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A Theoretical Model and Empirical Evidence of an Electronic Digital Platform

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ABSTRACT

Nowadays, education is inseparable from interactions with global communities via the Internet. The need to help the education system adopt information technology (IT) is prominent. The talents can learn from e-learning, and those learning experiences from educational systems can trigger one's imagination. Otherwise, the purchase and transfer of technology and investment will be nothing but a waste of resources. However, very little or no prior studies on educational systems have investigated the factors influencing information quality (IFQ). Thus, this study aimed to determine the crucial reasons that reflect the IFQ of an e-learning platform. The four primary e-learning constructs, indicators and model relationships are demonstrated by retesting the theoretical framework from a prediction perspective. The author investigated the five dimensions of IFQ to determine the factors affecting customer loyalty (CML) through user satisfaction mediation. The author analysed recent review studies to highlight the popular reasons for partial least square structural equation modelling (PLS-SEM) usage. PLS-SEM was used when the path model includes one or more formatively measured. The author collected sample data from 721 Taiwanese technical university students. The empirical study result verified the theoretical framework's feasibility. In addition, the result also predicted the simultaneous interrelationships between the constructs and the factors. Based on the empirical study results, contextual quality (CLQ), interaction quality (ITQ), connection quality (CNQ) and content quality (CTQ) through mediation by USS are the most related factors in enhancing the CML of IT. The analytical findings can serve as the basis for the design, development and improvement of CML.

Keywords: Information Quality (IFQ), Connection Quality (CNQ), Content Quality (CTQ), Interaction Quality (ITQ), Contextual Quality (CLQ), User Satisfaction (USS), Customer Loyalty (CML)

INTRODUCTION

E-learning (EL) is the advanced development of ICT because of its accessibility and flexibility. Learning management systems (LMS) facilitate EL, particularly in the field of education. According to previous findings, although ubiquitous, the underlying problems of underuse or no use cannot identify the factors that influence EL usage from the students' perception, not to mention their USS with EL's CML.

Based on three factors, PU, EU and PA, the users' motivation of the technology acceptance model (TAM) is explained. In addition, users' attitudes would be significantly influenced by two central beliefs, such as PU and EU. Taylor & Todd (1995) suggested that the decomposed theory of planned behaviour (DTPB) aimed to understand the factors that affect behaviours. The DTPB extended the theory of planned behaviour (TPB). Taylor et al. (1995) also suggested that E-learning, one of the e-service areas, can be applied to DTPB. Azjen (1991) suggested that DTPB also provides the information system adoption framework for investigating the effects of external elements.

Meanwhile, the unified theory of acceptance and use of technology (UTAUT) model is composed of six constructs: PE (PE), social influence (SI), facilitating conditions (FC), behavioural intention to use the system (BIU) usage behaviour (UB) and behavioural intention (BI). Washaw and Davis (1985) found that PE, effort expectancy (EE), SI, and FC directly influence BI and user acceptance (UA). Also, according to Venkatesh, Morris, Davis, & Davis (2003), FCs directly affect user behaviour (UB) but not BIs. Therefore, EL system (ELS) design and implementation should consider the factors influencing CML through USS from education.

The author collected data from 721 undergraduate students to demonstrate the proposed analytic framework's feasibility. The participants studied in the colleges of science, engineering, business and humanities for about 18 weeks. The participants had to fill out a questionnaire concerning the IFQ of an EL through USS. This study aims to investigate the factors that influence potential users' CML of the technical university. We created a Chinese questionnaire based on prior research, and the author hypothesised that the four dimensions positively influence USS and CML. All the respondents were undergraduate students and majored in business, engineering, science, arts and humanities, service industries and others. Thus, the results showed that CNQ, CTQ, IRQ and CLQ influence the CML of an ELP through the mediation of USS. Also, the activities that can enhance the USS of ELP to enhance CML. To achieve these research purposes, the author utilised the PLS-SEM method to confirm the correlational analysis relationships according to the hypothesis testing results. The organisation of the remaining sections is as follows: In section 2, the literature review introduces the definition of the proposed model of EL and ELP and reviewed the theories related to EL projects and PLS-SEM evaluation criteria. Section 3, which describes the PLS-SEM model, is composed of four IFQ dimensions, one for USS and one for CML, followed by an empirical research study as a process to evaluate the measurement model. The most relevant findings obtained in this study are presented and discussed in section 5. The conclusion is in section 6. Finally, section 7 summarises the research problems in our future work.

LITERATURE REVIEW

EL AND EL PLATFORM TRENDS

The researchers found a trend indicating that EL has been widely used in recent years and is rapidly increasing in popularity. Rodrigues, et al. define EL as a web-based system innovation providing other educational materials alongside digital technologies. The primary goal of EL is to enhance learning processes with a learner-centered, open, and interactive learning environment. Dron and Anderson (2019) write that the pedagogical approach of EL utilizes unique technological capabilities such as learning analytics, collective technologies, deep learning and artificial intelligence to bolster traditional learning methods. EL's popularity and development will continue apace. According to Valverde-Berrocoso et al. (2020), pedagogies of next generation EL will look significantly different to traditional learning pedagogies. They will be student-focused; in line with technology, society, and organization; responsive to crowd-driven support and emergencies; integrated, timely, and authentic. Curriculum will play a less critical role and learning will be separate from certification.

