Contents lists available at GrowingScience

International Journal of Data and Network Science

homepage: www.GrowingScience.com/ijds

Evaluation of factors affecting university students' satisfaction with e-learning systems used during Covid-19 crisis: A field study in Jordanian higher education institutions

Ra'ed Masa'deh[a*], Dmaithan Almajali[b], Ala'aldin Alrowwad[a], Rami Alkhawaldeh[a], Sufian Khwaldeh[a] and Bader Obeidat[a]

[a]*The University of Jordan, Jordan*
[b]*Applied Science Private University, Jordan*

C H R O N I C L E

Article history:
Received: March 14, 2022
Received in revised format: September 26, 2022
Accepted: November 13, 2022
Available online: November 13 2022

Keywords:
e-learning
Covid-19
Students' satisfaction
Higher education institutions
Jordan

A B S T R A C T

E-learning results from the integration of technology and education and has become an effective learning medium today. E-learning courses and systems with various services are on the rise owing to its importance. E-learning systems should be evaluated to assure successful delivery, effective usage, and positive impacts on learners. A holistic model that identifies various levels of success on a vast range of success determinants was proposed. The model was empirically validated using data obtained from 724 e-learning student users in Jordan. Structural Equation Modelling (SEM) was used in data analyses. Results showed that perceived usefulness of information systems, user training, system quality, and management support have positive effects on user's behavioral intention; whereas perceived ease of use has not. Also, SEM displayed that user behavioral intention has a positive effect on information systems use, use on student satisfaction, and the latter on student loyalty. Machine Learning (ML) methods produce high correlation values reaching up to 80% in predicting Behavior Intention (BI) from the input factors, and student loyalty from student satisfaction factors. This indicates that the ML are promising techniques to forecast the future targets based on the input independent features.

1. Introduction

Information Technology (IT) advancement contributes to the enhancements of many domains including the domains of health, business, finance, and education. Furthermore, the rapid development of education has been facilitated by the advancement of e-learning, making e-learning a potent learning medium for learning (Masa'deh et al., 2022; Al-Fraihat et al., 2017). Higher education sector has been heavily relying on e-learning nowadays. In fact, as reported by Dahlstrom et al. (2014), the use of Learning Management Systems (LMSs) can be observed in nearly all higher education institutions, with 85% rate of utilization. In the UK, McGill and Klobas (2009) reported that the use of LMS can be observed among 95% of higher education institutes to facilitate their educational services. Many studies have been carried out to examine e-learning systems quality, mainly focusing on its success factors to achieve maximum effectiveness (Fathema et al., 2015). The majority of these research focused on particular aspects of the crucial factors that determine the success of e-learning systems without taking into account how the many success factors interact with one another (Eom & Ashill, 2018). Studies have also looked at the connections between e-quality learning's components and usage or satisfaction as in Selim (2003) and Ozkan and Koseler (2009). Earlier e-learning studies have presented major success factors of e-learning and they are system quality, information quality, service

* Corresponding author.
E-mail address: r.masadeh@ju.edu.jo (R. Masa'deh)

ISSN 2561-8156 (Online) - ISSN 2561-8148 (Print)

doi: 10.5267/j.ijdns.2022.11.003

quality, satisfaction, and usefulness, and various measurements have been proposed. However, the overabundance of measurements has made the formation of e-learning success model challenging. Still, as implied in Eom and Ashill (2018), For multiple-level success, there is yet no complete success model. It is necessary to study the various aspects of e-learning success in regard to both human and non-human entities. In this case, learners and instructors are considered human entities in the context of e-learning, while learning management systems are considered non-human entities. Examining e-learning studies from 2001 till 2016, Cidral et al. (2018) reported that the initial e-learning studies (beginning year 2001) were mostly focusing on the factors of intention to use, adoption, usability, course contents and customization, and starting 2007, e-learning studies began to add the factor of satisfaction. Then, in year 2013, the researchers began to look into the overall success of e-learning and the impacts of the characteristics of students as e-learning user on e-learning success (Cidral et al., 2018). As can be observed, early e-learning studies were mainly focusing on the technological aspects of e-learning. Then, when e-learning became established, the focus of researcher has shifted to the attitudes and interactions of e-learning users (students and instructors) as these are also major factors affecting e-learning success (Cheng, 2011). E-learning needs to be examined further, especially in terms of its continuous improvement and in catering to the needs of learner. Notably, the success factors of e-learning differ with regards to their relative significance following the context, and so, the factors need to be dealt with using different strategies. For instance, developing countries were facing challenges in their e-learning implementation, and these challenges related to resources, infrastructure, accessibility and the users as well. Meanwhile, e-learning implementation in developed countries has been viewed as effective and beneficial as it improves lifelong education and provides quality information, among others (Abu-Taieh et al., 2022; Mohammadi, 2015). Based on the discussion above, the goal of the current study was to examine the variables influencing the success of e-learning. Accordingly, a model comprising e-learning success determinants for current e-learning users was proposed. The following section of this research article discusses the findings of earlier studies, the research methodologies employed, the findings of this research, the outcomes of the results discussion, and the study's conclusion.

2. Theoretical Foundation

E-learning has been experiencing dramatic progressions, facilitated by the availability of devices like computers, laptops, tablets, and smartphones. With the advancement of technology, education today has changed in terms of the methods used in learning and teaching. Previously, only select few had access to learning materials, while communication and collaboration of students only could occur face to face, within the same classroom. Contrariwise, colossal amounts of learning resources in various formats like videos, images, texts and so forth are boundlessly available to everyone, providing that user has the right devices and access to the internet. Additionally, the availability of chat, forums, wikis, and peer-to-peer activities has provided user with more opportunities for collaboration and interactive communication. Technology today is experiencing constant evolution, resulting in a varied definition of e-learning. Lee et al. (2011) for instance referred e-learning an information system with the ability to integrate various instructional materials like audio, video, text, etc., delivered via various mediums like online discussions, forums, e-mail, live chat sessions, and so forth. On the other hand, Sun et al. (2008) described e-learning as the technology intervention during learning. Meanwhile, the present study perceives e-learning system of e-learning as an information system, and so, e-learning system success is considered a success of IS. In their literature review, Al-Fraihat et al. (2017) found that there were four main models in the measurement of e-learning success measurement. First, DeLone and McLean information systems success model, Second, Technology Acceptance Model (TAM), Third, User Satisfaction Models, and the Fourth is E-Learning Quality Models. Based on IS success studies published between 1981 and 1987, DeLone and McLean (1992) proposed a model for measuring information systems success. This model, which has comprehensive framework, includes six variables namely system quality, information quality, use, user satisfaction, individual impact, and organizational impact. DeLone and McLean (1992) proposed developing and validating their model further. The model has been tested by various researchers (Taylor & Todd, 1995). Seddon and Kiew (1994) had tested the model partially and expressed support to several paths in the model. In utilizing the model in their study, Pitt et al. (1995) added the construct of service quality. Jurison (1996) carried out a longitudinal study on IS benefits and stated the need to first evaluate the individual impacts, while noting that the evaluation of organizational impact is time consuming. In examining the IS success model, Seddon (1997) considered the mutual relationship between use and user satisfaction as confusing, and so, the model was altered whereby ‘system use’ was replaced with ‘perceived usefulness’ and only one direction of causality was allowed. The model proposed by Seddon (1997) was examined by Rai et al. (2002) and was compared to the DeLone and McLean’s (1992) model, resulting in a new model. This model includes a correlational path between perceived usefulness and use. The IS success model was updated by the original authors in 2002 with the inclusion of the construct of ‘service quality,’ while the construct of ‘use’ was broken down into two parts namely ‘intention to use’ and ‘use’ for systems success measurement in the situation where system use is voluntary and mandatory. In addition, the constructs of individual impact and organizational impact were combined into one construct named as benefits.

This modified IS success model has been employed to understand systems success, including those of e-learning (Cidral et al., 2018; Lin, 2007). Based on the extant literature, the model is valid, fully or in part, in e-learning systems success evaluation. However, results have been mixed. Specifically, some reported a significant impact of the overall quality aspects (system, information, and service quality) on actual use of a given system, while some found that the impact was not significant. Lin (2007) examined actual use of Online Learning System (OLS) and concluded that system quality, information quality, and service quality had a significant effect on the actual use of the system via user satisfaction and OLS behavioral intention.

Meanwhile, Eom et al. (2012) found significant direct relationship between system quality and information quality on use of system. However, Klobas and McGill (2010) examining Australian university and Cidral et al. (2018) examining Brazilian universities, found no significant relationship between the aspects of quality and use. The inconsistent outcomes can be attributed to the system's utilization being either compulsory or optional. In their study, Eom et al. (2012) indicated that in obligatory (non-voluntary) situation, e-learning system would be used by students no matter its quality because it is the only place for students to obtain learning resources. On the other hand, in voluntary situation, the decision of user to whether use or abandon the system is affected by the system quality. The overriding variables not included in the model can also factor the mixed results. Equally, the results could be affected by the study context and the differences of the sample used, whereby in these models, the differences appear to exist between the variance explained (R^2) by quality factors among the dependent variables. Eom et al. (2012) relevantly mentioned the narrow explanatory power of the DeLone and McLean model in describing the role of e-learning systems on the e-learning outcomes. Hence, the IS success model should be examined and tested further, in order to expand its explanatory power (Awang et al., 2018).

