

Article

A Derivation of Factors Influencing the Diffusion and Adoption of an Open Source Learning Platform

Chi-Yo Huang ¹, Hui-Ya Wang ^{1,2,*} , Chia-Lee Yang ³ and Steven J. H. Shiau ³

¹ Department of Industrial Education, National Taiwan Normal University, Taipei 106, Taiwan; cyhuang66@ntnu.edu.tw

² Department of Business Administration, Minghsin University of Science and Technology, Hsinchu 30076, Taiwan

³ National Center for High-performance Computing, No. 7, R&D Rd. VI, Hsinchu 30076, Taiwan; joy.yang@nchc.org.tw (C.-L.Y.); steven@nchc.org.tw (S.J.H.S.)

* Correspondence: wang.anny@gmail.com; Tel.: +886-277-493-257

Received: 31 July 2020; Accepted: 7 September 2020; Published: 12 September 2020



Abstract: During the past two decades, open source learning platforms (OSLPs) have become a dominant part of modern education. OSLPs are free for usage and customization—unlike proprietary software restricted by copyright licenses. By utilizing OSLPs, users can download and use the source code, write new features, fix bugs, improve performances, or learn from others how specific problems can be solved. Albeit dominant, the frequency of usage and motivation of OSLPs by students is not high; however, there has been very little research about this, and the problem is significant. Therefore, this research aimed to derive the factors that affect the adoption and diffusion of OSLPs. The factors on the diffusion and adoption were defined based on the innovation diffusion theory (IDT) and the technology acceptance model (TAM), where the integrated theoretical framework is called the IDT-TAM. Partial Least Square structural equation modeling was used to confirm the hypothesized IDT-TAM. An empirical study was based on the sample data collected from 340 Taiwanese technical university students to demonstrate the feasibility of the analytical framework and derive the factors related to the adoption and diffusion of the OSLP for students. Based on the results of the empirical study, through the mediation of perceived attitude (PA) and perceived usefulness (PU), trialability (TL), observability (OS), ease of use (EU), and relative advantage (RA) are the factors most related to the diffusion and acceptance of the OSLP innovations. The analytical results can serve as the basis for the design, development, and enhancement of acceptance and diffusion of OSLP.

Keywords: open source learning platform (OSLP); innovation diffusion theory (IDT); technology acceptance model (TAM); partial least square structural equation modeling (PLS-SEM)

1. Introduction

In the last few decades, the universal access to high-quality education has increased peace, sustainable social and economic development, and intercultural dialogue [1]. People have seen a burgeoning technology-enhanced learning and the application of that technology to personalized learning in recent years. Considerable concerns about cyberspace have led students to adapt to the changes and the inclusion of the new set of Web 4.0, which connects bits of intelligence in a ubiquitous web where both people and things can reason and communicate together [2].

A learning management system (LMS), also called a learning platform, includes a wide range of online learning services that assist students, teachers, and administrators in accessing online learning services [3,4]. Open source learning platforms (OSLP), where users can download and use source codes, write new features, fix bugs, improve performances, and learn from others about how specific

problems can be solved, have attracted a large population of registered users. For example, one of the most famous OSLPs, Moodle [5], allows institutions to use the platform as their LMS to provide fully online courses with a large population of registered users. Many activity modules, such as assignment, exam, asynchronous assignment and synchronous quiz, advanced grading, and user and overview reports, have been used to enrich the learning communities around their subject. Other activities, such as assignments or quizzes, have also been used to deliver content to students [6]. From the school's perspective, the OSLP can be downloaded by and modified for students without additional license and usage fees. Thus, educators continue to use the LMS as long as the OSLP does not increase the students' system usage fees [7]. Therefore, OSLPs are very suitable for students' learning when schools have very limited or no budget for purchasing expensive commercial learning platforms. Albeit important, existing research related to OSLPs has focused mainly on studying the concept of ubiquitous learning. Very few studies have discussed the status of students' acceptance of OSLPs or the diffusion and usage of these learning platforms, especially in the related field of education. Thus, an investigation of the factors influencing the acceptance and diffusion of OSLPs in school is critical for OSLP providers, educators, and users, and warrants further study. The current research aims to investigate related factors that affect the diffusion of innovation, which supports the need for constant change and renewal [8] in LMS.

Rogers [9] defined innovation diffusion theory (IDT) as "the process by which an innovation is communicated through certain channels over time among the members of a social system." The IDT has been widely applied in anthropology, sociology, education, communication, marketing, etc. Scholars (e.g., Moore and Benbasat [10]) have also defined or refined a set of constructs tailored to the characteristics of the innovation presented by Rogers for innovation diffusion. Davis' technology acceptance model (TAM) [11], the most influential and commonly employed theory for describing an individual's acceptance of information systems [12], is comprised of core variables of user motivation, such as ease of use (EU), perceived usefulness [13], and perceived attitude (PA) toward using the new computers, mobile phones, and OSLPs. The TAM has also included outcome variables, such as behavioral intention (BI) and technology use. Of these variables, PU and EU are considered vital variables that directly explain the most results from TAM-related research. Since innovating wisely with a focus is essential [14], various researchers have adopted IDT-TAM to analyze the adoption and innovation diffusion behaviors of new technology. The two theoretical frameworks are very suitable for deriving factors for the acceptance of the OSLPs. Thus, the IDT-TAM integrated framework is adopted in this research.