Table 1. Abbreviations and explanations for the terms and variables.

Abbre-viation	Explanations
IFQ	The output of the Information System welcomes the nature of the information. The computation of IFQ includes information correctness, fulfillment, consistency, accuracy, or connection (Laumer, Maier, & Weitzel, 2017).

Abbre-viation	Explanations
CNQ	CNQ is achieved when customers can arrive at stable mobile service without suspension consistently (Chae, Kim, Kim, & Ryu, 2002a).
CTQ	CTQ is the intrinsic value and helpfulness of the information provided (Huizingh, 2000).
ITQ	ITQ is an objective quality that measures the ITQ between the system and the employer to a certain extent (Schmitt & Ultes, 2015).
CLQ	CLQ is the data quality, consists of value-added, relevance, timeliness, completeness, and appropriate amount (Wahyudi, Farhani, & Janssen, 2018).
USS	USS is the user's attitude toward the system (Muylle, Moenaert, & Despontin, 2004).
CML	CML is a feeling of dedication to someone or something consistently in the future, despite situational influences and marketing efforts having the potential to cause switching behavior (Oliver Richard, 1997).

CONNECTION QUALITY (CNQ)

Gay (2016) suggested that technological readiness is an essential factor influencing EL outcomes. Gros and García-Peñalvo (2016) agreed on the significance of stable network connections, as well as the interconnection between platforms, tools, and services requiring communication protocols, interfaces, and data and resource description standards. According to Freeze, Kelly, & Batista (2019), system quality is influenced by specific issues, including browser compatibility, point connection (dial-up versus campus network versus cable), and the operating system used.

CONTENT QUALITY (CTQ)

Kimiloglu, et al. (2017) found that learner-content interaction is a vital advantage of EL and more effective than learner-learner and learner-teacher interaction. Al-Rahmi et al. (2018) indicated that both the content of EL and how it is delivered are of equal importance. Gay (2016) found that promptly producing and organizing appropriate course content is essential for EL IFQ. Al-Fraihat et al. (2020) suggested that sufficient and required information, concise and precise information, updated content, and attractive content design are essential factors contributing to students' overall satisfaction of EL. Besides, logical and understandable components may result in the fast accomplishment of their learning tasks Aparicio et al. (2017) suggested that the IFQ can be measured in terms of usefulness, reliability, understandable and interest of the content.

INTERACTION QUALITY (ITQ)

INTERACTION EQUIVALENCY THEOREM

Al-Fraihat, et al. (2020) write that EL's PU should be compatible with students' needs. This will increase successful interaction and communication between learner and content and the completion of learning goals. Uppal et al. (2018) implies that online students have led to a decrease in EL interaction and dependence on others. Vaona, et al. (2018) suggested that students in high-interaction programs (a combination of at least three components, such as web modules, chat and email) perform significantly better than the low interaction programs (fewer than three components). Rhode (2009) demonstrated that deep and meaningful formal learning is supported when student-instructor, student-student, and student-content interactions are strong. However, these interactive learning experiences may be more exorbitant and laborious than those fewer interactive ones.

LEARNER-LEARNER INTERACTION

According to Diep, Cocquyt, Zhu, Vanwing, & de Greef (2017), Garrison, Anderson, & Archer (2001), online ITQ refers to the learning motivation and knowledge construction from constructive and reflective online peer conversation. According to Paechter, Maier, & Macher (2010), peer students interaction benefits the discursive communication process. Kuo, Walker, Schroder, & Belland (2014) suggested that peer interaction facilitates students to construct ideas and gain achievement genuinely. Kuo et al. (2014) also indicated that learner-learner interaction entails two-way reciprocal communication, with or without an instructor. According to Brophy-Herb, Gibbons, Omar, & Schiffman (1999), students benefit from understanding in small groups, mutual social-emotionally support, and learning within a cohesive and positive learning environment.

LEARNER-INSTRUCTOR INTERACTION

Chen, Lin, & Kinshuk (2008) agreed with the findings of Burnett (2001) and Parker (1999) that learners gain information, advice, and guidance with high levels of communication among learners and between learners and instructors. According to Bhuasiri, Xaymoungkhoun, Zo, Rho, & Ciganek (2012) and Swan (2001), online interactions among learners and learners and instructors increase interactive activity in education. Baturay et al.

(2011) and Saba (2000) implied that the interaction among learners and instructors might affect persistence or withdrawal from a course. The tools of interactions among learner-learner, learner–instructor, and learner–content is listed below:

- Online assessment
- Bulletin boards, chat rooms, messengers, and so on

LEARNER-CONTENT INTERACTION

Kuo, Walker, Schroder, et al. (2014) concluded that learner-content interaction is more effective than the other two modes of interaction on USS. Kuo et al. (2009) indicated that learner-content interaction initiates an internal didactic conversation. Moore (1989), Moore and Kearsley (2011) said that learners cognitively elaborate, organize, and consider the erudition by integrating previous knowledge through reflection. Garrison and Cleveland-Innes (2005) claimed that online cognitive interaction influences deep learning and meaningful educational experiences.

