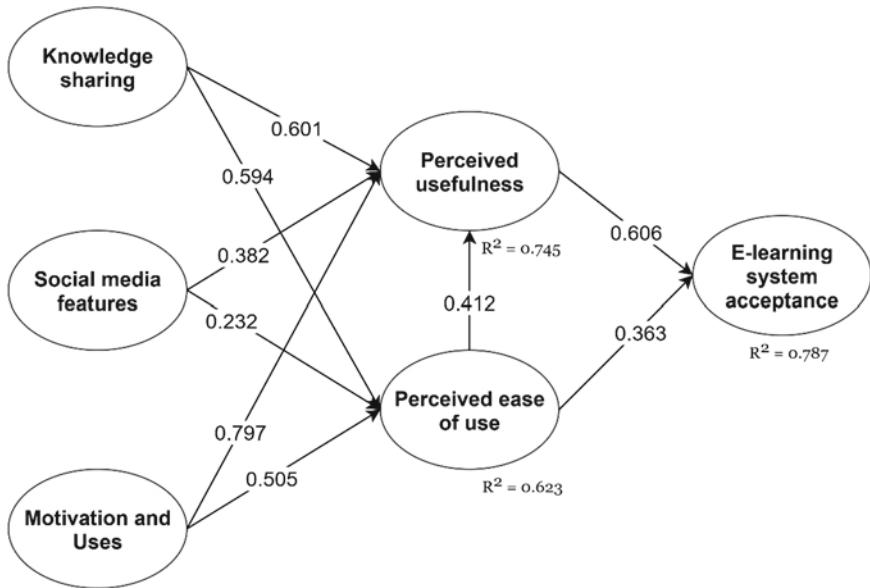


Fig. 2 Path analysis results

together with the indirect effects of KS, SMF, and MU accounted for 78.7% of the explained variance (R^2) in e-learning system acceptance.

4.3 Importance-performance map analysis (IPMA)

Ringle and Sarstedt [38] claimed that the importance-performance map analysis (IPMA) reinforces the understanding of PLS-SEM results by providing more insights about causal relationships. Accordingly, this research employs the IPMA as an advanced approach in PLS-SEM using the e-learning system acceptance as the target factor. As an alternative to only estimating the path coefficients (i.e., “importance measure”), IPMA likewise includes the average value of the variables and their indicators (i.e., “performance measure”) [38]. The IPMA postulates that the total impacts designate the predecessor variables’ importance in estimating the target variable (i.e., e-learning system acceptance), while the average of variables’ values designates their performance.

Figure 3 shows the IPMA results. The importance and performance of social media practices (i.e., knowledge sharing, motivation and usage, and social media features) and individual’s beliefs (i.e., perceived ease of use and perceived usefulness) were measured. In terms of importance, it can be observed that perceived ease of use represents the most important factor influencing the e-learning system acceptance, followed by perceived usefulness, knowledge sharing, motivation and usage, and

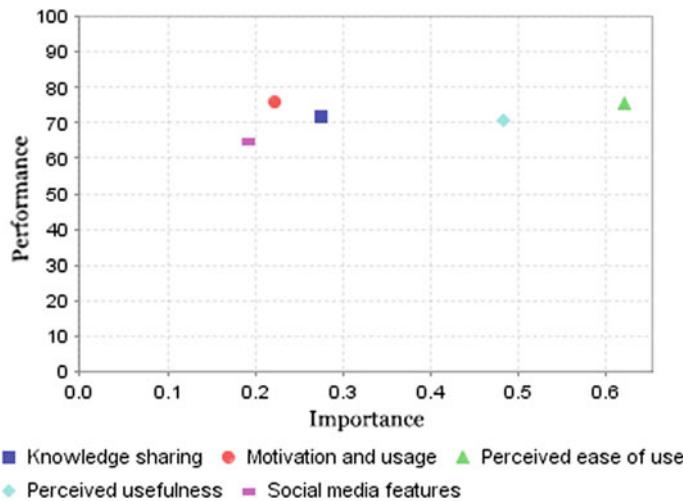


Fig. 3 IPMA results

social media features, respectively. Concerning the performance, the results exhibit that perceived ease of use and motivation and usage together score the highest performance values, followed by both (perceived usefulness and knowledge sharing), and social media features, respectively.

5 Conclusion

5.1 Discussion

A numerous amount of research articles was published regarding the factors influencing the e-learning systems acceptance through HEIs. However, very little was known regarding the effect of social media practices on e-learning systems acceptance through the employed social media applications in HEIs. Accordingly, this research was set out with the aim of evaluating the impact of social media practices (i.e., knowledge sharing, social media features, and motivation and uses) on e-learning systems acceptance through the extension of TAM with these antecedents. The findings were discussed from the perspective of social media practices and individual's beliefs.

Concerning social media practices, the results pointed out that knowledge sharing has a significant positive impact on perceived usefulness and perceived ease of use of e-learning systems. This result confirms the results obtained by Salloum et al.

[17] in which knowledge sharing has a significant effect on the acceptance of e-learning systems. Knowledge sharing through social media platforms explains a good correlation with perceived usefulness and perceived ease of use. In this sense, the higher the knowledge shared through these platforms, the higher the perceived usefulness and ease of use of e-learning systems would be. The results also indicated that social media features have a significant positive impact on perceived usefulness and perceived ease of use of e-learning systems. This result was in agreement with the results observed in the previous literature [23, 24]. This indicates that the higher the extensive features of social media applications, the higher the perceived usefulness and ease of use of e-learning systems would be through these applications. Moreover, the results pointed out that motivation and usage have a significant positive impact on perceived usefulness and perceived ease of use of e-learning systems. This result was also consistent with the results noticed in the previous literature [26–28]. A possible explanation of this result stems from the fact that the higher the students' motivation and usage of social media platforms, the higher the ease of use and usefulness of e-learning systems would be via these platforms.

In terms of individual's beliefs, the results showed that perceived ease of use has a significant positive impact on the perceived usefulness of e-learning systems. This result corroborates the recent findings provided by Salloum et al. [7]. This result was expected as it corresponds to the original theoretical hypothesis of TAM in which the higher the perceived ease of use of a particular technology, the higher the usefulness perceived using that technology. Further, the results revealed that both perceived ease of use and perceived usefulness showed positive significant impacts on e-learning systems acceptance. The result noticed in this study mirrors those observed in the previous literature [32, 33]. This indicates that the higher the easiness and usefulness of the e-learning systems, the higher the students' acceptance of these systems would be.

5.2 Research implications

There are several practical and theoretical implications derived from the results of this research. From the practical side, the IPMA results showed that perceived ease of use was the most important influential factor of e-learning systems acceptance. The designers and developers of e-learning systems need to design and develop the e-learning systems in a way that is easy to use and user-friendly in order to sustain the acceptance of these systems by students. On the other side of the coin, they also need to consider the social media practices (i.e., knowledge sharing, motivation and usage, and social media features) while designing and developing e-learning systems in order to promote the usage of these systems through social media platforms. The educators need to instill the approach of employing e-learning systems through social media platforms in the students' minds in order to achieve higher levels of acceptance. From the theoretical side, this research is believed to be one of the few attempts made to investigate the impact of social media practices on e-learning systems acceptance

in general, and the UAE context in particular. Further, the results of this study add a significant contribution to the original TAM by extending the model with the newly introduced factors at one hand, and to the e-learning systems acceptance on the other hand.

5.3 *Limitations and future research directions*

This research throws up three main limitations that need to be acknowledged. First, the results of this study may not be applicable to the entire population of the UAE context or other similar contexts as the data were collected from only one institution in the UAE. Therefore, further attempts need to consider samples from different institutions in order to get broader insights. Second, the results of this research cannot be generalized to the other institutions in the UAE context or other contexts due to the limitation of the convenience sampling technique employed in this study. Thus, further research needs to consider other sampling techniques in order to further generalize the results to other similar contexts. Third, the sample of this research was comprised of students only. Since, the usage of e-learning systems is a bi-directional process (i.e., students and educators), there is a need to understand the educators' acceptance of these systems as well.

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EyeTell: Disabled Patients Communication Application



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Abstract Eye-tracking technology is a growing field used to detect eye movements and analyze human processing of visual information for interactive and diagnostic applications, especially in human and computer interaction. In this paper, we are presenting EyeTell as a system of gaze tracking through the front-facing camera of android devices to help use an application that solves the miscommunication problem between disabled patients and their caregivers. EyeTell application allows severely disabled patients to communicate easily and effectively through easy to use interfaces.

Keywords Frame preprocessing · Eye detection · Eye tracking · Region division · Eyeball movement detection · Direction of eyeball movement

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1 Introduction

Communicating with caretakers usually is very easy but that is not the case with people with severe disabilities caused by physical damage or certain diseases such as cerebral palsy and amyotrophic lateral sclerosis (ALS) [1], as their only way of communicating with anyone is their eyes which makes their caretakers guess what they want to say or have, patients usually suffer from psychological problems caused by their case and not being able to communicate properly makes their problems worse, sometimes it gives their families psychological problems too as their loved ones are in pain and they can't even say anything, patients should be able to clearly state what they want to say or have. Most of the patients suffer from this miscommunication all of their lives all day every day. The development of mobile learning [2] and new technologies assisting people with severe disabilities were developed by a lot of developers unfortunately many of them get abandoned by users or have limited usage reasons differ but the most known reasons are the high cost of the hardware and it's software, difficulty getting the hardware needed, and the difficulty using it, so it's either hard for the patient or his caretaker. Eyes are the most important feature of the human face, and in most cases of people with severe disabilities eyes is the only part of their bodies that they can move however they want, that what makes eye tracking really important for them. Eye tracking is a very common way of solving the miscommunication problem [3, 4]. Eye tracking is the process of measuring where the user looks (i.e. Users point of gaze). These measurements are carried out by an eye tracker which records the position of the eyes and the movements they make [5]. A method of recording eye position and movements is called oculography. There are a couple of well-known ways or methods of tracking the motion of the eyes, one way is Electro-Oculography where sensors are attached at the skin around the eyes, when eyes rotate the sensors measure the electric field, this method is cheap, easy and invasive, the most important feature of this method is that it's able to detect eye movement even when the eye is closed. However, this method isn't suitable for everyday use, because it requires close contact of electrodes to the user. The second method is Scleral Search Coils where a coil is attached to the eye, then a signal of eye position will be produced, this method requires the user to have a special lens inserted into the eye after local anesthetic has been introduced, this makes eye tracking very accurate but it's an invasive method, requiring something to be placed into the eyes. Another way is Infrared Oculography that measures intensity of reflected infrared light, light source and sensors are needed to implement this method these can be placed on spherical glasses, Infrared Oculography has the ability to measure eye movement in darkness, however it can measure eye movement only for about ± 35 degrees along the horizontal axis and ± 20 degrees along the vertical axis. Last method is Video Oculography which is a video-based eye tracking method and the most widely used method, this method took eye-gaze tracking from a very complex and expensive task limited for only laboratory search to a low cost and efficient task. Video Oculography uses either single or multiple cameras to determine the movement of eyes using information from the captured images [6].

Severely disabled patients with no ability to talk or move. So, the aim of this work is to develop an android application to solve the miscommunication problem through eye tracking using the android tablet camera only without the need of external hardware or device. EyeTell service tracks the eye movements of the patients with the front-facing camera of the android device and translates them into the movements of the cursor. This gives the patient the ability to use the whole device with the movement of their eyes. The application then enables them to form sentences using a special keyboard or choose a graphical representation of her/his needs. First the camera will capture the video and take it as an input the video will then be split into frames each frame will be pre-processed to get rid of any noise that could reduce the eye tracking quality after that the system will detect the eye and then track it then it will divide regions then detect eyeball movement lastly the direction of eyeball movement will be had. The proposed application is limited to android OS devices, and the languages are Arabic or English only.

2 Literature Survey

Eye tracking today is used in a wide range of applications. For example, in medical research, eye tracking helps people with disabilities increase their independence and communication possibilities using their eyes only [7]. Eye tracking technology began in the late nineteenth century and was launched in 1879. During 1970s and 1980s, eye tracking devices became less instructive, provided better accuracy and were able to separate the eye from the movement of the head [8]. Image preprocessing is one of image processing techniques which can be used in a variety of different fields such as object detection, locating objects in face recognition, and iris recognition [9]. The aim of preprocessing is to increase the quality of an image, by reducing the amount of noise appearing in the image. Two typical techniques used in preprocessing are filtering and contrast enhancing [10]. Eye region detection must be done before detecting the eye movement. Eye detection is classified into two categories: traditional image-based passive approaches and active IR-based approaches. The traditional methods are classified into three categories: template-based methods, appearance-based methods and feature based methods. Color is one of the useful features used for eye detection [11]. In this stage, images containing the eye regions is extracted, while excluding regions of no interest to reduce the search space for the next steps [12]. Haar-like feature could be applied to the greyscale image to detect the exact eye region. Its extraction depends on the feature of the eye. It is when the eye socket appears darker in grayscale than the area of skin below it. The width of the rectangle window is approximately equals the horizontal length of the eye, and the height of the window is variable [13]. To locate the iris boundary the Circular Hough Transform can be used. The Hough transform algorithm is used to detect features of a particular shape [14]. In this stage, only vertical gradients are used for locating the iris boundary edge; because the eyelid edge map will misrepresent the circular iris boundary edge map, as the upper and lower iris regions are usually covered by the

eyelids. To reduce the effect of the eyelids and to make the circle localization accurate and efficient, horizontal edge map could be excluded as the eyelids are horizontal [13]. KCF solves tracking problems with simple linear regression and non-linear regression through double filters training data, making it possible to use multi-dimensional features such as Histogram of Gradient (HOG) and nonlinear kernels such as Gaussian Filter. Like other detection-based trackers, KCF can be trained using a set of training template variations. To increase the processing speed of various template variations, KCF utilizes circulant matrix properties [15]. Eye movements are monitored by extracting the motion vectors of multiple iris features. Trained convolutional network (CNN) is used to segment the iris from each frame. To ensure high quality motion signals, Speeded Up Robust Features (SURF) feature descriptors are used to extract feature vectors, which are then matched in consecutive frames, using brute force matching followed by random sample consensus and homography. Tracking the geometric median of these matched key points excludes outliers, and the velocity is approximated by scaling by the sampling rate. Microsaccades are then identified by thresholding the velocity estimate. For head motion compensation across each frame, a hybrid cascaded similarity transformation model is introduced using tracking and matching of features of rectangular patches in regions of the observer's cheek. Iris Segmentation The region of each frame containing the iris must be isolated from the rest of the frame before velocity estimation can begin. A number of approaches have been used for iris segmentation including ellipse fitting, geodesic active contours, Hough circle fitting, edge detection, integrodifferential operators, graph cuts, and Zernike moments. All of these methods require tuning for good results and fail to generalize across observers with different iris and skin pigmentation. CNN method can classify the type of eye movement [16].

3 Related Works

Eye Tracking is a technology that enables the computer or other devices to mark where the eye's sight focuses on the screen. Primarily, researchers found many devices and programs that track the eye's sight in an accurate way. Some trackers have been very helpful in this field like Tobii Eye Tracker [17] which is designed to be a light weighted tracker where your eye gaze control the PC that is suitable for the eye's sight. Unfortunately it only works on Windows. Second device researchers suggest is Tobii Pro Glasses 2. It is an eye tracking tool which can be worn on the head. It is an easy to use wearable eye-tracker. Primarily, this device works when the person is in a wide range of studies. Nonetheless, the product consists of a head unit, recording unit, and control software and is designed for its own software, and it only works with Windows 8 or 7 users [18]. These devices can work easily but have terminal components that may prevent the assessment of the workload.

There are many important applications related to eye tracking. The main one is Eye Type [19] which is a free application that allows users to input text to a mobile device, using only the movements of their eyes. It consists of visual keywords whose keys

are clicked by estimating the user's gaze. Thereby, the text is composed of predictive text input, which depends on the combination of the keys clicked (each containing a specific subset of letters). Instead of using a traditional keyboard QWERTY which makes it difficult, in contrast the productive text input facilities this task by moving your eyes and using the handheld device to communicate. Unfortunately, it only works for Android. Eye Tracking Keyboard [20] is an application where the user should flash their left eye to move the cursor to left, their right eye to move the cursor Right, or close both eyes to define. Nonetheless, this takes a lot of time for the user to type-in the required text and it only works for Android users. Eye Tracker—Write Messages [21] is considered as Eye tracking keyboard application that depends only on the direction of the eye whether it is looking right or left. It implements bisection method, first divides 26 letters into 2 groups. Looking left will choose letters a-m, looking right choose letters n-z, and keeps dividing until it gets to the desired letter. Eye Tribe Tracker [22] is an Eye tracking technology that allows the user to control the mouse cursor and to make single mouse clicks.

3.1 Proposed and Similar Systems Comparison

A comparison between the proposed application and the existing systems is shown in Table 1.