Therefore, this study aims to determine the factors that affect the diffusion and adoption of innovation. To confirm the proposed IDT-TAM theoretical model to the diffusion and acceptance of OSLPs, Partial Least Square structural equation modeling [15] is used to verify the hypothesized IDT-TAM. An empirical study based on the data collected from 340 undergraduate students enrolled in the general English courses of a Taiwanese technical university adopting an OSLP, Moodle, is used to demonstrate the feasibility of the proposed analytic framework. The participants had studied via the OSLP for about 18 weeks prior to the study. The participants are asked to fill out a questionnaire concerning their attitudes and intention to continue using the OSLP. The empirical study results are used to determine the most related factors in the diffusion and acceptance of OSLP innovations. The analytical findings can serve as the basis for the design, development, and enhancement of acceptance and diffusion of OSLP.

The remainder of this paper is organized as follows: The literature is reviewed in Section 2, which offers a short overview of the concepts and theoretical background regarding open systems for education, the two theories related to users' acceptance of technology innovations (i.e., IDT and TAM), and the IDT-TAM integrated model. The partial least square structural equation modeling (PLS-SEM) research model is presented in Section 3, followed by an empirical study of the research hypothesis based on the IDT-TAM integrated model. The most relevant findings obtained from this study are presented and discussed in Section 5. Section 6 concludes the paper.

2. Literature Review

Many research works have examined the use of OSLP to understand numerous approaches [16–18]. The majority of educational institutions have installed internet-based systems for online courses. These can be engaged from any location, providing learning opportunities through various materials alongside or instead of face-to-face teaching delivery [7]. For example, Coursera boasts a total enrolment of 1.5 million students from 190 countries [19]. Also available on Android and iOS platforms is Moodle, a free LMS. Instructors can use Moodle to develop online courses or improve their face-to-face classes with online components in which learners can access the mobile learning engine, Moodle, using a variety of mobile devices. Moodle is an HTML web application that requires an Internet connection to provide the best performance level, although it also includes some offline tasks [7]. There have already been significant developments in the increased globalization of education (which we now describe as global competence thanks to the creation of entirely internet-based universities, such as Kaplan University and Germany's State Distance-Learning University). A vital aspect of this development is the need to find qualified participants who can cover all the different project problems, regardless of where they live. This informal approach to innovation requires the use of new methods and tools to support collaboration and the online 'co-creation' of new products and technologies [20].

However, there is no consensus on the field's essential knowledge base, and there has been little empirical research on adopting new technologies in classrooms. Although no one denies the plausibility of this hypothesis, little empirical evidence has been gathered to support it. The purpose of this study is to determine whether and to what extent the factors influence the acceptance and continuance of the educational learning systems.

Previous studies have found that IDT includes five significant innovation characteristics: relative advantage (RA), compatibility [21], complexity, trialability (TL), and observability (OS). RA refers to the innovation generating benefits [22]. Research has found that users have no direct effect on intention, but they have indirect effects via attitudes [23]. In addition, structural models with different user goals (i.e., utilitarian or hedonic) indicate that users who value functional purposes pay more attention to the quality of service content, whereas hedonists value the interaction more [24]. Research has also found that product image positively influences the price, while value shows a pleasing and reputed brand that can increase the price and improve product/service value [25]. In addition, the intention to continue to use e-learning will influence individual performance, legitimize huge investments organizations have made in e-learning, and provide valuable activities for individuals using e-learning [26]. Unfortunately, few longitudinal studies exploring the effects of website design quality aspects have included antecedents on performance expectancy, effort expectancy, and related usage behavior using the current research model [27].

In CP, there are no explicit relationships between innovation diffusion and TAM, but it shares some key constructs [28]. To promote the use of new technology, Venkatesh [29] emphasized the importance of interventions. He exemplified that different types of training can be used to operate system-specific action, which enhances the system's EU as a determinant of BI [30].

- Regarding EU, research has revealed that system quality [31–33] has a positive correlation on EU and PU [34]. There are several pre-selected advantages, including reducing unqualified suppliers from the final pre-selected list, reducing the time and effort of decision-makers to collect information and implement the methodology [31], and reducing unqualified suppliers in the selection phase. Thus, pre-selection should be systematic and transparent from both an effectiveness and efficiency perspective [35].
- In terms of TL, the demographic distribution used as a recommendation for the use of indicators is categorized into one indicator/question, especially two similar items, because of the respondents' cognition and responses. When exploring OS, studies have also demonstrated that experienced users decide whether to use it based on their performance expectancy and website design quality [27]. Socialization positively influences attitude directly as well as the perceived degree of

recognition received by users. Research results indicate that acceptance does not directly influence attitude; however, acceptance positively influences the perceived benefits of using this service. The perceived reciprocal benefits have been found to be a strong predictor of attitude toward the service. Indeed, attitude is a strong predictor of intention to continue using and recommend the service to other people [36].