2.1. E-learning Success based on Technology Acceptance Model

Technology Acceptance Model (TAM) was created by Davis et al. (1989) based on Theory of Reasoned Action (TRA). This Social Psychology type model has been popular among IS success studies, to measure the success of new technology particularly with respect to technology use and acceptance (Surendran, 2012). According to TAM, several factors will affect the decision of user in using a new technology, particularly in terms of how and when (Davis, 1989). Perceived usefulness and perceived ease of use as two of the model's constructs are affected by factors namely social factors, cultural factors, external factors, and political factors (Surendran, 2012). Meanwhile, perceived usefulness and perceived ease of use become key determinants of attitude towards technology use and use intention. For actual system usage, it majorly affected by behavioral intention. The robustness and validity of TAM have been empirically examined in various studies in various contexts, including the context of e-learning. TAM has been expanded by Venkatesh and Davis (2000) resulting in TAM2 that considers social influence processes (subjective norm, voluntariness, experience, and image), and cognitive instrumental processes (job relevance, output quality, and result demonstrability). TAM2 has been proven superior in describing user acceptance. As further expansion of TAM is Unified Theory of Acceptance and Use of Technology (UTAUT) created by Venkatesh et al. (2012). UTAUT considerably improves the explanation power of the variance in usage intention. TAM has indeed evolved over the years, from TAM, to TAM2, TAM3, UTAUT and most recently, UTAUT2. All of these models have been empirically tested in various domains, including the domain of e-learning. TAM has been used in e-learning studies to predict usefulness, intention to use and e-learning systems use. In understanding the determinants of acceptance and usage of e-learning systems, TAM has been extended through the addition of external variables, and this helps researcher in understanding the adoption potential of a system, and so, appropriate 'corrective steps' can be determined, as necessitated (Davis et al., 1989). Abdullah and Ward (2016) reported the factors of self-efficacy, computer anxiety, subjective norm, enjoyment, and prior experience as commonly employed external factors to TAM in examining e-learning. Šumak et al. (2011) found that TAM has been used as information system theory in most e-learning acceptance studies. Petter et al. (2008) notably stated that acceptance and use cannot be deciphered as success, and so, TAM has been criticized despite its popularity in technology acceptance studies. The practical effectiveness and theoretical assumptions of TAM has been questioned by some (Chuttur, 2009). Additionally, Legris et al. (2003) stated the need to expand TAM by adding variables associated to human and social change processes. Legris et al. (2003) added that TAM had poor fit and inadequate explanatory and predictive power, aside from lacking practical value. Also, the authors reported that TAM and TAM2 clarified approximately 40% of system use. On the other hand, when extended with the addition of other variable(s), the explanatory power of TAM will increase (52% to 70%) (Abdullah & Ward, 2016). However, expanding TAM may also cause "theoretical chaos and confusion" (Benbasat & Barki, 2007).

2.2. E-learning Success based on User Satisfaction Models

User satisfaction approach has also been used in measuring IS in terms of its success, effectiveness, usage, and acceptance (DeLone & McLean, 1992). Satisfaction is regarded as user's attitude (Thong & Yap, 1996), while user satisfaction can be regarded as discrepancy measure between the expectations of user concerning a given IS and the system's perceived performance (Remenyi & Money, 1991). The evaluation of IS success with user satisfaction was pioneered by Cyert and March (1963), and the authors indicated that satisfaction will increase when IS fulfils the needs of user. On the other hand, lower satisfaction will impede use of the system, besides the success of IS has been frequently measured using user satisfaction (Seddon & Kiew, 1994). In their study on computer user satisfaction to examine IS success, Bailey and Pearson (1983) employed an instrument comprising 39 factors. In a comparable study, Ives et al. (1983) employed an instrument comprising 13 factors, but according to Goodhue (1986), such instrument had weak theoretical support. However, the instrument was empirically validated by Baroudi and Orlikowski (1988). In another study, Chin et al. (1988) produced a highly reliable questionnaire for measuring user satisfaction. Additionally, owing to its high reliability and validity, DeLone and McLean (1992) used satisfaction as a single construct in their model. In examining end-user computing satisfaction (EUCS), Doll et al. (2004) utilized a 12-item scale which was validated. User satisfaction has been measured using various approaches. Some studies evaluated satisfaction level of certain case of information systems, for instance, IS at micro level (Ilias et al., 2009) or at macro level like the overall computer system in the organization (Wixom & Todd, 2005). On the other hand, some studies evaluated IS success using satisfaction as a single broad construct (Leclercq, 2007; Doll et al., 2004). There were also studies that

incorporated the construct of satisfaction in the model to combine with other constructs (DeLone & McLean, 1992). The examining the success of e-learning systems, user satisfaction has been used as one broad factor or together with other factors. In their study, Sun et al. (2008) proposed a model comprising six dimensions that critically affect satisfaction of learner. These dimensions are: instructors, learners, course, design, technology, and environment. Based on these six dimensions, thirteen hypotheses were proposed involving the factors of computer anxiety, course quality, the attitude of instructor toward e-learning, flexibility, perceived ease of use, perceived usefulness, and diversity in assessment. All of the hypotheses were supported. The authors concluded that the increase in satisfaction of users via these factors leads to e-learning system success. In another study on e-learning success, Ozkan and Koseler (2009) proposed a hexagonal model comprising six dimensions, three of which belong to the quality factors (system quality, information quality, and service quality) while the remaining three belong to social related factors (supportive factors, learner perspective, and instructor attitudes). The authors found that all six dimensions had significant relationship with e-learning satisfaction, and they describe 76.9% of the variance in e-learning satisfaction. Hence, the proposed hexagonal model could information system the evaluation of e-learning effectiveness and could also be expanded through the inclusion of other dimensions. Wu et al. (2010) studied blended e-learning system environments utilizing an e-learning satisfaction model called BELS. The model tested utilizing 212 participants, and the results showed that student learning satisfaction was majorly determined by computer self-efficacy, interaction, content feature, system functionality, performance expectations, and learning climate. The conjectured relationships were all significant, and the proposed model described 67.8% of the variance of learning satisfaction.

2.3. E-learning Success based on E-learning Quality Models

E-learning systems can be evaluated in terms of its overall quality, and there are various existing approaches and models in quality evaluation, for instance, benchmarking, excellence models, e-learning quality surveys, ISO 9000, just to mention a few. In their evaluation of web-based learning (WBL) systems, MacDonald et al. (2001) proposed a model called the Demand-Driven Learning Model (DDLM) comprising five interrelated dimensions including the dimension of consumer demands that include quality content, delivery, and service. The second dimension is superior structure as the quality standard for the provision of the desired content, delivery and service – this dimension requires understanding the needs and motivation of learner, learning facilitators for the formation of healthy collaborative and convenient learning environment, among others. The third dimension is learner outcomes, which concern cost, personal advantages, and learning outcomes achievement. Ongoing program evaluation is the fourth dimension, while continual adaptation and improvement are the fifth dimension. The model was empirically tested and validated (MacDonald et al., 2005). Ehlers (2004) utilized multi-dimensional model to evaluate e-learning quality. Developed based on learners' perspectives, the model advocates the importance of understanding the needs of learners prior to commencing any e-learning project. The model perceives e-learning quality as a co-production process between the learner and the learning environment to empower learner. In another study, Boud and Prosser (2002) proposed the use of the aspects of learners' engagement, context acknowledgement, challenge for learners, and practice involvement, to measure e-learning quality. Meanwhile, Oliver (2005) mentioned benchmarking and specification of standards as the two major approaches in examining e-learning quality assurance. The author described benchmarking as the comparison of performance and outcomes in one environment, while standards were described as the criteria used in performance evaluation. In a related study, Pawlowski et al. (2007) employed a quality adaption model that compares the approaches of e-learning quality with ISO/IEC. A quality model from the perspective of developer was employed by Abdellatief et al. (2011), and the model comprises four variables of service content, system functionality, information technology, and system reliability. Meanwhile, Ireland et al. (2009) constructed a framework in their evaluation of e-learning quality, to achieve superior skills of academics, to stimulate e-learning quality. Quality of e-learning can be evaluated through the use of agencies and programs that guarantee quality standards of e-learning. This can be exemplified by the European Union e-learning program, the Institute for Higher Education Policy in the USA, and the Quality Assurance Agency QAA in the UK (Oliver, 2005). Additionally, Massy (2002) examined e-learning quality in Europe with the purpose of rating the quality of e-learning quality. E-learning quality has been comprehensively examined in countless of studies but considering that e-learning systems have complex nature, in addition to the presence of diverse e-learning stakeholders, and the broadness of quality as a concept, Oliver (2005) indicated that a quality e-learning approach is an ambiguous and unclear concept. Furthermore, it is not easy to come up with measurements that are fully accurate for e-learning systems evaluations based on quality approaches, considering the variations of criteria in organizations.