4 Proposed Methodology

Due to the increase in the number of severely disabled patients due to traffic accidents, physical damage or certain diseases, and the lack of affordable and Arabic-supporting options that enables these patients to communicate and express feelings. an EyeTell application is developed to enable these patients to communicate with the movement of their eyes where. This application captures real-time frames from the front-facing camera of the android tablet. At first a frame is taken every second, gets processed and the process of detecting the eye is applied. The frame is a greyscale jpeg image taken from the front-facing camera of the android tablet; it's taken automatically every one second without the interaction of the user. EyeTell consists of two parts the first part is the eye tracking service that tracks the eye and moves the cursor accordingly, whenever the eye lands on an object for 5 s the object is chosen and performs its functionality this enables the patient to use the entire device with the movement of their eyes, the system also has an application part the has a lot of functionalities that helps the patients, care takers and doctors communicate easily and effectively, it enables the patient to form a sentence in a quick and easy way. However, it only works for the Android system. The EyeTell application block diagram as indicated in Fig. 1 and the details as follows:

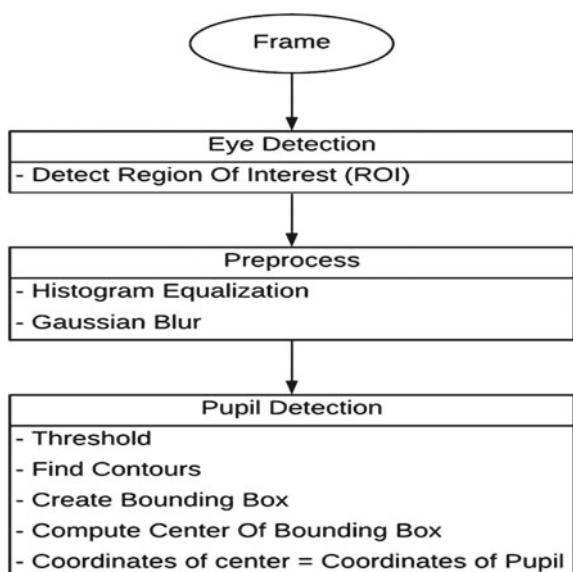
Table 1 Comparison between the proposed application and the existing systems

Name of application	Features	Limitations
Tobii Eye Tracker [17]	<ul style="list-style-type: none"> • Accurate gaze tracking • Slim and lightweight design 	<ul style="list-style-type: none"> • The price may be high for some patients • Assigned for window only • Adds clutter to your setup • The cable is very short, and desktop users will need to have their computer positioned close to their screen
Tobii Pro Glasses 2 [18]	<ul style="list-style-type: none"> • Gives researchers deep and objective insights into human behavior by showing exactly what a person is looking at in real time as they move freely • Can be used as a tool for training, skills transfer 	<ul style="list-style-type: none"> • Radio transmitters and receivers (WLAN) in the recording unit have to be placed as far as possible from any object sensitive to these signals • Tobii Pro Glasses Controller Software is limited on Windows 8 or later tablet, or a computer with Windows 7 or later • The glasses include rechargeable Lithium-ion batteries, which if charged incorrectly can explode or cause fire
Eye Type [19]	<ul style="list-style-type: none"> • Predictive text engine predicts the desired word and allows the user to either accept it, or select an alternative suggestion. As the user continues to type, the predictive text engine attempts to determine which word the user means to input and also offers alternative predictions • Free application 	<ul style="list-style-type: none"> • Uses the traditional QWERTY keyboard which makes it hard to accurately determine the key that the user is looking at • Only available on android devices
Blink to Text Eye Tracking Keyboard [20]	<ul style="list-style-type: none"> • Doesn't require internet connection • Free application 	<ul style="list-style-type: none"> • Selecting a column and a letter takes a long time • Only available on android devices

(continued)

Table 1 (continued)

Name of application	Features	Limitations
Eye Tracker—Write Messages [21]	<ul style="list-style-type: none"> Supports different device orientations (Landscape and Portrait) Provides guidelines for face recognition and setting the light conditions to proper values Works with tablets like Nexus 7 Free application 	<ul style="list-style-type: none"> Bad light conditions and reflections on the eye makes it hard to use the application Moving and tilting the head effects the work of the application
Eye Tribe Tracker [22]	<ul style="list-style-type: none"> Users can set a gaze-operated password, where they would have to look at certain parts of the screen in order to unlock the device Videos can be paused or rewind with certain movements of the eyes 	<ul style="list-style-type: none"> The cost is very high as the price is 80 €
EyeTell	<ul style="list-style-type: none"> Supports Arabic and English languages Provides images to allow easy and fast communication Rapid response in case of emergency Free application Eye tracking works on the whole device 	<ul style="list-style-type: none"> Only available on android devices

Fig. 1 EyeTell application block diagram

4.1 Eye Detection

This step takes the frame as whole image containing the face of the patient and sometimes other objects too, it then detects the rectangular region where the eye is and ignores the rest of the image we call this region the Region Of Interest (ROI). For this step we used the haar cascade eye classifier which is a machine learning approach where the cascade function is trained on both negative (i.e. not containing eyes) and positive (i.e. containing eyes) images.

4.2 Pre-processing

This step is performed on the ROI detected in the previous step. Histogram Equalization: this step normalizes the brightness and increases the contrast of the image which makes it easier for the next steps to specify where the pupil is. We used the equalizeHist from the openCV library that uses Eq. 1 to compute the integral of the histogram and Eq. 2 to transform the image using H' as a look-up table.

$$H'_i = \sum_{0 \leq j < i} H(j) \quad (1)$$

$$dst(x, y) = H'(src(x, y)) \quad (2)$$

Gaussian Blur: the result of histogram equalization step has a lot of sharp edges that could lead to mis-detecting the pupil and detecting other objects like eyelashes, nevus, etc. we used the Gaussian Blur method from OpenCV library where we used 35,35 kernel size and 0 sigmaX. We had to use large kernel size because the frames we get from the front-facing camera of the android device is high quality so we needed to blur it more.

4.3 Pupil Detection

1. Threshold: in this step we apply the threshold method from OpenCV library we used 8 as the threshold value and 255 as the maximum value, with the type TRESH_BINARY_INV where it uses Eq. 3.

$$dst(x, y) = \begin{cases} 0 & \text{if } src(x, y) > thresh \\ maxval & \text{otherwise} \end{cases} \quad (3)$$

2. Find Contours: in this step we used the threshold method from OpenCV library that uses the algorithm of Satoshi Suzuki and others to retrieve contours, and we

used the RETR_TREE retrieval mode that retrieves all of the contours and reconstructs a full hierarchy of nested contours, and used CHAIN_APPROX_NONE as our contours approximation mode which stores all the contour points. Then we sort these contours.

3. Create contours bounding box: in this step we create a bounding box around the contours from the last step and get it's coordinates (x, y), width (w) and height (h).
4. Compute the center of the bounding box: in this step we get the x and y coordinates of the center point of the bounding box by adding half of the width to the x coordinate and adding half of the height to the y coordinate.
5. Assuming that the coordinates of the center computed in the last step equals the coordinates of the pupil so these coordinates will be sent back to the android service to move the pointer accordingly.

$$\text{Coordinates of the center} = \text{coordinates of pupil}$$

5 System Analysis and Design

The proposed EyeTell application Use-case Diagram as shown in Fig. 2, Context diagram as shown in Fig. 3 and Entity Relationship Diagram (ERD) for system as shown in Fig. 4. The EyeTell system architecture is shown in Fig. 5 and architecture layers description in Table 2. As shown in Fig. 6, the keyboard layout in the application is completely different than the usual keyboard layout the letters are split into 6 groups in the Arabic keyboard and into 5 groups in the English keyboard, when the patient desires a letter in a group she/he chooses the group with their eyes then the group is zoomed in and the patient chooses whatever letter she/he desires. This layout makes it easier for the patient to accurately choose the letter without any random clicking as the letters are widely separated.

6 Experimental Results

EyeTell application is a powerful solution to severely disabled patients with no ability to talk or move. The performance of the proposed EyeTell application is evaluated using the Intersection Over Union (IOU), that is calculated by Eq. 4. The experiments are conducted on 20 samples using different lightings, positions and cameras to evaluate the performance of the proposed EyeTell application, and the results be reported in Table 3. Performance comparison between the proposed systems and

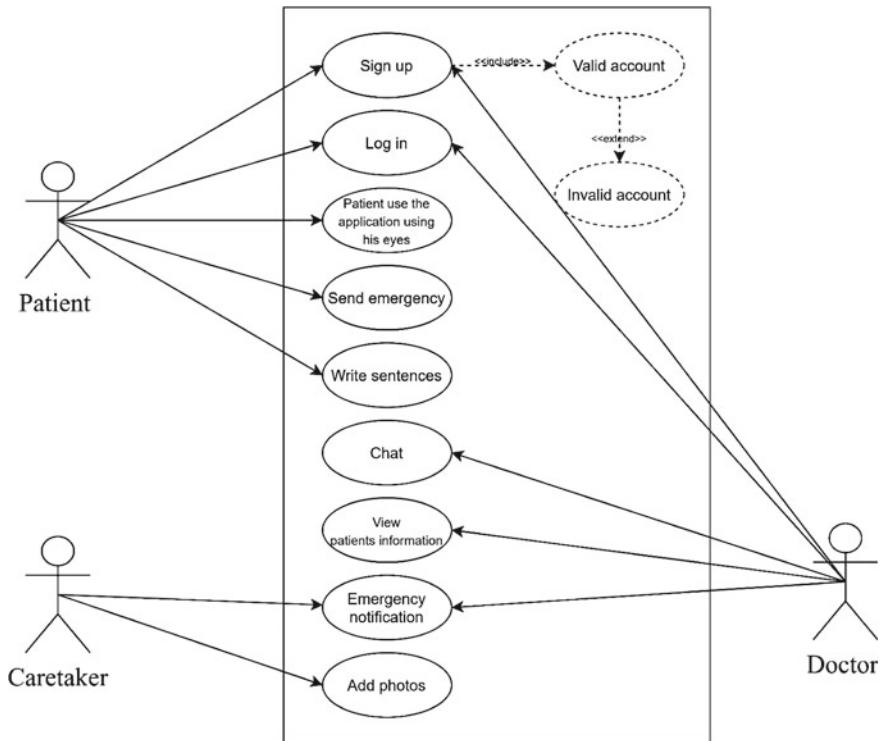


Fig. 2 Use-case diagram

the existing systems is indicated in Table 4. The application part of the system is evaluated using unit and integration testing and the results are indicated in Table 5.

$$IOU = \frac{area_{inter}}{area_{GT} + area_{pred} - area_{inter}} \quad (4)$$

where:

- $area_{inter}$ is the area of intersection between the ground truth box and predicted box.
- $area_{GT}$ is the area of the ground truth box which we determined manually.
- $area_{pred}$ is the area of the predicted box that the system detected.

6.1 EyeTell System Features

1. Provide the patient with graphical representations to choose from to communicate without the need of writing.
2. Provide a special keyboard that enables the patient to form a sentence easily.
3. Notify the caretaker whenever the patient needs something.

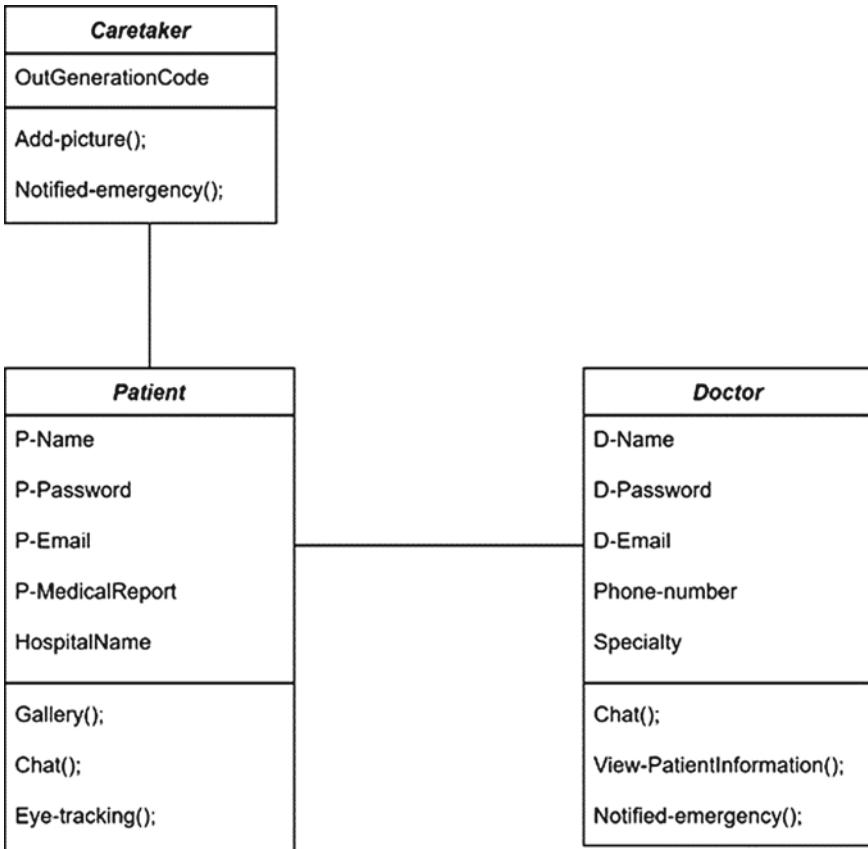


Fig. 3 Context class diagram

4. Give the patient the ability to report an emergency.
5. Give the caretakers the ability to add photos of things the patient asks for most of the time.
6. Give the patient the ability to choose from the photos.
7. Give the patient the ability to chat and socialize with other patients.

7 Conclusion

Communicating with a severely disabled patient was a stressful procedure according to specialists in that field, communicating with the patients used to depend on pure guessing of their needs or software's and hardware's that sometimes doesn't do the job either to language limitations or high cost. In this paper, Eye Tell application based on eye tracking technique is presented. It depends on software only and consists

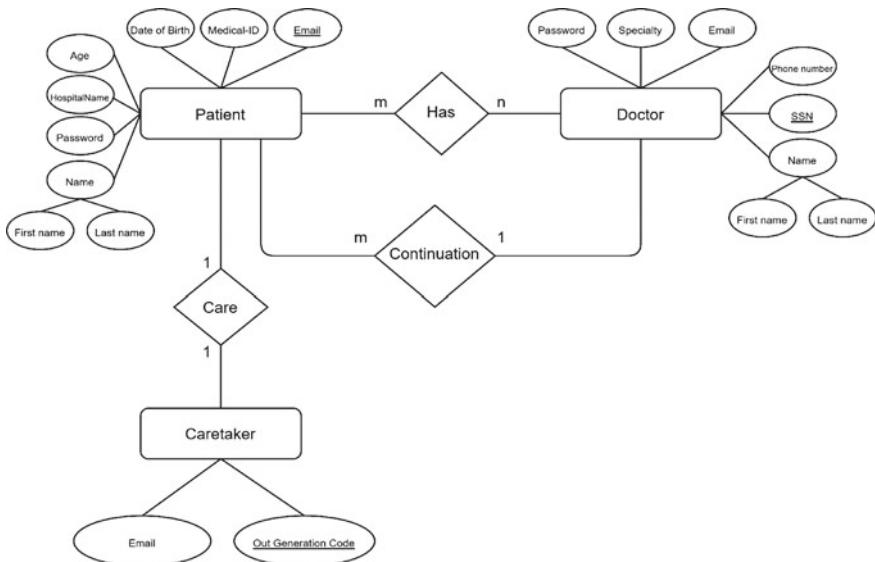


Fig. 4 ERD diagram

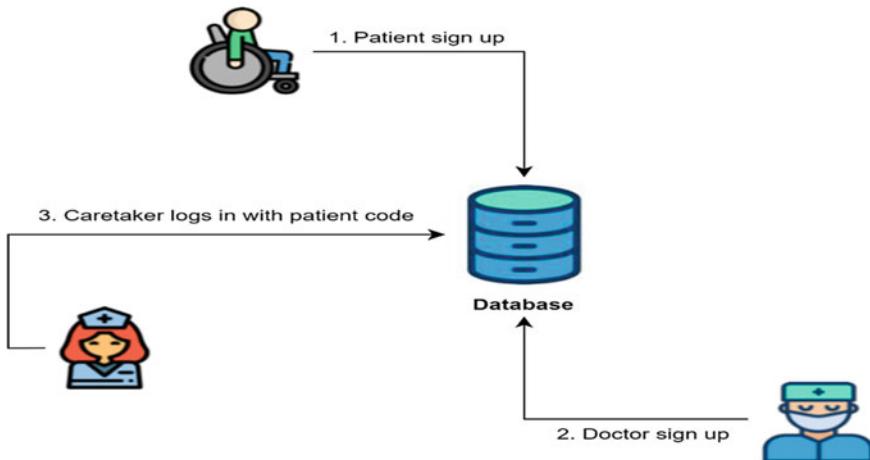
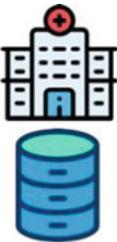


Fig. 5 Architecture diagram

of two parts the actual application that has a lot of functionalities that improves the lifestyle of the patients, doctors and caretakers, in addition to the mouse cursor service that translates the movements of the patient's eyes to movements of the cursor moving on the screen of the android device. In this application the patient can use it with the movement of her/his eyes which we hope will make their lives easier and enables all of the severely disabled patients to communicate and express their feelings

Table 2 Architecture layers description

 	Application layer	<p>When the patient sends messages with the special keyboard chat interface, the receiver can reply to her/him using the chat interface</p> <p>When the patient reports an emergency, the system alerts his doctor and caretaker</p>
	Camera layer	Real-time video is taken from the front-facing camera of an android tablet and our eye tracking algorithm is applied to it
	Database layer	After the hospital adds the admin to the admin database, admins will be able to add doctors to the doctor database, while a patient is added to the patient database by signing up her/himself to the system, the patient database has an auto-generated field which is the code of the patient, the code of the patient is used for the caretaker login. Admins will then connect patient database and doctor database to assign each patient to a doctor

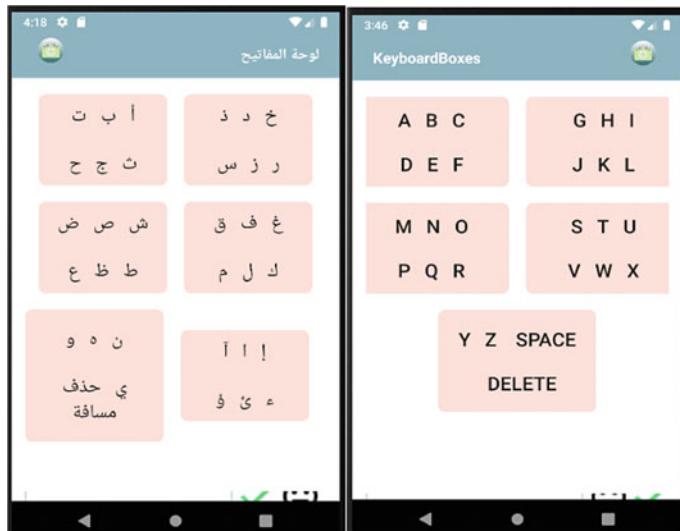
**Fig. 6** Special keyboard interfaces

Table 3 Accuracy test results

Sample#	GT-coordinates	Pred-coordinates	IOU%
1	23, 9, 29, 15	22, 11, 28, 17	75.00
2	28, 12, 34, 18	27, 12, 33, 18	75.00
3	28, 11, 34, 17	27, 12, 33, 18	75.00
4	45, 17, 51, 23	44, 12, 50, 18	75.00
5	19, 9, 25, 15	19, 8, 25, 14	100.00
6	42, 14, 48, 20	41, 13, 49, 21	75.68
7	35, 11, 41, 17	35, 10, 41, 16	100.00
8	65, 22, 71, 28	66, 23, 72, 29	75.00
9	31, 12, 37, 18	32, 12, 38, 19	84.21
10	28, 17, 34, 23	28, 18, 34, 24	100.00
11	37, 12, 43, 18	37, 12, 43, 18	100.00
12	35, 20, 41, 26	34, 20, 40, 26	75.00
13	20, 12, 26, 18	19, 12, 25, 18	75.00
14	29, 11, 35, 17	29, 12, 35, 18	100.00
15	25, 10, 31, 16	24, 11, 30, 17	75.00
16	17, 8, 23, 14	17, 8, 23, 14	100.00
17	23, 12, 29, 18	22, 12, 28, 18	75.00
18	31, 13, 37, 19	31, 13, 37, 19	100.00
19	17, 6, 23, 12	16, 6, 22, 12	75.00
20	19, 8, 25, 14	18, 8, 24, 14	75.00
Avg. accuracy		84.24%	

Table 4 Performance comparison between the proposed systems and the existing systems

Authors	Accuracy (%)
Zheng et al. [12]	94.3
Pangestu et al. [23]	85
Prasetya et al. [24]	80
Chen et al. [25]	69.1
EyeTell	84.24

Table 5 Unit and integration testing results

Test type	Total no. of cases	Passed cases	Failed cases
Unit testing	23	22	1
Integration testing	1	1	0

as it's a free application available to everyone. The experimental results over 20 samples using different lightings, positions and cameras are acceptable as compared to other existing systems. Finally, the proposed systems performance is compared with different commonly existing systems. In the future, EyeTell application will be implemented in iOS. Also, artificial intelligence will be used to EyeTell predict what the user needs to write.

