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Exploring Students' Acceptance of E-Learning Through the Development of a Comprehensive Technology Acceptance Model

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ABSTRACT Extending the Technology Acceptance Model (TAM) for studying the e-learning acceptance is not a new research topic, and it has been tackled by many scholars. However, the development of a comprehensive TAM that could be able to examine the e-learning acceptance under any circumstances is regarded to be an essential research direction. To identify the most widely used external factors of the TAM concerning the e-learning acceptance, a literature review comprising of 120 significant published studies from the last twelve years was conducted. The review analysis indicated that computer self-efficacy, subjective/social norm, perceived enjoyment, system quality, information quality, content quality, accessibility, and computer playfulness were the most common external factors of TAM. Accordingly, the TAM has been extended by the aforementioned factors to examine the students' acceptance of e-learning in five different universities in the United Arab of Emirates (UAE). A total of 435 students participated in the study. The results indicated that system quality, computer self-efficacy, and computer playfulness have a significant impact on perceived ease of use of e-learning system. Furthermore, information quality, perceived enjoyment, and accessibility were found to have a positive influence on perceived ease of use and perceived usefulness of e-learning system.

INDEX TERMS E-learning, higher education, TAM, PLS-SEM.

I. INTRODUCTION

Electronic learning (E-learning) is fast becoming an essential tool that is widely used and implemented by educational institutes and universities across the globe [1], [2]. Al-Rahmi *et al.* [3] argued that e-learning provides students with a virtual atmosphere in which students take part in several activities. There are extensive benefits of e-learning systems, including ease of access to materials content, effortless team collaboration, and on-time mutual discussions [4], [5]. In the developed countries, these benefits could be further extended due to the physical infrastructure presence, and that the geographical gap could be bridged. However, the e-learning system in developing countries has partially or entirely been unsuccessfully adopted; its utilization has not been completed and is considered to be less than the satisfactory level [6]. This refers to the lack of understanding the factors affecting its adoption [7]. In addition, most of the prior studies have focused on examining the impact of particular factors on e-learning adoption. Those factors are usually varied from one study to the other depending on the individuals and context. Thus, it is believed that there is a need for a comprehensive theoretical model that can fully understand the factors affecting the e-learning adoption under any circumstances regardless of the context and individuals.

To handle the above limitations, the main purpose of this paper is two-fold. First, to analyze the e-learning research studies which employed the Technology Acceptance Model (TAM) and determine the most frequent external factors. Second, to empirically examine the impact of the external factors that achieved significant results in the literature on students' adoption of e-learning through the extension

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of TAM with these factors. In addition, recognizing these factors is going to enhance the researchers' capability on the topic, and improve the e-learning adoption rates by working on the relevant cultural, social, and technical factors that facilitate the adoption process. Further, the understanding of these factors is expected to help the decision-makers in determining the strengths and weaknesses of their e-learning infrastructure and assisting them to achieve higher levels of technology acceptance.

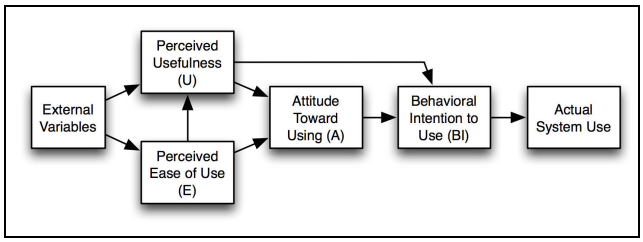

FIGURE 1. Technology acceptance model (TAM) [13].

II. LITERATURE REVIEW

A. DEFINITION OF E-LEARNING

E-learning is defined as "a method of teaching and learning that fully or partially signifies the educational model used, based on the use of electronic media and devices as tools for enhancing availability of training, communication, and interaction, and that helps in accepting novel ways of comprehending and establishing learning" [8], [9]. Rissa [10] revealed that e-learning takes place using various forms of technologies and media. An essential element of e-learning is the use of electronic media, and in present times, e-learning is explained as the learning that is employed through different computational devices, such as computers, mobile phones, tablets, and virtual environments [11].

Like any educational technology, there are many strengths, weaknesses, opportunities, and threats associated with the use of e-learning [12]. In terms of strengths, e-learning can establish community spirit among the learners, create independent learners, build strong relationships among the learners and instructors, and improve problem-solving skills. Concerning the weaknesses, e-learning makes it difficult in terms of students' and instructors' workload. E-learning is less trustworthy than traditional learning in terms of peer feedback and collaborative activities assessment. With respect to the opportunities, e-learning allows students to produce high-quality work and assists in developing alumni communities. With regard to the threats, it is difficult to ensure the reliability of the learning services provided through e-learning systems. It is also difficult to adopt the publicly available resources through e-learning systems.

B. TECHNOLOGY ACCEPTANCE MODEL (TAM)

The Technology Acceptance Model (TAM) proposed by Davis [13] has been employed in various research studies, and therefore, it has become quite significant in the literature pertaining to technology acceptance [14]. Besides, it has been concluded in a recent systematic review that the application of TAM in educational technology acceptance has proved its effectiveness as compared with the other theoretical models [15]. According to the theory, two personal beliefs (i.e., "perceived usefulness" and "perceived ease of use") are affected by external and system-specific factors to predict the attitude towards using a technology. The attitude itself affects the behavioral intention to use a particular technology, which in turn, predicts the actual system use. Figure 1 shows the TAM model.

C. TAM AND E-LEARNING

In the previous studies pertaining to technology acceptance, various research themes have been presented to determine the reasons for which people accept new technology. The TAM model has become a robust model that is appropriate for predicting the acceptance of several technologies [16], [17]. Although TAM was established in the USA, it has been used and evaluated in different contexts and empirical studies [8], [16], [18]–[23].

Abdullah and Ward [24] identified 152 external factors by reviewing 107 published articles in the duration of ten years. The results of their study revealed that self-efficacy, subjective norm, enjoyment, computer anxiety, and experience were considered as the most extensively used external factors that extended the TAM in more than 10 of the analyzed studies in their study. It has been noticed that the effect of the most widely used external factors was only limited to the core beliefs of TAM (i.e., "perceived usefulness" and "perceived ease of use"). Although Abdullah and Ward [24] achieved a significant contribution to the existing of body literature, their study does not cover all the related studies in the context of e-learning adoption. As a result, this study aims to analyze the studies that were already examined by Abdullah and Ward [24] as well as other relevant studies that were collected based on the inclusion and exclusion criteria of this study. In that, this study is more comprehensive as it considers more external factors.

D. DATA SOURCES AND CORRELATION ANALYSIS

In order to achieve the first purpose of this study, a review of the literature has been conducted by following the method used by Abdullah and Ward [24] with further adjustment. The review was carried out to analyze the sources pertaining to the acceptance of e-learning. That is, the e-learning acceptance studies concerning the extension of TAM with the external factors were analyzed. The studies were identified using different keywords that were related to TAM (see Table 1) by using various databases (i.e., Emerald, IEEE, ProQuest, ScienceDirect, Springer, Wiley, Taylor & Francis, ACM, and Google Scholar). By following the search results, 408 studies were retrieved based on the search terms (see Table 2). While performing the data analysis, low-quality

TABLE 1. Keywords search.

Keyword search
"TAM" AND "E-learning"
"Technology Acceptance Model" AND "E-Learning"
"Perceived Ease of Use" AND "E-Learning"
"Perceived Usefulness" AND "E-Learning"
"TAM" AND "web-based learning"
"TAM" AND "online learning"

TABLE 2. Initial search results across the databases.

Databases	Frequency
Emerald	39
Google Scholar	109
IEEE	41
ProQuest	38
ScienceDirect	74
Springer	54
Wiley	23
Taylor & Francis	27
ACM	3
Total	408

studies were removed from the synthesis, and 54 duplicate articles were eliminated. Additionally, qualitative studies that did not offer extensive information, like e-learning outcomes, or those which seemed to depend more on the experience of the researcher instead of the field observations were removed. A total of 120 studies fulfilled the inclusion criteria and were included in the analysis. These are the same procedures followed by the previous studies for conducting similar research [17], [25].

To make this research distinct from the one conducted by Abdullah and Ward [24], the criteria given below were used when choosing the valid papers to make sure that there is consistency in the studies for data analysis:

- The papers must be published in the last 12 years.
- The papers should have extended the TAM in an empirical study.
- The papers should have examined the adoption or acceptance of e-learning systems.
- The study methodology should be clearly described.
- The study results should be completed and given.

Overall, 239 external unique factors were identified and assessed in the 120 collected studies. It was determined that only eight external factors (i.e., computer self-efficacy, subjective/social norm, enjoyment, system quality, information quality, content quality, accessibility, and computer playfulness) had a relationship with TAM in at least four of the analyzed studies (see Table 3). Table 3 shows the distribution of the most common external factors across the databases.

III. RESEARCH FRAMEWORK AND HYPOTHESES

A. SYSTEM CHARACTERISTICS

System characteristics consist of content quality (CQ), information quality (IQ), and system quality (SQ) [26].

1) SYSTEM QUALITY (SQ)

System quality (SQ) determines the way that the system characteristics like usability, reliability, availability, and adaptability influence the outlooks of the users with respect to the use of e-learning system [27]. Research indicated that SQ characteristics have a crucial role in adopting and using an e-learning system [28]–[32]. Previous studies found that SQ has a positive impact on perceived ease of use of e-learning [26], [32]–[34]. Besides, it was also found that SQ has a positive effect on perceived usefulness of e-learning [29], [33], [35]. Therefore, the following hypotheses were formulated:

H1a1: System quality (SQ) has a positive effect on the perceived usefulness (PU) of e-learning system.

H1a2: System quality (SQ) has a positive effect on the perceived ease of use (PEOU) of e-learning system.

2) CONTENT QUALITY (CQ)

It has been pointed out that the content quality (CQ) aspect in e-learning signifies the depth and frequent updates of the content [36]. CQ is a significant factor that describes e-learning acceptance or adoption [37]. It has been determined in previous research that there is a significant impact of content quality on perceived usefulness [26], [32], [37]–[40]. In addition, previous studies also found that there is a positive correlation between CQ and the perceived ease of use of e-learning system [38], [39]. Therefore, the following hypotheses were formulated:

H1b1: Content quality (CQ) has a positive effect on the perceived usefulness (PU) of e-learning system.

H1b2: Content quality (CQ) has a positive effect on the perceived ease of use (PEOU) of e-learning system.

3) INFORMATION QUALITY (IQ)

Information quality (IQ) refers to ''using e-learning for seeking information that may be important for learning and which is updated, so as to make it easier for the learner to comprehend it'' [41], [42]. Information quality also refers to the ''users' belief regarding the quality of information given on a Website'' [43] or ''the degree to which the customer receives complete, precise and well-timed information over the electronic service interface'' [44]. It was found in previous e-learning research that there was a significant effect of information quality on the perceived ease of use [33], [42], [45]. Moreover, previous research also found that there is a positive relationship between IQ and the perceived usefulness of e-learning system [30], [31], [33]. Therefore, the following hypotheses were developed:

H1c1: Information quality (IQ) has a positive effect on the perceived usefulness (PU) of e-learning system.

H1c2: Information quality (IQ) has a positive effect on the perceived ease of use (PEOU) of e-learning system.

TABLE 3. The most commonly used external factors across databases.