CONTEXTUAL QUALITY (CLQ)

Borokhovski, Bernard, Tamim, Schmid, & Sokolovskaya (2016) suggested that the contextual interaction provided more options and alternatives for communication through the technological affordances' tools. Lee & Lee (2008) suggested that IFQ classification includes intrinsic, contextual, representative, and accessible quality. For example, Faul, Frey, and Barber (2004) suggested that web-based programming-assisted systems, such as Blackboard, provide various interaction-enabling features.

USER SATISFACTION (USS)

Al-Fraihat, et al. (2020) suggested that instructor quality significantly affects the perceived USS and PU of an EL system. They underline the importance of organizing sufficient, concise, and clear information into logical and understandable components, as well as regularly updating content. Valverde-Berrocoso et al. (2020) and Rodrigues, et al. (2019) emphasize personalized education, online USS, motivation, and instructional planning and design for EL. Pham, et al. (2019) also show that overall service quality has a positive effect on EL USS and CML.

CUSTOMER LOYALTY (CML)

Pham et al. (2019) suggested that overall EL quality influences EL CML directly. According to Edvardsson & Roos (2003), loyalty may be defined as an intention or predisposition that the consumers with brand loyalty are more likely to repurchase the same brand in the future. Flavián, Guinalíu, & Gurrea (2006) and Keating, Rugimbana, & Quazi (2003) suggested that in achieving company success and sustainability, loyalty has long been considered a key factor to the success of businesses. Kasiri, Cheng, Sambasivan, & Sidin, (2017) suggested that a high-spirited level of USS influences greater CML. Chae and Kim (2002) indicated that CML is significantly related to USS, and USS is affected by IFQ.

RESEARCH METHOD

According to the proposed theoretical framework, the correlational relationships are confirmed by using PLS-SEM. The statistical significance level is referred to for model evaluation and improvement.

PLS-SEM

Sarstedt et al. (2020) suggested that the ultimate aim of PLS-SEM is to maximize the robustness analyses of the explained variance of the dependent construct and validation in PLS-SEM. Ringle, Sarstedt, Mitchell, & Gudergan (2020) suggested that researchers establish links between constructs through a set of paths in the structural model, which usually reflects the hypotheses. The relationship between constructs can capture direct, indirect (mediated), and interaction (moderated) effects. Ali et al. (2018) suggested that PLS-SEM can evaluate the interdependent relationships simultaneously between multiple sets of constructs of variables. Yang, Huang, & Hsiao (2021) suggested that PLS-SEM analyzed various relationships among variables, i.e., la-tent and observed variables. In this study, we regard six themes as latent variables and 21 topics as observed variables. Initially, the author needs to distinguish between reflectively and formatively measurement models. Then, Ringle et al. (2020) indicated that the author is required to evaluate the structural model by analyzing the path coefficients between the indicators and the associated constructs to confirm the hypothesis of the theoretical model. Finally, Sarstedt et al. (2020) suggested that it would be helpful to assess the directionality of the path relationships between the constructs in a structural model.

SAMPLE AND MEASURES

According to Ringle, Sarstedt, & Straub (2012), to collect the data of research, a questionnaire was used by the users of cross-disciplinary programs based on the proposed hypotheses. Typically, these theories or concepts are operationalized by a measurement model. Given that the constructs of variables are not

observable (i.e., variables that are not directly measured). The theoretical construct can only be measured indirectly by using observable variance indicators in a set of manifested variables. Table 1 includes the abbreviations and definitions for the latent variables. All questionnaire items used a 5-point Likert scale, where "1" represented 'strongly disagree', and "5" represented 'strongly agree'. The questionnaire was adapted from previous studies (see Table 1). After the training sessions, the students answered the questionnaire immediately. According to the collected 721 surveys, 709 survey responses were valid, of which 59.8% were males, and 40.2% were females. Most of the respondents (87.7%) were between 18 to 22 years old. Most students were undergraduates during the day (rather than the evening courses). Table 2 shows a summary of the descriptive analysis of valid respondents' responses.

According to Joseph F Hair Jr et al. (2021), to determine the minimum sample size specific to the PLS path model (i.e., ten times the number of independent variables for the most complex OLS regression in the structural model or any formative measurement model).

RESEARCH HYPOTHESES

Based on the literature review, the proposed IFQ model is as follows: There are four dimensions of IFQ, one for USS and one for CML. The relationships between the con-structs are shown in Figure 1. The path coefficients represent the relationships between latent variables. The author suggests the following analysis using PLS-SEM, which allows the hypotheses tested according to the theory that supports this change by designing a questionnaire.