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Relative Impact of Assistive Technology Diffusion: A Case Study from Abu Dhabi City Public Schools



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Abstract The purpose of this study is to assess and investigate the relative contribution of assistive technology (AT) against other six intervention strategies. The student performance profile (SPP) was used as an instrument for the first time in the Middle East and in the United Arab Emirates (UAE). The study applied quantitative methods and parametric techniques, such as One-Way ANOVA, Fisher Pairwise Comparisons, and paired t-tests, as well as descriptive and inferential statistics utilizing the data gathered during the research. This research was conducted at six public schools in Abu Dhabi City, covering 126 students with Special Education Needs and Disability (SEND) with varying disability types. Students were from grades 1–12 and from ages 5–24. The student performance profile (SPP) was redesigned to suit the UAE education system and schools. The data was then collected, studied, and analyzed using Minitab® 17. The analyzed data inferred that Assistive Technology, redesign the activity or adaptations of specific curricular tasks, and personal assistance intervention strategies make similar high-level of contributions to help students with SEND to achieve individualized education program (IEP) objectives and goals among seven intervention strategies.

Keywords Abu Dhabi · Special needs students · SEND · Special needs education · IEP objectives · Assistive technology

1 Introduction

Disabilities are difficulties encountered in three functioning areas, including, (1) impairments in body functions; for example, blindness, (2) activity limitations, such as difficulties in executing activities.; for example, walking or eating, and (3) participation restrictions, as with problems involved in living life.

Instructional intervention strategies are very diverse and can play a vital role helping the student with special education needs rectify learning difficulties and

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enhance their educational skills in order to achieve positive academic outcomes [1]. This research paper will focus on seven intervention strategies, detailed later, and compare their relative outcomes with assistive technology, which is considered one of the most effective intervention strategies.

Despite the efforts made, there is still a scarcity of studies in the field of special education in the UAE. The majority of the few existing studies target the inclusion of the students with special education needs within the instructional environment. One prominent study was conducted by Nadera Emran and Eman Gaad [2]. It took place during a full academic year (2011–2012) in three government primary schools. Other interesting studies were conducted to look at the position of inclusion status in the UAE [3, 4]. The studies were interested in the different stakeholders' perceptions concerning the implementation of inclusive education strategies in the UAE.

However, when it comes to AT implementation, effectiveness, usability, impact, and level of participation in the education system, the researchers could not find studies. That is one of the key factors for exploring and investigating the relative impact of assistive technology within inclusive education in the UAE, and particularly in the Abu Dhabi public schools.

The two problem statements that this study intends to investigate are:

- A statistically significant difference in contributions toward student academic performance exists between the seven intervention strategies.

H10: Contribution mean of AT, natural development, compensation for impairment, adaptations of specific curricular tasks, redesign of the instructional environment, support services, and personal assistance are equal.

H1a: Contribution mean of AT, natural development, compensation for impairment, adaptations of specific curricular tasks, redesign of the instructional environment, support services, and personal assistance are different.

- AT has a significant and relative positive impact on special needs student academic performance compared to the other six intervention strategies.

2 Literature Overview

2.1 From Special Education to Full Inclusion

Disability, as defined under the Equality Act of 2010, is “a physical or mental impairment which has a long-term and substantial adverse effect on their ability to carry out normal day-to-day activities” [5].

The inclusion of students with special needs into the education system was not an easy task. It took almost two decades internationally to pave the way for it [6]. However, students/adults with special education needs still encounter a level of exclusion in their communities in one way or another.

In the early days of special education, students with disabilities were placed in special classrooms, separated from their peers, and consequently, there was no

interaction between those students and the general school population during various activities. Beginning in the US in 1975, the government enacted Public Law 94-142, known as the Education for All Handicapped [sic] Children Act, which has been renamed to the Individuals with Disabilities Education Act (IDEA) in 1990. This was followed by the Americans with Disabilities Act (ADA), [6]. IDEA provided rights for all children, aged 3–21, to be included in mainstream schooling, apart from children with severe disabilities. Those children are enrolled in special education classes or separate schools. Implementation of that trend was not as expected by families, advocates, or pedagogical professionals.

In 1994, the United Nations Educational, Scientific, and Cultural Organization (UNESCO), announced the Salamanca Statement as a worldwide commitment for inclusive education for students with SEND [6]. That was a paradigm shift for stimulating and persuading mainstream education to integrate students with special needs within it and enact the required amendments of the curriculum to consider those students, providing government funded programs, and providing proper training for school personnel and teachers. That then set the stage for adequately experienced staff and stakeholders in the treatment of students with SEND in public education.

In the UAE, the government did not spare any effort to be a pioneer in the field of special education as a part of its global commitment toward students with SEND, who represent an important part of the country, region, and world community. The federal government developed a variety of actions by signing an optional Protocol to the UN CRPD [7] in 2008, then ratified during the convention in 2010 [8]. Furthermore, the UAE federal government enacted legislation toward formalizing a framework for the inclusion of special needs students to become an integral part of the general educational system [9].

In May, 2010, MOE released the initiative, ‘School for All,’ which consists of general rules and regulations for the provisioning of special education programs and services to “people of determination,” in collaboration with MOSA and MOH [10, 11].

2.2 *Interventions in Special Education*

In the education process, intervention strategies are concerned with the student’s academic progress. It is an attempt to assess performance and define the gaps, for example, in cognitive reading, writing, and math skills; or behavior and attitude at early stages in the child’s development. Early intervention plays a crucial role in the students’ academic life. It helps identify the weaknesses, which cause underperformance of the student in comparison to others.

This study adopted seven intervention strategies that enhance the performance of students with disabilities. These strategies serve as the basis for the Student Performance Profile (SPP), an instrument used in this research. In 2000, Smith introduced these intervention approaches as, (1) remediate the impairment and natural development, (2) teach the individual to compensate for the impairment, (3) provide assistive

technology, (4) redesign the activity or adaptations of specific curricular tasks, (5) redesign the environment, and (6, 7) use personal assistance and support services [12].

An overview of the seven intervention strategies as follows:

Remediate the impairment and natural development. A language specialist/pathologist can reduce the impairment and ameliorate the disability. A difficulty with word finding and word meaning can be remediated by a group or individual activity by matching a word to a choice of pictures.

Teach the individual to compensate for the impairment. For example, a student can be taught to use the other hand if one is impaired.

Provide assistive technology. Low, moderate, or advanced technology or services can assist the individual after selecting the appropriate tool/device, buying it, and training him/her to use it effectively.

Redesign the activity or adaptations of specific curricular tasks. The teacher can modify a math task to simplify the activity. For example, counting by using objects, or play math games.

Redesign the environment. The classroom teacher can develop new ways to present the curriculum by group discussions, interactive instructions, playing activities, and/or altering the physical layout of the classroom.

Use personal assistance and support services. A student with SEND can get a bundle of support services as a part of special educational services from the school and medical team. Examples might be a personal assistant, an aide, a shadow teacher, a helper, and/or an interpreter. In addition, support services can be occupational therapy or physical therapy or any similar services.

2.3 Assistive Technology

As illustrated in the previous section, the third intervention strategy is assistive technology devices and services, which are usually provided by the school system and the Department of Education. AT is considered as an equalizer for students with varying types of disabilities, mild to severe, to practice and participate in various types of education activities equitably with their nondisabled peers. Assistive Technology can be defined as, “any item, piece of equipment or product system, whether acquired commercially or off the shelf, modified, or customized, that used to increase, maintain, or improve functional capabilities of individuals with disabilities” [13]. AT can assist students in accessing the curriculum, execute assigned tasks, address and augment weaknesses in comprehension, and ameliorate the defects hindering the student from achieving desired goals and outcomes.

AT can also provide tremendous opportunities for students with SEND to maintain their presence in the education system. Some of the areas in which assistive technology can play a vital role are communication, reading, writing, and math [14].

Communication. AT helps in reducing the effects of communication disorder. This type of AT is called, “augmentative and alternative communication” (AAC).

Table 1 Assistive technology devices and applications

Disability domain	Low tech	Mid tech	High tech
Communication	Communication board with symbols, a dry erase board	Symbols board with recorded voice	Touch screen AAC device, text-to-speech devices, and software

AAC supports students who have difficulty in articulating ideas to talk with others and respond in meaningful ways. In addition, it fosters social interaction and daily conversation. AAC comes in many forms, from a simple eye-gaze board to speech synthesis devices or software.

Reading. A student with SEND may have a reading problem, such as dyslexia. Reading could be one of the difficulties encountered by the student, where the ability to identify and remembering the written text is at its lowest level. AT helps reducing the negative impact of this thru various applications of technology, by a simple reading pen to high-tech text-to-speech software.

Writing. Similar to the reading skills, a student with learning disabilities can experience what is called, dysgraphia. Dysgraphia is “a neurological disorder characterized by writing disabilities. Specifically, the disorder causes a person’s writing to be distorted or incorrect.” [15]. AT can facilitate and address this weakness via several technologies, from simple pencil grips to high-tech word processing software.

Math. This learning disability is called dyscalculia [15]. Commonly, for the student who has this difficulty, his/her performance would be adversely affected in the execution of math tasks, assignments, and activities. Assistive technology has many techniques and technologies to assist with these challenges by offering a simple tactile ruler or more sophisticated math software with or without voice recognition.

Table 1 exhibits some AT tools, devices, and software applications, which cover the areas as an example of their usage, varying from low-tech, mid-tech, to high-tech.

2.4 Assistive Technology Outcomes

Students with learning disabilities are found to benefit from AT. For example, in science classrooms, students were able to improve biology vocabulary using AT devices [16]. Writing skills are notably enhanced and a positive impact for students was achieved, such as in text quality, time spent writing the assignment, spelling errors improved, and an increase in legibility [17, 18]. In addition, for the students who experience difficulties in reading, AT offers text-to-speech tools and applications, which increased their performance by helping them have enough time to listen and comprehend the content [19]. Interestingly, assistive technology advancements bring intrinsic hope for students who suffer from other educational needs, such as physical, visual, hearing impairment, intellectual, ADHD, and emotional disorders. It provides support for the students in their education, social, and personal lives [20].

2.5 Technology Acceptance Model (TAM)

One of the main factors that affect the intention of people to use technology is its perceived ease of use and usefulness. These two factors represent the two main concepts upon which the Technology Acceptance Model (TAM) is based on [21]. This model in consistence with some other models such as Diffusion of Innovation [22].

2.6 Acceptance of Assistive Technology

Two of the main principles that TAM is based on are the ease of use and the perceived usefulness. The latter (i.e. the perceived usefulness) was found to be one of the dominant factors that affect the use of assistive technology by special education teachers teaching students with visual impairment [23]. [24] believes that there is a kind of causality between the ease to use and usefulness. According to him, a person would consider a new technology useful if he or she is able to use.

AT is usually divided into three categories; low tech such as grabbers, med-tech such as calculators and high tech devices which depend on natural language processing applications such as speech recognition and artificial intelligence [25]. According to [26] a person would adopt a new technology if he/she believes that it would improve his/her job performance. Mobility and availability were also considered two of the main determinants that help a user to adopt a new technology [27].

3 Research Methodology

3.1 Research Type and Data Collection

The process for research and data collection included taking feedback from an Arabic/English of a customized Student Performance Profile (SPP). This tool was originally created by the Ohio Department of Education and the Rehabilitation Research Design and Disability (R2D2) Center for Ohio Assistive Technology Infusion Project [28]. The survey was conducted in 2017 and statistically compared the relative contribution of AT with a variety of other intervention strategies and techniques on student progress.

The researchers then employed quantitative methods with parametric techniques to determine the significance of the statistical comparisons. Parametric tests can be applied against non-interval data, despite the fact that it doesn't comply with the minimum requirements, such as sample size, normality, and un-equal variances [29]. The use of parametric tests for ordinal data provided more robust results than the

non-parametric tests [30]. The large sample size of data increased the validity of the results [31], and in this study, the sample size is 126. The usage correlation parametric (Pearson) tests, or non-parametric (Spearman rho) on Likert data did not affect the conclusions drawn from the derived results [32]. While doing the parametric analysis, an 11-point Likert scale was used for better results and it provides more success in determining the construct validity [33].

The essence of the research was to find significant differences between the relative advantages of AT's contribution to improving performance of the student with special needs over the relative contribution of other intervention strategies. ANOVA is the primary tool for analyzing Likert scale data or when data may not be equidistant [34]. In addition, for comparison of the variance ratio in a balanced way, one-way ANOVA is the best approach. One-way ANOVA takes into consideration the consequences of both types of errors (false positive and false negative), which may be seen during hypothesis testing [35].

The research found that using Fisher's exact test is a very robust method for estimating the significance of the statistical comparisons [36]. Additionally, Fisher's exact test helps in identifying the association among the data sample variables [37]. Practically, Fisher's exact test aids in testing the significance of the statistical comparison of categorical data. It helps in identifying the exact difference of the null hypothesis to the alternate hypothesis based on the analysis results [38].

To find the correlation among sample variables, the study used the Pearson correlation, which is a helpful in identifying the coefficient correlation from the collected data [39]. The Pearson correlation assisted the research by statistically determining the correlative relationships between two variables [40].

A paired t-test helped to further increase the precision of the statistical results by finding evidence that would show whether the mean difference between the paired samples was the same or significantly different from zero [41]. It also assisted with precision by using a mean-centered independent variable [42]. Using the paired t-tests was very beneficial for comparison of the means and the test results are robust, without being dependent on the input data, whether or not it showed falling normal distribution or equal variances [43].

3.2 Survey Design and Distribution

The questionnaire (SPP) form consisted of three sections. Section 1, which comprised of four sub-sections. Sub-sections 1, 2 capture student's information. Sub-section 1, first field is School-Student/Code, which is mandatory to have a code basis for all students across all schools, keeping all student information confidential and easy to follow-up in future inquiries between the researcher and the case manager. The second field, School Name, is optional. The third field is Student Grade and the fourth field is Student Birth (year).

Sub-section 2, Student Disability Category, has nine check boxes, wherein, the respondent selected one of the categories. Sub-section 3 requires identifying the AT

devices provided by the Department of Education. Finally, Sub-section 4 captures the respondent's role.

Section 2 captures the students' areas of need based on disability type. All respondents had been requested to list the top three "Student Area of Need" from their IEP. Those areas will be used in Sect. 3.

Section 3 covered responses from special need teachers and coaches or student case managers to record the contribution of all intervention types on student academic performance. The responses were captured on a Likert scale of 0–10, where 0 = No Contribution, 10 = Full Contribution. The respondents were asked to rate the contribution of each intervention method independently from each other. For example, two interventions could have same level of contribution to student progress. This was done to maintain the internal credibility of the information collected and minimize any bias.

The questionnaire form was customized from an original SPP to accommodate the ADEC/ADEK educational curriculum subjects, such as adding Arabic language to the area of need Sect. 2.

3.3 Data Collection Method

After the pilot study, respondents were given time (2–4 weeks) to fill out the questionnaire (SPP) forms. There were corresponding e-mails and direct phone calls between the researcher and the respondents to clarify any concerns and inquiries. The hard copies of the completed SPP forms were then collected and were subsequently analyzed for correctness. Based on the input received, data analysis was conducted using Minitab® 17 and pivot tables to generate statistical descriptive and inferential results.

3.4 Timeframe, Context, Population and Ethics

The questionnaire (SPP) forms were distributed at six public schools at Abu Dhabi during first, second and third semester of academic year 2016/2017. The responses were completed for the top three IEP objectives for all 126 students by June 2017.

The confidentiality and anonymity of all participant information was preserved. The research results intended to be used to help the students and for academic research to identify in which areas AT can contribute in the best way to assist the academic progress of students with SEND.

Table 2 Intervention type description

Intervention code	Intervention description
Intv. 1	Natural development
Intv. 2	Compensation for impairment by the student
Intv. 3	Adaptations of specific curricular tasks
Intv. 4	Redesign of instructional environment
Intv. 5	Related support services
Intv. 6	Personal assistance
Intv. 7	Assistive technology tools, devices, or software

4 Research Results and Discussion

4.1 Inferential Analysis and Intervention Strategies Contribution Level

In this section, the contribution of various intervention strategies on the academic performance of students with special needs were analyzed, to test research statement 1 and research statement 2. It helped further in identifying the statistical significance contribution levels for each intervention type based disability type. Table 2 depicts the intervention description and the code for each of the intervention types that have been used by Minitab® 17 to simplify the analysis of the data instead of long wording.

4.1.1 Assessment of Intervention Types Contribution (Research Statement 1)

In this section, exploratory data is analyzed to check the mean results for intervention types 1–7. For this, one-way ANOVA was applied between sample results from intervention 1–7 to check whether there were statistically significant differences among the means of sample results or they are same. The positive result against research statement 1, would lead to further analysis, and research would be conducted to identify where the differences are happening.

One-Way ANOVA

Are means of Intv. 1, Intv. 2, Intv. 3, Intv. 4, Intv. 5, Intv. 6, and Intv. 7 equal?

As illustrated in Tables 3, 4 and 5, the degree of freedom (df) is 6. As the P -value is smaller than the α value, it infers that the samples have statistically different means. Hence, the null hypothesis is rejected, so at least one statistical significant difference in means is available between at least two of the interventions.

Table 3 Method

Null hypothesis	All means are equal
Alternative hypothesis	At least one mean is different
Significance level	$\alpha = 0.05$
Equal variances were assumed for the analysis	

Table 4 Factor information

Factor	Levels	Values						
Factor	7	Intv. 1	Intv. 1	Intv. 1	Intv. 1	Intv. 1	Intv. 1	Intv. 1

Table 5 Analysis of variance

Source	DF	Adj. SS	Adj. MS	F-value	P-value
Factor	6	4208	701.278	88.00	0.00
Error	2639	21,030	7.969		
Total	2645	25,238			

Table 6 Means

Factor	N	Mean	St. dev.	95% CI
Intv. 1	378	2.206	2.021	(1.922, 2.491)
Intv. 2	378	2.463	2.285	(2.178, 2.748)
Intv. 3	378	5.341	2.357	(5.057, 5.626)
Intv. 4	378	4.13	2.782	(3.845, 4.414)
Intv. 5	378	4.481	2.882	(4.197, 4.766)
Intv. 6	378	5.481	3.594	(5.197, 5.766)
Intv. 7	378	5.254	3.457	(4.969, 5.539)

Table 6 shows the mean, standard deviation, and confidence interval (95% confidence) for each intervention type.