External factors	Databases									
	Emerald	Google Scholar	IEEE	ProQuest	ScienceDirect	Springer	Wiley	Taylor & Francis	ACM	Total
Computer self-efficacy	3	16	5	4	10	0	3	10	1	52
Subjective/social norm	1	6	3	2	9	1	4	8	0	34
Perceived enjoyment	2	5	2	5	3	0	1	1	0	19
System quality	0	2	1	0	5	1	1	1	0	11
Information quality	0	2	2	0	5	0	0	1	0	10
Content quality	1	1	0	3	1	1	2	1	0	10
Accessibility	0	4	1	1	0	1	1	0	0	8
Perceived playfulness	0	0	0	0	3	0	0	1	0	4

B. INDIVIDUAL FACTORS

1) COMPUTER SELF-EFFICACY (CSE)

Self-efficacy refers to "the individuals' confidence in their own capacity to take steps needed to deal with future situations" [46]. In this study, self-efficacy is related to computer systems (i.e., the confidence exhibited by the users in their own ability to use the e-learning system). According to Compeau and Higgins [47], a significant part is performed by computer self-efficacy (CSE) in determining the feelings and behavior of an individual. In that, it is argued that the higher efficacy expectations, the higher chances of leading to success in a particular task. By analyzing the e-learning literature (as shown in Table 3), computer self-efficacy was found as the most widely employed external factor of TAM. It was revealed in various empirical studies that computer self-efficacy had a significant impact on the perceived usefulness and perceived ease of use of e-learning system [35], [48], [49]. Hence, we hypothesize the following:

H2a1: Computer self-efficacy (CSE) has a positive effect on the perceived usefulness (PU) of e-learning system.

H2a2: Computer self-efficacy (CSE) has a positive effect on the perceived ease of use (PEOU) of e-learning system.

2) SUBJECTIVE NORM (SN)

Subjective norm (SN) is considered a part of the social influence variable and signifies the perceived social pressure to carry out or avoid carrying out a behavior [50]. The subjective norm refers to "the person's perception that most people who are important to him or her think he or she should or should not perform the behavior in question" [13]. In certain situations, it is likely that people may employ a system to conform the requirements of other people, instead of focusing on their personal emotions and beliefs [13]. Revythi and Tselios [51] indicated that there is a significant association between subjective norm and the perceived usefulness and perceived ease of use of e-learning system. Therefore, this leads to the following hypotheses:

H3a1: Subjective norm (SN) has a positive effect on the perceived usefulness (PU) of e-learning system.

H3a2: Subjective norm (SN) has a positive effect on the perceived ease of use (PEOU) of e-learning system.

3) PERCEIVED ENJOYMENT (PE)

Perceived enjoyment (PE) is defined as "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" [52]. PE is a significant factor that explains the e-learning adoption or acceptance. It was demonstrated in previous research that PE has a significant effect on perceived ease of use [48], [53]–[56] and perceived usefulness [14], [57]–[59] of e-learning. When the student is aware that working on an e-learning system is enjoyable, there is a greater chance that s/he will have a positive impact on the usefulness and ease of use of such system [14], [53]. Hence, the following hypotheses were developed:

H4a1: Perceived enjoyment (PE) has a positive effect on the perceived ease of use (PEOU) of e-learning system.

H4a2: Perceived enjoyment (PE) has a positive effect on the perceived usefulness (PU) of e-learning system.

4) PERCEIVED ACCESSIBILITY (PA)

Perceived accessibility (PA) refers to "the degree of ease of how a user can access and use the information and extracted from the system" [60]. According to the existing literature, perceived accessibility is found to have a significant effect on perceived ease of use [38], [49], [51], [55], [61], [62] and perceived usefulness [38], [42], [51], [61] of e-learning system. When the student considers the e-learning system to be accessible, there is a greater chance that the usefulness and ease of use of such system would increase [38], [51], [61]. Therefore, we hypothesize the following:

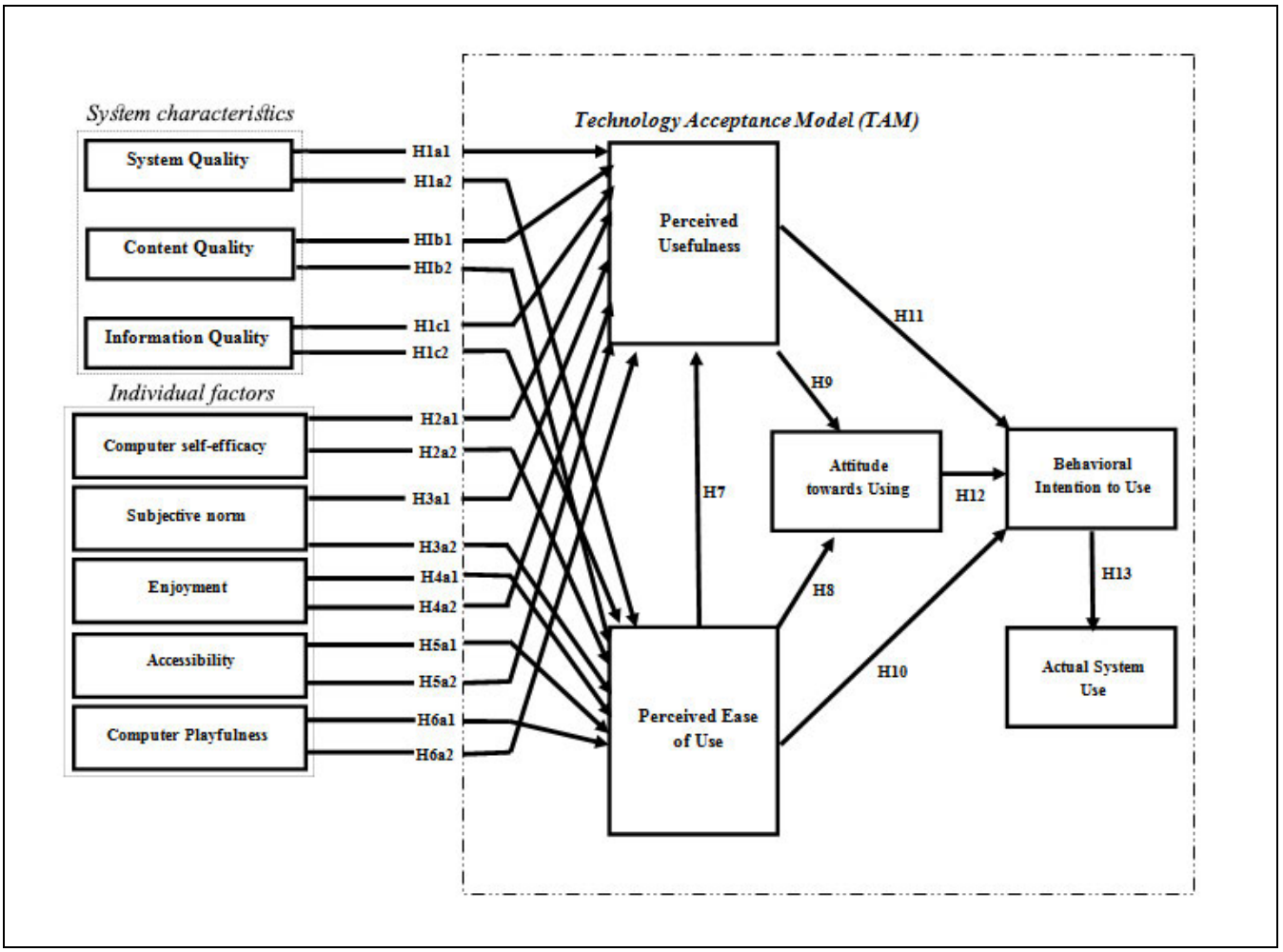

FIGURE 2. Research model.

H5a1: Perceived accessibility (PA) has a positive effect on the perceived ease of use (PEOU) of e-learning system.

H5a2: Perceived accessibility (PA) has a positive effect on the perceived usefulness (PU) of e-learning system.

5) PERCEIVED PLAYFULNESS (PP)

Perceived playfulness (PP) refers to "the degree of cognitive spontaneity in microcomputer interaction" [63]. Concepts like examination, discovery, curiosity, and difficulty are considered as a part of the term playfulness [52]. The term signifies the intrinsic motivation factor which is related to the use of a new system [64]. Al-Aulamie [61] indicated that perceived playfulness has a strong relationship with perceived ease of use and perceived usefulness. Therefore, the following hypotheses were developed:

H6a1: Perceived playfulness (PP) has a positive effect on the perceived usefulness (PU) of e-learning system.

H6a2: Perceived playfulness (PP) has a positive effect on the perceived ease of use (PEOU) of e-learning system.

C. TECHNOLOGY ACCEPTANCE MODEL (TAM) CONSTRUCTS

On the basis of the extended TAM (see Figure 2), the correlation between the users' beliefs are explained in detail as follows.

1) PERCEIVED EASE OF USE (PEOU)

The perceived ease of use (PEOU) of a system refers to the degree to which an individual perceives that the use of a specific technology would not be complicated [13]. It has been shown in several studies carried out in the past that the PEOU has a positive relationship with the behavioral intention to use (BI), directly as well as indirectly [6], [33], [65], [66]. With respect to e-learning, PEOU refers to the extent to which a student perceives that the use of e-learning system would not require a lot of efforts and would be easy to use. Thus, this leads to the following hypothesis:

H10: Perceived ease of use (PEOU) has a positive effect on the behavioral intention to use (BI) the e-learning system.

Also, it was revealed in the previous studies that there is a significant correlation between PEOU and perceived usefulness (PU) [56], [67]–[73]. Based on that, we hypothesize the following:

H7: Perceived ease of use (PEOU) has a positive effect on the perceived usefulness (PU) of e-learning system.

In addition, previous research indicated that there is a positive relationship between PEOU and the attitudes toward the use of e-learning system [27], [32], [78], [35], [40], [66], [70], [74]–[77]. Hence, the following hypothesis is put forward:

H8: Perceived ease of use (PEOU) has a positive effect on the attitude towards the use (ATT) of e-learning system.

2) PERCEIVED USEFULNESS (PU)

Perceived usefulness (PU) refers to the degree to which individuals believe that the use of a new technology can improve their job performance [13]. Various empirical studies indicated that PU is the primary determinant of using a specific technology [6], [16], [20], [39], [42], [79]. The e-learning system can only be accepted by the students when they perceive that its use is going to improve their learning performance. Previous e-learning studies indicated that there is a significant positive correlation between perceived usefulness (PU) and the behavioral intention to use the e-learning system (BI) [29], [80], [81]. Hence, the following hypothesis is formulated:

H11: Perceived usefulness (PU) has a positive effect on the behavioral intention to use (BI) the e-learning system.

It is argued that the higher the perceived usefulness of the e-learning system, the higher the individual's positive attitude would perceive [82]. According to the literature, it has been pointed out that there is a strong empirical support for the correlation between PU and the attitude towards the use [40], [66], [70], [81], [83]–[86]. Hence, the following hypothesis is developed:

H9: Perceived usefulness (PU) has a positive effect on the attitude towards the use (ATT) of e-learning system.

3) ATTITUDE TOWARDS USE (ATT)

Attitude refers to ''the degree to which a person has a positive or negative feeling towards e-learning systems'' [87]. It has been shown by various studies that attitude has a direct impact on behavioral intention [35], [40], [51], [66], [88]–[90]. Hence, the following hypothesis is formulated:

H12: Attitude towards use (ATT) has a positive effect on the behavioral intention to use (BI) the e-learning system.

4) BEHAVIORAL INTENTION TO USE (BI)

Concerning the e-learning, the behavioral intention (BI) refers to the intent of the learners to employ e-learning systems and involves persistent use from the present to the future [91]. It has been shown by various studies that behavioral intention directly and significantly influences the actual use (AU) of e-learning system [39], [40], [56], [92]–[94]. Hence, the following hypothesis is put forward:

H13: The behavioral intention to use (BI) has a positive effect on the actual use (AU) of e-learning system.