Through communication devices such as e-mail, telegram, Facebook, and other virtual communication devices, the students have connections with their lecturers. According to Sharma & Baoku (2013), service quality results in USS, making customers loyal. According to Zhao (2016), Roca and Gagne (2008) proposed that when users feel connected to and supported by other users, they enjoy EL more. Accordingly, we generated the following hypothesis:

H1: CNQ is positively related to USS towards CML.

Liaw & Huang (2013) suggested that system quality, usability, and CTQ significantly affect USS. Ozkan and Koseler (2009) discovered that system quality enhanced LMS' effectiveness, while CTQ created the im-portance and USS. According to Calisir et al. (2014), the CTQ significantly affects USS; as the content quality improves, the system is more likely to be accepted by users. Chaiprasurt, Esichaikul, & Wishart, (2011) suggested that factors that affect student behaviors include influencing USS and behavior variables. Hence, the following directional hypotheses are proposed:

H2: CTQ is positively related to USS towards CML.

Kuo, Walker, Belland, Schroder, & Kuo (2014) suggested that learner-content interaction is highly effective on USS. Concannon, Flynn, & Campbell (2005), Nagel and Kotzé (2010) suggested that mutual support and group cohesion have relationships with a social presence, teamwork, learning motivation, and USS. Therefore, the following hypothesis the author proposed is to study ITQ and USS toward CML:

H3: ITQ is positively related to USS toward CML

Chae et al. (2002) found evidence suggesting that IFQ dimensions (CLQ, CTQ, ITQ, and CLQ significantly influence USS, related to CML. Besides, Zeithaml & Bitner (2013) suggested that service quality affects a deep feeling of USS. Consequently, the author put forward the following hypotheses:

H4: CLQ is positively related to USS toward CML.

According to Pham, Limbu, Bui, Nguyen, & Pham (2019), EL loyalty is positively affected by EL USS and EL service quality. Hassanzadeh, Kanaani, & Elahi (2012) suggested that the system's direct effect will increase when an EL user system is more satisfied. Mahamad & Ramayah (2010) suggested that USS provides directional influence as a moderator between CLQ and CML. Thus, the author developed the following hypotheses to study the effects of USS and CML:

H5: USS is positively related to CML.

The proposed theoretical framework is defined based on these hypotheses (see Figure 1). The empirical study methods and the procedure will be discussed in the following sections.

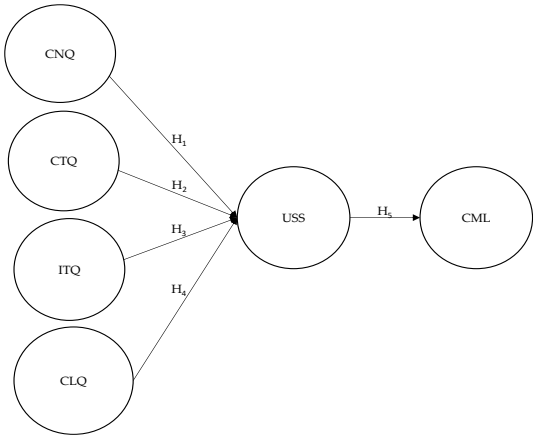

Figure 1. The proposed research model.

RESULTS

The author utilized Smart PLS version 3.2.8 to perform this empirical study. This study adopted Valls Martínez's two-step approach to scrutinize and diagnose the PLS-SEM result. First, the results identified the constructs, their indicators, and their relationships between them. Then, the author discussed the theoretical model's hypotheses of the structural model. Before reaching conclusions about the structural model's hypotheses, this process ensured the construct validity and reliability.

MEASUREMENT MODEL

According to Sarstedt et al. (2020), the results showed 2 stages of evaluation. Stage 1 shows the measurement model, whereas Stage 2 evaluates the structural model. When evaluating measurement models, constructs of formatively or reflectively measured models need to be distinguished. Indicator reliability was associated with factor loadings. The cross-loadings were lower than the cutoff value of 0.7 when constructs were formatively measured, demonstrated in Table A4. Sarstedt et al. (2020) suggested that Cronbach alpha (α) and composite reliability appear to measure the reliability of the construct. Barclay, Higgins, & Thompson (1995) suggested that both reliability criteria (see Table A2) need to be above 0.700 confirmed acceptable reliability. Joe F Hair Jr, Howard, & Nitzl (2020) suggested that prior research indicated that CR (weighted) is a more accurate method than Cronbach's α (unweighted). According to Joe F Hair Jr et al. (2020), CR and AVE are not related to evaluating formative measurement models. According to Yang (2021), the data summarized indicate Cronbach's α may underestimate results in the PLS-SEM model. Therefore, the analysis of CR showed the internal consistency reliability of the constructs. Analysis of loadings exceeded the CR value of 0.7 and below 0.95 (0.812), revealed the construct's reliability is within acceptable limits (Table A2).