3. Hypotheses Development

Perceived Usefulness (PU) is a strong influence of user intentions (Davis, 1989). However, studies that employed this construct have reported mixed outcomes. Still, as reported by Petter et al. (2008), PU has been considered as main predictor of behavior intention (BI) of user, especially in MIS studies. Studies on information systems adoption evaluation have also employed this relation. Youngberg et al. (2009) for instance, reported a strong association between PU and BI, in their examination of user perceptions of certain component of information system. Equally, significant relationship was reported by Rajan and Baral (2015) and Sternad and Bobek (2013) in their use of PU in describing BI of user. Based on these findings, PU is expected to successfully predict BI of user towards the use of information system. Hence, the hypothesis below was proposed:

H_1: *Perceived usefulness of information system has a positive effect on user's Behavioral Intention.*

Through PU, Perceived Ease of Use (PEOU) affects behavioral intention both directly and indirectly, affecting Behavioral Intention (BI) (Davis, 1989). Notably, Petter et al. (2008) reported that PEOU was less significant in its impact compared to PU. Still, as stressed by Venkatesh and Davis (2000), the relation has solid basis and its relevance and impact must be taken into account, including in information system studies which reported support for this relation (Rajan & Baral, 2015; Sternad & Bobek, 2013). This study therefore anticipated positive impact of perceived ease of use on behavioral intention of user, as specified by the following hypothesis:

H_2: *Perceived ease of use has a positive effect on user's Behavioral Intention.*

Yusliza and Ramayah (2012) who studied user acceptance towards the use of e-HRM platforms have affirmed the significant role of user training, and so, user training on using e-HRM system should be taken into account in the link between e-HRM and the effectiveness of human resource service. Hence, this study proposed the hypothesis below:

H_3: *User training is positively linked to user's behavioral intention.*

Past studies have reported the impact of system quality on the behavioral intentions of user. In examining information systems implementation among three companies (Chien & Tsaur, 2007), found that user's behavioral intention was significantly affected by the quality of information system. Based on the extant studies, it was expected that System Quality (SYSQ) of information system will affect Behavioral Intention (BI) of user, as proposed by the following hypothesis:

H_4: *System quality of information system has a positive effect on user's behavioral intention*.

Management support denotes various conditions including top management support, ample financial resources, and employee competency, all of which, aid in the adoption of innovation. In general, new technology implementation and deployment in organizations occurs in a top-down manner, that is, from top management to the bottom of the organization's hierarchy. In this regard, top management support concerns the degree to which top management is aware of the importance of the IS function and the degree to which it has involvement in IS activities (Ragu-Nathan et al., 2004). Maduku et al. (2016) perceived such support as integral in the establishment of a supportive environment and in the provision of ample resources in the facilitation of new technology adoption. Studies including Ahmad et al. (2019), AlSharji et al. (2018), and Hasani et al. (2017) have indicated the inclination of top management and/or decision makers towards adoption of innovation that provides benefits greater than the existing technology and that offset the adoption risks. In a related study, Lai et al. (2018) reported that perceived benefit stimulates the adoption of big data analytics among supply chain and logistics firms. Some studies (Kurdi and Alshurideh, 2020; Oliveira, 2019) reported top management support as an indicator for innovation adoption. Hence, it can be anticipated that top management support and adoption of autonomous robots are relatable to the supply chain and logistics. The hypothesis below was thus proposed:

H_5: *Management support has a positive impact on user's behavioral intention.*

Behavioral Intention (BI) affects the actual system usage (USE) significantly (Davis et al., 1992). Behavioral intention of user has been shown to have full mediation over the impact of PU, PEOU and subjective norm, on actual system use (Venkatesh & Davis, 2000). In addition, a meta-analysis carried out by Legris et al. (2003) involving adoption models showed that studies that tested the BI-USE relation had reported a positive relation. Similar to other IS related studies, those that examined information systems also reported a significant relation between behavioral intention (BI) of user and actual information system use (USE) (Sternad & Bobek, 2013). Hence, this study expected that BI of information system systems usage significantly and positively affect information systems actual use, as expressed in the following hypothesis:

H_6: *User behavioral intention has a positive effect on information systems use.*

Delone and McLean (2003) examined the impact of usage (USE) on the user satisfaction (USS) in examining IS success. Mardiana et al. (2015) and Tsai et al. (2012) reported user satisfaction as the most important dimension that affects net benefits during IS success evaluation. In information system studies, the impact of usage (USE) on user satisfaction (USS) has been deemed significant, and yet, this has not been sufficiently studied. This study hence proposed the hypothesis below, concerning information system use (USE) and user satisfaction (USS):

H_7: *Usage of information systems has a positive effect on user Satisfaction.*

Customer satisfaction is an important determinant of loyalty (Ryu et al., 2012) and corporate image (Alves & Raposo, 2010). In fact, customer loyalty has been regarded as the main outcome of customer satisfaction (Helgesen & Nesset, 2011). Customer satisfaction was found to affect loyalty positively and significantly (Athiyaman, 1997). Studies carried out in higher education by Arif and Ilyas (2013), Helgesen and Nesset (2011) and Palacio et al. (2002) have found a connection between student satisfaction and student loyalty. Considering these relevant findings, this study proposed the following hypothesis:

H_8: *Overall student satisfaction significantly impacts student's loyalty.*

The suggested model shown in Fig. 1.

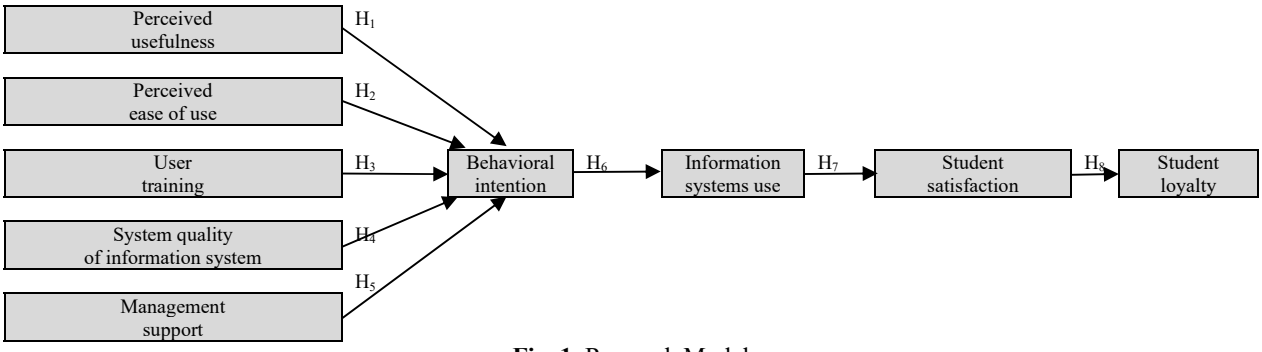

Fig. 1. Research Model

4. Analysis of Data and Findings

Table 1 reports the respondents' demographic information. As indicated in Table 1, the demographic profile of the respondents for this study showed that they are typically males, between 20-less than 23 years old, the majorities from public universities at scientific schools, held bachelor degree, used mobile phones, and had good internet experience.

Table 1
Profiles of respondents' racial and ethnic groups are described

Category	Category	Frequency	Percentage%
Gender	Male	397	54.8
	Female	327	45.2
	Total	724	100
Age (Year)	< than 20	197	27.2
	20 to less than 23	411	56.8
	23 and over	116	16.0
	Total	724	100
University Sector	Public	632	87.3
	Private	92	12.7
	Total	724	100
Academic Year	1st Year	248	34.3
	2nd Year	170	23.5
	3rd Year	165	22.8
	4th Year	124	17.1
	5th Year	9	1.2
	6th Year	8	1.1
	Total	724	100
School Type	Scientific	349	48.2
	Humanities	240	33.1
	Health	135	18.6
	Total	724	100
Academic Level	Bachelor	684	94.5
	Master	36	5.0
	Doctorate	4	0.6
	Total	724	100
Resident Place	The Capital (Amman)	258	35.6
	Northern Territory	131	18.1
	Middle Territory	122	16.9
	Southern Territory	213	29.4
	Total	724	100
No Hours Using eLearning	< than 16	379	52.3
	16-less than 21	241	33.3
	21-less than 30	62	8.6
	30 and above	42	5.8
	Total	724	100
Internet Type	Land line	270	37.3
	Mobile phone	373	51.5
	Others	81	11.2
	Total	724	100
Technology Type to Use eLearning	Personal computer	62	8.6
	Laptop	385	53.2
	Smartphone	277	38.3
	Total	724	100
Internet Provider	Orange	290	40.1
	Zain	234	32.3
	Umniah	188	26.0
	Others	12	1.7
	Total	724	100
Internet Evaluation	Excellent	113	15.6
	Very good	186	25.7
	Good	242	33.4
	Weak	183	25.3
	Total	724	100

4.1. Descriptive Analysis

In order to describe the responses and thus the attitude of the respondents toward each question they were asked in the survey, the mean and the standard deviation were estimated. While the mean shows the central tendency of the data, the standard

deviation measures the dispersion which offers an index of the spread or variability in the data (Pallant, 2005; Sekaran & Bougie, 2013). In other words, a small standard deviation for a set of values reveals that these values are clustered closely about the mean or located close to it; a large standard deviation indicates the opposite. The level of each item was determined by the following formula: (highest point in Likert scale - lowest point in Likert scale) / the number of the levels used = (5-1) / 5 = 0.80, where 1-1.80 reflected by "very low", 1.81-2.60 reflected by "low", 2.61-3.40 reflected by "moderate", 3.41-4.20 reflected by "high", and 4.21-5 reflected by "very high". Then the items were being ordered based on their means. Tables 2 and Table 3 show the results.