IV. RESEARCH METHODOLOGY

A. TARGET POPULATION

The target population of this study is the students enrolled at five different universities in the UAE (i.e., Abu Dhabi School of Management, Skyline University College, University of Fujairah, The British University in Dubai, and MENA College of Management (MCM)). This research employs the quantitative approach through the use of a questionnaire survey. According to the statistics obtained from the five universities, there were 5000 enrolled students at the time of data collection. With reference to Krejcie and Morgan [95], the minimum sample size for a population of 5000 is 357. Based on that, the questionnaire surveys were distributed among the students in the five mentioned universities.

B. DATA COLLECTION

The data collection was carried out during the fall semester 2017/2018 by distributing self-administrated surveys among the students in both University of Fujairah and the British University in Dubai. Overall, 300 questionnaires were circulated among the students. Out of these, 79 questionnaires were not considered due to the large number of missing values. Subsequently, only 221 usable questionnaires were evaluated; providing a response rate of 73.6%. In addition, an online questionnaire was also employed in this study and was distributed among the students in Abu Dhabi School of Management, Skyline University College, and MENA College of Management (MCM). The survey link was sent through email to all the targeted students. A total of 214 students have fully completed the survey.

Overall, 435 valid responses were obtained from the five universities, and thus, they were included in the analysis. In this case, the collected sample size (N = 435) is greater than the minimum sample size requirements (N = 357). Hence, the sample size is regarded to be acceptable. The extensive details of the collected data are shown in Table 4. The participated students had distinct majors and were studying in different departments at different levels of studies (i.e., undergraduate (Diploma, Advanced Diploma, and Bachelor) and postgraduate (Master and Ph.D.)). According to the literature [96], [97], the convenience sampling approach was employed in this research as the participants were easily accessible and ready to be involved in the study.

TABLE 4. Prticipants details.

University	No. of students
The British University in Dubai (BUiD)	135
University of Fujairah	86
Skyline University College	77
Abu Dhabi School of Management (ADSM)	83
MENA College of Management (MCM)	54
Total	435

C. PILOT STUDY

Prior to conduct the final survey, a pilot study was carried out to measure the reliability of the questionnaire items. For this study, 50 students were randomly selected from the target population. The Cronbach's alpha was used to measure the internal reliability of the constructs' items. A reliability coefficient of 0.70 or above is deemed to be acceptable [98]. In this study, the Cronbach's alpha values for all the constructs were above 0.7 as shown in Table 5. Therefore, all the constructs were reliable, and hence, they can be used in the final study.

TABLE 5. Cronbach's alpha values for the pilot study.

Construct	Cronbach's Alpha
System Quality	0.921
Content Quality	0.974
Information Quality	0.868
Computer self-efficacy	0.844
Subjective norm	0.838
Enjoyment	0.899
Accessibility	0.892
Computer Playfulness	0.891
Perceived Usefulness	0.828
Perceived Ease of Use	0.897
Attitude towards	0.873
Behavioral Intention to Use	0.866
Actual Use	0.925

D. STUDY INSTRUMENT

To test the hypotheses presented in this research, a survey instrument was developed. The survey involved 30 items to measure the thirteen constructs in the research model. Table 6 presents the sources of these constructs, whereas the Appendix illustrates the constructs and their items. The items from the earlier studies were modified to make them consistent with the requirements of the current study.

TABLE 6. Constructs and their sources.

Constructs	Number of items	Source
Accessibility	5	[49], [55], [61]
Actual use	4	[55], [93], [94]
Attitude towards use	4	[27], [35], [37], [46]
Behavioral intention to use	4	[35], [37]
Computer playfulness	5	[11], [64]
Computer self-efficacy	5	[35], [37], [49], [59]
Content quality	5	[36]–[38], [71]
Perceived enjoyment	5	[14], [40], [55], [59]
Information quality	5	[30], [94], [99]
Perceived ease of use	4	[35], [49], [55], [100]
Perceived usefulness	4	[14], [35], [55], [99], [100]
Subjective norm	5	[14], [19], [101]
System quality	5	[35], [65], [102]

E. SURVEY STRUCTURE

A questionnaire survey was developed and disseminated among the students. There were three sections in the survey. The first section consists of the personal data of the participants. The second section includes the items related to the usage of e-learning system. The third section involves the items pertaining to the factors affecting the e-learning system acceptance. The items in the third section were measured using a five-point Likert scale where 1 represents "strongly disagree", and 5 represents "strongly agree".

V. RESULTS

A. STUDENTS' PERSONAL INFORMATION

The personal/demographic data are summarized in Table 7. The percentage of female students was 54% while only 46% was males. 55% of the students' age range between 18 and 29 while this percentage is very close to those who were above 29 (45%). 36% of the students majored in IT while students in business management, engineering, science, law, education, and humanities were 27%, 9%, 3%, 3%, 16%, and 0.5%, respectively. 38% of the students were studying a bachelor's degree, 35% were studying a master's degree, and 16% as doctoral students, while the rest were categorized under the diploma and advanced diploma. With regard to the e-learning system usage, 60% of the respondents have utilized the Blackboard system, while 40% of them have used the Moodle system.

B. DATA ANALYSIS

The current study employs the Partial Least Squares-Structural Equation Modeling (PLS-SEM) approach to analyze the developed model using SmartPLS 3.2.7 [103]. In this study, the PLS-SEM is used to assess the measurement and structural models. The association between the constructs and their indicators refers to the measurement model (outer model), whereas the association between the latent constructs themselves refers to the structural model [104]. The selection of PLS-SEM in this study refers to the fact in which PLS-SEM provides concurrent analysis for both measurement and structural model, which in turn, leads to more accurate estimations [105].

C. MEASUREMENT MODEL EVALUATION

There are two kinds of validities that are required for evaluating the measurement model, namely convergent validity and discriminant validity [104].

1) CONVERGENT VALIDITY

Different measures need to be considered when evaluating the convergent validity. These measures include the factor loading of the individual measures, composite reliability, and the average variance extracted (AVE). According to the literature [104], the values of the factor loadings and composite reliability should be equal to or greater than 0.7, whereas the values of the AVE should be greater than 0.5 in order to be accepted. Table 8 shows the convergent validity results. In this study, it was exhibited that the loadings for the measurement items were higher than the recommended value. Besides, it was also demonstrated that the values of composite reliability (CR), Cronbach's alpha, and AVE were

TABLE 7. Students' demographic data.

Characteristics	Answers	Frequency	Percentage %
Gender	Female	237	54.5 %
	Male	198	45.5 %
Age	18 to 29	239	54.9 %
	30 to 39	153	35.2 %
	40 to 49	37	08.5 %
	50 to 59	6	01.4 %
	Above 60	0	0 %
College	College of Business and Economics	118	27.1 %
	College of Humanities and Social Sciences	22	05.1 %
	College of Information Technology	158	36.3 %
	College of Engineering	41	09.4 %
	College of Education	70	16.1 %
	College of Law	13	03.0 %
	College of Science	13	03.0 %
Level of education	Diploma	26	6.0 %
	Advanced Diploma	22	5.0 %
	Bachelor	166	38.2 %
	Master	154	35.4 %
	Doctorate	67	15.4%
Type of e-learning system	Blackboard	260	60 %
	Moodle	175	40 %

above the recommended values. Thus, the convergent validity is confirmed.

2) DISCRIMINANT VALIDITY

The degree to which one construct differs from all other constructs in the research model refers to discriminant validity [106]. For the determination of the discriminant validity, three measures should be taken into account: the Fornell-Larcker scale (i.e., the square root of AVE), cross-loadings, and the Heterotrait-Monotrait ratio of correlations (HTMT). The first condition for discriminant validity is that the square root of AVE (diagonal value) in every construct in the correlation matrix should surpass the correlation of latent constructs, which is met by the present study as demonstrated in Table 9.

As per Gefen and Straub [107], the second condition of discriminant validity is that the loading of every item must be higher as compared to the loading of its equivalent variable. Hence, it is evident from Table 10 that the second criterion has also been fulfilled. The third condition of discriminant validity is that the values of HTMT must be less than 0.85. It is evident from Table 11 that the third criterion has also been confirmed; resulting in the fact that the discriminant validity has been established.

D. STRUCTURAL MODEL EVALUATION

1) COEFFICIENT OF DETERMINATION

The most common measure used to analyze the structural model is the coefficient of determination (R^2) [104]. The predictive accuracy of the model is determined using this measure. In addition, it also signifies the degree of variance in the endogenous constructs validated by every exogenous construct related to it. According to the recommendations provided by Chin [106], when the R^2 value is more than 0.67, it is perceived as "high", whereas the values between 0.33 and 0.67 are considered as "moderate", and the values between 0.19 and 0.33 are considered as "weak".

According to Table 12, the R^2 values for the attitude towards use, behavioral intention to use, perceived ease of use, and perceived usefulness were found to be between 0.33 and 0.67; and hence, the predictive power of these constructs is considered as moderate. Besides, the R^2 value of the actual use is found to explain 68.1% of the variance, and therefore, the predictive power of this construct is considered as high.

2) PATH ANALYSIS

To analyze the various hypothesized associations in the developed model, the path coefficient analysis has been employed. The model was made to run through a bootstrap re-sampling routine to obtain the path significances [108]. In this study, a total of 5000 re-samples were used. A one-tailed t-test was employed in this study as all the hypotheses are directional. The one-tailed t-test (df = 435) entails that the 0.05 significance level (i.e., $p < 0.05$) requires a t-value > 1.657, the 0.01 significance level (i.e., $p < 0.01$) requires a t-value > 2.354, and the 0.001 significance level (i.e., $p < 0.001$) requires a t-value > 3.152. The hypotheses testing results of the suggested research model are shown in Figure 3 and Table 13. Five endogenous variables were verified in the model (PU, PEOU, ATT, BI, and AU). Generally, sixteen out of twenty-three hypotheses were supported. In that, the hypotheses H1a2, H1c1, H1c2, H2a2, H4a1, H4a2, H5a1, H5a2, H6a1, H7, H8, H9, H10, H11, H12, and H13 were supported by the empirical data, while H1a1, H1b1, H1b2, H2a1, H3a1, H3a2, H6a2, and H10 were rejected.

The results showed that PU is significantly influencing the ATT ($\beta = 0.521$, $p < 0.001$) and the BI ($\beta = 0.193$,

TABLE 8. Convergent validity results.

Constructs	Items	Factor Loading	Cronbach's Alpha	CR	AVE
System quality	SQ1	0.961	0.842	0.923	0.856
	SQ2	0.888			
	SQ3	0.722			
	SQ4	0.781			
	SQ5	0.801			
Content quality	CQ1	0.973	0.976	0.984	0.954
	CQ2	0.979			
	CQ3	0.773			
	CQ4	0.863			
	CQ5	0.781			
Information quality	IQ1	0.886	0.742	0.862	0.758
	IQ2	0.855			
	IQ3	0.711			
	IQ4	0.819			
	IQ5	0.728			
Computer self-efficacy	CSE1	0.897	0.721	0.846	0.733
	CSE2	0.813			
	CSE3	0.844			
	CSE4	0.777			
	CSE5	0.713			
Subjective norm	SN1	0.709	0.724	0.828	0.547
	SN2	0.704			
	SN3	0.771			
	SN4	0.770			
	SN5	0.861			
Perceived enjoyment	PE1	0.908	0.772	0.898	0.814
	PE2	0.922			
	PE3	0.733			
	PE4	0.820			
	PE5	0.825			
Accessibility	AC1	0.744	0.759	0.828	0.709
	AC2	0.930			
	AC3	0.878			
	AC4	0.710			
	AC5	0.798			
Computer playfulness	CP1	0.912	0.749	0.888	0.798
	CP2	0.875			
	CP3	0.773			
	CP4	0.871			
	CP5	0.800			
Perceived usefulness	PU1	0.890	0.677	0.822	0.698
	PU2	0.778			
	PU3	0.874			
	PU4	0.766			
Perceived ease of use	PEOU1	0.973	0.928	0.965	0.932
	PEOU2	0.958			
	PEOU3	0.883			
	PEOU4	0.769			
Attitude towards use	ATT1	0.894	0.749	0.889	0.800
	ATT2	0.885			
	ATT3	0.833			
	ATT4	0.711			
Behavioral intention to use	BI1	0.934	0.831	0.897	0.745
	BI2	0.860			
	BI3	0.791			
	BI4	0.840			
Actual use	AU1	0.945	0.842	0.926	0.862
	AU2	0.912			
	AU3	0.819			
	AU4	0.781			

TABLE 9. Fornell-larcker scale.