- Chang et al. [22] found that computer self-efficacy is the most important variable affecting behavior when using online learning websites [22]. The level of computer self-efficacy is regarded as a fuzzy set, with the specific cutoffs for placement within a group (i.e., the boundary conditions) being indeterminate but contained [37]. Based on the different user goals (i.e., utilitarian or hedonic) included in the research, users with utilitarian goals value the quality of the services. In contrast, those with hedonic goals value the quality of interaction more [24]. However, when considering PU, it can be inferred from the findings that college students seem to be motivated to adopt new technologies due to social influence rather than the embedded utility-based functions [38]. Researchers studying ubiquitous learning (u-learning) provided participants with a mobile app to access the learning materials. The u-learning and blended learning, combined with an experimental laboratory, helped students improve their academic performance (e.g., Tsai et al. [39] and Manuel et al. [40]).

In terms of the intention of continuous usage (ICU), research has found that information quality impacts user satisfaction and customer loyalty [24]. The principles of system thinking include the complexity of cause and effect, the importance of indirect effects, and the need to carefully examine the leverage of the system. To comprehend that the whole is greater than the sum of its parts, understand the system by analyzing subsystems and the supra system, and recognize the importance of organizational learning and renewal [41]. The impacts of information and communication technology (ICT) on organizations and their members are neither simple nor deterministic. They are still shaped by social processes and the strategies they use to plan in the organizations [41]. Organizations that successfully adopt and acknowledge that stability and change are needed [41]. A sustainable organization can continue to make large-scale technical changes, according to Stinchcombe's [42] instructions namely, "proper balance between valid formal approximations that can cause reliable social effects, and substantive perception to know their limit and to improve approximations" [42].

To provide an overview of OSLPs, the literature reviewed next discusses OSLPs for education, open innovation, and the diffusion of innovation, as well as the two theories related to users' acceptance of technology innovations (i.e., IDT and TAM) and the IDT-TAM integrated model. Finally, an analytic framework is developed based on the results of our literature review, with research hypotheses proposed based on IDT and TAM. Refer to Table 1 for the list of abbreviations and explanations being used for the terms and variables in our study.

Table 1. Abbreviations and Explanations for the Terms and Variables.

Abbreviation	Explanations
CP	Compatibility (CP) [21] refers to the degree to which innovation is consistent with the current value, needs, and experience of potential adopters.
EU	Ease of use (EU) refers to students' perceptions of the ease with which they can use the OSLP [43].
ICU	Intention of continuous usage (ICU) refers to an individual's intention to continue to use the OSLP after the initial usage [44].
IDT	Rogers [9] defined innovation diffusion theory (IDT) as "the process by which an innovation is communicated through certain channels over time among the members of a social system."
OS	Observability (OS) refers to the degree to which others can perceive the results of an innovation.
OSLP	Open source learning platforms (OSLP) are information systems where users can download and use source codes, write new features, fix bugs, improve performances, and learn from others about how specific problems can be solved. They have attracted a large population of registered users.
PA	PA is the abbreviation of perceived attitude. Attitude refers to a physical tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor [45]. Attitude has a direct effect on intention to use technology [45,46].

Table 1. Cont.

Abbreviation	Explanations
PU	Perceived usefulness (PU) [13] means that a learner thinks that it is beneficial to use the OSLP in completing their work.
RA	Relative advantage (RA) refers to an individual's belief that the OSLP is better than traditional learning platforms and can be related to diverse economic, social, convenience, and satisfaction dimensions of learning platforms [47].
TAM	Originally developed by Davis [11], the technology acceptance model (TAM) proposes that actual system use is influenced by an individual's behavioral intention to use that system, which in turn is motivated by their attitudes towards using the technology [48].
TL	Trialability (TL) refers to the degree to which an innovation is considered trialable before it is accepted whereas perceived OS refers to the degree to which others can perceive the results of an innovation.

2.1. Open Innovation

The term 'open innovation' was coined by Chesbrough [49], who highlighted several factors that eroded the boundaries within which innovation took place and catalyzed a move towards more open models of innovation [50]. Although OI's original concept is enterprise-centric, the literature correlated it to various related innovation phenomena, such as users as innovators [51,52], innovation communities [53,54], and open-source software development. Cooperating with external knowledge partners to keep up to date with the latest trends and network technologies can reduce costs of knowledge dissemination, communication, and coordination expenditures, enabling companies to gather and easily disseminate knowledge around the world [55]. "Thus, the extended definition includes motivations for different types of open innovation. For example, doing various practices such as looking at the external environment for ideas, acquiring a technology based on the market" [55]. Therefore, they are close to external knowledge sources and collaborate with individuals. Companies and other organizations have relevant knowledge that may be used in the company's innovation process [55]. On the other hand, Han et al. [56] discussed how that participation of a company in an IT-based open innovation alliance or the ecosystem could enhance not only its valuation, but also that of the other ecosystem participants. Firms are working on new platforms with collaborators.