According to Gefen, Straub, & Boudreau (2000), the Fornell-Larcker criterion and the cross-loading criterion were utilized to assess the measurement model. According to Panigrahi, Azizan, & Shamsi (2021), the Fornell-Larcker criterion can be assessed by the Average Variance Extracted, measuring the average variance shared between the construct and its indicators. Besides, the sum of the number of variances a con-struct obtains caused by the measurement error (s) identifies with the convergent validity. Yang et al. (2021) suggested that the critical value for AVE should be 0.5 or above. The results indicated that the AVE (from 0.740 to 1.000), above the critical value of 0.5, as recommended by Bagozzi and Yi. (1988) (See Table A2) The analytical results demonstrated an excellent convergent validity and analytical reliability (see Table A2). Ringle et al. (2020) suggested that indicator reliability, internal consistency reliability, convergent validity, and discriminant validity make up formative measurement models. According to Table A3, the square roots of each AVE for all six dimensions is shown between 0.651 and 0.904, greater than the critical value of 0.5 (see Table A3), which fulfils the Fornell-Larcker criterion, indicating that it has discriminant validity.

STRUCTURAL MODEL

According to Hair et al.(2018), collinearity happens when two or more independent variables are highly correlated in a regression model. According to Cassel, Hackl, & Westlund (2000), Multi-collinearity can be detected via various methods. In this article, the author focused on the most common one – VIF (Variable Inflation Factors). Hair et al. (2020) advised that updated guidelines on PLS-SEM also indicate that VIF values below 3 are ideal. According to Montgomery, Peck, & Vining (2012), the VIF values ranged from 1.000 to 4.789 (Table 4), which are lower than the maximum level of 5 of VIF. Besides, according to Shiau & Chau (2016), the VIFs shown in these tables are all less than 10 indicating that the multi-collinearity does not pose a severe problem for those models. Thus, multi-collinearity is unlikely to be a problem. Indeed, the conceptual definition of the con-structs was confirmed and validated. Thus, the statistical consequences of multi-collinearity were demonstrated as acceptable.

In this research, Hu & Bentler (1998) suggested that the value of SRMR was 0.045, which is less than the maximum level of 0.080 or less than or equal to 0.10. The SRMR analysis indicated the difference between the observed

correlation and the model implied correlation matrix to test the model fit. Thus, the proposed model was confirmed to have a good model fit.

Table 2. Questionnaire on the acceptance and uses of EL.

Latent Variables	Item Code	Descriptions
CNQ	cnq1	The stability of the internet content system
	cnq2	This internet content system is almost free of errors
	cnq3	Fast downloading time
	cnq4	The response time to my input or clicks is quick
CTQ	ctq1	The system provides objective content of information.
	ctq2	The system provides understandable content of information
	ctq3	The system provides enough content
ITQ	itq1	The menus of this content site are categorized
	itq3	I can quickly move back to the page I previously visited.
	itq6	The system provides a harmonious screen design of the content
CLQ	clq1	The content of information is accessible whenever I need
	clq2	The content of information is accessible wherever I need
	clq3	The system automatically recognizes me
	clq4	The system input process is quite simple
USS	uss1	The system can effectively help achieve the objectives through the content of information
	uss2	The content of the information is overall interesting to me
	uss3	The content of the information is overall satisfactory
CML	pa1	I would visit this content site again

1 Source: Adapted from (Chae et al., 2002b)

Table 3. Profile of valid respondents.

Profile Category	Frequency	Percentage (%)
Gender		
Female	291	40.1%
Male	430	59.9%
Age (years)		
<18	3	0.4
18-22	637	87.7%
23-26	37	5.1%
>26	49	6.8%
Education		
Undergraduate(Day time)	577	79.5%
Undergraduate(Evening)	144	20.5%
Business	310	43%
Engineering	217	30.1%
Service	124	17.2%
Humanities and Design	70	9.7%

Table 4. Significant testing results of the structural model path coefficients.

Hypothesis	Original Sample (O)	Sample Mean (M)	Std. Dev. (STDEV)	Path Coeff. (β)	t Statistics	p-Values	VIF
CLQ → USS	0.433	0.429	0.054	0.433	8.065	0.000	4.394
CNQ → USS	0.273	0.274	0.038	0.273	7.263	0.000	2.755
CTQ → USS	0.118	0.118	0.049	0.118	2.414	0.016	4.385
ITQ → USS	0.132	0.135	0.056	0.132	2.339	0.020	4.789
USS→ CML	0.799	0.798	0.021	0.799	38.400	0.000	1.000

Note: $R^2_{cml} = 0.639$, $R^2_{uss} = 0.778$, $SRMR = 0.045$

*Figure 2. Path analysis results. (Note. *p < 0.05; **p < 0.01; ***p < 0.001.)*

Hypotheses Test Results

Table 5 and Figure 2 illustrated the five hypotheses proposed in Section 3.3 using PLS-SEM. The path coefficient shows the direct effect of independent variables on de-pendent variables. Figure 2 presents the importance of and the path coefficients of the proposed model. According to Tao, Zhang, & Lai (2018), the hypothetical model in path analysis indicates the path coefficients' value. Wu & Wang (2006) suggested that independent variables explain the amount of variance to demonstrate the value. Besides, Ringle, Wende, & Becker (2015) suggested that the value of and path coefficients show how well the hypothetical model supports the data. Table 4 presents the analysis results. The hypothesized model was proposed in Figure 2 by using PLS-SEM. 77.8% of the USS variance and 63.9% of the CML variance were explained in the proposed model.