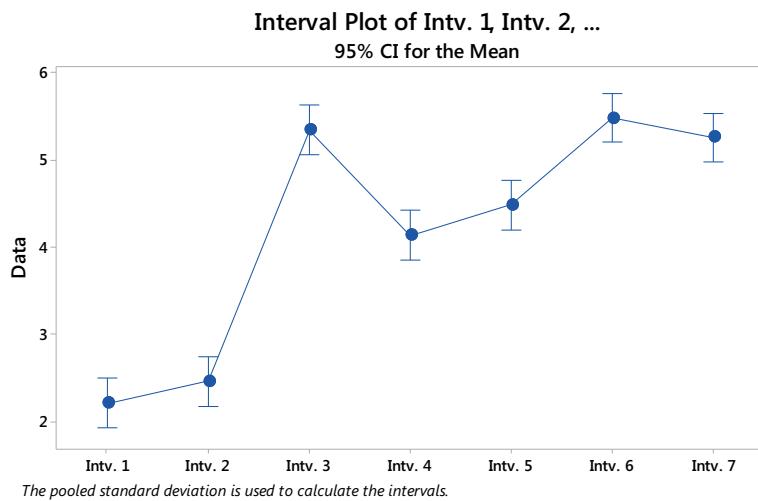
Fisher Pairwise Comparisons

This comparison was used among intervention types to check which interventions were significantly different.

As shown in Table 7, means that do not share a letter are significantly different. Here, it is found Assistive Technology to be significantly different from related and support services, the redesign of the instructional environment, the compensation for impairment by the student, and Natural development. Figure 1 depicts intervals plotted among different intervention types.

Table 7 Grouping information using the fisher LSD method and 95% confidence

Factor	N	Mean	Grouping		
Intv. 6	378	5.481	A		
Intv. 3	378	5.341	A		
Intv. 7	378	5.254	A		
Intv. 5	378	4.481	B		
Intv. 4	378	4.130	B		
Intv. 2	378	2.463	C		
Intv. 1	378	2.206			

**Fig. 1** Interval plot of results from Intv. 1 to Intv. 7

As illustrated in Table 8, Fisher's individual tests for the difference of means with 95% confidence intervals were observed. The adjusted p -values for differences in assistive technology and other intervention types is >0.05 solely for adaptations of specific curricular tasks and personal assistance. This signifies that assistive technology, adaptations of specific curricular tasks, and personal assistance have statistically similar contributions for student academic performance.

Figure 2 depicts Fisher's individual tests among results from different intervention types. Again, it was found that assistive technology is significantly different from natural development, compensation for impairment by the student, the redesign of the instructional environment, and related support services because among all the confidence intervals (CI), there is no zero in the range.

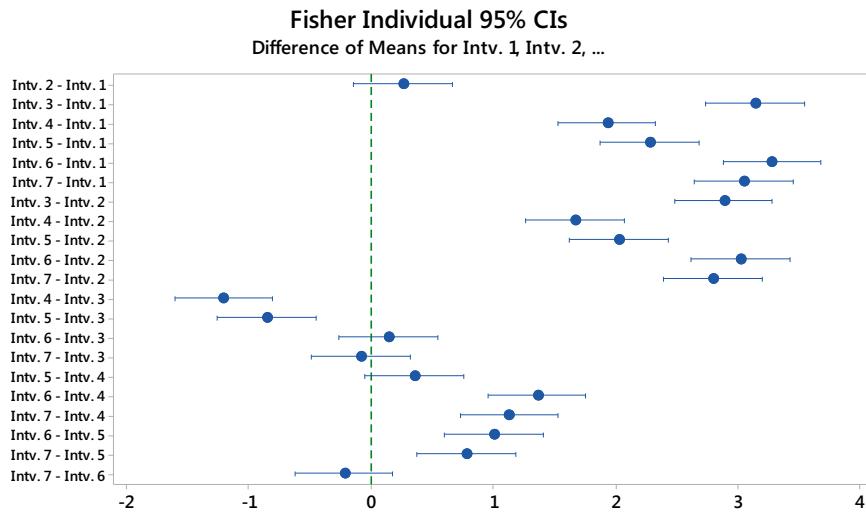
Table 8 Fisher individual tests for differences of means

Difference of levels	Difference of means	SE of difference	95% CI	T-value	Adjusted P-value
Intv. 2–Intv. 1	0.257	0.205	(−0.146, 0.659)	1.25	0.212
Intv. 3–Intv. 1	3.135	0.205	(2.732, 3.538)	15.27	0.000
Intv. 4–Intv. 1	1.923	0.205	(1.521, 2.326)	9.37	0.000
Intv. 5–Intv. 1	2.275	0.205	(1.872, 2.678)	11.08	0.000
Intv. 6–Intv. 1	3.275	0.205	(2.872, 3.678)	15.95	0.000
Intv. 7–Intv. 1	3.048	0.205	(2.645, 3.450)	14.84	0.000
Intv. 3–Intv. 2	2.878	0.205	(2.476, 3.281)	14.02	0.000
Intv. 4–Intv. 2	1.667	0.205	(1.264, 2.069)	8.12	0.000
Intv. 5–Intv. 2	2.019	0.205	(1.616, 2.421)	9.83	0.000
Intv. 6–Intv. 2	3.019	0.205	(2.616, 3.421)	14.7	0.000
Intv. 7–Intv. 2	2.791	0.205	(2.388, 3.194)	13.59	0.000
Intv. 4–Intv. 3	−1.212	0.205	(−1.614, −0.809)	−5.9	0.000
Intv. 5–Intv. 3	−0.86	0.205	(−1.262, −0.457)	−4.19	0.000
Intv. 6–Intv. 3	0.14	0.205	(−0.262, 0.543)	0.68	0.495
Intv. 7–Intv. 3	−0.087	0.205	(−0.490, 0.315)	−0.43	0.671
Intv. 5–Intv. 4	0.352	0.205	(−0.051, 0.754)	1.71	0.087
Intv. 6–Intv. 4	1.352	0.205	(0.949, 1.754)	6.58	0.000
Intv. 7–Intv. 4	1.124	0.205	(0.722, 1.527)	5.48	0.000
Intv. 6–Intv. 5	1	0.205	(0.597, 1.403)	4.87	0.000
Intv. 7–Intv. 5	0.772	0.205	(0.370, 1.175)	3.76	0.000
Intv. 7–Intv. 6	−0.228	0.205	(−0.630, 0.175)	−1.11	0.268
Simultaneous confidence level = 56.01%					

4.1.2 Assessment of Intervention Types Contribution Level (Research Statement 2)

Paired T-Test Between Assistive Technology and Other Intervention Types

In this test, the evidence of a significant difference between the sample mean of Assistive Technology and each of the other intervention types was investigated. Here



If an interval does not contain zero, the corresponding means are significantly different.

Fig. 2 Fisher individual test among intervention types (Intv. 1–7)

Table 9 Paired T for Intv. 7–Intv. 1

	N	Mean	St. dev.	SE Mean
Intv. 7	378	5.254	3.457	0.178
Intv. 1	378	2.206	2.021	0.104
Difference	378	3.048	3.724	0.192

95% lower bound for mean difference: 2.732

T-test of mean difference = 0 (vs. > 0): T-value = 15.91 P-value = 0.000

it was assumed that H₀ was the null hypothesis, which assumes there is an equal or less than contribution mean of AT against other intervention strategies. Moreover, the alternative hypothesis, H₁, the contribution mean of assistive technology > the contribution mean of a respective intervention type is true.

Paired T-Test: Assistive Technology, Natural Development

Table 9 shows that the *p* value is <0.05 and the *t* value is significantly higher than 0. Hence, the mean of the differences of the student progress is statistically significant. Therefore, the null hypothesis is rejected, and it is concluded that the contribution mean of assistive technology is greater than the contribution mean of natural development. Figure 3 depicts a 95% lower bound between the mean difference of intervention 7. And intervention 1 is higher than the null hypothesis (H₀).

Paired T-Test: Assistive Technology, Compensation for impairment by the student

Table 10 shows that the *p* value is <0.05 and the *t* value is significantly higher than 0. Hence, the mean of the differences of student progress is statistically significant.

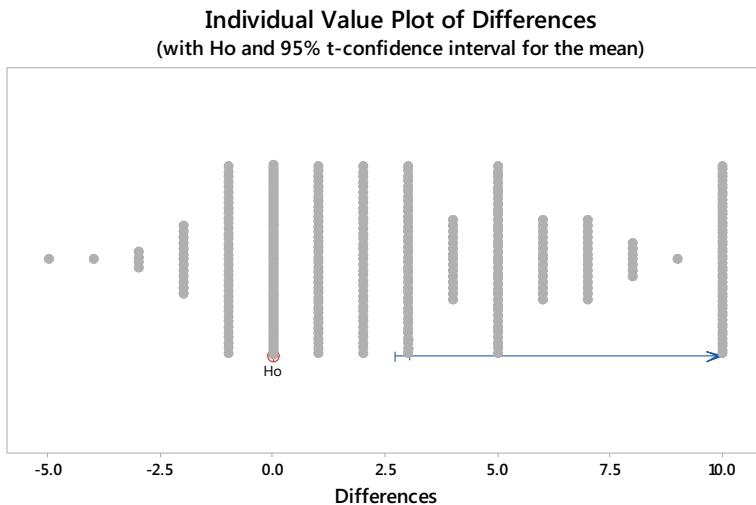


Fig. 3 Paired *t*-test: individual value plot of difference (Intv. 7 vs. Intv. 1)

Table 10 Paired T for Intv. 7–Intv. 2

	N	Mean	St. dev.	SE Mean
Intv. 7	378	5.254	3.457	0.178
Intv. 2	378	2.463	2.285	0.118
Difference	378	2.791	3.673	0.189

95% lower bound for mean difference: 2.479

T-test of mean difference = 0 (vs. >0): *T*-value = 14.77 *P*-value = 0.000

Therefore, the null hypothesis is rejected, and it is concluded that the contribution mean of assistive technology is greater than the contribution mean of compensation for impairment by the student. Figure 4 depicts a 95% lower bound between the mean difference of intervention 7 and intervention 2 and is 2.479 higher than the null hypothesis (H_0).

Paired T-Test: Assistive Technology, Adaptation of specific curricular tasks

Table 11 shows that the *p* value is >0.05 and the *t* value is not significantly different than 0. Hence, the mean of the differences of the student progress is statistically similar. Therefore, there is insufficient evidence to reject the null hypothesis and it is concluded that the contribution mean of assistive technology is equal or less than the contribution mean of adaptations of specific curricular tasks. Figure 5 depicts a 95% lower bound between the mean difference of intervention 7 and intervention 3 that is -0.369 , and the mean difference range is touching the null hypothesis (H_0).

Paired T-Test: Assistive Technology, Redesign of instructional environment

Table 12 shows that the *p* value is <0.05 and the *t* value is significantly higher than 0. Hence, the mean of the differences of the student progress is statistically

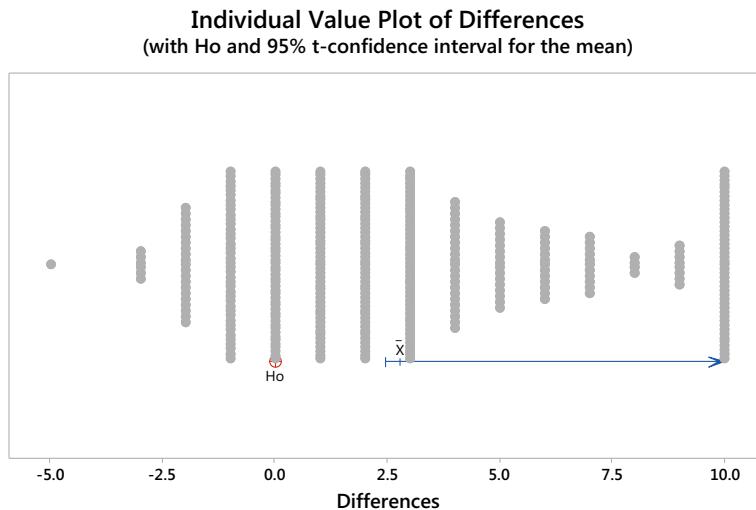


Fig. 4 Paired *t*-test: individual value plot of difference (Intv. 7 vs. Intv. 2)

Table 11 Paired T for Intv. 7–Intv. 3

	<i>N</i>	Mean	St. dev.	SE Mean
Intv. 7	378	5.254	3.457	0.178
Intv. 3	378	5.341	2.357	0.121
Difference	378	-0.087	3.326	0.171

95% lower bound for mean difference: -0.369

T-test of mean difference = 0 (vs. >0): *T*-value = -0.51 *P*-value = 0.695

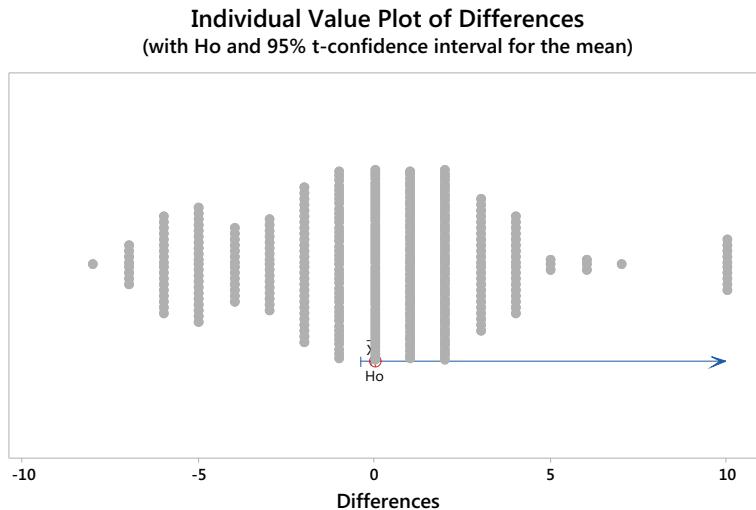


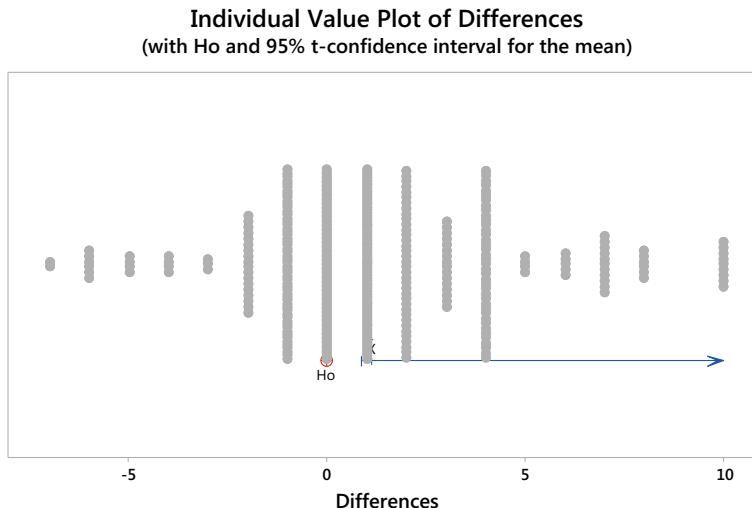
Fig. 5 Paired *t*-test: individual value plot of difference (Intv. 7 vs. Intv. 3)

Table 12 Paired T for Intv. 7–Intv. 4

	N	Mean	St. dev.	SE Mean
Intv. 7	378	5.254	3.457	0.178
Intv. 4	378	4.13	2.782	0.143
Difference	378	1.124	2.932	0.151

95% lower bound for mean difference: 0.876

T-test of mean difference = 0 (vs. > 0): T -value = 7.46 P -value = 0.000

**Fig. 6** Paired t -test: individual value plot of difference (Intv. 7 vs. Intv. 4)**Table 13** Paired T for Intv. 7–Intv. 5

	N	Mean	St. dev.	SE Mean
Intv. 7	378	5.254	3.457	0.178
Intv. 5	378	4.481	2.882	0.148
Difference	378	0.772	4.698	0.242

95% lower bound for mean difference: 0.374

T-test of mean difference = 0 (vs. > 0): T -value = 3.20 P -value = 0.001

significant. Therefore, the null hypothesis (H_0) is rejected and it was concluded that the contribution mean of assistive technology is greater than the contribution mean of the redesign of the instructional environment. (Figure 6).

Paired T-Test: Assistive Technology, Related support services

Table 13 shows that the p value is <0.05 and the t value is significantly higher than 0. Hence, the mean of the differences of the student progress is statistically significant. Therefore, the null hypothesis (H_0) is rejected and it's concluded that the

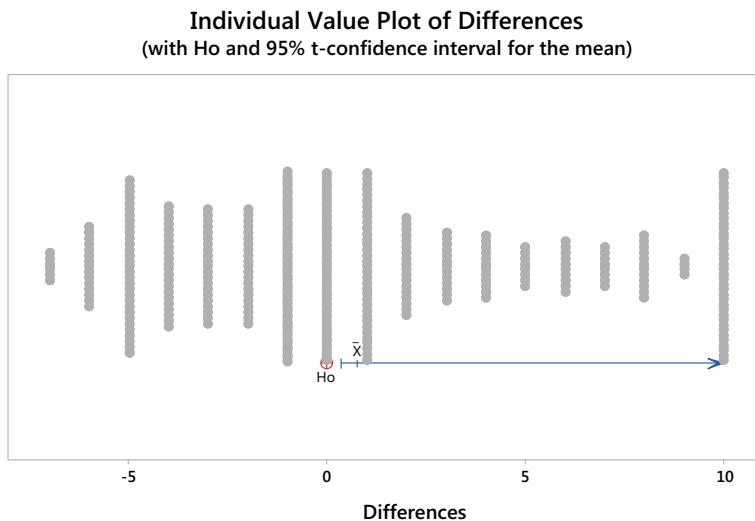


Fig. 7 Paired *t*-test: individual value plot of difference (Intv. 7 vs. Intv. 5)

Table 14 Paired T for Intv. 7–Intv. 6

	<i>N</i>	Mean	St. dev.	SE Mean
Intv. 7	378	5.254	3.457	0.178
Intv. 6	378	5.481	3.594	0.185
Difference	378	-0.228	4.074	0.21

95% lower bound for mean difference: -0.573

T-test of mean difference = 0 (vs. > 0): *T*-value = -1.09 *P*-value = 0.861

contribution mean of assistive technology is greater than the contribution mean of related support services (Fig. 7).

Paired T-Test: Assistive Technology and Personal Assistance

Table 14 shows that the *p* value is >0.05 and the *t* value is not significantly different than 0. Hence, the mean of the difference of the student progress is statistically similar. Therefore, there is insufficient evidence to reject the null hypothesis and it is concluded that the contribution mean of assistive technology is equal to or less than the contribution mean of personal assistance (Fig. 8).

5 Conclusion and Recommendations

This section explores the results, summaries and findings, which was derived from the study, based on using student performance profile (SPP) as a research tool.