Table 2
Overall mean and standard deviation of the study's variables

Type of Variable	Variables	Mean	Standard Deviation	Level	Order
Independent Variable	Perceived Usefulness (PU)	3.3243	1.23028	Moderate	2
	Perceived Ease of Use (PE)	3.4540	1.17536	High	1
	Training (TR)	3.2376	1.05396	Moderate	4
	System Quality (SQ)	3.1436	1.20057	Moderate	5
	Management Support (MS)	3.2514	1.08910	Moderate	3
Mediating Variable	Behavioral Intention (BI)	3.2040	1.36623	Moderate	3
	Use (US)	3.7337	1.02819	High	1
	Student Satisfaction (SS)	3.3033	1.29791	Moderate	2
Dependent Variable	Student Loyalty (SL)	3.3071	1.26536	Moderate	-

The findings of data analysis have demonstrated, as stated in Table 2, that all research variables are used at moderate levels; whereas respondent's attribute of Perceived Ease of Use and Use do occur extremely. Table 3 shows the average, standard deviation, level, and order of the scores for each variable's items.

Table 3
Mean and standard deviation of the study's variables

Perceived Usefulness (PU)	**Mean**	**SD**	**Level**	**Order**
PU1: The e-learning system used in my university is useful and improves my ability to understand the study material.	3.26	1.387	Moderate	4
PU2: The e-learning system enables effective communication with the subject teacher.	3.27	1.371	Moderate	3
PU3: The e-learning system enables the delivery of the study material to the students.	3.23	1.379	Moderate	5
PU4: The e-learning system is suitable for giving assignments.	3.53	1.295	High	1
PU5: The e-learning system is suitable for conducting exams.	3.34	1.422	Moderate	2
Perceived Ease of Use (PE)	**Mean**	**SD**	**Level**	**Order**
PE1: The e-learning system used in my university is easy and user friendly.	3.57	1.251	High	1
PE2: Dealing with the e-learning system does not require much time.	3.41	1.304	High	2
PE3: Dealing with the e-learning system does not require much mental effort.	3.39	1.329	Moderate	3
Training (TR)	**Mean**	**SD**	**Level**	**Order**
TR1: I received adequate training on the e-learning system used in my university through a training program held by my university.	3.75	1.139	High	2
TR2: I rely on the help of my colleagues to use and practice the e-learning system.	3.67	1.166	High	3
TR3: Currently, I do not need extensive training to use the e-learning system.	3.76	1.142	High	1
System Quality (SQ)	**Mean**	**SD**	**Level**	**Order**
SQ1: There are no interruptions or continuous technical failures in the e-learning system used in my university.	3.81	1.207	High	1
SQ2: The e-learning system used in my university is characterized by the speed in downloading educational materials.	3.67	1.308	High	2
SQ3: The e-learning system provides effective communication with subject teachers.	2.90	1.376	Moderate	5
SQ4: The e-learning system allows effective communication with fellow students.	3.19	1.274	Moderate	4
SQ5: In general, the e-learning system used in my university is well organized and of high quality.	3.61	1.259	High	3
Management Support (MS)	**Mean**	**SD**	**Level**	**Order**
MS1: Subject teachers encourage me to use the e-learning system used in my university.	2.90	1.358	Moderate	3
MS2: The University Management encourages me to use the e-learning system used in my university.	3.14	1.335	Moderate	2
MS3: Subject teachers do not encourage me to use alternative platforms to the e-learning system used in my university.	3.23	1.345	Moderate	1
Behavioral Intention (BI)	**Mean**	**SD**	**Level**	**Order**
BI1: I plan to use the e-learning system used in my university on an ongoing basis.	3.26	1.322	Moderate	2
BI2: I enjoy using the e-learning system instead of the usual face-to-face method.	3.18	1.320	Moderate	3
BI3: I would like to continue using the e-learning system in the future.	3.31	1.257	Moderate	1
Use (US)	**Mean**	**SD**	**Level**	**Order**
US1: Subject teachers present the educational material through the e-learning system used in my university.	3.33	1.229	Moderate	1
US2: Subject teachers answer my questions and interact with students through the e-learning system.	3.11	1.267	Moderate	5
US3: Subject teachers conduct tests and exams using the e-learning system.	3.26	1.374	Moderate	2
US4: The Corona pandemic has been a turning point for using the e-learning system extensively and as a main method.	3.16	1.461	Moderate	4
US5: At the moment, I consider myself accustomed to using the e-learning system.	3.20	1.481	Moderate	3
Student Satisfaction (SS)	**Mean**	**SD**	**Level**	**Order**
SS1: In general, I am satisfied with the ease of use of the e-learning system used in my university.	3.33	1.378	Moderate	1
SS2: In general, I am satisfied with the quality of the e-learning system used in my university.	3.29	1.364	Moderate	3
SS3: In general, I am satisfied with the interaction with the subject teachers through the e-learning system.	3.32	1.373	Moderate	2
SS4: In general, I am satisfied with the e-learning system used in my university.	3.33	1.366	Moderate	1
SS5: In general, I am satisfied with the educational attainment through the e-learning system used in my university.	3.25	1.429	Moderate	4
Student Loyalty (SL)	**Mean**	**SD**	**Level**	**Order**
SL1: I will recommend to my colleagues the use of the e-learning system in the upcoming semesters.	3.24	1.416	Moderate	3
SL2: If I had to choose between the e-learning system used in my university and other electronic platforms, I would choose the current e-learning system.	3.37	1.374	Moderate	1
SL3: I prefer to use the e-learning system than to use other electronic media (such as YouTube, Facebook, Emails, etc.).	3.31	1.347	Moderate	2

4.2. Analysis of SEM

In order to test the research hypotheses, SEM analysis was used.

4.2.1. Measurement Model

Confirmatory factor analysis (CFA) was conducted to check the properties of the instrument items. Indeed, the measurement model indicates how latent variables or hypothetical constructs are assessed in terms of observed variables; and embodies the validity and reliability of the observed variables responses for the latent variables (Bagozzi & Yi, 1988; Hair et al., 2006; Newkirk & Lederer, 2006; Kline, 2010). Table 4 shows the factor loadings, Cronbach alpha, composite reliability, and Average Variance Extracted (AVE) for the variables. All of the indicators of the factor loadings exceeded 0.50, thus constitute evidence of convergent validity (Bagozzi & Yi, 1988; Creswell, 2009). Indeed, while the measurement reached convergent validity at the item level because all of the factor loadings went above 0.50, all of the composite reliability values exceeded 0.60, demonstrating a high level of internal consistency for the latent variables. In addition, since each value of AVE exceeded 0.50 (Bagozzi & Yi, 1988; Hair et al., 2010), the convergent validity was proved.

Table 4
The final measuring model's characteristics

Constructs and Indicators	Factor Loadings	Std. Error	Square Multiple Correlation	Error Variance	Cronbach Alpha	Composite Reliability*	AVE**
Perceived Usefulness (PU)					0.939	0.89	0.90
PU1	0.913	***	0.834	0.318			
PU2	0.890	0.025	0.792	0.390			
PU3	0.901	0.025	0.811	0.359			
PU4	0.806	0.027	0.649	0.588			
PU5	0.837	0.028	0.701	0.604			
Perceived Ease of Use (PE)					0.893	0.82	0.86
PE1	0.877	***	0.770	0.360			
PE2	0.856	0.033	0.732	0.454			
PE3	0.830	0.035	0.689	0.548			
Training (TR)					0.835	0.75	0.51
TR1	0.770	***	0.593	0.468			
TR2	0.567	0.044	0.321	0.410			
TR3	0.719	0.042	0.517	0.464			
System Quality (SQ)					0.940	0.89	0.91
SQ1	0.829	***	0.688	0.575			
SQ2	0.872	0.035	0.760	0.428			
SQ3	0.899	0.034	0.808	0.347			
SQ4	0.842	0.035	0.708	0.509			
SQ5	0.918	0.033	0.842	0.275			
Management Support (MS)					0.880	0.80	0.84
MS1	0.922	***	0.850	0.237			
MS2	0.925	0.024	0.856	0.218			
MS3	0.585	0.036	0.343	0.953			
Behavioral Intention (BI)					0.945	0.89	0.92
BI1	0.894	***	0.799	0.380			
BI2	0.940	0.027	0.884	0.247			
BI3	0.942	0.027	0.886	0.249			
Use (US)					0.913	0.88	0.59
US1	0.854	***	0.729	0.351			
US2	0.827	0.035	0.685	0.428			
US3	0.762	0.037	0.581	0.546			
US4	0.822	0.037	0.676	0.471			
US5	0.846	0.039	0.716	0.484			
Student Satisfaction (SS)					0.966	0.93	0.75
SS1	0.930	***	0.866	0.255			
SS2	0.930	0.021	0.865	0.250			
SS3	0.916	0.022	0.840	0.301			
SS4	0.954	0.019	0.911	0.166			
SS5	0.890	0.024	0.792	0.423			
Student Loyalty (SL)					0.906	0.83	0.86
SL1	0.924	***	0.853	0.293			
SL2	0.881	0.024	0.776	0.423			
SL3	0.798	0.027	0.637	0.658			

* Employing some formula, the composite reliability calculation is expressed by the following equation:
Composite Reliability = $(\Sigma Li)^2 / ((\Sigma Li)^2 + \Sigma \text{Var}(Ei))$
where Li is the standardized factor loadings for each indicator, and Var (Ei) is the error variance associated with the individual indicator variables.