2.2. E-Learning Platform and OSLP

Learning platform is a general term used to describe a series of integrated web-based applications [57]. According to Boggs et al. [58], an e-learning platform is a computer program used to enhance the teaching of courses through computers and the internet. An e-learning platform also allows for multiple methods of communication between the student and the teacher. The use of this common platform in many classes can clearly illustrate the interrelationships and interdependencies between them [59].

The platform's key feature is that it becomes the foundation for learning built upon as the student's course progresses. The learning platform automatically scores any generated test versions and records them in the e-scoring book [58]. The learning platform also provides an option that allows students to view their answers and the correct answers to each question on the test, which is a good way for them to learn from their mistakes [58]. Furthermore, the learning platform allows multiple communication methods between students and teachers [58]. Like any other multi-user system, the learning platform must allow access to different user groups that will each play a specific role in the education process, namely, lecturers, students, mentors, and administrators. The platform should allow different types of configuration files to define different views and functions accordingly.

An OSLP is a learning platform designed to provide educators, administrators, and learners with a single robust, secure, and integrated system to create personalized learning environments [60]. Users can download and use source codes, write new features, fix bugs, improve performances, or learn from others about how specific problems can be solved. Consequently, OSLPs such as e-learning, Xerte Online Toolkit (XOT), and Course Builder [61] have attracted a large population of registered

users. Moodle is another OSLP that allows users to change and adapt the source code. The other benefits of Moodle are the unlimited numbers of courses and the simultaneous operation of a large number of users [62]. Using these platforms, teachers can design mathematical content to suit their teaching methods.

2.3. IDT

IDT refers to “the process by which an innovation is communicated through certain channels over time among the members of a social system” [9]. The most important factors include RA, CP, complexity, TL, and visibility. Of these factors, RA and CP have provided the most consistent explanation for consumer intention to adopt new technologies. Studies in this field build on the diffusion of innovation theory [9], and widely applied behavioral models include the technology acceptance model or the theory of reasoned action [63]. In the work by Shiau et al. [64], IDT is appropriate for investigating students’ BI in the context of a cloud computing classroom. Meanwhile, Zhang et al. [65] used Rogers’ IDT as a theoretical lens to analyze the impact of factors on patients’ attitudes toward the acceptance or rejection of an e-appointment service.

2.4. TAM

TAM explains users’ motivation based on three factors: PU, EU, and PA. In addition to being included in TAM, the two main beliefs, such as PU and EU, would have a great impact on users’ attitudes. These can be determined as unfavorable or beneficial to the system. Other factors have also been considered in TAM. Taherdoost et al. [66] called the factors external variables (user training, system characteristics, and the nature of user participation in the design and implementation process). The extension of TAM (ETAM) [66] added several new factors TAM to improve its adaptability, explanatory power, and specificity.

In TAM, based on the consumer’s overall assessment, RA means that innovation is considered a better choice than other options. In this case, rational consumers will directly form a strong willingness to adopt the innovation because the old practice is no longer optimal [67].

TL refers to the degree to which an innovation is considered trialable before it is accepted, whereas perceived OS refers to the degree to which others can perceive the results of an innovation [67]. Therefore, output quality and EU indirectly affect continuous usage through PU and perceived pleasure [66]. Essentially, perceived testability is an important consideration for consumers, and it is only applicable to initial adoption rather than continuous use [68]. The same reasoning can be applied to the OS of perception.

Perceived CP refers to the degree to which innovation is consistent with the current value, needs, and experience of potential adopters [9]. Perceived OS is also related to the degree to which others are observing innovations.

Davis [69] concluded that usefulness is the second factor affecting users’ adoption of new technologies. Usefulness is “the degree to which people think that using certain technologies can improve their work performance.” Research findings have also shown that perceived EU and PU are crucial determinants of consumer acceptance of technology [70]. As the findings on the correlation of external variables indicate [71], training methods aimed at improving the practicality of perception and the ease of perception may focus on improving teachers’ self-efficacy when using technology.

Marangunić et al. [72] suggested that in the future direction of TAM, researchers should incorporate more variables and find boundary conditions. In the same year, Legris et al. [73] published an analysis of empirical research using TAM, but the findings were inconsistent and unclear. They found that some important factors were not included in the model. However, these factors must be included in a large set [73]. This collection of data contains all the variables of human and social change processes. King and He [74] conducted a statistical meta-analysis of TAM as applied in various fields. Their studies demonstrated that TAM is a valid and broad model that can be widely used in different fields [74]. Sharp [75] examined the development, extension, and application of TAM and identified

three main research areas: mixed results of PU and EU to make a decision, volitional versus mandatory use environments, and role of attitude in user acceptance [72].

Marangunić et al. [72] also showed that cognitive abilities are strong predictors of elderly disability that may contribute to the interpretation of TAM. Related cognitive skills like spatial and reasoning abilities, processing speed, and memory abilities can also contribute to TAM [72]. In addition to cognitive conditions, TAM research (such as examining different information systems and environments) should consider emotional factors, such as computer anxiety or fear of failure, and the gender of experts in relationships [72].