	Accessibility	AU	ATT	BI	CP	CSE	CQ	PE	IQ	PEOU	PU	SN	SQ
Accessibility	**0.842**												
AU	0.171	**0.929**											
ATT	0.299	0.220	**0.894**										
BI	0.388	0.194	0.487	**0.863**									
CP	0.435	0.254	0.272	0.363	**0.894**								
CSE	0.469	0.277	0.416	0.445	0.441	**0.856**							
CQ	0.113	0.117	0.153	0.235	0.119	0.272	**0.977**						
PE	0.470	0.275	0.421	0.411	0.566	0.618	0.203	**0.902**					
IQ	0.422	0.262	0.405	0.438	0.409	0.589	0.372	0.599	**0.871**				
PEOU	0.285	0.154	0.369	0.294	0.275	0.304	0.062	0.181	0.273	**0.965**			
PU	0.385	0.142	0.585	0.429	0.287	0.383	0.146	0.373	0.399	0.416	**0.836**		
SN	0.546	0.204	0.403	0.450	0.531	0.582	0.294	0.597	0.564	0.260	0.355	**0.739**	
SQ	0.151	0.054	0.087	0.022	0.154	0.038	0.110	0.109	0.079	0.139	0.087	0.128	**0.925**

$p < 0.01$); thus, supporting hypothesis H9 and H11, respectively. PEOU was determined to be significant in affecting the PU ($\beta = 0.296$, $p < 0.001$) and this supports hypothesis H7. Furthermore, PU was significantly influenced by three exogenous factors: IQ ($\beta = 0.138$, $p < 0.05$), PE ($\beta = 0.132$, $p < 0.05$), and PA ($\beta = 0.158$, $p < 0.05$) which in turn supports hypotheses H1c1, H4a2, and H5a2. PEOU was found to be significantly influenced by six exogenous factors: SQ ($\beta = -0.101$, $p < 0.01$), IQ ($\beta = 0.154$, $p < 0.05$), CSE ($\beta = 0.207$, $p < 0.01$), PN ($\beta = -0.201$, $p < 0.01$), PA ($\beta = 0.128$, $p < 0.05$), and PP ($\beta = 0.157$, $p < 0.01$); thus, supporting the hypotheses H1a2, H1c2, H2a2, H4a1, H5a1, and H6a1, respectively.

The results also revealed that ATT is significantly influencing the BI ($\beta = 0.342$, $p < 0.001$) and this gives support to hypothesis H12. BI was found to be significant in influencing the AU ($\beta = 0.194$, $p < 0.01$); therefore, supporting hypothesis H13. The relationships between PU and SQ ($\beta = -0.005$, $p = 0.911$), CQ ($\beta = 0.017$, $p = 0.750$), CSE ($\beta = 0.057$, $p = 0.379$), SN ($\beta = 0.012$, $p = 0.860$), and PP ($\beta = -0.026$, $p = 0.657$) were found to be statistically not significant, and thus, the hypotheses H1a1, H1b1, H2a1, H3a1, and H6a2 are generally not supported. In addition, the results indicated that both content quality (CQ) and subjective norm (SN) have a negative impact on the PEOU ($\beta = -0.062$; $p = 0.251$), and ($\beta = 0.024$; $p = 0.736$), respectively. Hence, H1b2 and H3a2 are not supported. Furthermore, the effect of PEOU on BI ($\beta = 0.088$; $p = 0.062$) was found to be not significant; hence, H10 is not supported.

VI. DISCUSSION

Although Abdullah and Ward [24] achieved significant results by determining the most frequent factors affecting the e-learning adoption (i.e., self-efficacy, subjective norm, enjoyment, computer anxiety, and experience), it was found in this study that (system quality, content quality, information quality, computer self-efficacy, subjective norm, enjoyment, accessibility, and computer playfulness) were the most extensively used factors. In accordance with the study purpose, we have analyzed the studies that were already examined by Abdullah and Ward [24] with other relevant studies that were collected based on the inclusion and exclusion criteria of this study. Accordingly, a new model has been developed through the extension of TAM with the most frequent factors resulted in this study. The results were discussed from the lenses of system characteristics, individual factors, and TAM constructs.

Concerning the system characteristics, the results demonstrated that system quality and information quality have significant positive effects on the students' perceived ease of use of e-learning systems. These results suggest that when the information underlying the e-learning system and its quality is deeply-rooted, the students' perceived ease of use would undoubtedly increase. Although information quality was found to affect the students' perceived usefulness of e-learning systems, system quality did not expose any significant effect on perceived usefulness. This result disagrees with the results reported in a previous study [35], in which system quality showed a significant effect on perceived usefulness. Further, the results indicated that content quality has an insignificant positive effect on perceived usefulness and perceived ease of use of e-learning systems. These results were not in agreement with the results provided in the past [38]. The discrepancy amount between the relationships observed in this study and those found in the literature might refer to the limited quality characteristics in which the e-learning system provides in the targeted institutions. Thus, the policy-makers and IT managers in these institutions need to consider these gaps by enhancing the quality of their e-learning systems in order to achieve high levels of adoption rates.

In terms of individual characteristics, the results showed that computer self-efficacy, enjoyment, and computer playfulness have significant positive impacts on perceived ease of use of e-learning systems. These results suggest that when the students have sufficient computer skills and expose a positive tendency to interact spontaneously with the e-learning system, their usefulness of the system would definitely increase. The results also revealed that enjoyment and accessibility have significant positive effects on perceived usefulness of e-learning systems. Although previous studies have

TABLE 10. Cross-loading results.

	Accessibility	ATT	AU	BI	CP	CQ	CSE	PE	IQ	PEOU	PU	SN	SQ
AC1	**0.744**	0.149	0.159	0.266	0.340	0.126	0.367	0.393	0.349	0.186	0.201	0.464	0.162
AC2	**0.930**	0.318	0.141	0.374	0.395	0.082	0.426	0.413	0.373	0.280	0.406	0.475	0.113
AC3	**0.878**	0.117	0.305	0.186	0.481	0.130	0.321	0.114	0.280	0.171	0.314	0.342	0.125
AC4	**0.710**	0.220	0.126	0.276	0.512	0.172	0.237	0.216	0.177	0.343	0.205	0.336	0.223
AC5	**0.798**	0.122	0.240	0.412	0.445	0.388	0.460	0.510	0.275	0.254	0.116	0.363	0.416
ATT1	0.246	**0.894**	0.216	0.431	0.241	0.147	0.360	0.392	0.420	0.339	0.523	0.345	0.085
ATT2	0.288	**0.885**	0.178	0.440	0.245	0.127	0.384	0.361	0.305	0.321	0.523	0.376	0.070
ATT3	0.127	**0.833**	0.217	0.310	0.504	0.527	0.220	0.555	0.513	0.153	0.286	0.653	0.225
ATT4	0.392	**0.711**	0.373	0.406	0.569	0.572	0.246	0.568	0.559	0.213	0.417	0.642	0.211
AU1	0.164	0.243	**0.945**	0.198	0.261	0.099	0.270	0.248	0.241	0.181	0.146	0.197	0.082
AU2	0.152	0.157	**0.912**	0.158	0.206	0.121	0.243	0.265	0.246	0.095	0.114	0.180	0.010
AU3	0.303	0.213	**0.819**	0.432	0.286	0.401	0.241	0.395	0.440	0.373	0.625	0.398	0.136
AU4	0.323	0.178	**0.781**	0.440	0.287	0.417	0.212	0.360	0.346	0.367	0.660	0.398	0.267
BI1	0.374	0.532	0.223	**0.934**	0.347	0.241	0.468	0.445	0.438	0.289	0.444	0.441	0.066
BI2	0.354	0.368	0.164	**0.860**	0.320	0.183	0.373	0.335	0.382	0.261	0.355	0.414	-0.010
BI3	0.261	0.316	0.084	**0.791**	0.264	0.173	0.275	0.243	0.292	0.198	0.284	0.286	-0.022
BI4	0.427	0.223	0.533	**0.840**	0.407	0.513	0.318	0.446	0.506	0.333	0.560	0.526	0.227
CP1	0.426	0.256	0.224	0.340	**0.912**	0.078	0.427	0.502	0.379	0.254	0.287	0.493	0.143
CP2	0.345	0.228	0.232	0.308	**0.875**	0.140	0.358	0.513	0.351	0.237	0.222	0.455	0.133
CP3	0.583	0.264	0.304	0.363	**0.773**	0.229	0.555	0.281	0.622	0.506	0.186	0.345	0.647
CP4	0.534	0.271	0.278	0.359	**0.871**	0.192	0.508	0.346	0.640	0.477	0.159	0.280	0.616
CP5	0.266	0.172	0.240	0.285	**0.800**	0.336	0.398	0.379	0.333	0.482	0.063	0.248	0.398
CQ1	0.114	0.139	0.117	0.211	0.127	**0.973**	0.269	0.210	0.372	0.057	0.127	0.291	0.113
CQ2	0.107	0.152	0.105	0.235	0.104	**0.979**	0.255	0.185	0.365	0.063	0.142	0.289	0.119
CQ3	0.112	0.156	0.121	0.240	0.118	**0.773**	0.272	0.202	0.354	0.061	0.158	0.283	0.093
CQ4	0.251	0.163	0.257	0.320	0.322	**0.863**	0.305	0.474	0.081	0.258	0.391	0.224	0.305
CQ5	0.268	0.180	0.246	0.320	0.342	**0.781**	0.325	0.467	0.068	0.264	0.401	0.232	0.325
CSE1	0.451	0.395	0.287	0.413	0.444	0.244	**0.897**	0.583	0.589	0.270	0.386	0.543	0.032
CSE2	0.341	0.309	0.175	0.344	0.296	0.220	**0.813**	0.464	0.400	0.252	0.256	0.446	0.034
CSE3	0.581	0.300	0.429	0.445	0.558	0.399	**0.844**	0.412	0.557	0.267	0.464	0.558	0.288
CSE4	0.488	0.185	0.348	0.380	0.434	0.215	**0.777**	0.509	0.498	0.245	0.323	0.546	0.216
CSE5	0.300	0.227	0.382	0.359	0.403	0.425	**0.713**	0.402	0.369	0.186	0.410	0.550	0.280
PE1	0.443	0.381	0.227	0.360	0.476	0.197	0.588	**0.908**	0.539	0.164	0.347	0.538	0.089
PE2	0.405	0.379	0.270	0.383	0.548	0.169	0.525	**0.922**	0.542	0.163	0.325	0.539	0.107
PE3	0.552	0.270	0.379	0.383	0.644	0.561	0.295	**0.733**	0.405	0.185	0.411	0.465	0.224
PE4	0.526	0.304	0.399	0.379	0.484	0.615	0.354	**0.820**	0.224	0.241	0.454	0.289	0.214
PE5	0.500	0.161	0.300	0.402	0.404	0.505	0.356	**0.825**	0.219	0.165	0.343	0.223	0.064
IQ1	0.374	0.352	0.266	0.332	0.364	0.258	0.523	0.526	**0.886**	0.249	0.367	0.453	0.083
IQ2	0.361	0.354	0.186	0.438	0.349	0.399	0.503	0.518	**0.855**	0.225	0.326	0.535	0.053
IQ3	0.528	0.214	0.401	0.469	0.475	0.598	0.514	0.583	**0.711**	0.210	0.440	0.653	0.230
IQ4	0.236	0.176	0.452	0.331	0.195	0.319	0.073	0.215	**0.819**	0.372	0.513	0.262	0.072
IQ5	0.168	0.151	0.333	0.282	0.170	0.251	0.066	0.178	**0.728**	0.257	0.432	0.172	0.034
PEOU1	0.307	0.404	0.153	0.306	0.288	0.082	0.329	0.195	0.295	**0.973**	0.433	0.292	0.137
PEOU2	0.236	0.298	0.143	0.258	0.237	0.032	0.251	0.150	0.224	**0.958**	0.363	0.200	0.130
PEOU3	0.393	0.187	0.485	0.403	0.329	0.487	0.256	0.405	0.453	**0.883**	0.289	0.444	0.236
PEOU4	0.290	0.170	0.506	0.384	0.245	0.274	0.177	0.359	0.371	**0.769**	0.491	0.317	0.063
PU1	0.360	0.561	0.102	0.413	0.251	0.153	0.384	0.320	0.362	0.404	**0.890**	0.360	0.056
PU2	0.276	0.399	0.143	0.292	0.230	0.082	0.239	0.306	0.301	0.277	**0.778**	0.216	0.096
PU3	0.558	0.252	0.331	0.422	0.503	0.553	0.325	0.541	0.574	0.145	**0.874**	0.290	0.221
PU4	0.614	0.212	0.336	0.424	0.564	0.564	0.341	0.594	0.544	0.161	**0.766**	0.226	0.252
SN1	0.452	0.321	0.232	0.401	0.360	0.247	0.490	0.475	0.456	0.174	0.227	**0.709**	0.037
SN2	0.366	0.201	0.046	0.252	0.353	0.190	0.347	0.370	0.254	0.139	0.262	**0.704**	0.145
SN3	0.379	0.323	0.097	0.314	0.416	0.230	0.390	0.418	0.418	0.169	0.311	**0.771**	0.129
SN4	0.424	0.339	0.225	0.367	0.433	0.207	0.496	0.501	0.522	0.274	0.246	**0.770**	0.069
SN5	0.617	0.274	0.389	0.413	0.408	0.384	0.351	0.536	0.581	0.157	0.431	**0.861**	0.113
SQ1	0.158	0.124	0.179	0.240	0.130	0.131	0.171	0.136	0.120	0.141	0.113	0.135	**0.961**
SQ2	0.113	0.111	0.113	0.124	0.268	0.157	0.222	0.244	0.102	0.110	0.127	0.295	**0.888**
SQ3	0.182	0.246	0.380	0.396	0.466	0.488	0.298	0.285	0.469	0.275	0.357	0.199	**0.722**
SQ4	0.229	0.216	0.249	0.222	0.185	0.296	0.185	0.263	0.217	0.070	0.202	0.242	**0.781**
SQ5	0.191	0.074	0.086	0.126	0.217	0.187	0.240	0.211	0.111	0.005	0.091	0.250	**0.801**