H1 examined that CNQ was significantly related to USS toward CML (β =0.273, p =0.000, p <0.001). H2 inspected that CTQ was significantly related to USS (β =0.118, p =0.016, p < 0.050). Next, H3 investigated that ITQ was significantly related to USS (β=0.255, p =0.000, p >0.05). H4 assessed that CLQ was significantly related to USS (β =0.433, p = 0.000, p < 0.001). H5 predicted an effect of USS on CML, and this effect was also significant (β =0.799, p = 0.000, p < 0.001). Thus, the PLS-SEM results fully supported H1, H2, H3, H4 and H5. The hypothesis testing results are presented in Table 5.

Table 5. Hypothesis testing results.

Item code	Hypotheses	Results
H1	CNQ→USS	Supported
H2	CTQ→USS	Supported
H3	ITQ→USS	Supported
H4	CLQ→USS	Supported
H5	USS→CML	Supported

The results indicated that the direct, indirect, and total measures to understand the path coefficient of each dimension's criteria are demonstrated in Table 6. The participants' CML can be improved by enhancing CNQ, CTQ, CLQ, and ITQ through the process of mediation by USS. Figure 2 and Table 6 illustrate that CLQ appears to be the most correlated coefficient factor affecting users' CML. CLQ and CML's path correlation coefficient can be obtained with the following calculation: CLQ→CML (0.433 ×0.799 =0.346). CNQ is the second important determinant of CML, and the following formula is used to determine the correlation coefficient between CNQ and CML: CNQ →CML (0.273 × 0.799 =0.2181). ITQ seems to be the third crucial aspect of CML, and the correlation coefficient between ITQ and CML path can be calculated with the following steps: ITQ→CML (0.132 ×0.799=0.105). CTQ is the fourth most crucial determinant of CML. The correlation coefficient path of CTQ and CML was measured using the following rule: CTQ →CML (0.118 ×0.799=0.0943).

Table 6. Direct, indirect and total effects.

Relationships	Direct	Indirect	Total
CNQ → CML		0.218	0.218
CNQ → USS	0.273		0.273
CTQ → CML		0.095	0.095
CTQ → USS	0.118		0.118
CLQ → CML		0.346	0.346
CLQ → USS	0.433		0.433
ITQ → CML		0.105	0.105
ITQ → USS	0.132		0.132
USS → CML	0.799		0.799

Discussion

This work proposed an analytical framework to confirm the factors correlated with the CML of ELP. Based on the analytical results, this section provides the empirical findings and discussions.

The Relationship among CNQ, CTQ, ITQ, CLQ

In this study, the author attempted to assess the crucial reasons that reflect the IFQ of an EL platform; furthermore, the author evaluated the relationships between individual indicators, such as CNQ, CTQ, CLQ, and ITQ through the process of mediation by USS to improve CML. Evidence that supports the following five hypotheses is discussed with a review of the literature. These analytic results may be explained by considering the perspectives of CNQ, CTQ, CLQ, and ITQ and mediation through USS to improve CML in the following sub-sections.

The Perspective of H1 (CNQ → USS)

CNQ had a significant positive effect on USS (H1). Rodríguez, Román, & Zúñiga-Vicente (2019) revealed that using the EL platform improved professor-student communication and increased students' USS with the courses. The findings of H1 are consistent with the results of Tam, Loureiro, & Oliveira (2019), Wixom and Todd (2005), and Xu, Benbasat, & Cenfetelli (2013), who found significant positive results between IFQ connection and USS.

The Perspective of H2 (CTQ → USS)

In supporting H2, the results suggest that CTQ has a significant correlational relationship with USS. The CTQ of the ELP can be improved to enhance the outcome of the USS. The correlation between the CTQ and USS can then be investigated further in the future. Consistent with the findings of Burns, Clift, & Duncan (1991), Arbaugh (2000), and Chen, Wong, & Hsu (2003) found that USS can have an impact on CML if the content of new findings and information would be updated regularly. Further, Lee & Lee (2008) suggested that in the ELS' post-implementation stage, the content quality of information, together with the model quality of information, interaction quality of service, PU, and Perceived Ease of Use all have significant effects on USS. Critical to quality, Navimipour & Zareie (2015) also found that CTQ is the key process input that leads to the successful implementation of EL and USS. However, the findings of Regmi & Jones (2020) found no significant differences between EL and traditional education. Similar results were shown in knowledge, mainly on levels of USS.