** The formula for the variance extracted is:
Average Variance Extracted = $\Sigma Li^2 / (\Sigma Li^2 + \Sigma \text{Var}(Ei))$
where Li is the standardized factor loadings for each indicator, and Var (Ei) is the error variance associated with the individual indicator variables.

Additionally, Table 5 shows that none of the correlations between construct pairs were greater than the square root of the AVE estimations for the two components, demonstrating discriminant validity (Hair et al., 2006). As a result, the measurement findings showed that the study's convergent and discriminant validity were satisfactory.

Table 5
Correlations of constructs

Constructs	PU	PE	TR	SQ	MS	BI	US	SS	SL
PU	0.94								
PE	0.849	0.92							
TR	0.893	0.898	0.71						
SQ	0.874	0.841	0.638	0.95					
MS	0.795	0.757	0.686	0.856	0.91				
BI	0.887	0.780	0.660	0.847	0.777	0.96			
US	0.799	0.828	0.684	0.800	0.779	0.727	0.77		
SS	0.899	0.840	0.686	0.902	0.818	0.920	0.690	0.87	
SL	0.909	0.835	0.604	0.896	0.823	0.945	0.698	0.767	0.92

Note: Diagonal elements are square roots of the average variance extracted for each of the ten constructs. Off-diagonal elements are the correlations between constructs.

4.2.2. Structural Model

The study's ideas were tested using structural equation modeling on the Amos 20 platform. All hypotheses, including those involving direct and indirect effects, can be tested concurrently using SEM. The direct effects' outcomes demonstrate that Perceived Usefulness, Training, System Quality, and Management Support are positively and significantly impacted Behavioral Intention; therefore H1, H3, H4, and H5 were accepted; whereas Perceived Ease of Use did not have influences on Behavioral Intention; consequently, H2 was rejected. Also, Behavioral Intention does affect Use, and the latter on Student Satisfaction, and then on Student Loyalty; therefore, H6, H7 and H8 were accepted. Moreover, the coefficient of determination (R^2) for the research endogenous variables for Behavioral Intention, Use, Student Satisfaction and Student Loyalty were 0.577, 0.322, 0.488 and 0.794 respectively, which suggests that the model does take the proposed model's variation into consideration. The tested hypotheses are summarized in Table 6 below.

Table 6
Summary of the theoretical model's proposed findings

Research Proposed Paths	Coefficient Value	t-value	p-value	Empirical Evidence
H1: PU → BI	0.541	26.933	0.000	Supported
H2: PE → BI	0.031	1.461	0.144	Not supported
H3: TR → BI	0.072	3.060	0.002	Supported
H4: SQ → BI	0.301	14.607	0.000	Supported
H5: MS → BI	0.137	6.049	0.000	Supported
H6: BI → US	0.510	18.535	0.000	Supported
H7: US → SS	0.932	26.276	0.000	Supported
H8: SS → SL	0.879	52.831	0.000	Supported

4.3. Machine Learning Techniques

This research evaluates five Machine Learning (ML) supervised learning techniques that derive knowledge from a dataset in a form of patterns (Witten et al., 2016). These ML techniques are Artificial Neural Network (ANN) (Da Silva et al., 2017), Linear Regression (Yao & Li, 2014), Sequential Minimal Optimization algorithm for Support Vector Machine (SMO) (Platt, 1998), Bagging using REFTree model (Breiman, 1996), and Random forest (Tasin & Habib, 2022), to create and assess models for the E-learning dataset application. The back-propagation approach in ANN estimates the error of the prediction and actual targets. The weights and biases of ANN architecture are then updated to reduce the estimated errors. The linear regression model is a polynomial function with weighted coefficients for the independent variables and a target-dependent outcome. The training phase modifies the linear function's coefficients from the training dataset through a series of procedures. The weighted vectors of the SVM model are altered by the SMO approach using the Sequential Minimal Optimization algorithm. Using a random selection of the training set's objects and characteristics, the bagging technique generates many REFTree models; the final projected value is determined by the average of the trees. The Random Forest (RF) is a decision Tree (DT) model that uses a random sampling of training data items as well as random attribute subsets for each sub-tree. The average value of the DT trees is the model's final output.

This research evaluates the students' satisfaction with e-learning systems used during the COVID-19, which affirmably influences academic achievement in Jordanian higher education institutions. We study four models of datasets including inherited hypotheses as follows: (1) model 1 (or H1, H2, H3, H4, H5) studies the effect of usefulness, effectiveness, ease of use, and training quality on the tendency of students to use the system in the future. (2) Model 2 (or H6) reflects how much desire the students have to adapt to the e-learning systems and use them as a learning tool. (3) model 3 (or H7) validates the students' satisfaction after they pursued using the e-learning system, which merely affects the use of the learning system. (4) model 4 (or H8) evaluates the effect of students' satisfaction on continuous use of the e-learning system and how the degree of

recommendation the students encourage others to use it. Figure 2 shows the experimental findings using R^2 and Mean Square Error (MSE) as evaluation metrics. On the y-axis, the R^2 and MSE values are shown, while the models are shown on the x-axis. The R^2 illustrates how the independent variables should influence the dependent variable (target). The MSE calculates the average difference between the evaluated and actual output values of a model.

As shown in Fig. 2(a), the ML approaches produce reasonable R^2 values in predicting the target for each model. Models 1 and 4 have high correlation values for ML approaches, indicating that students are more likely to utilize the systems in the future and to promote them to others. These findings show that machine learning can accurately forecast target values. Fig. 2(b) also assures that the same ML models achieve low MSE values between the target and actual values of the model are effective.

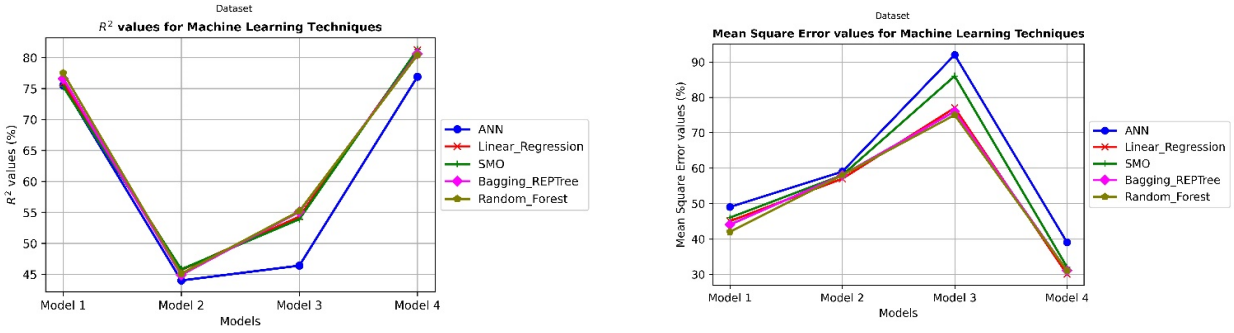

Fig. 2. Results of using ML techniques on E-learning dataset (a) R^2; (b) MSE

5. Discussion and Conclusions

The proposed hypotheses were all discussed by the study results. In specific, results on H1 showed a highly significant influence of perceived usefulness on behavioral intention. For H2, the results showed insignificant relation between perceived ease of use and perceived usefulness. On the other hand, results on H3 demonstrated low impact of training on behavioral intention. Similarly, information system adoption studies by Rajan and Baral (2015), and Sternad and Bobek (2013) were showing comparable outcomes. Results on Hypothesis 4 were showing weak linkage of system quality with behavioral intention. Observing the results reported by Nwankpa (2015), system quality could be linked to the implementation level of the information system, so long that the system demonstrates the ability to establish the initial circumstances for application integration and improvements of business processes. Owing to the modularity characteristics of the information system, having implementation in varied scopes and depth levels is possible, and more studies need to be carried out on this matter. Additionally, the result shows management support and system quality as key drivers to two dimensions, namely use and user satisfaction. As also mentioned in Ranjan et al. (2016), the dimensions of use and user satisfaction can be linked to change management and information system selection.