established positive relationships between computer self-efficacy [48] and computer playfulness [61] with perceived usefulness, it is surprising that different relationships have emerged in this study. This discrepancy might refer to the individuals' preferences and cultural differences between the developed and developing countries. In the same vein,

TABLE 11. Heterotrait-Monotrait ratio (HTMT).

	Accessibility	AU	ATT	BI	CP	CSE	CQ	PE	IQ	PEOU	PU	SN	SQ
Accessibility													
AU	0.245												
ATT	0.404	0.271											
BI	0.517	0.214	0.595										
CP	0.631	0.317	0.361	0.454									
CSE	0.730	0.364	0.591	0.584	0.618								
CQ	0.156	0.129	0.184	0.266	0.136	0.339							
PE	0.581	0.252	0.546	0.466	0.688	0.827	0.208						
IQ	0.488	0.261	0.494	0.522	0.455	0.796	0.492	0.804					
PEOU	0.356	0.167	0.436	0.326	0.325	0.388	0.063	0.176	0.208				
PU	0.569	0.187	0.816	0.558	0.452	0.613	0.195	0.553	0.562	0.583			
SN	0.758	0.293	0.494	0.522	0.651	0.745	0.301	0.796	0.697	0.231	0.519		
SQ	0.217	0.080	0.091	0.047	0.201	0.070	0.108	0.088	0.106	0.153	0.111	0.191	

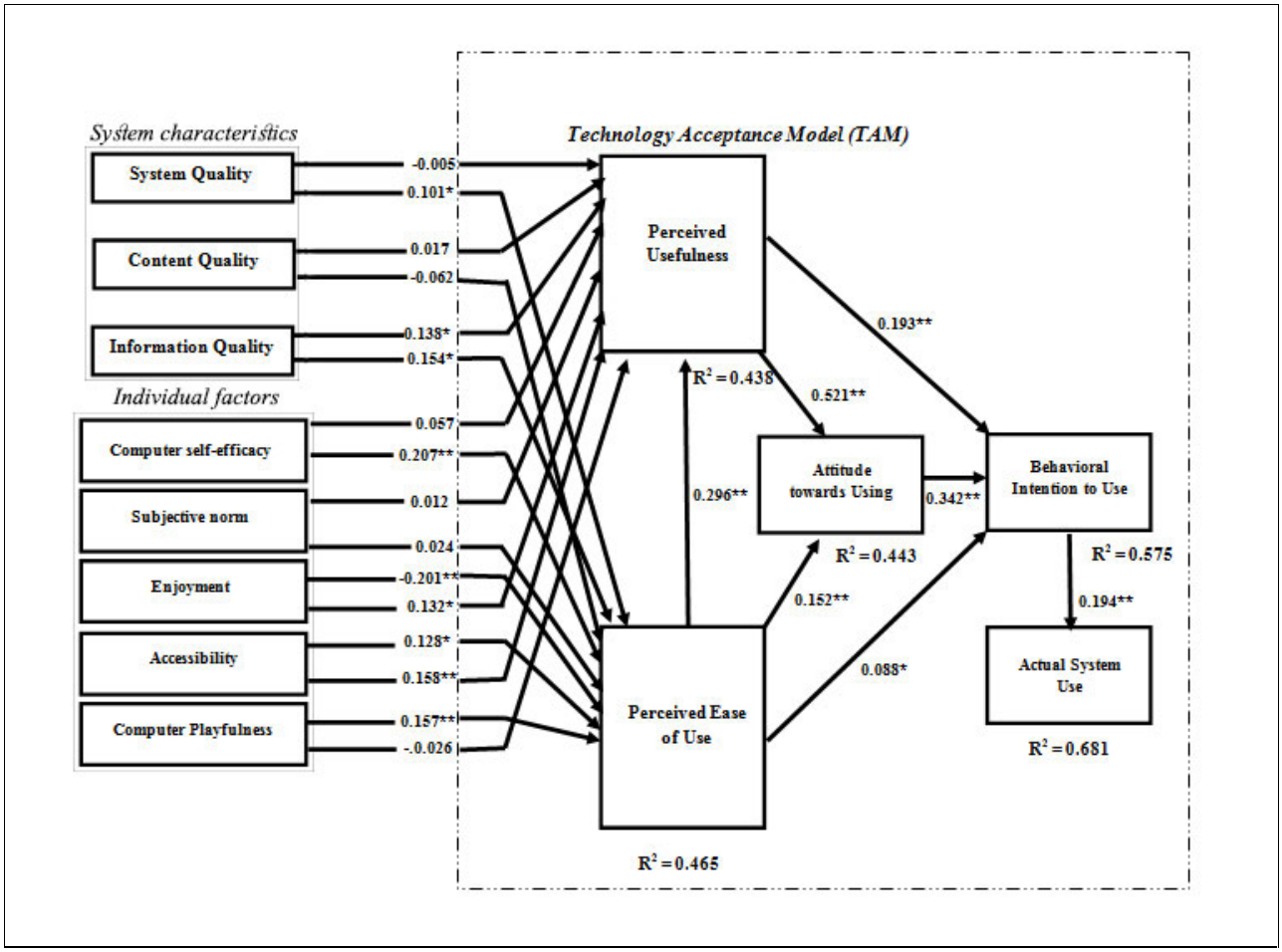

FIGURE 3. Pat. coefficient results (significant at p** < = 0.01, p* < 0.05).

the results indicated that subjective norm has an insignificant positive impact on perceived usefulness and perceived ease of use. These results were not in agreement with the results observed in prior studies [109]. These results postulate that even if the e-learning system is socially sound by the students' colleagues, students cannot be convinced that the e-learning system would be easy and useful to them.

With respect to TAM constructs, the results pointed out that perceived ease of use has a significant positive impact on perceived usefulness, attitudes, and behavioral intention to use e-learning systems. These results correspond to the original theoretical foundation of TAM [13]. These results are expected as when the students perceive that the e-learning system is user-friendly and easy to use, their usefulness,

TABLE 12. R^2 of the endogenous latent variables.

Constructs	R^2	Results
Actual use	0.681	High
Attitude towards use	0.443	Moderate
Behavioral intention	0.575	Moderate
Perceived ease of use	0.465	Moderate
Perceived usefulness	0.438	Moderate

attitudes, and behavioral intention would undoubtedly increase. The results also indicated that perceived usefulness has a significant positive effect on both attitudes and behavioral intention. These results also support the original hypotheses of TAM [13]. When students believe that the e-learning system is useful to them, their attitudes and behavioral intention would get better. Moreover, it was clear from the results that students' attitudes have a significant positive effect on behavioral intention, where the latter provided a strong positive association with the actual use of e-learning. These results stem from the fact that when the students expose positive attitudes towards using the e-learning system, their behavioral intention would increase, and consequently, their actual use would get better.

Overall, given the contextual sensitivity and the variety of factors affecting the core constructs of TAM [17], it can be seen that some of the factors were not supported in the UAE context. This requires further research to be conducted for examining the other individual factors that may affect e-learning acceptance. In addition, recognizing these factors is going to help in enhancing the capability of researchers and improving the e-learning acceptance rates in the UAE context by considering the factors studied in this research.

VII. IMPLICATIONS FOR RESEARCH AND PRACTICE

This study reinforces the application of TAM alongside with the additional factors added to the model in the UAE context. The study outcomes also offer a deeper understanding of the external factors and give useful suggestions for policy-makers, professionals, developers, and designers in effectively adopting the e-learning systems. First, the university administration needs to establish the appropriate infrastructure of e-learning systems and evaluate the readiness of students for e-learning systems. Second, the decision-makers and managers of e-learning systems in the UAE higher educational institutions need to focus on those factors that play an influential role in enhancing the students' acceptance of such systems which in turn affects the teaching performance and students' efficiency. Third, the research findings show how external factors pertaining to students' acceptance of e-learning systems are significant. Hence, the culture of e-learning systems should be instilled within the students. As such, students' readiness to e-learning systems should be examined and developed, and computer labs that are installed with suitable facilities for e-learning systems should be developed and made accessible to all the students in the university. Fourth, training courses should be set up to encourage students' perception of ease and usefulness of e-learning systems as that would improve the positive attitudes of students, and subsequently, their behavioral intention to use the e-learning systems. Fifth, the empirical results of this study could inform stakeholders in making effective decisions related to e-learning acceptance, which mainly supporting the implementations of e-learning systems in the UAE context and other similar contexts.