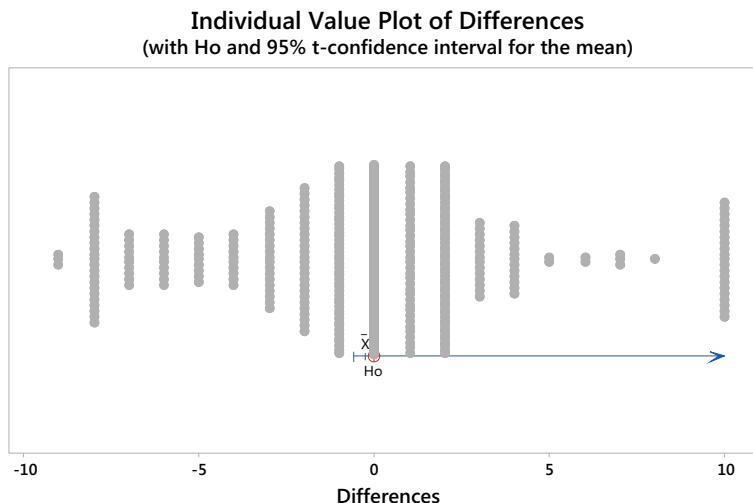


Fig. 8 Paired *t*-test: individual value plot of difference (Intv. 7 vs. Intv. 6)

The study found that assistive technology, adaptations of specific curricular tasks and personal assistance interventions have a similar and highest level of contribution towards achieving academic performance of students with SEND among the seven intervention strategies.

This result is consistent with the quasi-experiment study conducted by [44]. Furthermore, it was found that assistive technology's contribution as an educational strategy, can achieve significant results with other intervention strategies if multidisciplinary team members, for instance; AT team, special services team and teachers; work together as a team in the special education field.

This research was striving to explore the importance and relative contribution of assistive technology, at Abu Dhabi public schools' settings, toward achieving the optimum academic outcomes for the students with special needs and disability. It showed a positive impact of AT as a potential intervention strategy. Furthermore, this research encourages Abu Dhabi Department of Knowledge to invest more in assistive technology as an enabler to the students with SEND, to enhancing their academic performance and empower them for a brighter future.

After a perusal of results generated out of this research, the following steps are recommended:

- Offering training programs for teachers, AT team, special education team, students and parents-on the latest AT technology and its best practices.
- Encourage parents and families and engage them into AT usage by the students at the school place and at home.
- Applying the similar study at private schools.

The assertion of SEND's future in the UAE is always a part of the government vision for the “people of determination” to assure their vital role and contribution in the nation development.

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The Impact of COVID-19 on Rural Citizens for Accessing E-Governance Services: A Conceptual Model Using the Dimensions of Trust and Technology Acceptance Model



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Abstract World Bank Report highlights that nearly 65% of the entire population resides in rural villages. This displays the majority of the population has been covered by rural people in India. Hence any facilities offered by our government should productively reach the rural people, as they face multiple challenges in meeting their basic needs and requirements. E-governance is one of the successful platforms to provide convenience government services and communicate with the rural citizen with rural citizens at the most pandemic situation of COVID-19. Therefore this study has done a theoretical review on accessing the e-governance services by the rural people in this pandemic situation of COVID-19 through measuring the attitude of the people in the rural areas and their behavioral intention with the dimensions of trust. The study has discussed various dimensions of Trust for adopting e-governance services. The researchers have highlighted the percentage of people accessing government websites and obtaining e-governance health care services to safeguard their lives in a pandemic situation of COVID-19. The conceptual model developed by the authors can be extended by the researchers for making an empirical investigation through collecting the primary data from the government officials and people in rural and urban areas to view the obstacles in implementing it effectively. The findings of the research study help the government officials, policymakers, and people living at various places in society to understand basic needs and requirements for accepting the technology.

Keywords E-governance · Rural people · Common service centres · Health care services · COVID-19

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1 Introduction

E-governance is described as the system of facilitating government services through Information and Communication Technology. ICT is said to be the most comfortable mode for transferring the information between the citizens and the government [1]. Researchers call e-governance services as “SMART” which means Simple, Moral, Accountable, Responsible, and Transparent methods to deliver the services to the people living in our country. Effective and Smooth administrative function of offering the favours for the poor people is the ultimate aim of e-governance services [2]. It is successfully developed and utilized effectively in developed countries like UK, USA, China, etc. But in our country using government services through ICT is still in a growing phase. In our country, out of the total population 69.8% of people reside in rural villages and the literacy rate is comparatively lesser than 80% in rural villages across various states of India. It is considered to be a greater challenge and obstacles for the government officials to reach the rural people and facilities their services in a productive way [3]. The GOI has taken various actions for the development of rural villages and have taken various efforts to create awareness for the rural people to utilize the technology. It has developed Common Service Centres in remote villages to satisfy the needs and requirements of rural citizens. CSCs are considered as an umbrella to facilitate e-governance services like Agriculture, Financial Inclusion, Digital platform services, and Health care services [4]. This study has developed a review report on Common Service Centres of e-governance for health care services of rural development, highlighted the initiatives taken under e-governance services to safeguard the people from the pandemic virus COVID-19 and its impact on people to trust and believe the government services through ICT. This research study has examined the dimensions of Trust among the rural respondents towards accessing e-governance services and ascertained the impact of COVID-19 regarding the actual usage of e-governance services.

2 Dimensions of Trust Among the Rural Respondents Towards Accessing E-Governance Services

Trust is stated as a belief or an expectation towards the opposite party associated with the sensation of risk if the trust is reduced [5]. Trust is said to be build when the customers compute positive feelings on the networking sites and they are ready to adopt the vulnerabilities [6]. It is the belief or confidence that the customers have over another party and accept the facilities or services offered through the internet [7]. Trust plays an important role in making rural citizens access e-governance services [8]. Trust is stated as the challenging dimension for our government since citizens in our society get dominated by security and privacy issues. Hence trust is described as a perceived environmental security and competency issue for the citizen for using e-governance services [9].

2.1 Perceived Security (PS)

Perceived Security is defined as the degree in which a person believes that using smartphones are secure for sharing sensitive information like financial transactions and information about the consumers [10]. The Online environment is highly concerned regarding the importance of Security and privacy issues. Researchers have reported that security and privacy issues are the primary barriers found in Internet Shopping. These issues are further extended to accessing internet banking [11]. Security is considered as the major challenge for accepting banking services through Internet [12]. The range of accessing internet banking services has not further modified due to several security issues [13]. Studies examined that security issues are determined as significant dimensions to adopt online banking services in Australia [14]. Threats involved in internet banking can either be through the financial data that is transacted or with the networking sites, or with the unauthorized usage [15].

2.2 Perceived Privacy (PP)

Privacy is defined as the ability of a group or an individual to shelter their information about themselves and expressing themselves selectively [16]. Studies highlight that challenges related to the security and privacy of customer's information make unfavorable consequences towards assessing online services [17]. Researchers have identified that due to a lack of confidence in Information and Communication Technology's privacy and security, people hesitate to accept the vulnerabilities in accessing it or share their information [18]. Authors have discussed that a lack of control in the privacy of customer personal information leads to privacy risk in using an online transaction system [19]. According to the usage of e-commerce services in Spain, privacy and security are said to be the important dimensions to develop trust over the people for accessing it frequently [20].

2.3 Perceived Risk (PR)

Perceived risk is described as the customers' perception towards uncertainty on accessing Information and Communication Technology. It is stated that perceived risk is the likelihood of unlikely consequences regarding the purchase intention in consumer research [21]. It is the amount of uncertainty faced by consumers for utilizing specific products or services [22]. Authors have examined that, the perceived risk highly influences the willingness of a consumer to accept the innovation made in any services or products. In their study, the researchers found that there is a significant relationship between total perceived risk and consumer's perceived risk for adopting online banking services [23]. It is specified in the research study that perceived risk

for accessing the technology by the consumers affects their decision for utilizing it frequently [24].

2.4 *Information Quality (IQ)*

According to Information System Model, the successful system's output is called as the quality of Information provided by the system [25]. It is stated as the bulk of factors that are interrelated, functions, distribute, and store the information for supporting decision making and have control in an organization [26]. The research study has determined the various factors of Information and System Quality that impact the adoption of e-governance websites. The researchers have stated that the characteristics of information quality consists of timeliness, accuracy, relevance, completeness, and precision [27]. The study examined that out of various dimensions of Information System, relevancy, Completeness, and Accuracy plays a significant role when compared with other dimensions of Information System [28]. To access the frequent usage of e-governance website by the people, it is important to examine the quality of information facilitated by the website for the users [29]. Authors have measured that Information Quality is said to be the most significant factor with 0.84 as the coefficient value with the service quality of common service centres in rural areas [30].

2.5 *Perceived Usefulness*

Perceived Usefulness (PU) is described as the consumers' perception in connection with the results of experience [31]. Researchers have examined the impact of institutional beliefs regarding internet banking adoption. The research objective of the study is to analyze the pattern of using technology by bank customers in South Africa. The researchers have collected information from 300 respondents for the study. The authors have explored that 61% of the customers are highly benefitted in using Banking Services through Internet. The customers perceived that Banking services through internet are extremely useful to them [32]. Studies found that perceived usefulness is the most influential dimension for accepting e-recruitment techniques for job seekers. The study has been conducted among 356 job seekers for utilizing e-recruitment techniques. It is found that perceived usefulness has a coefficient value of 0.53 towards the attitude of the respondents [33]. Researchers have applied the TAM model to evaluate the actual behavior of the user for accessing banking transactions and gathering the information and purchasing the products [34]. Perceived Usefulness of Banking services are supportive in checking the bank balances, payment of bills and money transactions [35].

2.6 Perceived Ease of Use (PEOU)

Perceived Ease of Use (PEOU) is stated as the belief of the person on accessing a specific application or the system will be exempted from effort [36]. Researchers have identified the antecedents which impact the adoption of banking technologies by customers. The authors have utilized the TAM in the study and the information is gathered from 208 customers and made a path analysis for analyzing the significance between the variables used in the study. Result of the study highlights the positive relationship linking the variables PEOU and the bank customers' attitude with the beta value of 0.23 [37]. The Author has described the attitude of faculty members towards using ICT for teaching higher education. The researcher has gathered the primary data from 261 lecturers. The study has suggested that ICT will enhance competences and performance towards the faculty members for handling classes in universities [38]. The Study argued that banking services through technology have ease of use and minimum effort to process [39].

2.7 Attitude

Attitude is defined as both positive and negative feelings of a person or an individual concerning a particular behavior. Researchers have described that people encounter positive or negative feelings when they are accomplishing a specific behavior [40]. The researchers have identified that the dimension “attitude” is the most influential dimension to understand the behavior of the people living in rural areas [41]. Several theories such as TPB (Theory of planned behavior), TRA (Theory of reasoned action), and Technology Acceptance Model (TAM) described various dimensions of an attitude of a people for accessing technology [42–44]. The authors have used the Technology Acceptance model to build the conceptual framework on examining the attitude of people living in rural areas towards accepting mobile banking services with the business correspondent model as mediating variable [45]. Studies determine that the dimension of behavioral beliefs increase the acceptance rate of the cashless payment system among rural citizens [46]. Perceived Trust, ICT Literacy, and Service Quality are the important factors to describe the attitude of rural citizens to utilize the e-governance service [47]. The researchers have identified that perceived usefulness is the most influencing factor for examining the factor “attitude of rural citizens” towards adopting technology-based banking [48]. Through Information and Communication Technology (ICT) acceptance factors like Perceived usefulness (PU), Perceived Ease of use (PEOU), subjective norms, and voluntariness, the attitude of the people from rural villages can be analyzed for adopting mobile banking [49]. An increase in awareness of ICT among rural people increases their attitude for accessing it frequently [50].

2.8 Behavioral Intention (BI)

Behavioral Intention is referred to as analyzing the likelihood of a person when they adopt the system or an application. It is the dimension that predicts the future behavior of a person to use technology [40]. The authors have built a conceptual framework for the adoption of technology using TAM. Information has been collected from the 720 employees in a steel manufacturing company. Results highlight that the factors “behavioral intention” and “actual usage” have a relationship for accepting the technology among the employees [51]. Authors have identified that the dimension “behavioral intention” is the dominant variable to examine the utilization of mobile banking [52]. Researchers have analyzed the Behavioral Intention of the people for using 3G Technology. Researchers have utilized the TAM (Technology Acceptance Model) and the UTAT (Unified Theory of Acceptance and Use of Technology) for constructing a theoretical framework. The result of the study reveals that a variety of 3G services, perceived usefulness, social influence, and service quality are the various dimensions of Behavioral intention of the people for accessing 3G Technology [53].

2.9 Actual Usage (AU)

Actual usage is defined as the behavioral response examined by the actions of the individual in real life. It is the amount of time utilized in the system and using it frequently [54]. Researchers have examined the customers’ intention of accessing Shopping through the Internet. Researchers have utilized TAM (Technology Acceptance Model) and TPB (Theory of Planned Behaviour) to construct a conceptual model for analyzing the actual usage of customers Internet shopping [55]. Studies have targeted senior analysts in business schools under the marketing section for gathering the primary data. The study pointed out variables used in the study has a significant relationship with the standardized range of 0.7 [56]. The study has proposed the conceptual model for measuring the acceptance of technology by the employees. The authors reported that the variables “intention of the employees” and “Actual Usage” has a significant and positive relationship [57]. The study implications described that the attitude of the rural people is dependent on a lack of awareness on using the services through mobile banking [58]. Analysis of the study on accessing mobile based services reveals that there is a positive relationship between the attitude of the rural people and the Intention towards usage of technology [59].

3 Impact of COVID-19 for the Actual Usage of E-Governance Services

E-governance acts as the key to facilitate government services through the electronic system for the people living in the unreacheds systems in society. It facilitates the citizens to get benefited from their services at a reasonable cost. But, our government has faced several challenges and obstacles to reach the citizen in remote villages and create awareness about the e-governance services facilitated in rural areas. Due to a lack of awareness and lower level of literacy rates at villages, our government officials have suffered in making the rural people access e-governance services. People living in rural areas resist to change themselves and adopt technology-based services offered by the government. There occurs a drastic change among the people for adopting technology-based services during the pandemic situation of COVID-19.

On 31st December, 2019, strange a new pneumonia virus was reported in WHO (World Health Organization) country office, China. A cluster of cases with this virus was infected in Wuhan city, China. This deadly infected virus has given a name called “2019 Novel Corona Virus” (COVID-19) [60]. It causes respiratory infection to humans and it widely spread from person to person similarly like flu. This virus has spread all over the world countries like United States, Brazil, Russia, Spain, United Kingdom, Italy, India, Germany, etc. Thousands and Lakhs of cases have been reported daily in various countries [61]. World Health Organization (WHO) insisted people use masks during traveling at roads, doing home care and health care services, and use hand sanitizers for the prevention of the virus. India is in 7th place among the most affected countries like Italy [62]. The entire country was under complete lockdown for more than 75 days. Our government has regulated various moments to take care of public health. Under this condition, health care services under common service centres (CSCs) health care services play an important role in safeguarding the lives of people living in remote villages [63].

3.1 CSC (Common Service Centre) Health Care Services

The primary objective of CSC health care services is to protect the health and cure the illness of people in remote villages through Information and Communication Technology [64]. The objectives of CSC Health care services through ICT are:

1. Facilitate clinical support under non-emergency health conditions.
2. Associating the users by overcoming geographical barriers even for the people who are not in the same location.
3. Using several types of ICT based delivery channels to facilitate health care services even in the unreacheds corners of the society.
4. To provide quality and cost-effective health care services to the unserved and underserved people.

5. To improve rural entrepreneurship, enhance community participation, and promote activities for social improvements.

3.2 *Health Care Services Offered Under CSC*

There are about 8 different services offered under CSC [65]. They are listed below:

1. **Telemedicine:** It is the form of primary care for the people visiting CSC for seeking advice from the doctors during nonemergency medical conditions and when the direct contact with the doctor is not necessary. CSC-SPV (Special Purpose Vehicle) provides a platform to Village Level Entrepreneurs (VLEs) to get integrated with Digital Seva for getting consultations from specialists in Allopathy, Homeopathy, Ayurveda, and Veterinary Doctors.
2. **Diagnostic Services:** To identify the specific weakness and health conditions of village people, a diagnostic test has been done. There are two sets of diagnostic services provided in CSCs such as Invasive diagnostic tests and Non-invasive diagnostic tests.
3. **Medicines:** Under PRADHAN MANTRI BHARTIYA JAN AUSHADHI PARIYOJANA (PMBJP) scheme quality medicines are offered at affordable prices through JAN AUSHADHI KENDRA. These Kendra offers specific drugs that are available at lower prices to complete the vision of providing quality medicines to the poor at a reasonable cost.
4. **Products:** There are three different products facilitated under CSC. They are Patanjali Products for VLEs. They provide membership cards for the buyers to get benefited on their products, JIVA Ayurveda Products to get ayurvedic treatments at doorsteps and Essilor to prescribe lenses, spectacles, and sunglasses.
5. **Customized Health Packages:** It is the cost-effective treatment provided for the rural villages. The package includes the Health Homeo plan for 1 month that provides two teleconsultations and one medicine sent to the patient through courier. In Health Homeo 499 plan, the patients get facilitated for 5 video consultations with the doctors, first aid family kits, and 2 medicines will be sent through couriers. Health Homeo plan for Rs. 999 is the one year plan to get 9 video consultations, free medical consultation for the registered family members, first aid family kits, and 6 medicines sent through couriers.
6. **Training:** CSC SPV offers a training programme for blood sample collection to Village Level Entrepreneur (VLE). It is the 11 days training programme containing 2 days theory and 9 days of practical sessions.
7. **CSC Wellness Centres:** It is organized to facilitate tele-medicines, generic medicines services, and diagnostic services under one common roof through the networks of Common service centres (CSCs) [66].
8. **Digigaon:** It is the “Digi Gaon Initiatives” taken by the Ministry of Electronics and Information Technology for remote and rural villages. Through this platform, the citizens can get online services from the state, central and

private players. They create agents for promoting rural entrepreneurship, building capacity development programmes, and activities for social improvements.

3.3 Aarogya Setu App

On 2nd April 2020, the Ministry of Electronics and Information Technology, India has launched the Mobile Application called Aarogya Setu for limiting the spread of Coronavirus in the country. It enables contract tracing via Bluetooth, receiving recent information about COVID-19 and mapping with hotspots. The application can be accessed with 12 different languages on Android, KaiOS, and IOS platforms. The Application has successfully reached 114 million users till 26th May 2020. Transparency, Privacy, and Security are the three main pillars of this application to safeguard the citizens from this deadly Virus. The Government of India (GOI), have demonstrated the Aarogya Setu Application clearly and transparently to benefit the people by facilitating technology-based services and fight against the pandemic disease [67].