The Perspective of H3 (ITQ → USS)

ITQ (H3) has a positive effect on USS. The hypothesized testing result is consistent with Battalio (2007), Bolliger and Martindale (2004), and Thurmond (2003)'s research result. Similarly, Bolliger and Martindale (2004) indicated that learner–instructor interaction affected USS predictor. The hypothesis is consistent with many research findings, such as Bernard et al. (2009), Bray et al. (2008), Burnett (2001), Eom (2012), Juwah (2006), Moore and Kearsley (2006), Northrup et al. (2001), Thurmond and Wambach (2004), etc. Al-Balas et al. (2020) suggested some critical problems that researchers in the medical field have addressed. However, the study of Al-Balas et al. (2020) indicated that such distance EL could partially overcoming the traditional method in delivering theories but not clinical skills.

The Perspective of H4 (CLQ → USS)

In H4, CLQ is hypothesized to have a positive effect on USS. Students can learn how to use ELP due to its observability of the functions. The result of the hypothesized path between CLQ and USS (H4) is consistent with Shukla's (2009), whose study suggested that contextual factors influence brand loyalty and switching behavior. Waheed, Kaur, & Kumar (2016) also indicated that the instructors provide quality information based on more reliable indicators, such as intrinsic, contextual, emblematic, obtainable, and litigious components. The hypothesis is supported because the innovation results are observable to the users.

Mediation of USS in the relationship of CML

Pham, L. et al. (2019) suggested that overall EL service quality is positively associated with EL USS, and EL USS is positively related to EL CML. USS had a positive effect on CML, according to the results of this study (H5). The USS and CML (H5) findings are partly consistent with a study by Srivastava and Rai (Srivastava & Rai, 2013) to test this hypothesis. USS serves as the mediator between ELS quality and output fidelity. Besides, Casalo, Flavian, and Guinaliu (2007) argued that levels of usability influence CML through USS if familiarity increases. Shin (2015) also suggests that high USS, in turn, affects CML. Faisal, Gonzalez-Rodriguez, Fernandez-Lanvin, & de Andres-Suarez (2016) also offers that web design positively attributes user trust and joy, leading to loyalty. According to Chen et al. (2008), user loyalty is improved by enhancing member USS's high-quality information. The hypothesis is supported because many research findings have shown that USS is the crucial factor in CML.

Limitations and Possibilities for Future Study

The other significant outcome factors of ELP adoption decisions are in different industries should be investigated in future research. Some systematic errors and the risks of the factors should be accounted for. Information diffusion in knowledge diffusion, the questionnaires could not involve the critical factors with other components of the complex adaptive system. The knowledge diffusion processes and mechanisms are different in different fields. Thus, restricting the generalization of results to apply to other catch-up ELPs is still controversial. Future studies need to compare more of the ELP adoption decisions in various universities and countries.

Conclusions

This study aims to identify critical factors that reflect the e-learning platform's IFQ. This research discusses the evidence supporting the following five hypotheses through a literature review. These analytical results can improve CML by considering the relationship between various indicators such as CNQ, CTQ, CLQ and ITQ and through the mediation process of USS. Four main e-learning structures, metrics, and model relationships are shown by retesting the theoretical framework from a predictive perspective. The researchers investigated five dimensions of the IFQ to identify factors affecting

customer loyalty (CML) mediated by USS. The researchers collected data from a sample of 721 technical university students. The empirical research results verify the feasibility of the theoretical framework. The researchers analyzed recent review studies to demonstrate the reasons for the popularity of using partial least squares structural equation modelling (PLS-SEM). In addition, the results predict simultaneous interrelationships between the constructs and the factors. According to empirical findings, context quality (CLQ), interaction quality (ITQ), connection quality (CNQ), and content quality (CTQ) mediated through USS are the most relevant factors for improving IT CML. The defined measurement model makes it possible to estimate and make recommendations for the existing ELPs of technical universities. Future research should investigate interdisciplinary USS in different fields. Our findings suggest that USS has the most significant positive impact on ELP adoption. Faculty members, computer centers, and university IT departments should focus on CLQ, ITQ, CNQ, and CTQ through USS to enhance CML.

CNQ had a significant positive effect on USS (H1). The studies suggested that potential users may have CML if they found the USS. In supporting H2, CTQ had a significant positive effect on USS (H1). The CTQ of ELP can be increased to enhance the results of USS. The correlation between CTQ and USS can be further investigated in the future. ITQ (H3) has a positive impact on USS. In H4, CLQ is hypothesized to have a positive effect on USS. Students can learn how to use ELP due to its observability of the functions. EL USS was positively correlated with EL CML. According to the results of this study (H5), USS has a positive effect on CML. USS acts as a mediation between ELS quality and output fidelity. This hypothesis is supported as numerous findings suggest that USS is a crucial factor in CML.

The defined measurement model can estimate and recommend the existing ELP in the technical universities. Future research should investigate cross-discipline USS in different fields. Our findings suggested that USS had the most significant positive impact on the ELP's adoption. To enhance the CML, instructors, computer centers, and universities' IT departments should focus on CLQ, ITQ, CNQ, and CTQ through USS. In conclusion, CLQ, ITQ, CNQ, and CTQ are the most related USS factors to ELP's CML.

Author Contributions:

H.-Y.W coordinated the project, investigated, software, methodology, revised and finalized the work

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Appendix 1

Table A1. Skewness, kurtosis and normality test results.