2.5. Integration of TAM and IDT

The constructs used in the TAM are a subset of the IDT; the integration of both models is a more robust model than the single model. There are definite similarities and complementarity between the constructs of IDT and TAM. Regarding the adoption of new technologies, the IDT-TAM integration model has been applied in various fields. Typical examples include the adoption of IT technologies, BIs of business employees using an e-learning system, derivation of factors influencing users' adoption of new technology, and the factors influencing the intention to use mobile banking services. These are typical studies using the IDT-TAM integrated model [76].

3. Research Method

The theoretical framework is proposed accordingly in Section 3.1. In Section 3.2, the correlation relationships are verified utilizing the PLS-SEM for model evaluation and improvement in Section 3.2. The statistical significance of the hypothesis testing results of this comparative analysis can confirm the correlation relationships.

3.1. Research Hypotheses

Based on the literature review, the factors that influence students' acceptance and continuous usage of the OSLP can be defined. According to the theory that supports the design of the questionnaires, the EU dimension replaced the complexity determinant in the surveys [30]. RA is the degree to which an innovation is better for the product it supersedes or with which it will compete. Tung et al. [77] integrated IDT-TAM with system quality and computer self-efficacy to propose a new hybrid TAM to study students' BIs for new types of online learning. Kuo et al. [23] argued that attitude is the most critical factor in BI for 3G services, followed by perceived enjoyment, EU, and PU. The direct effect of PU on intention is not significant, but its indirect impact through attitude on intention is significant [70]. Therefore, we developed the following hypothesis:

Hypothesis 1 (H₁). *RA is positively related to the PA toward ICU.*

Rogers [9] pointed out that CP is defined as "the degree to which an innovation is perceived as consistent with past values, experience, and the needs of the potential adopters." Meanwhile, de Sena Abrahão et al. [78] suggested that potential users confirmed a significant influence of the factors analyzed, with CP being the most relevant of the behavioral beliefs [78]. Agag et al. [70] found the perceived comparative advantage and CP are related to consumer attitudes towards the online travel community, which in turn is an essential predictor of consumer willingness to participate in the online travel community [70]. Shaikh et al. [79] revealed that CP, PU, and PA are the most critical significant drivers of intentions toward using mobile banking. Therefore, we proposed the following hypothesis to study CP and PA on OSLP users.

Hypothesis 2 (H₂). *CP is positively related to PA.*

The innovative characteristics of the cloud computing classrooms include CP, voluntariness, result demonstrability, visibility, and TL [64] according to the IDT results. Park et al. [80] suggested that PU and EU positively determine attitude toward using a smartphone. Meanwhile, Tung et al. [77]

hypothesized that EU affects attitudes through PU [77]. In addition, Kuo et al. [23] found that EU has a more substantial effect on attitude than PA in the World Wide Web context, whereas perceived playfulness has a more significant effect on attitude than PU [23]. Al-Hujran et al.'s [81], finding is consistent with previous TAM research; they assumed a positive correlation between EU and citizens' attitudes toward e-government use [81]. Thus, to investigate the effects of EU and PA on OSLP users, we developed the following hypothesis:

Hypothesis 3 (H₃). *EU is positively related to PA toward ICU.*

Nor et al. [82] found that internet banking's TL has a significant positive impact on attitudes towards using the technology [82]. Wang et al. [67] found that consumers' perceptions of CP and TL and complexity affect their willingness to adopt technology indirectly through attitudes, both positively and negatively [67]. Therefore, to find the relationship between TL and PA for OSLP users, we developed the following hypothesis:

Hypothesis 4 (H₄). *TL is positively related to PA.*

Agag et al. [70] confirmed that EU and PU influence consumers' trust and attitude toward the online travel community. Therefore, to promote online booking, managers can take steps to increase EU and PU. Kim et al. [38] showed that EU, through PU, had an indirect effect on attitude toward use and actual use, which supports the findings of Davis [45], who claimed that EU is an antecedent of PU. Abdullah et al. [83] showed that the factors that affect students' perceived practicality of electronic folders are EU and entertainment [83]. Sánchez-Prieto et al. [84] suggested that the path coefficients highlight the importance of PU as a predictor of BI and the effect of EU on PU. Thus, we proposed the following hypothesis:

Hypothesis 5 (H₅). *EU is positively related to PU toward ICU.*

TL offers opportunities for relevant experiences. Oh et al. [28] indicated that congruent experiences and opportunities in adopting a new technology affect user attitudes through the three extended technology acceptance model. Shiau et al. [58] showed that TL and OS significantly affect the adoption intentions of late adopters, but not early adopters [58]. The more times they experiment, the more useful the users may consider it to be. Thus, we proposed the following hypothesis:

Hypothesis 6 (H₆). *TL is positively related to PU toward ICU.*

Rogers et al. [9] indicated that OS is the extent to which innovations are visible to others [9]. Chang et al. [22] found that OS refers to the degree to which people can observe the results of innovation. They used these characteristics to explain user adoption and decision-making processes [22]. Lee et al. [85] proposed that OS would have a positive effect on PU, PEU, and BI when using an e-learning system [85]. The results of Shiau et al. [64] showed that TL and OS significantly affect the adoption intentions of late adopters, but not early adopters [64]. Therefore, regarding the relationship between OS and PU, we proposed the following hypothesis:

Hypothesis 7 (H₇). *OS is positively related to PU.*

Shiau et al. [64] reported that cloud-hosted services are considered more user-friendly compared to OSLP services and provide higher levels of perceived usefulness [13] compared to standard learning management tools [64]. Therefore, we developed the following hypothesis:

Hypothesis 8 (H₈). *PU is positively related to PA when using OSLP.*

The analysis supports all the proposed relationship hypotheses and suggests that stronger relationships are established between PU and BIs, EU and PU, self-efficacy, and EU [84]. The study results by Abdullah et al. [83] showed that PU of the e-portfolio is a key determinant of students' BI to use the e-portfolio [83]. Accordingly, we proposed the following hypothesis:

Hypothesis 9 (H₉). *PU is positively related to the ICU.*

Chen et al. [86] suggested that the tested TAM shows that both EU and PU have a direct and positive impact on attitudes [86]. The result of Kim's study indicated that attitude toward an online shopping system is significantly positively related to the first purchase intention [38]. Thus, we developed the following hypothesis.

Hypothesis 10 (H₁₀). *PA toward using open source LMS is positively associated with ICU.*

Based on these hypotheses, the proposed theoretical framework is defined (see Figure 1). To confirm the hypothesized paths, the research methods adopted and the empirical study process will be discussed in the following sections.

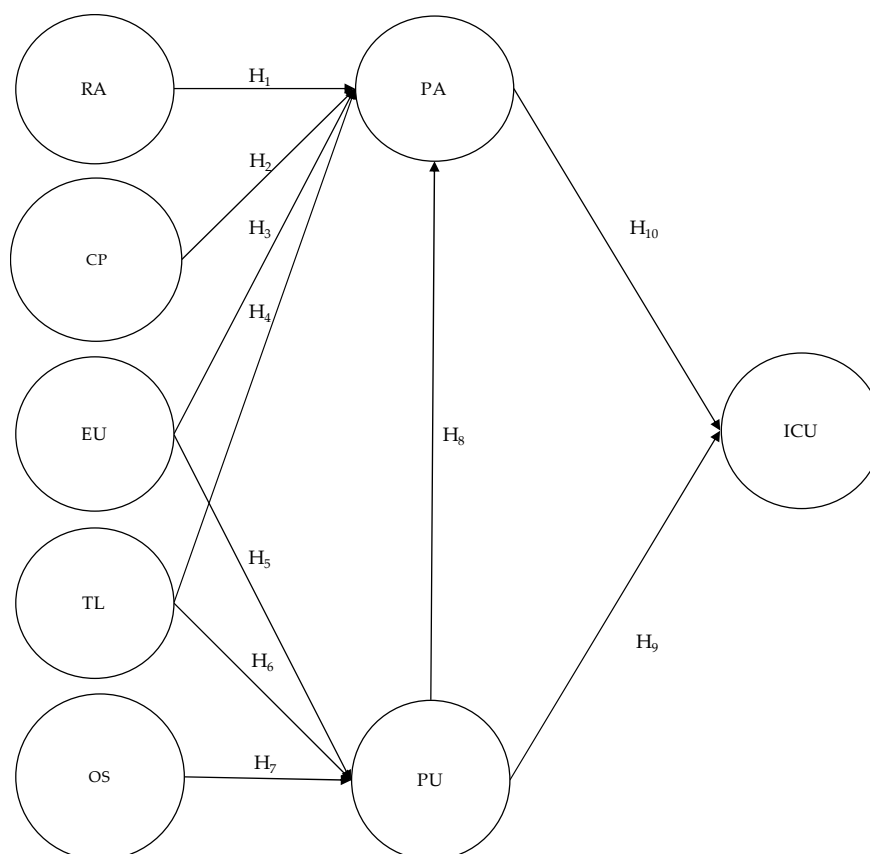


Figure 1. The proposed research model.

3.2. PLS-SEM

PLS-SEM is one of the most critical research methods across all disciplines [87]. It has the ability to simultaneously examine a series of interdependent relationships between sets of constructs represented by multiple variables while taking into account measurement errors, which has contributed to the full application of SEM [87]. The most frequently cited reasons relate to small sample sizes, non-normal data, and the use of latent variables using formative measurements [33].

PLS-SEM is a distinct method for analyzing composite-based path models. By combining principal components analysis with ordinary least square regressions, PLS-SEM is a causal-predictive approach to SEM that emphasizes prediction in estimating statistical models. Hair et al. [88] suggested that researchers should consider selecting PLS-SEM when the analysis is concerned with the following conditions: (1) a theoretical framework is tested from a prediction perspective; (2) the structural model is complex; (3) the path model includes one or more formatively measured constructs; (4) the

population sample size is small; and (5) the distribution of samples is lack of normality. Evaluation of PLS-SEM results involves examining the measurement models and structural models.