Results on Hypothesis 5 affirmed the impact of management support on behavioral intention. The projected relation in the hypothesis was proven to be positive and significant. In a related study, Nwankpa and Roumani (2014) reported the importance of management support in educating users regarding the usefulness of information systems. The outcome of the behavioral intention has a positive impact on user satisfaction as in Hypothesis 6. Meanwhile, results on Hypothesis 7 explaining the significant impact of user satisfaction on student loyalty. Lastly, student satisfaction has a positive impact on student loyalty. Furthermore, the present study pioneered the combination of IS Adoption and IS Success theories, and the scrutiny of adoption and user satisfaction towards information systems using one model. The results showed system quality is a pivotal determinant of user satisfaction within the context of information systems. Consistent care must be in place in order to maintain system quality, and all components of the system need to be holistically defined, so that perfect balance could be achieved. System quality affects user satisfaction and adoption, and management support is crucial. These relations need to be taken into account during information system implementation. Also, management has to play an active role in assuring the achievement of system quality, user adoption, and user satisfaction. The study results essentially show that the encouragement of information system use by leaders of organizations, will increase the use of information systems among subordinates. information systems with high levels of functionality, reliability, flexibility, data quality and integration, will increase user intention and user satisfaction.

Service quality is crucial to higher education service providers because it could attract new students while keeping the current ones, and improve competitiveness of the services provided (Wong & Sultan, 2010). Higher education service quality can be measured using Higher education, which is a five-dimensional scale. The aspects measured in these scales include academic and non-academic elements, program issues, access and reputation (Abdullah, 2005). Higher education has been used in the evaluation of students' perceived service quality. Still, higher education and its impact on student satisfaction, loyalty of students, and image of education institutions have not been sufficiently examined. Hanaysha et al. (2011) stated that despite being frequently studied in higher education context, service quality as perceived by international students has not been

examined. Hence, the effect of service quality dimensions on the satisfaction of international students in international universities was examined to bridge the gap. The consequent impact of student satisfaction on the image of the university and student loyalty was also examined. The results demonstrated general satisfaction of students with service quality aspects, specifically with the academic and non-academic aspects, issues related to the program, access to university facilities, and the reputation of the university in general. Hence, all dimensions of service quality affected student satisfaction, and consequently the image of the university at large, and student loyalty as well. Relevantly, service quality has been reported to affect customer satisfaction (Helgesen & Nesset, 2011).

In higher education, hyper-competition motivates students to compare the "knowledge value" offered by service providers. In other words, students expect the best value for the littlest amount of money spent (Sharabi, 2013). Knowledge value creation is factored by academic staff quality, the curriculum, and the organization and delivery of international programs. As can be affirmed, students who rate the service quality dimensions high are more likely to experience higher levels of satisfaction, causing them to be more loyal to the university. Furthermore, the results showed that the dimensions of program issues and academic aspects scored the highest mean, implying the great importance of the types and range of programs, their flexibility, and curriculum in forming the perceptions of students towards service quality of their university. It is therefore important that higher education service providers pay more attention to these leading dimensions to service quality, to increase satisfaction of students (Abdullah, 2005). Also, service providers need to prioritize those influential dimensions to assure efficient allocation of resources.

It can be challenging to determine and evaluate student satisfaction according to their perception of the quality of the services provided by the university. However, as indicated by Hanaysha et al. (2011), doing so will help the university in building a strong relationship with their students. Students evaluate the services offered by the university based on factors like the structure, design and delivery of international programs. Additionally, students expressed satisfaction towards the programs and other academic aspects, implying the success of international universities in providing quality of academics and courses. The study results showed that despite the positive perception of these international students, Jordanian universities could still improve their ways of attracting students.

On the other hand, the dimension of access was low – access can denote ease of contact, approachability and accessibility of both non-academic and academic staff. Low scores on this dimension can reduce students' satisfaction level. Hence, it is important that Jordanian universities assure that international students can regularly contact the university staff using various mediums like face-to-face, email, or phone. Relevantly, electronic communication allows people to effectively communicate at all times and places (Jancey & Burns, 2013). For students, the use of electronic communication allows shy students to communicate or participate without hesitations, while the university staff could provide students with fair and timely responses (Errey & Wood, 2011). The availability of electronic communication by Jordanian universities could improve the relationship with students and the satisfaction of students as well, particularly the international students, leading to the improved image of Jordanian universities.

Satisfaction towards the services provided will increase the reputation of the university and the loyalty of students. Nonetheless, the results showed a low score for the dimension of reputation. This demonstrates the need for Jordanian universities to increase their reputation and create positive perception of the international students, by taking steps like creating better marketing and awareness campaigns. Increased reputation could increase the number of new international students enrolling in Jordanian universities, as aspired by the Jordanian Higher Education Ministry. However, international students enrolled in Jordanian public universities were generally expressing satisfaction towards other service quality dimensions like academic and non-academic aspects and program issues. All in all, Jordanian universities have been successful in improving their service quality.

5.1. Theoretical Implications

Three major theoretical implications can be brought forth in this study. Firstly, this study was among the early ones that evaluated the adoption of information system adoption and user satisfaction in an empirical manner, under one model. Secondly, in examining the variables, this study combined the dimensions from adoption models of Davis et al. (1992) and Venkatesh and Davis (2000), with the dimensions from IS success model of DeLone and McLean model (2003, 1992), in addition to the approaches proposed by Ruivo et al. (2014) and Urbach and Ahlemann (2010). The use of combined dimensions and approaches in this study makes this study unique. Thirdly, the results showed that system quality, especially for information systems, may best be used to explain user happiness. As a result, system quality should be considered a key factor in IS system evaluation.

5.2. Practical Implications

The model proposed in this study could become a tool that organization could be used in evaluating and predicting user adoption and satisfaction towards information systems. The adoption of information systems and user satisfaction are generally multidimensional and interdependent, with varied relationship strength reported. Somehow, all related constructs are

considered as vital and should not be isolated. From the results, the statistical significance of management support and training appeared to be weaker. Still, the influence of both dimensions should not be overlooked. From the results, system quality demonstrated the best explanatory capabilities, and was most influential in describing user satisfaction. As such, in the implementation and maintenance of an information system, the industry needs to take into account the aspect of system quality. Additionally, the real needs and requirements of an organization should be clearly understood, to assure that the implemented information systems are based on correct configuration and parameterization. Additionally, all system components, including the hardware and software, should be properly balanced and interconnected to ensure the dependability and accessibility of the data delivered.

5.3. Limitations and Future Work

Several limitations of the present study are discussed in this section. The first limitation of this study concerns the gathered data which were from various body representatives of leading universities. Despite the vastness of the data sources, it was found that the data were not comprehensive. In addition, the study samples were from one Middle eastern country only, and thus, the results may lack generalizability. Furthermore, despite the statistical relevance of the results, deeper studies need to be carried out involving larger territorial scope, so that the explanatory capabilities of the model could be improved. Hence, the strength of influence of System Quality on other constructs can be increased. Lastly, the explanatory capabilities of system quality in understanding user satisfaction were found as the most interesting discovery in this study.

5.4. Conclusions

Information systems are integral to businesses today, and this system oversees all the information flow within the organization. It is hence important to be aware of what best motivates users to use an information system. This study accordingly attempted to determine the main determinants of information system user adoption and satisfaction. Based on the extant literature, adoption and satisfaction are majorly affected by the factors of System Quality, Management Support, and Training. Additionally, Perceived Usefulness; Perceived Ease of Use; Behavioral Intention; Use; and User Satisfaction may also be considered in the development of the model, as they could function as the key dimensions in the validation and evaluation of user adoption and satisfaction. This study adopted a questionnaire to gather data on to validate the results of both the measurement and the structural model. The hypotheses were tested, and were all capable of providing the theoretical and practical implications.

References

Abdellatief, M., Sultan, A.B., Jabar, M., & Abdullah, R. (2011). A technique for quality evaluation of e-learning from developers' perspective. *American Journal of Economics and Business Administration, 3*(1), 157-164.

Abdullah, F. (2005). HEdPERF versus SERVPERF: The quest for ideal measuring instrument of service quality in higher education sector. *Quality Assurance in Education, 13*(4), 305-328. https://doi.org/10.1108/09684880510626584

Abdullah, F., & Ward, R. (2016). Developing a general extended technology acceptance model for e-learning (GETAMEL) by analysing commonly used external factors. *Computers in Human Behavior, 56*, 238-256.

Abu-Taieh, E., Alhadid, I., Alkhawaldeh, R., Khwaldeh, S., Masa'deh, R., Alrowwad, A., & Al-Eidie, R. (2022). An empirical study of factors influencing the perceived usefulness and effectiveness of integrating e-learning systems during the COVID-19 pandemic using SEM and ML: a case study in Jordan. *Sustainability, 14*(20), 13432,

Ahmad, S.Z., Abu Bakar, A.R., & Ahmad, N. (2019). Social media adoption and its impact on firm performance: the case of the UAE. *International Journal of Entrepreneurial Behavior & Research, 25*(1), 84-111.

Al-Fraihat, D., Joy, M., & Sinclair, J. (2017). Identifying success factors for e-learning in higher education. International conference on e-learning (pp. 247-255). Academic Conferences International Limited.

AlSharji, A., Ahmad, S.Z., & Abu Bakar, A.R. (2018). Understanding social media adoption in SMEs: empirical evidence from the United Arab Emirates. *Journal of Entrepreneurship in Emerging Economies, 10*(2), 302-328. doi:10.1108/jeee-08-2017-0058

Alves, H., & Raposo, M. (2010). The influence of university image on student behaviour. *International Journal of Educational Management, 24*(1), 73-85.