Latent Variables	Items	Factor Loading	Cronbach's Alpha	Dijkstra-Henseler's Rho	R2	Composite Reliability	Average Variance Extracted	Redundancy
CNQ	cnq1	0.853	0.905	0.908		0.934	0.779	0.748
	cnq2	0.870						
	cnq3	0.905						
	cnq4	0.902						
CTQ	ctq1	0.892	0.888	0.889		0.931	0.818	0.719
	ctq2	0.914						
	ctq3	0.907						
CLQ	clq1	0.868	0.883	0.886		0.919	0.740	0.775
	clq2	0.875						
	clq3	0.812						
	clq4	0.885						
CML	pa1	1.000	1.000	1.000	0.639	1.000	1.000	-
ITQ	itq1	0.906	0.875	0.875		0.923	0.800	0.724
	itq3	0.889						
	itq6	0.887						
USS	uss1	0.879	0.884	0.885	0.778	0.928	0.812	-
	uss2	0.906						
	uss3	0.916						

Table A2. Cronbach's alpha, R2, composite reliability, AVE.

Latent Variables	Items	Factor Loading	Cronbach's Alpha	Dijkstra-Henseler's Rho	R2	Composite Reliability	Average Variance Extracted	Redundancy
CNQ	cnq1	0.853	0.905	0.908		0.934	0.779	0.748
	cnq2	0.870						
	cnq3	0.905						
	cnq4	0.902						
CTQ	ctq1	0.892	0.888	0.889		0.931	0.818	0.719
	ctq2	0.914						
	ctq3	0.907						
CLQ	clq1	0.868	0.883	0.886		0.919	0.740	0.775
	clq2	0.875						
	clq3	0.812						
	clq4	0.885						
CML	pa1	1.000	1.000	1.000	0.639	1.000	1.000	-
ITQ	itq1	0.906	0.875	0.875		0.923	0.800	0.724
	itq3	0.889						
	itq6	0.887						
USS	uss1	0.879	0.884	0.885	0.778	0.928	0.812	-
	uss2	0.906						
	uss3	0.916						

Table A3. Discriminant validity – Fornell–Larcker criterion.

Latent Variables	CLQ	CML	CNQ	CTQ	ITQ	USS
CLQ	0.860					
CML	0.773	1.000				
CNQ	0.738	0.651	0.883			
CTQ	0.819	0.700	0.772	0.904		
ITQ	0.854	0.696	0.740	0. 838	0.894	
USS	0.843	0.799	0.781	0.794	0. 80	0.901

Table A4. Discriminant validity– loading and cross-loading criteria.

Latent Variables	CLQ	CML	CNQ	CTQ	ITQ	USS
CLQ14	0.868	0.69	0.564	0.718	0.765	0.702
CLQ15	0.875	0.652	0.604	0.691	0.738	0.697
CLQ16	0.812	0.617	0.673	0.659	0.656	0.704
CLQ17	0.885	0.697	0.693	0.747	0.775	0.792
CML21	0.773	1	0.651	0.7	0.696	0.799
CNQ1	0.605	0.575	0.853	0.654	0.64	0.652
CNQ2	0.639	0.551	0.87	0.676	0.644	0.66
CNQ3	0.64	0.568	0.905	0.654	0.628	0.704
CNQ4	0.716	0.605	0.902	0.738	0.698	0.737
CTQ5	0.736	0.674	0.722	0.892	0.743	0.714
CTQ6	0.743	0.611	0.671	0.914	0.766	0.718
CTQ7	0.743	0.615	0.701	0.907	0.764	0.721
ITQ10	0.751	0.618	0.713	0.718	0.889	0.724
ITQ11	0.776	0.665	0.623	0.74	0.887	0.728
ITQ12	0.762	0.583	0.648	0.79	0.906	0.699
ITQ13	0.776	0.715	0.663	0.756	0.761	0.879
ITQ8	0.728	0.695	0.698	0.668	0.68	0.907
ITQ9	0.774	0.748	0.748	0.719	0.724	0.916
USS18	0.868	0.69	0.564	0.718	0.765	0.702
USS19	0.875	0.652	0.604	0.691	0.738	0.697
USS20	0.812	0.617	0.673	0.659	0.656	0.704

Table A5. The sample means, standard deviations, t statistics and p-values.

Hypothesis	Original Sample (O)	Sample Mean (M)	Std. Deviation (STDEV)	t Statistics	p Values
CLQ -> USS	0.433	0.429	0.054	8.065	0.000
CNQ -> USS	0.273	0.274	0.038	7.263	0.000
CTQ -> USS	0.118	0.118	0.049	2.414	0.016
ITQ -> USS	0.132	0.135	0.056	2.339	0.020
USS -> CML	0.799	0.798	0.021	38.400	0.000

Table A6. Saturated model, estimated model.

Latent Variables	Saturated model	Estimated model
SRMR	0.045	0.048
d_{ULS}	0.466	0.523
d_G	0.411	0.425
Chi-Square	1721.558	1762.879
NFI	0.886	0.884

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