TABLE 13. Results of structural model (significant at p** < = 0.01, p* < 0.05).

H	Relationship	Path	*t*-value	*p*-value	Decision
H1a1	System Quality → Perceived Usefulness	-0.005	0.112	0.911	Not supported
H1a2	System Quality → Perceived Ease of Use	0.101	2.499	0.013	Supported*
H1b1	Content Quality → Perceived Usefulness	0.017	0.319	0.750	Not supported
H1b2	Content Quality → Perceived Ease of Use	-0.062	1.148	0.251	Not supported
H1c1	Information Quality → Perceived Usefulness	0.138	2.345	0.019	Supported*
H1c2	Information Quality → Perceived Ease of Use	0.154	2.244	0.025	Supported*
H2a1	Computer Self-Efficacy → Perceived Usefulness	0.057	0.881	0.379	Not supported
H2a2	Computer Self-Efficacy → Perceived Ease of Use	0.207	3.060	0.002	Supported**
H3a1	Subjective Norm → Perceived Usefulness	0.012	0.176	0.860	Not supported
H3a2	Subjective Norm → Perceived Ease of Use	0.024	0.338	0.736	Not supported
H4a1	Enjoyment → Perceived Ease of Use	-0.201	2.675	0.008	Supported**
H4a2	Enjoyment → Perceived Usefulness	0.132	2.110	0.035	Supported*
H5a1	Accessibility → Perceived Ease of Use	0.128	2.256	0.025	Supported*
H5a2	Accessibility → Perceived Usefulness	0.158	2.833	0.005	Supported**
H6a1	Computer Playfulness → Perceived Ease of Use	0.157	2.808	0.005	Supported**
H6a2	Computer Playfulness → Perceived Usefulness	-0.026	0.444	0.657	Not supported
H7	Perceived Ease of Use → Perceived Usefulness	0.296	5.164	0.000	Supported**
H8	Perceived Ease of Use → Attitude towards Use	0.152	3.125	0.002	Supported**
H9	Perceived Usefulness → Attitude towards Use	0.521	9.699	0.000	Supported**
H10	Perceived Ease of Use → Behavioral Intention to Use	0.088	1.869	0.042	Supported*
H11	Perceived Usefulness → Behavioral Intention to Use	0.193	2.834	0.005	Supported**
H12	Attitude towards Use → Behavioral Intention to Use	0.342	5.133	0.000	Supported**
H13	Behavioral Intention to Use → Actual Use	0.194	3.489	0.001	Supported**

VIII. LIMITATIONS AND FUTURE RESEARCH

Although the results of the study were quite interesting and played an essential role in describing the students' acceptance of e-learning systems, it also posits some limitations. First, the study was solely directed towards students, and if instructors' responses were considered, it would become possible to obtain comparisons between the analyses of instructors and students. Further research should consider this point. Second, the model is cross-sectional and determines users' perceptions and intentions for a single point in time. Therefore, it is suggested that more studies should be carried out using the longitudinal survey as it is possible that the perceptions and preferences of individuals would change when they acquire more experience with the passage of time. Third, the present study has focused on private universities in the UAE, and hence, the outcomes can only be generalized to the private universities and not the public ones. Fourth, the sample was obtained from a limited number of universities, and it was important to consider larger populations, having distinct income, education, demographical, and psychological attitudes. When the sample is highly representative, there is an opportunity to generalize the research findings to the entire UAE higher education context. Fifth, this study has used the convenience sampling technique, in which the generalization of the results should be treated with cautions. Further research should consider other sampling techniques in order to further generalize the results to the entire population.

IX. CONCLUSION

The objective of this study was twofold. First, to analyze the most commonly used external factors of the TAM concerning the e-learning adoption and acceptance studies. In that, a quantitative research approach comprising of 120 significant published studies from the last twelve years was conducted. As a result, the most extensively used external factors of TAM were identified, and these include computer self-efficacy, subjective/social norm, perceived enjoyment, system quality, information quality, content quality, accessibility, and computer playfulness. Second, a new model has been developed through the extension of TAM with these factors. Accordingly, the new model has been validated using the PLS-SEM approach.

According to the study findings, there was a positive impact of system quality, computer self-efficacy, and computer playfulness on students' perceived ease of use of e-learning systems. In addition, information quality, enjoyment, and accessibility have positively influenced the students' perceived ease of use and perceived usefulness of e-learning systems. Furthermore, perceived usefulness and perceived ease of use of e-learning systems have led to an increase in the students' intention to use e-learning systems in the future.

Moreover, perceived ease of use and perceived usefulness were found to be the most powerful predictors of usage intention. Therefore, it is the responsibility of the developers to build a system that is useful and easy to use. The content quality of the e-learning system does not adequately involve the learners. Hence, there should be audio and visual aid, animated simulation, and videos of experiments in the e-learning system contents so that the learners are fully engaged in the learning contents. The designers and developers should design the system and its interface in such a way that it is easy to use, which may improve the intent to accept and adopt e-learning systems. There should be an immediate and consistent response from the system so that the learners are encouraged towards its usage. When the system responds immediately, the users become more interested in the learning process.

APPENDIX

Accessibility

AC1: I access and use the e-learning system in the university without any problems.

AC2: The e-learning system can be accessed appropriately by using the chain of communication.

AC3: The e-learning system is accessible according to my own possibilities.

AC4: The chain of communication is suitable to get access to the e-learning tool.

AC5: I have no difficulty accessing and using an e-learning system in the university.

Actual use

AU1: I use the e-learning system frequently.

AU2: I use the e-learning on a daily basis.

AU3: To what extent did you use the e-learning system last month?

AU4: Overall, to what extent do you use the e-learning system?

Attitude towards use

ATT1: I feel positive regarding the utilization of e-learning system.

ATT2: In general, I admire the utilization of e-learning system.

ATU3: The e-learning system provides an attractive learning environment.

ATU4: Overall, I like using the e-learning system.

Behavioral intention to use

BI1: I will make use of the e-learning system regularly in the forthcoming time.

BI2: I intend to make use of the content and functions of e-learning system for providing assistance to my academic activities.

BI3: I will give out my recommendation to others to use the e-learning system.

BI4: I will use the e-learning system on a regular basis in the future.

Computer playfulness

CP1: I feel that my imagination will be enhanced by e-learning through the acquisition of information.

CP2: I feel that e-learning is enjoyable no matter what the usage purposes are.

CP3: I feel that e-learning helps me to improve my creativity.

CP4: I feel that e-learning helps me to improve my imagination by obtaining information.

CP5: I feel that I can have a variety of experiences without any interference.

Computer self-efficacy

CSE1: I feel confident in the utilization of e-learning system even when no one is there for assistance.

CSE2: I have sufficient skills to use the e-learning system.

CSE3: I feel confident when using the e-learning even if I have only the online instructions.

CSE4: I feel confident when using the e-learning system features.

CSE5: I feel confident when using the online learning content in the e-learning system.

Content quality

CQ1: The updated information is usually provided by the e-learning system.

CQ2: Learning content which I require can be provided by the e-learning system.

CQ3: I think there is a great value of the information I will acquire from e-learning.

CQ4: I search and share the related course content from the e-learning system to help my learning.

CQ5: Content of the e-learning system is updated on a regular basis.

Perceived enjoyment

PE1: I find the utilization of e-learning system to be fun.

PE2: My imagination is stimulated by using the e-learning system.

PE3: The e-learning system environment is enjoyable.

PE4: The use of the e-learning system is a fun activity.

PE5: The use of the e-learning system arouses my curiosity.

Information quality

IQ1: Information, which is relevant to my necessities, is acquired through e-learning.

IQ2: The information produced through the e-learning system is up-to-date enough for my needs.

IQ3: The output information from the e-learning system is clear.

IQ4: The e-learning system presents the information in an appropriate format.

IQ5: The reliability of output information from the e-learning system is high.

Perceived ease of use

PEOU1: There is clarity and understanding in my interaction with the e-learning system.

PEOU2: The e-learning system is easy to use for me.

PEOU3: Interacting with the e-learning system does not require a lot of my mental effort.

PEOU4: My interaction with the e-learning system is clear and understandable.

Perceived usefulness

PU1: The e-learning system enhances my learning performance.

PU2: My productivity is elevated through the utilization of e-learning in my study.

PU3: Using the e-learning system enhances my learning effectiveness.

PU4: I find the e-learning system to be useful in my learning.

Subjective norm

SN1: I should have participation in the e-learning activities, as per my instructors.

SN2: I should have participation in the e-learning activities, according to other students.

SN3: I should make use of the e-learning system, as per the people who affect my behavior or whose opinions I consider worthy.

SN4: Generally, I think that the utilization of the e-learning system would be supported by the university.

SN5: My friends think that I should use the e-leaning system.

System quality

SQ1: I consider the e-learning system interaction to be satisfactory.

SQ2: I consider the e-learning system functions to be satisfactory.

SQ3: I am satisfied with the e-learning system functions.

SQ4: I am satisfied with the e-learning system content.

SQ5: I am satisfied with e-learning system interaction.

REFERENCES

[1] K. L. Kumar and R. Owston, "Evaluating e-learning accessibility by automated and student-centered methods," *Educ. Technol. Res. Develop.*, vol. 64, no. 2, pp. 263–283, Apr. 2016.

[2] Y.-C. Yeh and L.-H. Chu, "The mediating role of self-regulation on harmonious passion, obsessive passion, and knowledge management in e-learning," *Educ. Technol. Res. Develop.*, vol. 66, no. 3, pp. 615–637, Jun. 2018.

[3] W. M. Al-Rahmi, N. Alias, M. S. Othman, A. I. Alzahrani, O. Alfarraj, A. A. Saged, and N. S. A. Rahman, "Use of E-learning by university students in Malaysian higher educational institutions: A case in Universiti Teknologi Malaysia," *IEEE Access*, vol. 6, pp. 14268–14276, 2018.

[4] F. Concannon, A. Flynn, and M. Campbell, "What campus-based students think about the quality and benefits of e-learning," *Brit. J. Educ. Technol.*, vol. 36, no. 3, pp. 501–512, May 2005.

[5] C. J. Bonk, R. A. Wisher, and J.-Y. Lee, *Moderating Learner-Centered E-Learning: Problems and Solutions, Benefits and Implications*. Hershey, PA, USA: IGI Global, 2004.

[6] A. Tarhini, K. Hone, X. Liu, and T. Tarhini, "Examining the moderating effect of individual-level cultural values on users' acceptance of E-learning in developing countries: A structural equation modeling of an extended technology acceptance model," *Interact. Learn. Environ.*, vol. 25, no. 3, pp. 306–328, 2017.

[7] S. A. Salloum, M. Al-Emran, K. Shaalan, and A. Tarhini, "Factors affecting the E-learning acceptance: A case study from UAE," *Educ. Inf. Technol.*, vol. 24, no. 1, pp. 509–530, 2019.

[8] K. S. T. Krishnan and H. Hussin, "E-learning readiness on Bumiputera SME's intention for adoption of online entrepreneurship training in Malaysia," *Management*, vol. 7, no. 1, pp. 35–39, 2017.

[9] A. Rhema, "An analysis of experiences and perceptions of technology-based learning in higher education institutions in Libya: Informing the advancement of e-learning," Ph.D. dissertation, Victoria Univ., Melbourne, VIC, Australia, 2013.

[10] J. Rissa, "An empirical study on the e-learning acceptance among the Finnish labor," Aalto Univ., Helsinki, Finland, Tech. Rep. 1-68, 2014.

[11] B.-C. Lee, J.-O. Yoon, and I. Lee, "Learners' acceptance of e-learning in South Korea: Theories and results," *Comput. Educ.*, vol. 53, no. 4, pp. 1320–1329, Dec. 2009.