4 Research Gap

Several research studies have focused on the challenges and obstacles faced by the rural citizens for accessing the e-governance services. This research study has analyzed various dimensions of Trust such as perceived Security, Perceived Privacy, Perceived Risk, and Information Quality for adopting e-governance services. Very few research studies have described the services offered to the rural people through common service centres of e-governance especially the health care services. This research study has given a detailed description of all the health care services offered for the rural citizen for the societal and rural developments. During this pandemic situation of COVID-19, Information and Communication Technology is the only mode for the people to obtain any kind of facilities availed by the government. The most talkable and successful application called “Aaroya Setu” has been discussed briefly in this study.

5 Conceptual Model

Figure 1 displays the conceptual model of the research study. The study has taken the Technology acceptance model developed by Davis et al. [54]. Research Study has extended the Technological Acceptance Model for examining the adoption of social media usage among the students. The authors have explored that ‘Subjective Norms’, ‘Perceived enjoyment’, ‘Self-efficacy’, ‘Perceived Connectedness’,

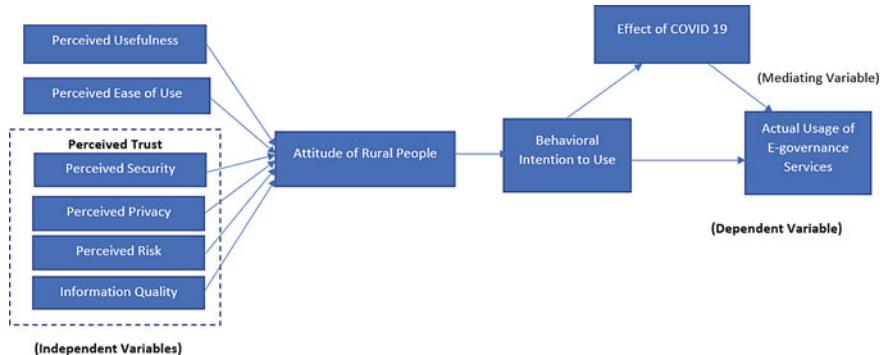


Fig. 1 e-Health care acceptance model

'Perceived Critical Mass', 'Perceived Trust', and 'Perceived Security' are the most constant factor for the extension of TAM [68]. Qualitative approach using meta analysis has been made by extending the UTAUT (Unified Theory of Acceptance and Use of Technology) Model for examining the adoption of mobile payment by the users. The finding of the research study reveals that Perceived Cost, Perceived Trust and Self-efficacy are the dimensions that have attained the significant results [69]. Perceived Trust and Perceived Risk are the most influential factors for Mobile payment usage among the students [70]. Performance Expectancy and Perceived Benefit has the positive relationship among the higher education students for adopting the system of e-payment [71]. To identify the technology impact on usage behavior, TAM is considered as the most inspiring models and it has been utilized widely in several contexts [72].

In this present study, the researchers have developed the conceptual model to examine the actual usage of the system by measuring the variable "Behavioral Intention (BI)" and "Attitude" to accept the services offered through technology. The researchers have considered the variables "Perceived Ease of Use (PEOU)" and "Perceived Usefulness (PU)" as the two independent variables for measuring the dimensions "Attitude of the people" and "Behavioral Intention" to adopt the technology. This study has considered attitude and actual usage as the study variables from the TAM. Additionally, the study has focused on analyzing the dimensions of perceived trust such as perceived security, perceived privacy, perceived risk, and information quality to measure the variables "Attitude" and "Behavioral Intention" of the people in rural villages for accessing e-governance Health care services with the mediating variable of COVID-19.

6 Limitations and Further Work

This study has discussed the positive view of COVID-19 and the drastic change in the mindset of the rural people to adopt the technology-based services offered by the government during the pandemic situation. The current study has described the present situation of rural development with the source of secondary data. Accessing the government websites has increased to 80% and accessing Aarokya Setu app has increased to 114 million people to safeguard their lives. This shows that people believe and trust the favours facilitated by our government through technologies. Even though this pandemic situation threatens the life of the people, it focuses on people to learn new knowledge and accept changes or innovations that are taking place in the countries. The study has limited with the theoretical discussion on people accepting the government services through ICT and constructed a model using TAM with the mediating effect of COVID-19. The study has proposed the “e-Health Care Acceptance Model” and it can further be extended by the researchers for making an empirical investigation through collecting the primary data from the government officials and people in rural and urban areas to understand the challenges in implementing it effectively.

7 Conclusion

The research study has identified the most influential gap from the existing literature survey by considering the positive view of COVID-19. It has created a huge revolution all over the world to create resistance in the mindset of the people in rural areas to accept e-governance services. It has created the strong hope that people in crisis receive and follow the guidelines of e-governance services specifically the health care facilities. Hence this research study helps the government officials, policymakers, and people living at various places in society to understand basic needs and requirements for accepting the technology. The researchers conclude with the statement that the study has highlighted the innovation of ICT created by the government and its successful acceptance rate of the people.

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Investigating the Impact of the Sense of Privacy on the Correlation Between Online Learning Interaction and Students' Academic Performance



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Abstract The purpose of this study is to investigate the impact of the sense of privacy on the correlation between online learning discussion on Social Networking Sites (SNS) and students' academic performance. Moreover, the study explores the actual use of SNS as a platform for students' and teacher online learning discussion. The sources of the data collection are students' and teachers' responses to online interaction questionnaire and the content of their online discussion. The data analysis involves the use of SPSS to analyse the descriptive data while SmartPLS to be used to analyse the correlations between online learning interaction and academic performance moderated by students' sense of privacy. The analysis of the online interaction through the pre-determined themes using Nvivo software. The researchers expect a positive relationship between online interaction and students' academic performance. Moreover, students' sense of privacy on SNSs might negatively affect the relationship between course-related discussion via SNSs and SNSs students' academic performance. The findings of this study aim to encourage instructors, students, and higher education institutions to consider students' sense of privacy when implementing SNS for online learning interaction.

Keywords Online learning interaction · Students and teacher interaction · Sense of privacy · Social networking sites · Academic performance

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1 Introduction

Online learning environments are witnessing exceptional development and expansion in twenty-first century. The ongoing technology expansion and advancement lead to a massive change in learning environment and the learners needs and expectations [1]. Social networking sites SNS is a significant result of the information communication technology advancement. SNSs have elements which made it a new phenomenon that brought an effect on many aspects of peoples' life. For instance, online learning in tertiary education was one of the most affected aspects by the advent of SNS. SNSs have brought a wide range of alternatives to online learning and its delivery mediums. Consequently, online learning environment is not limited to the traditional Learning Management System "LMS". SNSs are currently used by most of higher education students for the purpose of formal and informal online learning [2]. Interestingly, a national survey in Malaysia revealed that 67.6% of Malaysia internet users used the internet for study purpose where these type of activities were not limited to students [3]. According to the same survey, 89.3% of the internet users in Malaysia are visiting SNSs regularly.

SNSs have the characteristics and the features that make it a suitable tool to be used for educational purposes. For instance, SNSs have the capacity to facilitate many-to-many connectivity and to enable users to produce and share knowledge rather than merely consuming what was posted by other knowledge providers; More importantly, SNS support collaboration among learning community and inspire users' creativity [4]. The mentioned SNS characteristics made it vital for higher education institutions to catch up with its users [4].

2 Problem Statement and Study Rationale

The concerns about privacy invasion is principally true for SNSs under focus of this research. SNSs were designed to be a platform where users can create public or semi-public profile and share information [5] and personal details such as photos, name, gender, age, email address or hand phone number. Surprisingly, some users went beyond that to disclose their political view, religion, preferences, hobbies and even their physical places. Therefore, with students' preferences to use SNSs for learning, they still concern about the negative consequences of their privacy invasion when it comes to the interaction with the course instructor and other course participants.

The role of SNS in students learning process either formally or informally cannot be ignored. However, the existence of some negative consequences of SNSs use for education cannot be denied. For instance, sense of privacy is still concern when it come to the professional use of SNS. Nonetheless, research on the impact of students' sense of privacy on student's academic performance when using SNSs for course-related interaction is still limited. Therefore, this research is an effort to cover the

gap in the existing literature and to contribute for more reliable use of SNSs in higher education.

2.1 The Importance and the Benefits of the Research

SNSs are becoming inevitable reality in millions of people's life in this generation. SNSs are being part of people's daily life activities either it is social, professional, business, learning or entertainment activities. However, young people at high schools and university level are the most visitors of SNSs where they spend a lot of their time moving from one site to another. Therefore, it is imperative for educational system in any country around the world to consider the intensive existence of SNSs in students' life. In Malaysia for example, visiting SNSs was a common activity among 89% of the internet users in the country [3]. More importantly, young people's whose age between 20 and 34 years old were highest percentage 53.6 of the internet users in Malaysia in year 2016 [3]. Remarkably, 81% of Malaysian youth visit SNSs from 16 to 30 times a month where around 65% of them spent from 1 to 10 h each time they login SNSs [6]. Surprisingly, only 6.4% of Malaysian youths reported spending half hour or less each time they visit SNSs [6]. Consequently, considering the high number of Malaysian SNSs young users "most of them at university age" and the huge amount of time they spend on SNSs, it is imperative to conduct research in Malaysian context to figure out the viability of dedicating SNSs for course-related interaction to meet students' preference and interest and to point out the impact of students' sense of privacy on educational use of SNS. The finding of this research provides field-extracted findings for Malaysian higher education institutions' policy makers and top management to take steps forward about the possibility of harnessing the power SNSs in higher education institutions.

2.2 Objectives

This research aimed to achieve the following objectives:

1. To examine the actual use of SNSs for course-related discussion.
2. To explore student's perception towards the use of SNSs for course-related discussion.
3. To explore the relationship between Course-related discussion and students' Academic Performance.
4. To explore the moderation influence of students' sense of privacy on the relationship between course-related discussion and students' Academic Performance.

3 Literature Review

3.1 Students' Use of SNS

Nowadays, most young people are heavy users of SNS. Research findings showed that young people showed a positive attitude towards the use SNS where they spend a great deal of their time using those tools for different purposes [7–12]. In a study conducted in United Kingdom, the researchers reported that 45% of undergraduate and post-graduate students admitted spending between 6 and 8 h a day on SNS, 23% spend more than 8 h and 20% spend 2–4 h while only 12% of the students who spend less than 2 h on SNS [13]. Similarly, Malaysian teenagers reported that they spend 4 h each time they login SNSs or being online [14]. Remarkably, 67% of university students admitted that they keep using SNS during class time, while doing homework and during their study time [15].

Commonly, SNSs use is becoming a widespread phenomenon and highly used by young people around the world. In USA for example, a report by [16] revealed that 88% of American young people aged between 18 and 29 years old are using SNSs where most of the use four social networking platforms [16]. Moreover, a considerable percentage of the SNSs users indicated that they visit the sites several times a day [16]. Similarly, 88% of Malaysian young adult are using SNS [17]. In more recent report, visiting SNS was one of the common activities among 89% of Malaysian internet users [3]. For those reported facts, more research on the use of SNS in our daily life is needed to find out the benefit of its use and to reveal its negative effect especially on the young generation.

3.2 Course-Related Discussion on SNS

Course-related discussion in this project is the discussion and interaction among certain course participants that specified to discuss about the course content, share thoughts, ask questions or enquiries, reply to questions or enquiries. Course-related discussion also involve sharing related notes and materials, posting announcements, and setting time frame for the course activities that contribute to achieving the targeted learning outcomes. However, SNS tools are widely used as an online platform to facilitate course-related discussion by the instructors and students as well [18–22] where it can foster more discussion that stimulated by improved social presence [23–26].

In Malaysian context, [18] used Facebook as a medium to facilitate students and the instructor course-related discussion for Authoring System course. Their study examined the impact of metacognitive scaffolding of students learning where they developed a framework of metacognitive scaffolding (MS) to guide students in learning Authoring System. Jumaat and Tasir [18] argued that Facebook can be used to support students' knowledge sharing with the presence of the appropriate guidance

from the instructor based on reliable instructional strategies [27]. Moreover, [19] used WhatsApp as learning platform that support face-to-face learning environment for undergraduate and post-graduate students in EFL programs at university of Bahrain. WhatsApp was for posting, chatting and discussion for a period of 14 weeks. As a result, students shared a total of 445 posts and raised 232 questions to the instructor and peers about the class, learning materials, quiz and exam inquiries [19]. Furthermore, the reflection questionnaire showed that most students agreed that WhatsApp is a helpful tool for learning, allow sharing learning materials, improve teamwork skills and makes learning more enjoyable and motivate students to improve their assignment after receiving others comments [19].

An empirical study was conducted to examine the learners values of Facebook after they use it for 18 weeks for their writing course in Taiwan [22]. Facebook was used as a medium for instructor and students course-related discussion and interaction. Yu [22] study findings showed that 182 students' responses were posted to the instructor writing prompts and 178 students' responses to their peers posts [22]. Moreover, the survey findings showed that students considered Facebook as a useful for learning activities as it allows for interactive discussion at their convenient, motivate their learning, support collaborative learning and develop their critical thinking [22]. Hence, the previous studies showed that SNS can benefit students' learning and facilitate instructors teaching. However, the matter of privacy is still one of the barriers that limits the use of SNS for learning. However, investigating the effect of students' sense of privacy on using SNS for learning is an imperative to fill the gap in the existing literature and benefit the application of SNSs for learning through taking certain measures that protect students and the instructor privacy.

3.3 Sense of Privacy

Sense of privacy from users perspective is the “sense of anxiety regarding one's personal privacy” [28]. On the other hand, privacy invasion is the individuals' inability to maintain control over their personal data and information and its use [29]. Therefore, policymakers action is recommended to improve the protection regulations in order to insure the privacy and security of users personal data [30]. As a result, students in general perceive SNSs as social atmosphere which should be separated from University life [31] and they are not ready yet to use SNSs for formal learning [32]. A study conducted by Chu and Meulemans [33] reported that students prefer to use email as a mean of interaction with faculty more than SNSs. Moreover, another researchers found that even with students use of SNSs for informal learning, only 36% of the students agreed with the instructor use of Facebook for educational purpose or as formal learning medium [34]. Bruneel et al. [35] conducted an interview with 6 students as part of their study data collection; students were asked if they accept a friendship request on Facebook from faculty members, surprisingly all students were clear to decline friend request from faculty members. Students' attributed their decline decision to avoid privacy invasion and to keep faculty away

from students' personal life and their leisure time activities [35]. However, other researchers reported more moderate findings where students were positive about the use of SNS for education which involves contact with the instructor, nonetheless some students stressed the boundaries about the use of SNSs specifically in terms of privacy and the level of its use [36]. Additionally, students suggested SNS should be used in an informative and productive way with limiting its role as supplementary tool for the course content rather than its use as main platform [36].

In summary, SNSs have strongly established in people's personal life and in several ways connected to their professional life. It is hard for us to separate SNSs from education landscape and from higher education. The reported review of the previous studies showed no clear stand in either to use or not to use SNSs in education. It is clearly noticed that those experimental studies which employed SNSs in a real-world educational setting and for certain courses showed positive students' attitude towards SNSs and positive learning outcomes. Therefore, conducting more research on the use of SNSs for education in relation with students and instructor's privacy concern may offer ways to use SNSs without compromising both students and instructors' privacy.

4 Conceptual Framework

4.1 Instructor Interaction

Instructor interaction is the interaction direct from the instructor to the students. It reflects the online instructor actions and activities to communicate the course time frame, facilitate students discussion and share the knowledge and the learning materials [20, 37, 38]. In this study context, the focus is on the instructor interaction with students while using SNS tools for course-related interaction.

4.2 Students Interaction

Students interaction refer to student interaction with other students and with the instructor. It shows how students exchange knowledge, share ideas, ask or response to questions, reflect of learning and participate in the course discussion during online learning [21, 38]. Hence, this study investigates student's interaction when SNS is the online learning medium and course-related discussion platform.

4.3 Academic Performance

Academic performances in this study is a subjective estimation of what student believe he/she has learnt or achieved [39]. Perceived academic performance is the use of survey items to measure students belief of the level of learning, understanding and the improved skills that gained after going through certain course or training [23, 39] (Fig. 1).

5 Research Design

This study implements the mixed method which involve both qualitative and quantitative research design in collecting and analyzing the data. The use of mixed method strengthens research method through the possibility of triangulation [40]. Triangulation therefore helps researchers to deeply and accurately understand the issue under investigation. Accordingly, Quasi-experimental research design along with the correlational research design are opted to be applied. Hence, one group interventional design to be implemented to explore students actual use of SNS. To achieve that, the student's group can interact with peer and the instructor via SNS tools. Then, the interaction content will be coded on themes and the themes frequencies will be calculated. On the other hand, students' perception of using SNSs for online learning interaction and sense of privacy data to be collected using survey instrument. The survey data will be analyzed to find the correlation between the mentioned variables.

This study is designed to take place in 5 phases

- Phase 1: Adapting and developing research instruments, instruments validity, reliability test, and sampling.
- Phase 2: 7 weeks In-class learning activities supported by online discussion.
- Phase 3: Collecting Questionnaire data (Estimated 15 min to fill in each questionnaire).

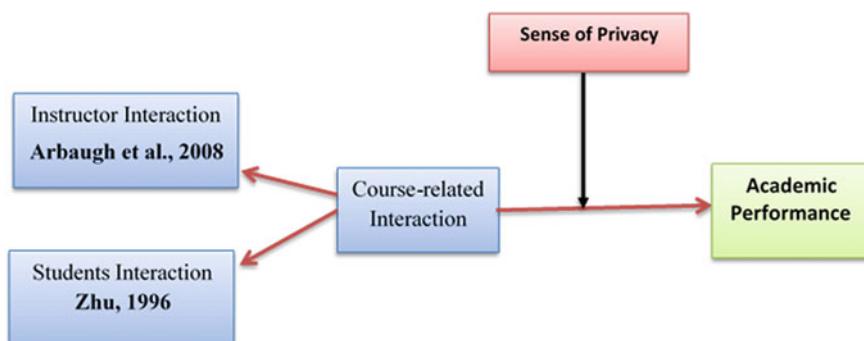


Fig. 1 Conceptual framework

Phase 4: Interview with selected students. Each selected student interview session will take about 20 min.

Phase 5: Data Analysis,

- (a) analysing the content of online discussion based on pre-determined themes
- (b) analysing the questionnaire data.

5.1 Study Population and Sample

The, population of this study is the total number of Pre-service teachers' programs students in one of the Malaysian Public Universities. The experimental part of this study is targeting one group students. The criteria of selecting the participants in the experimental part is that students who will registered for the course of multimedia in education will be asked to take part of course-related discussion sessions. For questionnaire data collection, However, through using random sample sampling method all pre-service teachers' programs students who enrolled at the time of conducting this study will be given the equal chance to respond to the questionnaire.

The estimated sample size for this study is estimated to be 300 students who are expected to be enrolled in pre-service teachers' programs in the targeted faculty of education at the time of conducting this study. However, sample size will be determine from the given population as suggested by Krejcie and Morgan [41]. The sample will be selected through random sample sampling. However, 30 students are estimated to register for multimedia in education course and is expected to participate in the experimental part of this study to achieve RO1. However, 10 participants in the experimental part of the study is the minimum number for reliable findings.