Arif, S., & Ilyas, M. (2013). Quality of work-life model for teachers of private universities in Pakistan. *Quality Assurance in Education, 21*(3), 282-298. https://doi.org/10.1108/QAE-Feb-2012-0006

Athiyaman, A. (1997). Linking student satisfaction and service quality perceptions: The case of university education. *European Journal of Marketing, 31*(7), 528-540. https://doi.org/10.1108/03090569710176655

Awang, H., Osman, W.R.S., & Aji, Z.M. (2018). A conceptual model to evaluate virtual learning environment among Malaysian teachers. *Journal of Telecommunication, Electronic and Computer Engineering, 10*(2-4), 59-63.

Bagozzi, R., & Yi, Y. (1988). On the evaluation of structural evaluation models. *Journal of the Academy of Marketing Science, 16*(1), 74-94.

Bailey, J.E., & Pearson, S.W. (1983). Development of a tool for measuring and analyzing computer user satisfaction. *Management Science, 29*(5), 530-545.

Baroudi, J.J., & Orlikowski, W.J. (1988). A short-form measure of user information satisfaction: a psychometric evaluation and notes on use. *Journal of Management Information Systems, 4*(4), 44-59.

Benbasat, I., & Barki, H. (2007). Quo vadis TAM? *Journal of the Association for Information Systems, 8*(4), 7.

Boud, D., & Prosser, M. (2002). Appraising new technologies for learning: A framework for development. *Educational Media International, 39*(3-4), 237-245.

Breiman, L. (1996). Bagging predictors. *Machine learning, 24*, 123-140.

Cheng, Y.M. (2011). Antecedents and consequences of e-learning acceptance. *Information Systems Journal, 21*(3), 269-299.

Chien, S.W., & Tsaur, S.M. (2007). Investigating the success of ERP systems: case studies in three Taiwanese high-tech industries. *Computers in Industry, 58*(8-9), 783-793.

Chin, J.P., Diehl, V.A., & Norman, K.L. (1988). Development of an instrument measuring user satisfaction of the human-computer interface. *In Proceedings of the SIGCHI conference on Human Factors in Computing Systems* (pp. 213-218).

Chuttur, M.Y. (2009). Overview of the technology acceptance model: origins, developments and future directions. *Working Papers on Information Systems, 9*(37), 9-37.

Cidral, W.A., Oliveira, T., Di Felice, M., & Aparicio, M. (2018). E-learning success determinants: Brazilian empirical study. *Computers and Education, 122*, 273-290.

Creswell, J. (2009). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 3rd ed., Thousand Oaks: Sage Publications.

Cyert, R.M., & March, J.G. (1963). *Englewood Cliffs, NJA behavioral theory of the firm*, Vol. 2, 169-187.

Da Silva, I.N., Spatti, D.H., Flauzino, R.A., Liboni, L.H.B., & dos Reis Alves, S.F. (2017). *Artificial neural network architectures and training processes*. In Artificial neural networks; Springer, pp. 21-28.

Dahlstrom, E., Brooks, D.C., & Bichsel, J. (2014). The current ecosystem of learning management systems in higher education: Student, faculty, and IT perspectives Research report. Louisville, CO: ECAR.

Davis, F.D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319-340.

Davis, F.D., Bagozzi, R.P., & Warshaw, P.R. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Management Science, 35*(8), 982-1003.

Davis, F.D., Bagozzi, R.P., & Warshaw, P.R. (1992). Extrinsic and intrinsic motivation to use computers in the workplace. *Journal of Applied Social Psychology, 22*(14), 1111-1132.

DeLone, W.H., & McLean, E.R. (1992). Information systems success: the quest for the dependent variable. *Information Systems Research, 3*(1), 60-95.

DeLone, W.H., & McLean, E.R. (2003). The DeLone and McLean model of information systems success: A ten-year update. *Journal of Management Information Systems, 19*(4), 9-30.

Doll, W.J., Deng, X., Raghunathan, T.S., Torkzadeh, G., & Xia, W. (2004). The meaning and measurement of user satisfaction: a multigroup invariance analysis of the end-user computing satisfaction instrument. *Journal of Management Information Systems, 21*(1), 227-262.

Ehlers, U.D. (2004). Quality in e-learning from a learner's perspective. *European Journal of Open, Distance and E-learning, 7*(1). https://doi.org/10.4000/dms.2707

Eom, S.B., & Ashill, N.J. (2018). A system's view of e-learning success model. *Decision Sciences Journal of Innovative Education, 16*(1), 42-76.

Eom, S.H., Kim, Y.M., & Kim, S.K. (2012). Antimicrobial effect of phlorotannins from marine brown algae. *Food and Chemical Toxicology, 50*(9), 3251-3255.

Errey, R., & Wood, G. (2011). Lessons from a student engagement pilot study: Benefits for students and academics. *Australian Universities' Review, 53*(1), 21-34.

Fathema, N., Shannon, D., & Ross, M. (2015). Expanding the technology acceptance model (TAM) to Examine Faculty Use of Learning Management Systems (LMSs) in higher education institutions. *Journal of Online Learning & Teaching, 11*(2).

Fronell, C., & Larcker, D. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*, 39-50. https://doi.org/10.2307/3151312

Goodhue, D. (1986). IS attitudes: towards theoretical definition and measurement clarity. In L. Maggi, R. Zmudand, & J. Wetherbe (Eds.). *Proceedings of seventh international conference on information systems, San Diego, calif* (pp. 181-194).

Hair, J., Black, W., Babin, B., Anderson, R., & Tatham, R. (2006). *Multivariate Data Analysis*. 6th ed., New Jersey: Prentice-Hall.

Hair, J., Black, W., Babin, B., Anderson, R., & Tatham, R. (2010). *Multivariate Data Analysis*, 7th ed., New Jersey: Prentice-Hall.

Hanaysha, J., Hilman Abdullah, H., & Warokka, A. (2011). Service quality and students' satisfaction at higher learning institutions: The competing dimensions of Malaysian universities' competitiveness. *Journal of Southeast Asian Research*, 1-10. DOI: 10.5171/2011.855931

Hasani, T., Bojei, J., & Dehghantanha, A. (2017). Investigating the antecedents to the adoption of SCRM technologies by start-up companies. *Telematics and Informatics, 34*(5), 655-675.

Helgesen, Ø., & Nesset, E. (2011). Does LibQUAL+ TM account for student loyalty to a university college library?. *Quality Assurance in Education, 19*(4), 413-440. https://doi.org/10.1108/09684881111170104

Ilias, A., AbdRazak, M.Z., Rahman, R.A., & Yasoa, M.R. (2009). End-user computing satisfaction (EUCS) in computerised accounting system (CAS): Which the critical factors? a case in Malaysia. *Computer and Information Science, 2*(1), 18.

Ireland, R.D., Covin, J.G., & Kuratko, D.F. (2009). Conceptualizing corporate entrepreneurship strategy. *Entrepreneurship Theory and Practice, 33*(1), 19-46.

Ives, B., Olson, M., & Baroudi, J.J. (1983). The measurement of user information satisfaction. *Communications of the ACM, 26*(10), 785-793.

Jancey, J., & Burns, S. (2013). Institutional factors and the postgraduate student experience. *Quality Assurance in Education, 21*(3), 311-322.

Jurison, J. (1996). The temporal nature of IS benefits: a longitudinal study. *Information and Management, 30*(2), 75-79.

Kline, R. (2010). *Principles and Practice of Structural Equation Modeling*. The Guilford Press.

Klobas, J.E., & McGill, T.J. (2010). The role of involvement in learning management system success. *Journal of Computing in Higher Education, 22*(2), 114-134.

Kurdi, B., & Alshurideh, M. (2020). Employee retention and organizational performance: Evidence from banking industry. *Management Science Letters, 10*(16), 3981-3990.

Lai, G., Chang, W. C., Yang, Y., & Liu, H. (2018). Modeling long-and short-term temporal patterns with deep neural networks. *In The 41st International ACM SIGIR Conference on Research & Development in Information Retrieval* (pp. 95-104).

Leclercq, A. (2007). The perceptual evaluation of information systems using the construct of user satisfaction: Case study of a large French group. *ACM SIGMIS - Data Base: Database for Advances in Information Systems, 38*(2), 27-60.

Lee, Y.H., Hsieh, Y.C., & Hsu, C.N. (2011). Adding innovation diffusion theory to the technology acceptance model: supporting employees' intentions to use e-learning systems. *Journal of Educational Technology and Society, 14*(4).

Legris, P., Ingham, J., & Collerette, P. (2003). Why do people use information technology? a critical review of the technology acceptance model. *Information and Management, 40*(3), 191-204.

Lin, H. F. (2007). Measuring online learning systems success: applying the updated DeLone and McLean model. *Cyber Psychology and Behaviour, 10(*6), 817-820.

MacDonald, C.J., Stodel, E.J., Farres, L.G., Breithaupt, K., & Gabriel, M.A. (2001). The demand-driven learning model: a framework for web-based learning. *The Internet and Higher Education, 4*(1), 9-30.