[12] A. Schroeder, S. Minocha, and C. Schneider, "The strengths, weaknesses, opportunities and threats of using social software in higher and further education teaching and learning," *J. Comput. Assist. Learn.*, vol. 26, no. 3, pp. 159–174, 2010.
[13] F. D. Davis, "Perceived usefulness, perceived ease of use, and user acceptance of information technology," *MIS Quart.*, vol. 13, no. 3, pp. 319–340, 1989.
[14] C.-T. Chang, J. Hajiyev, and C.-R. Su, "Examining the students' behavioral intention to use e-learning in Azerbaijan? The General Extended Technology Acceptance Model for E-learning approach," *Comput. Educ.*, vol. 111, pp. 128–143, Aug. 2017.
[15] N. Al-Qaysi, N. Mohamad-Nordin, and M. Al-Emran, "A systematic review of social media acceptance from the perspective of educational and information systems theories and models," *J. Educ. Comput. Res.*, 2018.
[16] K. A. Al-Busaidi, "An empirical investigation linking learners' adoption of blended learning to their intention of full e-learning," *Behav. Inf. Technol.*, vol. 32, no. 11, pp. 1168–1176, 2013.
[17] M. Al-Emran, V. Mezhuyev, and A. Kamaludin, "Technology acceptance model in m-learning context: A systematic review," *Comput. Educ.*, vol. 125, pp. 389–412, Oct. 2018.
[18] A. Tarhini, K. Hone, and X. Liu, "Factors affecting students' Acceptance of e-learning environments in developing countries: A structural equation modeling approach," *Int. J. Inf. Educ. Technol.*, vol. 3, no. 1, pp. 54–59, 2013.
[19] A. Tarhini, K. Hone, and X. Liu, "Extending the TAM model to empirically investigate the students' behavioural intention to use e-learning in developing countries," in *Proc. Sci. Inf. Conf. (SAI)*, Oct. 2013, pp. 732–737.
[20] G. W.-H. Tan, K.-B. Ooi, J.-J. Sim, and K. Phusavat, "Determinants of mobile learning adoption: An empirical analysis," *J. Comput. Inf. Syst.*, vol. 52, no. 3, pp. 82–91, 2012.
[21] S. H. Alshammari, M. B. Ali, and M. S. Rosli, "The influences of technical support, self efficacy and instructional design on the usage and acceptance of LMS: A comprehensive review," *Turkish Online J. Educ. Technol.*, vol. 15, no. 2, pp. 116–125, 2016.
[22] S. Baleghi-Zadeh, A. F. M. Ayub, R. Mahmud, and S. M. Daud, "Behaviour intention to use the learning management: Integrating technology acceptance model with task-technology fit," *Middle-East J. Sci. Res.*, vol. 19, no. 1, pp. 76–84, 2014.
[23] V. Mezhuyev, M. Al-Emran, M. Fatehah, and N. C. Hong, "Factors affecting the metamodelling acceptance: A case study from software development companies in Malaysia," *IEEE Access*, vol. 6, pp. 49476–49485, 2018.
[24] F. Abdullah and R. Ward, "Developing a general extended technology acceptance model for e-learning (GETAMEL) by analysing commonly used external factors," *Comput. Hum. Behav.*, vol. 56, pp. 238–256, Mar. 2016.
[25] W.-H. Wu, Y.-C. Jim Wu, C.-Y. Chen, H.-Y. Kao, C.-H. Lin, and S.-H. Huang, "Review of trends from mobile learning studies: A meta-analysis," *Comput. Educ.*, vol. 59, no. 2, pp. 817–827, Sep. 2012.
[26] I. Govender and I. R.-L. Grange, "Evaluating the early adoption of Moodle at a higher education institution," in *Proc. Eur. Conf. E-Learn.*, 2015, p. 230.
[27] A. Alia, "An investigation of the application of the Technology Acceptance Model (TAM) to evaluate instructors' perspectives on E-Learning at Kuwait University," Ph.D. dissertation, Dept. Social Sci., Dublin City Univ., Dublin, Ireland, 2016.
[28] G. U. D. Shah, M. N. Bhatti, M. Iftikhar, M. I. Qureshi, and K. Zaman, "Implementation of technology acceptance model in E-learning environment in rural and urban areas of Pakistan," *World Appl. Sci. J.*, vol. 27, no. 11, pp. 1495–1507, 2013.
[29] M. Mahmodi, "The Analysis of the Factors Affecting the Acceptance of E-learning in Higher Education," *Interdiscipl. J. Virtual Learn. Med. Sci.*, vol. 8, no. 1, 2017, Art. no. e11158.
[30] A. Y. Alsabawy, A. Cater-Steel, and J. Soar, "Determinants of perceived usefulness of e-learning systems," *Comput. Hum. Behav.*, vol. 64, pp. 843–858, Nov. 2016.
[31] V. Damnjanovic, S. Jednak, and I. Mijatovic, "Factors affecting the effectiveness and use of Moodle: Students' perception," *Interact. Learn. Environ.*, vol. 23, no. 4, pp. 496–514, 2015.
[32] F. Calisir, C. A. Gumussoy, A. E. Bayraktaroglu, and D. Karaali, "Predicting the intention to use a Web-based learning system: Perceived content quality, anxiety, perceived system quality, image, and the technology acceptance model," *Hum. Factors Ergon. Manuf. Service Ind.*, vol. 24, no. 5, pp. 515–531, 2014.
[33] O. A. Jaber, "An examination of variables influencing the acceptance and usage of E-learning systems in Jordanian higher education institutions," Ph.D. dissertation, London School Commerce, Cardiff Metropolitan Univ., Cardiff, U.K., 2016.
[34] M. Yang, Z. Shao, Q. Liu, and C. Liu, "Understanding the quality factors that influence the continuance intention of students toward participation in MOOCs," *Educ. Technol. Res. Develop.*, vol. 65, no. 5, pp. 1195–1214, 2017.
[35] N. Fathema, D. Shannon, and M. Ross, "Expanding The technology acceptance model (TAM) to examine faculty use of learning management systems (LMSs) in higher education institutions," *J. Online Learn. Teach.*, vol. 11, no. 2, pp. 210–232, 2015.
[36] Y.-C. Lee, "An empirical investigation into factors influencing the adoption of an e-learning system," *Online Inf. Rev.*, vol. 30, no. 5, pp. 517–541, 2006.
[37] B. Rym, B. Olfa, and B. M. Mélika, "Determinants of E-learning acceptance: An empirical study in the Tunisian context," *Amer. J. Ind. Bus. Manag.*, vol. 3, no. 3, pp. 307–321, 2013.
[38] M. A. Almaiah, M. A. Jalil, and M. Man, "Extending the TAM to examine the effects of quality features on mobile learning acceptance," *J. Comput. Educ.*, vol. 3, no. 4, pp. 453–485, 2016.
[39] E. T. Khor, "An analysis of ODL student perception and adoption behavior using the technology acceptance model," *Int. Rev. Res. Open Distrib. Learn.*, vol. 15, no. 6, pp. 275–288, 2014.
[40] Y.-M. Cheng, "Antecedents and consequences of e-learning acceptance," *Inf. Syst. J.*, vol. 21, no. 3, pp. 269–299, 2011.
[41] V. Cho, T. C. E. Cheng, and W. M. J. Lai, "The role of perceived user-interface design in continued usage intention of self-paced E-learning tools," *Comput. Educ.*, vol. 53, no. 2, pp. 216–227, Sep. 2009.
[42] W. Wongvilaisakul and S. Lekcharoen, "The acceptance of e-Learning using SEM approach: A case of IT Literacy development for PIM students," in *Proc. 12th Int. Conf. Electr. Eng./Electron., Comput., Telecommun. Inf. Technol. (ECTI-CON)*, Jun. 2015, pp. 1–6.
[43] V. R. McKinney, K. Yoon, and F. Zahedi, "The measurement of Web-customer satisfaction: An expectation and disconfirmation approach," *Inf. Syst. Res.*, vol. 13, no. 3, pp. 296–315, 2002.
[44] I.-F. Liu, M. C. Chen, Y. S. Sun, D. Wible, and C.-H. Kuo, "Extending the TAM model to explore the factors that affect Intention to Use an Online Learning Community," *Comput. Educ.*, vol. 54, no. 2, pp. 600–610, Feb. 2010.
[45] H. Motaghian, A. Hassanzadeh, and D. K. Moghadam, "Factors affecting university instructors' adoption of web-based learning systems: Case study of Iran," *Comput. Educ.*, vol. 61, pp. 158–167, Feb. 2013.
[46] R. A. Sánchez and A. D. Hueros, "Motivational factors that influence the acceptance of Moodle using TAM," *Comput. Hum. Behav.*, vol. 26, no. 6, pp. 1632–1640, 2010.
[47] D. R. Compeau and C. A. Higgins, "Computer self-efficacy: Development of a measure and initial test," *MIS Quart.*, vol. 19, no. 2, pp. 189–211, 1995.
[48] F. Kanwal and M. Rehman, "Factors affecting E-learning adoption in developing countries–empirical evidence from Pakistan's higher education sector," *IEEE Access*, vol. 5, pp. 10968–10978, 2017.
[49] S. Y. Park, "An analysis of the technology acceptance model in understanding university students' behavioral intention to use e-learning," *J. Educ. Technol. Soc.*, vol. 12, no. 3, pp. 150–162, 2009.
[50] I. Ajzen, "The theory of planned behavior," *Org. Behav. Human Decision Process.*, vol. 50, no. 2, pp. 179–211, 1991.
[51] A. Revythi and N. Tselios, "Extension of technology acceptance model by using system usability scale to assess behavioral intention to use e-learning," 2017, *arXiv:1704.06127*. [Online]. Available: https://arxiv.org/abs/1704.06127
[52] V. Venkatesh, "Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model," *Inf. Syst. Res.*, vol. 11, no. 4, pp. 342–365, 2000.
[53] A. M. Elkaseh, K. W. Wong, and C. C. Fung, "The acceptance of E-learning as a tool for teaching and learning in Libyan higher education," *IPASJ Int. J. Inf. Technol.*, vol. 3, no. 4, pp. 1–11, Apr. 2015.

[54] J. H. Al-Ammary, A. K. Al-Sherooqi, and H. K. Al-Sherooqi, "The acceptance of social networking as a learning tools at University of Bahrain," *Int. J. Inf. Educ. Technol.*, vol. 4, no. 2, p. 208, 2014.

[55] M. R. Martínez-Torres, S. L. T. Marín, F. B. García, S. G. Vázquez, M. A. Oliva, and T. Torres, "A technological acceptance of e-learning tools used in practical and laboratory teaching, according to the European higher education area," *Behav. Inf. Technol.*, vol. 27, no. 6, pp. 495–505, 2008.

[56] S. S. Al-Gahtani, "Empirical investigation of e-learning acceptance and assimilation: A structural equation model," *Appl. Comput. Inform.*, vol. 12, no. 1, pp. 27–50, Jan. 2016.

[57] P. E. Ramírez-Correa, J. Arenas-Gaitán, and F. J. Rondán-Cataluña, "Gender and acceptance of E-learning: A multi-group analysis based on a structural equation model among college students in Chile and Spain," *PLoS ONE*, vol. 10, no. 10, 2015, Art. no. e0140460.

[58] C. Yi-Cheng, C. Chun-Yu, L. Yi-Chen, and Y. Ron-Chen, "Predicting college student' use of E-learning systems: An attempt to extend technology acceptance model," in *Proc. PACIS*, 2007, p. 121.

[59] Y.-C. Lin, Y.-C. Chen, and R. C. Yeh, "Understanding college students' continuing intentions to use multimedia E-learning systems," *World Trans. Eng. Technol. Educ.*, vol. 8, no. 4, pp. 488–493, 2010.