For experimental part of the study, the sample will be selected on a purposive sampling technique. Every student who will register of Multimedia in Education course that offered for in education program will be given the chance to participate in the experimental process of this study. In the other side, random sample sampling will be applied through which where all pre-service teachers' programs students will have the equal chance to participate in answering the questionnaire.

5.2 Research Instruments

Two instruments will be used for data collection and data analysis. The researchers will use 4 sections questionnaire with total 29 items to measure students' perceptions of course-related online discussion on SNS. The researcher developed the questionnaire sections with total of 29 items which cover instructor interaction and student interaction sections in addition to students' sense of privacy and students' academic

performance sections. Furthermore, the content of the online discussion will be analysed using analysis schemes developed by Anderson et al. [42]. However, the validity and reliability of the research instruments will be conducted through pilot test for the questionnaire and inter-rater check for the content analysis instrument.

5.3 Data Collection Method

Two methods of data collection will be employed in this research. First, to achieve the first research objective, the participants in experimental part of this study will be asked to use Facebook group to discuss about the course activities, assignments and the project. The content of online discussion will be used to analyse the way students use SNS for course-related discussion to construct knowledge. Second, randomly selected students will respond to the questionnaire. The researcher in this study will only take the role of investigator through observation during online discussion and will manage the tool for collecting online Questionnaire responses.

The data confidentiality will be ensured through making students discussion on Facebook group using closed group feature that allow only the participants to access the group. Moreover, students who will evolve in answering the questionnaire are not required to reveal their identity in the demographic part of the questionnaire. The participants will be assured that the collected data will be used only the research purpose and the identities of the participants will not be revealed by anyway unless required by law. Moreover, the findings of this study will be reported in a group basis and not in individual basis.

5.4 Data Analysis

The content of the instructor and students' online discussion will be analyzed based pre-determined themes to find out how the instructor and students' interaction take place to facilitate learning and knowledge construction. Nvivo software will be used to manage the content analysis.

SPSS software will be used to analyze the descriptive part of the data. However, SmartPLS will be used to explore the direct effect of online interaction via SNS on students' academic performance and the indirect effect when including the effect of students' sense of privacy as a moderator variable. The purpose of moderating variable is to explore how sense of privacy affects the relationship between online interaction via SNSs and students' academic performance.

6 Conclusion and Future Research

This study explores student's actual use of SNS and the impact of students' sense of privacy on the relationship between course-related discussion and students' academic performance. The qualitative part of the study is designed to identify the types of instructor and students' discussion via SNSs tool through the actual discussion. The findings aim to reveal the way students' process their learning when it comes to online learning session and the roles the online instructor in this process. On the other hand, the quantitative data analysis aims to reveal students' perception about course-related discussion via SNS tool. However, the study findings might show a positive relationship between course-related discussion via SNS and students' academic performance. In contrast, students' sense of privacy on SNSs might negatively affect the relationship between course-related discussion via SNSs and SNSs students' academic performance. In general, these findings add a valuable information to the existing literature about educational use of SNSs specifically concerning the effect of students' sense of privacy on SNSs.

This study design imposes some potential limitations. This study is designed to target pre-service teachers in one of the Malaysian public universities. This limitation will limit the power of the finding's to be generalizable to other fields and contexts. Moreover, the number of the participants in this study is limited to 79 students. Therefore, we recommend the future researchers to design their research to include students from different universities, programs and fields. Furthermore, future research may target larger number of students for the findings to be generalizable.

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The Effect of IT Employees' Engagement on Work Attitudes Through Cloud Computing Services



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Abstract Employee Engagement can be characterised by employees who are being committed towards the organization and it is where the employees are being prepared to go beyond the expected to deliver outstanding service to the end customer. Employee engagement deals with psychological aspect than the physical one. The primary objective of the study is to understand the effect of employee engagement on work attitudes. The work attitudes considered in the study are job satisfaction and intention to quit. The study was conducted on information technology employees working in companies providing cloud computing services. The research was operated with a sample of 100 respondents through a structured questionnaire which contained demographic variables and scale variables. Regression analysis is used to test the proposed model. The results suggest that employee engagement is the significant predictor of job satisfaction and employee's intention to quit. When the workers are engaged in work, it enhances their satisfaction in work and also reduces the thoughts of leaving the job.

Keywords Employee engagement · Job satisfaction · Intention to quit · IT employees · Cloud computing services

1 Introduction

Employee Engagement can be characterised by employees who are being committed towards the organization and it is where the employees are being prepared to go beyond the expected, to deliver outstanding service to the end customer. Employee engagement deals with psychological aspect than the physical one. Engaged employees get inspired of their work; they concentrate more on customer satisfaction, move forward for the company's growth and invest to look how successful the organization [1]. Engagement of employees can be viewed as the way an employee considers and feels about the organization and how the employee behaves proactive in

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achieving organizational goals for their customers, colleagues and other stakeholders [2]. Employee engagement has changed the traditional view of the job for life. When organization try to keep their employees engaged, employees' expectations increase. The job security and loyalty of employer is being influenced by the external factors and it would also result in changing social norms [3]. Initially the managers were able to get the work done through command and leadership style which adopted carrot and stick approach to ensure its productivity and achieve results [4]. The latest trending organization needs to look for new techniques or ways to motivate its employees to give the best. Especially in IT industry, an extremely dynamic industry, the employees will be expected to be exceedingly competitive in learning and updating themselves in knowledge [5]. This pressure may have an indirect effect on employee's satisfaction in work and may develop intention to quit the job [6]. Without guaranteed stability, employees start to look for something else from their employers. This made the employers to recruit and retain engaged employees towards the organization [7].

The notation of employee engagement is the importance not only in creating workforce that satisfies and makes them committed to the organization but one that strives to go an extra mile to offer voluntary effort to enhance the performance of the organisation [8]. Challenge for today's business is not only to satisfy employees but also to create an environment where they want to do give voluntary effort to go beyond the job description [9]. The organization needs to work very hard to win the loyalty of the best employees. Employee engagement can be better explained with the following dimensions namely, identification of the employee in the organisation, satisfaction, loyalty and commitment of employees and the level of performance delivered by employees.

2 Literature Review

Markos [10, p. 201] have stated that employee engagement is an extensive construct that interconnects with almost all fields of Personnel Management. Unless the employees are handled properly in all aspects of personnel management, they fail to engage themselves into the job which may result in maladministration. Employee engagement is the positive outlook of an organisational performance; it also shows a two-way relationship between the employee and the employer. Employees who are engaged will have high emotional attachment towards the organization and have high involvement towards their job. Managers struggle a lot amongst different challenges to stand ahead of their competitors. Managers require skilled professionals and technically sound professionals. This grabbed the attention of managers towards the employee side. Employee's efficiency and productivity lies within the ability and commitment of the employees. Initiatives taken by the management cannot be successfully accomplished without the involvement and engagement of the employees.

Lockwood [11] states that employee engagement is key business driver for any organization's success. If any organization has high level of employee engagement in

both national and international firms, it stimulates retention of proficient employees, cultivate employee loyalty and enhance the performance of the organisation which in turn increases stakeholder value. The vital and difficult task in this aspect is employee engagement which includes more factors such as workplace, organization communication, managerial styles, leadership style and organization's reputation. In the present generation, training and career opportunities, work life balance and employment play the major role in decision making, which is more important. Encouraging culture of engagement leads to design workplace policies and practises that attract and retain the talented employees with the core competencies, which is necessary for growth and consistency. HR needs to develop an effective employee engagement programme for the current and for future workplace.

Truss [12] have examined whether personal engagement occurs when people bring or leave their personal selves during their work role. These behaviours can be defined as cognitive and emotional degree of themselves during work. Engagements of employees are expressed through their physical involvement and emotional connections. It could also help to improve individual outcomes. It develops a perception of positive fulfilment of work and the employees experience them to improve their current situation. Satisfaction engagement is also a part of employee engagement which speaks about the individual's satisfaction, enthusiasm for work. Employee engagement is an invariable win-win scenario for both employees and employers.

Kaliannan [13] have examined the effectiveness of employee engagement and organizational success. Employee engagement is an art of converting satisfied employees to committed employees to immerse them in the organization who play a major role behind the organization's success. The concept of success depends upon the brand equity, market share and critically on the revenue generated. The attributes of organization's success come from the employees. They are the success catalysts that make the competitive firm and their absence could create the vacuum. Organizations with high employee engagement will hold an increase in operating income and earnings per share and organizations have less employee engagement experience a drop in operating income and earnings per share. Worker engagement is nothing but relationship relative to organization whereas workers engagement is involved in relationship with one's work. Worker engagement is one of the critical tools of talent management, it is in recent drive for talent at retention.

Vance [14] have confirmed that employee engagement and commitment helps a company to go for long run even without energized employees who believes in firms' vision and mission statement of the organization and understand to achieve them. It is necessary to measure employee engagement at least once in a year to understand the employees through surveys so they are completely safe and are given freedom to speak their minds.

Kumar [15] have studied the benefits of employee engagement which are, the attitude of the employees towards the management affects the way an employee consider their jobs and treat their customers. Exalted level of employee engagement is connected with extraordinary rates of profitability growth. Some researches focused on worker burnout and employees who have not experienced burnout seems to be engaged, they are positive about their work and sound it meaningful, they receive the

sufficient resources to competing the task. Other researches focused on cognitive, emotional and behavioural components associated with individual's performance. Employee engagement is a multi-dimensional construct that encompasses different facets of attitude and comportments of employees towards organization. Engaged employees connect to the organization and perceive themselves as a part of the organization.

Chandani [16] have examined the factors affecting employee engagement, as it has become the topmost priority and employers look for various methods to keep the workforce engaged. The management is finding it as a challenge to retain their employees engaged while executing policies. An engaged employee who yields high productivity, do not like to change their job frequently while they stay as emissary of the company. An employee who is engaged can experience three types of engagement such as feeling engaged to the job, not feeling engaged to the job and feeling disengaged. Workers who are engaged, work with enthusiasm towards the managerial goals. Whereas worker who is not engaged will participate for name sake and show less interest towards the organization's goal. Disengaged workers are those who are dissatisfied with their job. Engagement is also found in three different aspects which are intellectual engagement which refers to dedication towards performing better in one's job, affective engagement or feeling positive after the performing one's job and the third one is social engagement which involves discussion about enhancing work related improvements.

Mishra [17] examined the factors influencing attrition and retention. Employee attrition and retention is demonstration of employee movement in organization. Having good HRM will generate loyalty, commitment or willingness to put in extra effort for organization goals. Factors affecting organization commitment and turnover intention have found that the organizational factors play a major role in an employee's decision either to stay in the company or to leave the company. This also has a wider category and which may be classified as organization support and organization culture. The organization needs to weigh the variables which may affect the employee's morale to a greater extent in order to notice effective turnover.

Osborne [18] examined the effectiveness of employee engagement in the workplace. In order to keep their employees engaged the companies' needs to maintain the profitability and the leaders of companies must take effort to retain its employees. The usage of advanced technologies, skilled labour, best practices and education has helped to increase the efficiencies in major organizations. Disengaged employees who have lowered productivity has dropped down the financial performance of the company. The life of the organization is affected by employee engagement which is one of the factors in financial performance.

Popli [19] have studied the drivers of employee engagement especially which influences the leadership style. In the global competition and slower growth prospects, the success of the organization is employee engagement. The researchers have proved that top three challenges which they faced and one of which is employee engagement followed by succession planning, culture engagement, employee retention and turnover and performance management. Identifying employee engagement

is a multidimensional construct, supervisors support, rewards, recognition and procedural justice as the predictors of employee engagement. Other drivers which include engagement are management practices, immediate supervisor, career development opportunities, team work and supportive environment. Additional drivers are input in decision making, constructive feedback, receiving formal appraisals and performance development plan implementation.

Gupta [20] have examined employee engagement as a way to enhance business performance. Employee engagement emerged as an important management focused activity. This study provided an exploratory study of employee engagement, its concepts and definition as evolved through recent times. There is no accepted definition of employee engagement, the global economy is battling with the problem of recession and instability in economic environment, retention arises as one of the greatest challenges for whole corporate world. To become successful in this turbulent market, companies needs to possess extremely knowledgeable, capable, flexible and dedicated workforce with adaptable and innovative management. Employee engagement is widely accepted in last decades because organization have realized that they can leverage for its higher employee retention, greater customer satisfaction and improved financial performance.

Schuck [21] have studied the primordial perspective of employee engagement. Workers who are engaged display profound positive affective connection with their work and are likely to exhibit concentration and mental attention in their work. Engaged workers seems to be more constructive, cost-effective, dependable, healthier and less likely to leave their employer. Researches have proved that engaged employees contribute to vastly to financial bottom-line of the organization. Organizations are continuously changing in order to meet the challenges bought by globalization and international competitiveness. These changes have influence in the nature of the work and demands placed by employees.

Mann [22] have analysed the world wide employee engagement crisis. The world is facing huge crisis of employee engagement with serious and potentially lasting effect over global economy. The leaders of worldwide companies have good knowledge about the advantages of engaging employees and they have barely emphasised it for a decade. Companies concentrate exclusively on measuring engagement than executing and they often fail to make necessary change in order to engage them and fulfil the employee's work place needs.

Poisat [23] have studied the critical analysis of organizational strategies for employee engagement. Organizations are looking ways to increase competitiveness to survive in the global economy. Researches have proved that engaged employees contribute vastly to financial bottom-line of the organization. Majority of the organization are not having an engagement strategy. Organizations are continuously changing in order to meet the challenges bought by globalization and international competitiveness. These changes have influence in the nature of work and demands placed by employers. Employees see changes in goals, process, technologies and work assignments. Employees remain responsible for adopting more adoptable and flexible approach.

Ram [24] have examined the effect of employee engagement on job-related consequences. Employee engaging is one of the top five import challenges for management. It is strategic approach for driving improvement and encouraging change. High level of employee's engagement occurs when employees are committed, enthusiastic, passionate towards their work. It is to examine the hypothetical relationship between job characteristics and rewards perceived by the employees. Engagement has been well-defined as workers' optimistic emotions towards their job when they realise their work to be meaningful, manageable and have positive expectation about their forthcoming job.

2.1 Research Model

Based on the empirical results obtained by researchers [2, 25–27] we have developed the hypothesis to be tested for the study. The conceptual model tested in this study is depicted in Fig. 1. The model comprises of employee engagement behaviour in employees, job satisfaction and perceived intention to quit towards the job.

The hypothesis derived from this model are:

- H1: There is significant effect of Employee engagement on Job satisfaction
- H2: There is significant effect of Employee engagement on Intention to quit.

3 Research Methodology

Research was conducted for IT (Information Technology) employees working in companies providing cloud computing services, and the data was collected from 100 employees of middle and top level. The data was collected through questionnaire which consisted of 21 items to measure employee engagement using 5point Likert scale. The first part of the questionnaire contains the demographic variables,

Fig. 1 Conceptual model tested

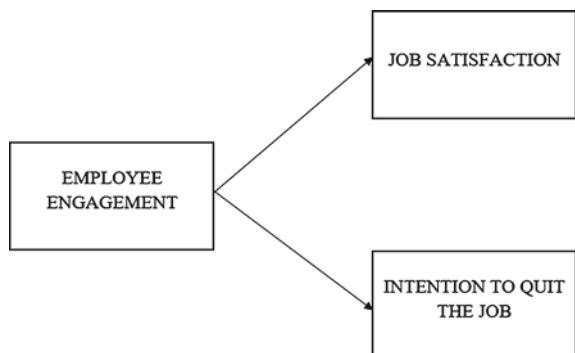


Table 1 Demographic profile of the respondents

Variables	Frequency	Valid percent
<i>Gender</i>		
Male	73	73.0
Female	27	27.0
<i>Age</i>		
18–25 years	80	80.0
26–40 years	20	20.0
<i>Educational qualification</i>		
Under graduate	8	8.0
Post graduate	92	92.0
<i>Annual income</i>		
<2 lakhs	6	6.0
2–5 lakhs	54	54.0
6–10 lakhs	40	40.0

the second part contains the items regarding employee engagement, the third part contains job satisfaction and the final part contains the intention to quit.

3.1 Measures

Employee engagement is measured using the Utrecht Work Engagement Scale developed by Schaufeli [28]. The work attitudes, Job satisfaction was measured using the scale developed by Cammann [29] and Intention to quit was measured by the scale developed by Colarelli [30]. The profile of the respondents is reported in Table 1.

3.2 Data Analysis

The data gathered is analysed using IBM SPSS Statistics Software version 21. The tool used to analyse the data is Simple Linear Regression analysis. In this study we are required to find the effect of employee engagement on job satisfaction. In order to find out whether employee engagement can significantly predict job satisfaction, regression analysis is used. Similarly to find out the level of prediction of employee engagement on employee's intention to quit the job is examined using regression analysis.

4 Results

The study have attempted to measure the effective consequence of employee engagement by using regression analysis (Table 2).

$$\text{Job satisfaction} = \alpha + \beta_1 \text{ Employee Engagement}$$

$$\text{Intention to quit} = \alpha + \beta_1 \text{ Employee Engagement}$$

4.1 Effect of Employee Engagement on Job Satisfaction

R, the multiple correlation coefficient, indicates the significance of prediction of the dependent variable. In model 1, R value of 0.70 designates that employee engagement is a good predictor of job satisfaction. The F value (94.12) is significant ($p < 0.01$) which depicts that the model fits the data. R^2 , coefficient of determination, represents the level of variation in dependent variable explained by independent variable. In this model, 49% of variance in job satisfaction is explained by employee engagement. It is a positive predictor of job satisfaction with beta value of 0.70.

4.2 Effect of Employee Engagement on Intention to Quit

R, the multiple correlation coefficient, specifies the significance of prediction of the criterion variable. In model 2, R value of 0.299 indicates employee engagement is a good predictors of intention to quit. The F value (9.60) is significant ($p < 0.01$) which confirms that the model fits the data. R^2 , coefficient of determination, represents the level of variation in criterion variable explained by independent variable. In this model, 10.90% of variance in intention to quit is explained by employee engagement. It is the significant ($p < 0.000$) predictor of intention to quit with beta value of –0.299 which means employee engagement is a negative predictor of intention to quit.