3.3. Sample and Measures

Based on the proposed hypotheses, a web-based questionnaire was conducted to collect the data required to test the research model [33]. The structural model represents the underlying theory or concept measured using items adapted from TAM and IDT research and their constructs (i.e., variables that are not directly measured), as represented in the PLS-SEM model. All questionnaire items used a five-point Likert-type scale, where “1” represented completely disagree and “5” represented completely agree. The questionnaire was adapted from previous studies (see Table 2). Table 2 includes the definitions of the abbreviations for the latent variables.

The OSLP includes software packages that enable educators to construct online learning sites to upload content materials; facilitate student/student-teacher interactions through discussion forums, e-mail, and chat features; set up online quizzes and questionnaires; and manage multiple student groups [89]. The OSLP can also be used to implement ongoing course evaluation, facilitate collaborative learning, and enhance student learning [89]. Students answered the questionnaire immediately after the training session. From the 340 surveys collected, 320 valid responses were received, of which 65.6% were from males and 34.4% were from females. Invalid respondents are those who did not answer all the questions. The majority of the respondents (88.8%) ranged from 18 to 22 years old. All respondents (100%) were undergraduate students. The majority (70.7%) studied during the day (instead of evening courses). Table 3 summarizes the descriptive statistics of the respondents with valid responses.

At least two methods are available to determine the minimum sample size for a PLS-SEM model. The first one is the 10-times rule. That is, the sample size should be greater than 10 times the maximum number of the inner or outer model links pointing at any latent variable in the model [32,90]. According to the 10-times rule, the minimum number of observations required to estimate the PLS path model was 80 (8×10). The second one, G*Power [91], is a newer method. Based on the F-test results of a regression, and given an effect size of 0.15 (medium level), an α error probability of 0.05, a power (1- β error probability) of 0.95, and five predictors, the minimum sample size derived by this method was 138. Therefore, according to the two methods mentioned above, the 320 valid responses received in this work were sufficient.

4. Results

The study embraced the two-step approach proposed by Valls Martínez [92] to examine and interpret the PLS-SEM result. First, the measurement model results were tested to specify the relationships between constructs and their indicators. Then, the structural model that contained the relationships between the constructs or the hypotheses of the theoretic model was evaluated. This process ensured that the measurement scales were valid and reliable before attempting to reach conclusions about the hypotheses included in the structural model. This study performed PLS analyses using SmartPLS version 3.2.8 [15].

4.1. Measurement Model

All 47 variables in this research deviated significantly from normality based on the Kolmogorov–Smirnov (KS) test [93] (see Table A1 in Appendix A). Therefore, PLS-SEM was an adequate analytic method for this research. In this work, the theoretical model had complicated latent variables. However, the sample size was 320, which is not particularly large. Therefore, the model was a composite one. The construct was measured in mode A, i.e., measured by using the correlation weights or the so-called reflective constructs. For the construct, which had four or more indicators in the proposed model, we could perform a confirmatory tetrad analysis (CTA) [94,95] to confirm if the measurement model was formative or reflective. With 5000 subsamples, two processes, two-tailed test

type, and a significance level of 0.05, the result of CTA in PLS path modeling for this study confirmed the reflective measurement model specification was adequate.

The measurement model was assessed in terms of individual item reliability, construct reliability, convergent validity, and discriminant validity. The individual item reliability was analyzed through the loadings. As demonstrated in Table A2, the factor loadings of all items exceeded 0.846, so all the loadings exceeded the cutoff value of 0.7. Cronbach's alpha, Dijkstra-Henselaer's rho coefficients, and composite reliability (CR) were used to evaluate construct reliability. All Cronbach's alpha and CR values (see Table A2) were greater than 0.700, which suggests an acceptable reliability according to Barclay et al. [96]. Further, the convergent validity was assessed by examining the average variance extracted [49], which provides the sum of variance that a construct gains from its items in relation to the amount of the variance caused by the measurement error(s). The analytic results in Table A2 also demonstrate good convergent validity and reliability, because the Average Variance Extracted (AVE) values range from 0.793 to 0.887, which is larger than the threshold value of 0.500 recommended by Bagozzi and Yi [97]. Hence, the convergent validity of the measurement model was acceptable. This study used two common approaches, the Fornell–Larcker criterion and the cross-loading criterion [98], to examine the discriminant validity. The Fornell-Larcker criterion was examined by comparing the square root of AVE with the correlations between the focal construct and all the other constructs [99]. In this work, all the variables could fulfill the Fornell-Larcker criterion because the square roots of each AVE were higher than the correlations between the other latent variables [99](see Table A3), which demonstrates adequate discriminant validity for all dimensions [99]. Moreover, the discriminant validity could further be verified by using the cross-loadings assessment proposed by Chin [100]. Table A4 demonstrates that each of the factor loadings (digits in bold) were greater than all of the cross-loadings.

4.2. Structural Model

After the verification of the measurement model, the structural model could be conducted. The analytic findings are presented in Table 4 and Figure 2. The significance levels of the path coefficients (refer to Table 4) were derived based on applying the bootstrap resampling method with 5000 subsamples. The hypotheses testing results were decided by inspecting these *p*-values in terms of the empirical study results (see Table 4). The variance inflation factors (VIFs), which evaluated every set of predictors for possible collinearity, are also demonstrated in Table 4.