MacDonald, R., Shildrick, T., Webster, C., & Simpson, D. (2005). Growing up in poor neighbourhoods: The significance of class and place in the extended transitions of 'socially excluded' young adults. *Sociology, 39*(5), 873-891.

Maduku, D.K., Mpinganjira, M., & Duh, H. (2016). Understanding mobile marketing adoption intention by South African SMEs: A multi-perspective framework. *International Journal of Information Management, 36*(5), 711-723.

Mardiana, S., Tjakraatmadja, J.H., & Aprianingsih, A. (2015). DeLone–McLean information system success model revisited: the separation of intention to use-use and the integration of technology acceptance models. *International Journal of Economics and Financial Issues, 5*(1), 172-182.

Masa'deh, R., Almajali, D., Majali, T., Hanandeh, A., & Al-Radaideh, A. (2022). Evaluating e-learning systems success in the new normal. *International Journal of Data and Network Science, 6*(4), 1033-1042.

Massy, J. (2002). Quality and elearning in Europe Summary Report 2002. UK: Bizmedia.

McGill, T.J., & Klobas, J.E. (2009). A task–technology fit view of learning management system impact. *Computers and Education, 52*(2), 496-508.

Mohammadi, H. (2015). Investigating users' perspectives on e-learning: an integration of TAM and IS success model. *Computers in Human Behavior, 45*, 359-374.

Newkirk, H., & Lederer, A. (2006). The effectiveness of strategic information systems planning under environmental uncertainty. *Information & Management, 43*, 481-501.

Nwankpa, J. (2015). ERP system usage and benefit: A model of antecedents and outcomes. *Computers in Human Behavior, 45*, 335-344.

Nwankpa, J., & Roumani, Y. (2014). Understanding the link between organizational learning capability and ERP system usage: an empirical examination. *Computers in Human Behavior, 33*, 224-234.

Oliveira, A.L. (2019). Biotechnology, big data and artificial intelligence. *Biotechnology Journal, 14*(8), 1800613.

Oliver, R. (2005). Quality assurance and e-learning: blue skies and pragmatism. *ALT-J, 13*(3), 173-187.

Ozkan, S., & Koseler, R. (2009). Multi-dimensional students' evaluation of e-learning systems in the higher education context: an empirical investigation. *Computers and Education, 53*(4), 1285-1296.

Palacio, A.B., Meneses, G.D., & Pérez, P.J. (2002). The configuration of the university image and its relationship with the satisfaction of students. *Journal of Educational Administration, 40*(5), 486-505.

Pallant, J. (2005). *SPSS Survival Manual: A Step Guide to Data Analysis Using SPSS for Windows Version 12*. Chicago, Illinois: Open University Press.

Pawlowski, J.M., Barker, K.C., & Okamoto, T. (2007). Foreword: quality research for learning, education, and training. *Subscription Prices and Ordering Information, 10*(2), 1-2.

Petter, S., DeLone, W., & McLean, E. (2008). Measuring information systems success: models, dimensions, measures, and interrelationships. *European Journal of Information Systems, 17*(3), 236-263.

Pitt, L.F., Watson, R.T., & Kavan, C.B. (1995). Service quality: a measure of information systems effectiveness. *MIS Quarterly, 19*(2), 173-187.

Platt, J. (1998). Sequential minimal optimization: A fast algorithm for training support vector machines. Available online: https://www.microsoft.com/en-us/research/publication/sequential-minimal-optimization-a-fast-algorithm-for-trainingsupport-

Ragu-Nathan, B.S., Apigian, C.H., Ragu-Nathan, T.S., & Tu, Q. (2004). A path analytic study of the effect of top management support for information systems performance. *Omega, 32*(6), 459-471.

Rai, A., Lang, S.S., & Welker, R.B. (2002). Assessing the validity of IS success models: an empirical test and theoretical analysis. *Information Systems Research, 13*(1), 50-69.

Rajan, C.A., & Baral, R. (2015). Adoption of ERP system: an empirical study of factors influencing the usage of ERP and its impact on end user. *IIMB Management Review, 27*(2), 105e117. http://dx.doi.org/10.1016/j.iimb.2015.04.008.

Ranjan, R., Rani, A., Metwally, A., McGee, H.S., & Perkins, D.L. (2016). Analysis of the microbiome: advantages of whole genome shotgun versus 16S amplicon sequencing. *Biochemical and Biophysical Research Communications, 469*(4), 967-977.

Remenyi, D., & Money, A. (1991). A user-satisfaction approach to IS effectiveness measurement. *Journal of Information Technology, 6*(3-4), 162-175.

Ruivo, P., Oliveira, T., & Neto, M. (2014). Examine ERP post-implementation stages of use and value: Empirical evidence from Portuguese SMEs. *International Journal of Accounting Information Systems, 15*(2), 166-184.

Ryu, K., Lee, H.R., & Kim, W.G. (2012). The influence of the quality of the physical environment, food, and service on restaurant image, customer perceived value, customer satisfaction, and behavioral intentions. *International Journal of Contemporary Hospitality Management, 24*(2), 200-223. https://doi.org/10.1108/09596111211206141

Seddon, P.B. (1997). A respecification and extension of the DeLone and McLean model of IS success. *Information Systems Research, 8*(3), 240-253.

Seddon, P.B., & Kiew, M.Y. (1994). A partial test and development of the DeLone and McLean model of IS success. *Australian Journal of Information Systems, 4*(1), 99-110.

Sekaran, U., & Bougie, R. (2013). *Research Methods for Business: A Skill-Building Approach*. 6th ed., New York: Wiley.

Selim, H.M. (2003). An empirical investigation of student acceptance of course websites. *Computers & Education, 40*(4), 343-360.

Sharabi, M. (2013). Managing and improving service quality in higher education. International Journal of Quality and Service Sciences. *International Journal of Quality and Service Sciences, 5*(3), 309-320.

Sternad, S., & Bobek, S. (2013). Impacts of TAM-based external factors on ERP acceptance. *Procedia Technology, 9*, 33e42. http://dx.doi.org/10.1016/ j.protcy.2013.12.004.

Sultan, P., & Wong, H.Y. (2010). Service quality in higher education–a review and research agenda. *International Journal of Quality and Service Sciences, 2*(2), 259-272. https://doi.org/10.1108/17566691011057393

Šumak, B., HeričKo, M., & PušNik, M. (2011). A meta-analysis of e-learning technology acceptance: the role of user types and e-learning technology types. *Computers in Human Behavior, 27*(6), 2067-2077.

Sun, P.C., Tsai, R.J., Finger, G., Chen, Y.Y., & Yeh, D. (2008). What drives a successful elearning? an empirical investigation of the critical factors influencing learner satisfaction. *Computers and Education, 50*(4), 1183-1202.

Surendran, P. (2012). Technology acceptance model: a survey of literature. *International Journal of Business and Social Research, 2*(4), 175-178.

Tasin, T., & Habib, M.A. (2022). *Computer-Aided Cataract Detection Using Random Forest Classifier. Proceedings of the International Conference on Big Data, IoT, and Machine Learning*. Springer, pp. 27-38.

Taylor, S., & Todd, P. (1995). Assessing IT usage: the role of prior experience. *MIS Quarterly, 19*(4), 561-570.

Thong, J.Y., & Yap, C.S. (1996). Information systems effectiveness: a user satisfaction approach. *Information Processing & Management, 32*(5), 601-610.

Tsai, W.-H., Lee, P.-L., Shen, Y.-S., & Lin, H.-L. (2012). A comprehensive study of the relationship between enterprise resource planning selection criteria and enterprise resource planning system success. *Information & Management, 49*(1), 36e46. http://dx.doi.org/10.1016/j.im.2011.09.007.

Urbach, N., & Ahlemann, F. (2010). Structural equation modeling in information systems research using partial least squares. *Journal of Information Technology Theory and Application (JITTA), 11*(2), 2.

Venkatesh, V., & Davis, F.D. (2000). A theoretical extension of the technology acceptance model: four longitudinal field studies. *Management Science, 46*(2), 186-204.

Venkatesh, V., Thong, J.Y., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly, 36*(1), 157-178.

Witten, I.H., Frank, E., Hall, M.A., & Pal, C.J. (2016). Data Mining, Fourth Edition: Practical Machine Learning Tools and Techniques, 4th ed.; Morgan Kaufmann Publishers Inc.: San Francisco, CA, USA.

Wixom, B.H., & Todd, P.A. (2005). A theoretical integration of user satisfaction and technology acceptance. *Information Systems Research, 16*(1), 85-102.

Wu, J.H., Tennyson, R.D., & Hsia, T.L. (2010). A study of student satisfaction in a blended e-learning system environment. *Computers and Education, 55*(1), 155-16.

Yao, W., & Li, L. (2014). A new regression model: modal linear regression. *Scandinavian Journal of Statistics, 41*, 656-671.

Youngberg, E., Olsen, D., & Hauser, K. (2009). Determinants of professionally autonomous end user acceptance in an enterprise resource planning system environment. *International Journal of Information Management, 29*(2), 138-144.

Yusliza, M.Y., & Ramayah, T. (2012). Determinants of attitude towards E-HRM: an empirical study among HR professionals. *Procedia-Social and Behavioral Sciences, 57*, 312-319.