Table 2 Coefficient values

Model No.	Dependent variable	Independent variable	β coefficient	Standard error
1	Job satisfaction	Employee engagement	0.700**	0.011
2	Intention to quit	Employee engagement	-0.299**	0.016

** $p < 0.01$

* $p < 0.05$

5 Discussion

The results prove that employee engagement (EE) positively affects the level of job satisfaction of employees. When employees feel engaged towards the job, their level of work satisfaction increases. The positive relationship between engagement and satisfaction is also proved by researchers like Vorina [31] and Kamalanabhan [2]. Employees who are wholehearted, focus their work efforts on accomplishments of organisation's goals, which is an additional competitive advantage in the dynamic business world. Abraham [32] have studied the reverse relationship of engagement and job satisfaction. He has concluded that factors of job satisfaction will lead employees to be engaged towards their job and organisation. His study is contradictory to the existing research work. This study has also focused on understanding the effect of engagement on employee's perception to quit the job and found that negative relationship exist. When an employee is highly engaged in his work, he never bothers to think about leaving the job. Mxenge [33] have also confirmed the negative relationship between worker's engagement and intention of workers to quit the job. This same theory has been established by Andrew [26] and Rusyandi [34]. Eventhough, Rigg [35] have proved the same negative relationship, they have also concluded the mediating effect of job satisfaction in the engagement and turnover intention relationship.

6 Conclusion

Every organization wants to be ahead in this competitive market and for the same, they strive to keep their employees engaged. Employees depend on different aspect of personnel management such as performance management, training and development, work life balance and employee welfare to stick on to an organization. The engagement aspect of workers also enhance their satisfaction and involvement which in turn increase their productivity. And also employees who are engaged do not have the intention of leaving the job, because of the involvement they experience. Hence, employers are well aware that engaged employees are valuable assets to the company and thereby the growth of the organization increases concurrently. With this effect, every organization should understand the importance of engaged employees and they should implement the different polices for the effective employee engagement in the organization. Especially in IT companies which provide cloud computing services, the employees need to be in their toes with the latest technology and high-speed competition. Hence it is highly necessary to implement engagement practices to help them handle stress and work-life balance issues. Employee engagement is linked to organization's performance because, when the employees perform well in the company, they would plan to invest on employee engagement programs. As we have seen that employee engagement is nothing but emotional and positive attachment to the organization, with the help of this study we will be able to know the

degree of engagement level in the organization which will definitely be helpful to employers as well as employees.

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Users Acceptance of Electronic Personal Synthesis Behavior (EPSB): An Exploratory Study



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Abstract Electronic Personal Synthesis Behavior (EPSB) algorithm is suggested for authenticating authorized users' behavior. It stands for the electronic diagnostic process to analyze the manner of the authorized user. The purpose of this algorithm is to analyze the human "behavior" on the authentication layer to improve the performance of passwords by improving the predictive layer. The main task of this algorithm is monitoring all the activities associated with the password on duration, error, and style to the authorized user. Normally, the security procedure in any system affects the users' acceptance and ease of use. This paper aims to evaluate the effects of applying EPSB on users' acceptance. The preliminary experiments were applied in Al Buraimi University College (BUC), Oman for ten working days. The data were collected from 220 students enrolled in the Departments of IT and Business. The validation structure was prepared based on the Technology Acceptance Model (TAM). The cumulative percentage results of Perceived Usefulness,

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Perceived Ease of Use, Behavioral Intention to Use, and Actual System Use are 84.4151%, 86.364%, 95.4542%, and 95.4545%, respectively. This indicates that the proposed EPSB is highly accepted among the collected sample.

Keywords TAM · EPSB · Acceptance · Ease of use · Usefulness

1 Introduction

The Electronic Personal Synthesis Behavior algorithm (EPSB) stands for the electronic diagnostic process to agree out the manner of the authorized user [1]. This algorithm has the potential to adopt in any authentication in public cloud computing, which is applied password with any factor [1]. The main body of the algorithm consists of four components, including time, password style, error, and classify data. This algorithm is an enhancement to one of the authentications in the public cloud area [2]. This algorithm improves the authentication accuracy and helps to deal with stolen password attacks by adding the predictability node [1]. This node is moving password-based authentication performance from traditional security strategies to intelligent security operations via analysing human behavior in the authentication process [2]. In related context, when applied any new security procedure in the system effects on users' acceptance and ease of use [3, 4]. Thus, we need to examine user's acceptance and ease of use in this system.

The user test or questionnaire was designed to determine how usable the authentication systems with EPSB and how the participants evaluated its acceptance, use, and perceived security. In this paper, a security procedure was suggested for improving the authentication accuracy when facing stolen password attacks. It was of particular interest to determine the effects of security procedure on acceptance and use level [3]. The validation structure was prepared based on the Technology Acceptance Model (TAM). The accept and use structure questionnaires in this section were conducted based on adoption some of previously used in many studies to be fitting with proposed algorithm evaluations [5, 6]. Besides, this questionnaire was sent to a native speaker expert who is an assistant professor in the field of software engineering for language and content validation. In addition, three experts in information technology have checked the criterion-related and approved this questionnaire with some modifications. The questions are listed in Table 1.

The second section presents the theoretical framework and research hypotheses of this study. The third section shows the study participants. The fourth section shows the pilot study. The fifth section presents the context and subjects and followed by data collection instrument and data analysis and results. Finally, the results are discussed in section eight.

Table 1 Acceptance and use questionnaire

No.	Perceived usefulness
PU1	The EPSB enhances my authentication efficiency
PU2	The EPSB algorithm enhances authentication productivity
PU3	The EPSB algorithm enables me to accomplish authentication tasks quickly
PU4	The EPSB algorithm improves authentication accuracy
PU5	The EPSB algorithm saves my time
PU6	The EPSB algorithm doesn't have any distinctive useful features
PU7	The EPSB algorithm is not applicable to all authentication process
<i>Perceived ease of use</i>	
PE1	The EPSB algorithm in authentication is easy to use
PE2	The EPSB algorithm enables me to access the data which saved in public cloud computing smoothly
PE3	The EPSB algorithm is convenient and user-friendly
PE4	The user should memorize complicated password in EPSB algorithm process
PE5	The EPSB algorithm is needed to memorize some secrets procedures
PE6	The EPSB authentication procedure is complicated to the user
PE7	The EPSB algorithm requires no training
<i>Behavioral intention to use</i>	
BI1	I intend to increase my use of the EPSB algorithm
BI2	It is worth to recommend the EPSB algorithm for other organizations
BI3	I am interested in using the EPSB algorithm more frequently in the future
<i>Actual system use</i>	
AU1	I use the EPSB algorithm on a daily basis
AU2	I use the EPSB algorithm frequently

2 Theoretical Framework and Research Hypotheses

Many information systems (IS) theories/models were developed to assess the acceptance of the new algorithms/technologies. The Technology Acceptance Model (TAM) is one of the theories that were developed by Davis in 1989 [7]. TAM has been developed based on the Theory of Reasoned Action (TRA) [8]. In this context, TAM suggests that the user's behavioral intention to use the EPSB algorithm is determined by two main beliefs; perceived usefulness (PU) and perceived ease of use (PEOU). PU refers to the degree to which a person believes F that using a particular system would R enhance his/her job performance, whereas PEOU denotes to the degree

to which user believes that using a particular system would be free from efforts. Various studies have adopted the TAM to study technology acceptance and usage. For instance, it has been successfully adopted in studies with similar objectives to the present research [9–11]. In this study, the TAM [7] is adopted for measuring the users' acceptance of the EPSB algorithm as technology in their authentication accuracy in public cloud computing. In this respect, TAM provides a solid background for the effectiveness of new technology. Besides, TAM also suggests that when users are exposed to new technology, many factors can influence their acceptance decision. Accordingly, many researchers have suggested groups of hypotheses [12]. In this study, the hypotheses used for this study were adopted from Al-Maroof and Al-Emran et al. [12]. Thus, this study suggests the following hypotheses:

- H1:** Perceived ease of use positively influences the perceived usefulness of EPSB.
- H2:** Perceived ease of use positively influences the behavioral intention to use EPSB.
- H3:** Perceived usefulness positively influences the behavioral intention to use EPSB.
- H4:** Behavioral intention to use influences the actual use of EPSB.

3 Participants

The total number of participants is 220 [13]. The same experiments test participants were chosen because they had already used the authentication system with EPSB 10 days during the accuracy test (in other study). Thus, all of the participants have an idea about the manner of using the EPSB algorithm.

4 Pilot Test

As explained by Creswell [14], pilot testing of research instruments provides researchers with an idea of whether the respondents were able to complete the questionnaire and understand the questions. More importantly, the appropriateness of the operational definitions and research methodology can be ascertained [15]. The aim of the pilot study is to assess the acceptance and use and acceptability of receiving the EPSB questionnaire questions. It was also of interest to assess whether the questions in the questionnaire are clear and are comprehended by most of the students. In the case of the current study, a pilot study which was conducted involving four students, two from both of female and male, two were monolinguals, and two were bilinguals, and two have high computer skills, and one in both of intermediate and basic computer skills. The pilot study was also carried out as a way of familiarizing with the data collection procedures. The pilot study generally revealed that changes only on the two deep technical questions, thus these questions were cancelled. In order to assess the reliability of the items of the questionnaire, composite reliability and

Table 2 Reliability statistics

TAM	Cronbach's alpha
PU	0.897
PE	0.748
BI	0.917
AU	0.84
Total	0.899

average variance extracted (AVE) measures were utilized. A value of 0.7 and greater for composite reliability and a value of 0.5 and greater for AVE were suggested by Hair et al. [16] for the factor to be considered as reliable. In this research, composite reliability values for all questions were well above the 0.9 and the AVE for all questions were above the 0.55 (see Table 3). These two results were very close to the recommended cut-off points of 0.7 and 0.5 respectively; therefore, they were considered as valid. By taking into consideration composite reliability and average variance extracted values, it can be concluded that questionnaire constructs were found to be reliable. Besides, the Cronbach's Alpha was used to test the reliability of questionnaire as well. The results are presented in Table 2. The results of PU, PE, BI, and AU around 89% are considered acceptable rates.

5 Context and Subjects

The study was conducted at Buraimi University College (BUC) in Oman. By the end of 2018, we have evolved the initiative of implementing the EPSB algorithm in authentication on a virtual authentication layer in the public cloud. The sample of this study consists of the same students who have used the EPSB in above experiment. A total of 220 valid responses were received from a total of 220 questionnaires administrated, which shows a response rate of 100%.

5.1 Data Collection Instrument

A questionnaire was distributed to all the enrolled students on this experiment for data collection. The questionnaire consists of 2 different parts. The first part aims to collect the students' demographic information. The second part is devoted to collect data regarding the Technology Acceptance Model (TAM) factors. These factors include the perceived usefulness (PU), the perceived ease of use (PEOU), the behavioral intention (BI), and the actual use (AU). The items used for this study were adopted from Al-Maroof and Al-Emran [12] with a further adjustment to fit the scope of this study. The passed value according to cumulative percentage value is supposed to be equal or greater than 80%. This rate covered strongly agree and agree in the

Table 3 Average variance extracted

	Variance (\mathbf{Y})	\mathbf{Y}^2	ϵ
PU1	0.667	0.444889	0.555111
PU2	0.917	0.840889	0.159111
PU3	0.917	0.840889	0.159111
PU4	0.917	0.840889	0.159111
PU5	0.667	0.444889	0.555111
PU6	0.667	0.444889	0.555111
PU7	0.917	0.840889	0.159111
PE1	0.250	0.0625	0.9375
PE2	0.917	0.840889	0.159111
PE3	0.917	0.840889	0.159111
PE4	0.917	0.840889	0.159111
PE5	0.917	0.840889	0.159111
PE6	0.917	0.840889	0.159111
PE7	0.667	0.444889	0.555111
BI1	0.667	0.444889	0.555111
BI2	0.250	0.0625	0.9375
BI3	0.250	0.0625	0.9375
AU1	0.667	0.444889	0.555111
AU2	0.250	0.0625	0.9375
N			19
Average variance extracted			0.551965
Composite reliability			0.953788

questionnaire. The data collection was conducted by distributing the questionnaire and collecting the feedback from students directly. Table 4 shows the five-level Likert scale that was used in the questionnaire.

Table 4 Five-level likert scale

Mark range	90–100	89.99–80	79.99–75	74.99–65	64.99–0
Grade points	4	3.5	3.12	2.7	0
Grade	A	B	C	D	F
Meaning	Outstanding	Very good	Marginal pass	Marginal pass	Fail
Statistical denote	1	2	3	4	5
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree

6 Data Analysis and Results

In this section, we present three factors according to TAM. These factors include the perceived usefulness (PU), the perceived ease of use (PEOU), the behavioral intention (BI), and the actual use (AU). The statistical analysis and evaluation of the data in this study were done by using the average mean, average median, mode, average std. deviation, average variance, and final percentages. SPSS was used for statistical relation analysis. There are many types of averages in statistics, and one of those averages is the mean and the median, which is the mid value. The recurring values are called mode. The standard deviation is a statistical dimension or appraisal of the dispersion of a set of data from its mean. The more spread the data is, the higher the deviation. Standard deviation is calculated as the square root of the variance. The variance is the measure of the spreading set of data that points around their mean value. Variance is a mathematical prospect of the average squared divergences from the mean. Moreover, the percentage presents the highest one chosen from five-levels Likert scale.

7 Descriptive Statistics

The data demonstrates the responses collected from samples which were 220 in total. The results showed that females constitute 63.63% of the collected data while only 36.37% are males. Furthermore, all of the users are aged between 18 and 23 years, which represent the sample population. In terms of the department, 32% of the students are from the Business Administration and Accounting; this is followed by 13% from the English Language, 42% from the Information Technology, and 13% from the Law, respectively. With regard to the computer skills, 50% of the participants have high computer skills proficiency, followed by 36.36% have intermediate computer skills proficiency, 13.63% have basic computer skills proficiency.

8 Discussion and Conclusion

In order to measure the validity of each item, the factor's total percent up to 80% should be measured. The data collection instrument is assumed as valid when the threshold value is equal or greater than 70% for each item and cumulative percentage value is of equal or greater than 80%. In addition, the average mean and median, and mode values should be equal or greater than 2.00. Based on Table 5, we can observe that the first construct of the questionnaire (PU) is near to agree on category (Average Mean = 1.999). Since this value is between 80 and 89 range in the five-level Likert scale, it could be considered as an acceptable value. However, the values of the questions respectively from PE, BI, and AU (Average Mean = 1.733757, 1.515133,

Table 5 Descriptive statistics for TAM

Constructs	Item	Mean	Average mean	Average median	Mode	Average Std. deviation	Average variance	Cumulative percentage (%)
Perceived usefulness	PU1	2.00	1.999	2.00	2.00	0.541051	0.303143	Strongly agree 15.584
	PU2	1.86						Agree 68.831
	PU3	2.045						Neutral 15.584
	PU4	1.773						Disagree 00.00
	PU5	2.273						Strongly Disagree 00.00
	PU6	2.091						
	PU7	1.954						
Perceived ease of use	PE1	2.136	1.7337	1.5714	2.00	0.689093	0.485286	Strongly agree 42.208
	PE2	1.818						Agree 44.15
	PE3	1.864						Neutral 12.99
	PE4	1.591						Disagree 00.649
	PE5	1.591						Strongly disagree 00.00
	PE6	1.682						
	PE7	1.454						
Behavioural Intention to use	BI1	1.454	1.515	1.333	1.00	0.5909	1.048	Strongly agree 53.03
	BI2	1.454						Agree 42.424
	BI3	1.636						Neutral 4.5454
								Disagree 00.00
								Strongly disagree 00.00

(continued)

Table 5 (continued)

Constructs	Item	Mean	Average mean	Average median	Mode	Average Std. deviation	Average variance	Cumulative percentage (%)
Actual use	AU1	1.689	1.6136	1.75	1.5	0.58185	0.339	Strongly agree 43.182
	AU2	1.545						Agree 52.272
								Neutral 4.5455
								Disagree 00.00
								Strongly disagree 00.00
Total		1.715632	1.6636822	1.625	0.600723	0.543857	90.39 to 80%	Total percent up Others 9.61

1.61365) are near to Agree as well. In addition, the cumulative percentage results up to 80% of PU, PE, BI, and AU are 84.4151%, 86.364%, 95.4542%, and 95.4545%, respectively. Accordingly, they could be considered as highly accepted results.

In this study, four hypotheses were listed in theoretical framework section and the research hypotheses are above the correlation coefficient results according to Spearman's [17]. In terms of path analysis, Fig. 1 and Table 6 demonstrate the path coefficients and *p*-values for each hypothesis. It can be noticed that all the hypotheses are supported, which in turn indicates that all the paths are significant between the independent and dependent variables. **H1** ($B = 0.225, p < 0.05$) describes the path between perceived ease of use and perceived usefulness; indicating that the perceived ease of use enhances the perceived usefulness of EPSB. **H2** ($B = 0.292, p < 0.05$) shows the path between perceived ease of use and behavioral intention; representing that the perceived ease of use leverages the behavioral intention to use EPSB. **H3** ($B = 0.320, p < 0.05$) demonstrates the path between perceived usefulness and

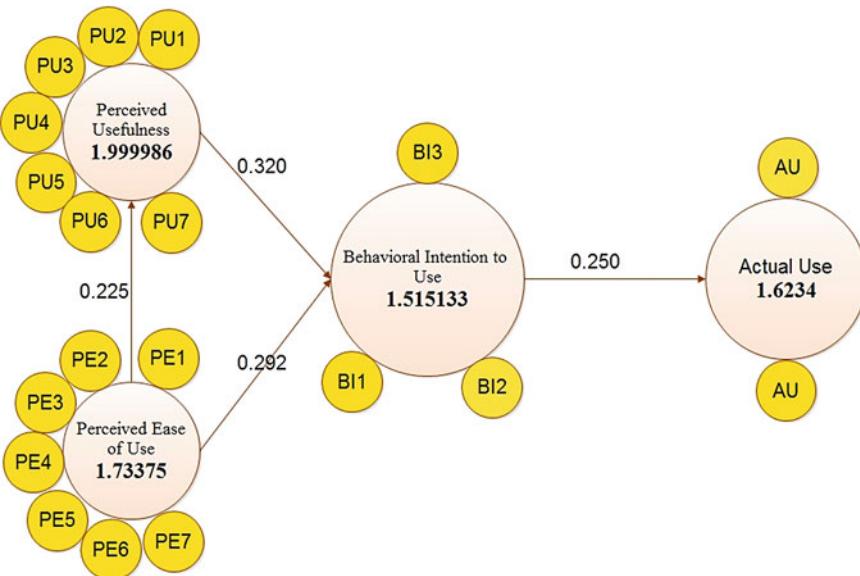


Fig. 1 Path analysis results

Table 6 Hypotheses testing results

Hypotheses	Path	Path coefficient	<i>P</i> -value	Remarks
H1	PE → PU	0.225	0.002	Supported
H2	PE → BI	0.292	0.001	Supported
H3	PU → BI	0.320	0.001	Supported
H4	BI → AU	0.250	0.001	Supported

behavioral intention; revealing that perceived usefulness positively influences the behavioral intention to use EPSB. **H4** ($B = 0.250, p < 0.05$) describes the path between behavioral intention and actual usage; indicating that behavioral intention is significantly affecting the actual usage of EPSB. The results of this study suggest that both PEOU and PU positively affect the behavioral intention by users who perceive the use of EPSB as easy and useful.

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