[60] M. M. Al-Debei, "The quality and acceptance of websites: An empirical investigation in the context of higher education," *Int. J. Bus. Inf. Syst.*, vol. 15, no. 2, pp. 170–188, 2014.

[61] A. Al-Aulamie, "Enhanced technology acceptance model to explain and predict learners' behavioural intentions in learning management systems," Ph.D. dissertation, Univ. Bedfordshire, Bedfordshire, U.K., 2013.

[62] S. Y. Park, M. M.-W. Nam, and S.-B. Cha, "University students' behavioral intention to use mobile learning: Evaluating the technology acceptance model," *Brit. J. Educ. Technol.*, vol. 43, no. 4, pp. 592–605, Jul. 2012.

[63] J. Webster and J. J. Martocchio, "Microcomputer playfulness: Development of a measure with workplace implications," *MIS Quart.*, vol. 16, no. 2, pp. 201–226, 1992.

[64] V. Venkatesh and H. Bala, "Technology acceptance model 3 and a research agenda on interventions," *Decision Sci.*, vol. 39, no. 2, pp. 273–315, 2008.

[65] N. Sandjojo and T. Wahyuningrum, "Measuring e-learning systems success: Implementing D & M is success model," in *Proc. 4th Int. Conf. Interact. Digit. Media (ICIDM)*, Dec. 2015, pp. 1–6.

[66] S. Alharbi and S. Drew, "Using the technology acceptance model in understanding academics' behavioural intention to use learning management systems," *Int. J. Adv. Comput. Sci. Appl.*, vol. 5, no. 1, pp. 143–155, 2014.

[67] T. M. Abbas, "Human factors affecting university hospitality and tourism students' intention to use e-learning: A comparative study between Egypt and the UK," *J. Hum. Resour. Hospitality Tourism*, vol. 16, no. 4, pp. 349–366, 2017.

[68] C. K. Y. Ho, W. Ke, and H. Liu, "Choice decision of e-learning system: Implications from construal level theory," *Inf. Manage.*, vol. 52, no. 2, pp. 160–169, Mar. 2015.

[69] S.-C. Lin, S. F. Persada, and R. Nadlifatin, "A study of student behavior in accepting the Blackboard Learning System: A Technology Acceptance Model (TAM) approach," in *Proc. IEEE 18th Int. Conf. Comput. Supported Cooperat. Work Design (CSCWD)*, May 2014, pp. 457–462.

[70] A. Al-Adwan, A. Al-Adwan, and J. Smedley, "Exploring students acceptance of e-learning using technology acceptance model in Jordanian Universities," *Int. J. Educ. Dev. Using Inf. Commun. Technol.*, vol. 9, no. 2, pp. 4–18, 2013.

[71] Y. M. Cheng, "Effects of quality antecedents on e-learning acceptance," *Internet Res.*, vol. 22, no. 3, pp. 361–390, 2012.

[72] A. R. Alenezi, A. M. A. Karim, and A. Veloo, "Institutional support and E-Learning acceptance: An extension of the technology acceptance model," *Int. J. Instrum. Technol. Distance Learn.*, vol. 8, no. 2, pp. 3–16, 2011.

[73] Y. J. Joo, N. Kim, and N. H. Kim, "Factors predicting online university students' use of a mobile learning management system (m-LMS)," *Educ. Technol. Res. Develop.*, vol. 64, no. 4, pp. 611–630, 2016.

[74] P. Bazelais, T. Doleck, and D. J. Lemay, "Investigating the predictive power of TAM: A case study of CEGEP students' intentions to use online learning technologies," *Educ. Inf. Technol.*, vol. 23, no. 1, pp. 93–111, Jan. 2018.

[75] M.-C. Lee, "Explaining and predicting users' continuance intention toward e-learning: An extension of the expectation–confirmation model," *Comput. Edu.*, vol. 54, no.2, pp. 506–516, 2010.

[76] C.-H. Ku, "Extending the technology acceptance model using perceived user resources in higher education Web-based online learning courses," Ph.D. dissertation, Dept. Educ. Res., Technol., Leadership, Univ. Central Florida, Orlando, FL, USA, 2009.

[77] M.-L. L. Jung, K. Loria, and R. M. P. Saha, "E-learning: Investigating University student's acceptance of technology," *Eur. J. Open, Distance e-Learn.*, vol. 11, no. 2, pp. 1–9, 2008.

[78] M. Masrom, "Technology acceptance model and E-learning," *Technology*, vol. 21, no. 24, p. 81, 2007.

[79] S. O. Ayodele, O. E. Oga, Y. G. Bundot, and M. E. Ogbari, "Role of power supply towards e-learning acceptance: VBSEM-AMOS," in *Proc. Int. Conf. Inf. Commun. Manage. (ICICM)*, Oct. 2016, pp. 151–155.

[80] J.-W. Hsia, C.-C. Chang, and A.-H. Tseng, "Effects of individuals' locus of control and computer self-efficacy on their e-learning acceptance in high-tech companies," *Behav. Inf. Technol.*, vol. 33, no. 1, pp. 51–64, 2014.

[81] H. Haryanto and H. U. Kultsum, "E-learning program adoption: Technology acceptance model approach," in *Proc. Int. Conf. Teacher Training Edu.*, 2016, vol. 2, no. 1, pp. 616–622.

[82] T. S. H. Teo, S. C. Srivastava, and L. Jiang, "Trust and electronic government success: An empirical study," *J. Manage. Inf. Syst.*, vol. 25, no. 3, pp. 99–132, 2008.

[83] I. Akman and C. Turhan, "User acceptance of social learning systems in higher education: An application of the extended technology acceptance model," *Innov. Educ. Teach. Int.*, vol. 54, no. 3, pp. 229–237, 2017.

[84] A. Tarhini, M. Hassouna, M. S. Abbasi, and J. Orozco, "Towards the acceptance of RSS to support learning: An empirical study to validate the technology acceptance model in Lebanon," *Electron. J. E-Learn.*, vol. 13, no. 1, pp. 30–41, 2015.

[85] S. A. Saaid and J. A. Rashid, "Interoperability of e-publishing: Knowledge and perception of iLearn system among students," in *Proc. Int. Conf. Edu. e-Learn.(EeL)*, Sep. 2012, p. 184.

[86] G. K. W. Wong, "The behavioral intentions of Hong Kong primary teachers in adopting educational technology," *Educ. Technol. Res. Develop.*, vol. 64, no. 2, pp. 313–338, 2016.

[87] Z. Hussein, "Leading to intention: The role of attitude in relation to technology acceptance model in E-learning," *Procedia Comput. Sci.*, vol. 105, pp. 159–164, 2017.

[88] D. U. Vidanagama, "Acceptance of E-learning among undergraduates of computing degrees in Sri Lanka," *Int. J. Mod. Educ. Comput. Sci.*, vol. 8, no. 4, pp. 25–32, 2016.

[89] N. F. A. Al-Mushasha, "Determinants of e-learning acceptance in higher education environment based on extended technology acceptance model," in *Proc. 4th Int. Conf. e-Learn. 'Best Pract. Manage., Design Develop. E-Courses, Standards Excellence Creativity'*, May 2013, pp. 261–266.

[90] Y. Deshpande, S. Bhattacharya, and P. Yammiyavar, "A behavioral approach to modeling Indian children's ability of adopting to e-learning environment," in *Proc. 4th Int. Conf. Intell. Hum. Comput. Interact. (IHCI)*, Dec. 2012, pp. 1–7.

[91] H.-L. Liao and H.-P. Lu, "The role of experience and innovation characteristics in the adoption and continued use of e-learning websites," *Comput. Educ.*, vol. 51, no. 4, pp. 1405–1416, Dec. 2008.

[92] J. Mou, D.-H. Shin, and J. Cohen, "Understanding trust and perceived usefulness in the consumer acceptance of an e-service: A longitudinal investigation," *Behav. Inf. Technol.*, vol. 36, no. 2, pp. 125–139, 2017.

[93] R. Cheung and D. Vogel, "Predicting user acceptance of collaborative technologies: An extension of the technology acceptance model for e-learning," *Comput. Educ.*, vol. 63, pp. 160–175, Apr. 2013.

[94] H. Mohammadi, "Investigating users' perspectives on e-learning: An integration of TAM and IS success model," *Comput. Hum. Behav.*, vol. 45, pp. 359–374, Apr. 2015.

[95] R. V. Krejcie and D. W. Morgan, "Determining sample size for research activities," *Edu. Psychol. Meas.*, vol. 30, no. 3, pp. 607–610, 1970.

[96] S. A. Salloum and M. Al-Emran, "Factors affecting the adoption of E-payment systems by University students: Extending the TAM with trust," *Int. J. Electron. Bus.*, vol. 14, no. 4, pp. 371–390, 2018.

[97] M. Alshurideh, S. A. Salloum, B. Al Kurdi, and M. Al-Emran, "Factors affecting the social networks acceptance: An empirical study using PLS-SEM approach," in *Proc. 8th Int. Conf. Softw. Comput. Appl.*, 2019, pp. 414–418.

[98] J. F. Hair, R. E. Anderson, B. J. Babin, and W. C. Black, *Multivariate Data Analysis: A Global Perspective*. Upper Saddle River, NJ, USA: Pearson, 2010.
[99] J. C. Roca, C.-M. Chiu, and F. J. Martínez, "Understanding e-learning continuance intention: An extension of the technology acceptance model," *Int. J. Hum. Comput. Stud.*, vol. 64, no. 8, pp. 683–696, 2006.
[100] C.-S. Ong and J.-Y. Lai, "Gender differences in perceptions and relationships among dominants of e-learning acceptance," *Comput. Hum. Behav.*, vol. 22, no. 5, pp. 816–829, 2006.
[101] M. M. Alkharang, "Factors that influence the adoption of e-learning: An empirical study in Kuwait," Ph.D. dissertation, Dept. School Inf. Syst. Comput. Math., Brunel Univ. London, London, U.K., 2014.
[102] D. Aixia and D. Wang, "Factors influencing learner attitudes toward E-learning and development of E-learning environment based on the integrated e-learning platform," *Int. J. E-Educ., E-Bus., E-Manage. E-Learn.*, vol. 1, no. 3, p. 264, Jan. 2011.
[103] C. M. Ringle, S. Wende, and J.-M. Becker, "SmartPLS 3. Bönningstedt: SmartPLS," Tech. Rep., 2015.
[104] J. F. Hair, Jr, G. T. M. Hult, C. Ringle, and M. Sarstedt, *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*. Newbury Park, CA, USA: Sage, 2016.
[105] D. Barclay, C. A. Higgins, and R. Thompson, "The partial least squares approach to causal modeling: Personal computer adoption and use as an illustration," *Technol. Stud., Special Issues Res. Methodol.*, vol. 2, pp. 282–324, Jan. 1995.
[106] W. W. Chin, "The partial least squares approach to structural equation modeling," *Mod. methods Bus. Res.*, vol. 295, no. 2, pp. 295–336, 1998.
[107] D. Gefen and D. W. Straub, "The relative importance of perceived ease of use in IS adoption: A study of E-commerce adoption," *J. Assoc. Inf. Syst.*, vol. 1, no. 1, p. 8, 2000.
[108] B. Efron and R. J. Tibshirani, "The jackknife," in *An Introduction to Bootstrap*. Springer, 1993, pp. 141–152.
[109] T. Teo, M. Zhou, A. C. W. Fan, and F. Huang, "Factors that influence university students' intention to use Moodle: A study in Macau," *Educ. Technol. Res. Develop.*, vol. 67, no. 3, pp. 749–766, 2019.

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