Table 2. Questionnaire on Acceptances and Uses of the OSLP.

Latent Variables	Item Code	Descriptions	Source
Relative advantage (RA)	<i>ra</i> ₁	OSLP is free of charge and allows me to learn at a lower cost.	Revised from Premkumar and Roberts [29], Moon and Kim [101], Liu and Li [102]
	<i>ra</i> ₂	The scale/granularity of OSLP provides various services to meet different kinds of needs.	
	<i>ra</i> ₃	OSLP is excellent and suitable for frequent usage.	
	<i>ra</i> ₄	The visualization techniques and symbolization of OSLP lets me communicate with others easily.	
	<i>ra</i> ₅	OSLP lets me finish a job more quickly.	
Compatibility (CP)	<i>cp</i> ₁	OSLP is compatible with other systems/services I am using and consistent with my habits.	Revised from Chen, J. L. [103]
	<i>cp</i> ₂	OSLP is compatible with MOOC, SPOC, a flipped classroom, and other application scenarios.	
	<i>cp</i> ₃	Using OSLP is compatible with all aspects of my learning [103].	
	<i>cp</i> ₄	Using OSLP is completely compatible with my current learning situation [103].	
	<i>cp</i> ₅	I think using OSLP fits well with the way I like to conduct learning activities [103].	
	<i>cp</i> ₆	Using OSLP fits into my learning style [103].	

Table 2. Cont.

Latent Variables	Item Code	Descriptions	Source
Ease of use (EU)	<i>eu</i> ₁	OSLP meets my own values.	Revised from Moon and Kim [101], Park and Chen [80], Liu and Li [102]
	<i>eu</i> ₂	OSLP is very consistent with my working model.	
	<i>eu</i> ₃	OSLP is very consistent with needs at work.	
	<i>eu</i> ₄	I believe OSLP data are guaranteed.	
	<i>eu</i> ₅	I can use the OSLP system service anytime, anywhere.	
	<i>eu</i> ₆	I believe OSLP is easy to use.	
	<i>eu</i> ₇	I can understand the functions of OSLP and think it is not complex when using it, such as the procedures to contribute the data.	
	<i>eu</i> ₈	It is easy for me to find the usage info or material of OSLP.	
Triability (TL)	<i>tl</i> ₁	I can try any kind of function before using OSLP officially.	Revised from Park and Chen [80,81], Malek [104], Shih [105]
	<i>tl</i> ₂	I know how to try it out before using OSLP officially.	
	<i>tl</i> ₃	I can quit it if I am not satisfied after trying OSLP.	
	<i>tl</i> ₄	I can try the technology provided by the OSLP vendor to evaluate if it meets my work or research needs.	
	<i>tl</i> ₅	I can accumulate useful experiences after trying the OSLP.	
Observability (OS)	<i>os</i> ₁	I have seen people around me using OSLP.	Revised from Park and Chen [80,81], Liu and Li [102], Shih [105]
	<i>os</i> ₂	It's easy for me to find others sharing and discussing the usage of OSLP.	
	<i>os</i> ₃	I can quickly feel that OSLP could bring me some benefits.	
	<i>os</i> ₄	I have seen my coworkers or friends using OSLP.	
	<i>os</i> ₅	I have seen the demonstrations and applications of OSLP.	
Perceived attitude (PA)	<i>pa</i> ₁	Overall, I believe it's a good idea to adopt OSLP.	Revised from Moon and Kim [101], Park and Chen [80,81]
	<i>pa</i> ₂	Overall, I am positive about adopting OSLP.	
	<i>pa</i> ₃	Overall, I support adopting OSLP	
	<i>pa</i> ₄	I believe it's very good to use OSLP at work.	
	<i>pa</i> ₅	I like the OSLP technology	
Perceived usefulness (PU)	<i>pu</i> ₁	I can describe the possible benefits of using OSLP in work or life.	Revised from Premkumar and Roberts [29], Moon and Kim [101], Park and Chen [80,81], Tung et al. [77]
	<i>pu</i> ₂	I believe OSLP makes work or life more efficient.	
	<i>pu</i> ₃	I believe OSLP can cut costs in work or life.	
	<i>pu</i> ₄	I believe OSLP is helpful in work or life.	
	<i>pu</i> ₅	Using OSLP may help improve my home work quickly.	
	<i>pu</i> ₆	Using OSLP may help me learn easily	
	<i>pu</i> ₇	OSLP is useful for my learning	
Intention of continuous usage (ICU)	<i>icu</i> ₁	I believe OSLP can make people use e-learning more frequently.	Revised from Moon and Kim [101], Liu and Li [102]
	<i>icu</i> ₂	I believe OSLP makes me more willing to use e-learning.	
	<i>icu</i> ₃	I will increase the frequency of OSLP use.	
	<i>icu</i> ₄	I will do more to understand the functions and user interface of OSLP.	
	<i>icu</i> ₅	I will highly recommend OSLP to others.	
	<i>icu</i> ₆	I look forward to using OSLP to meet the needs of work or life in the future.	

Source: Adapted from [76].

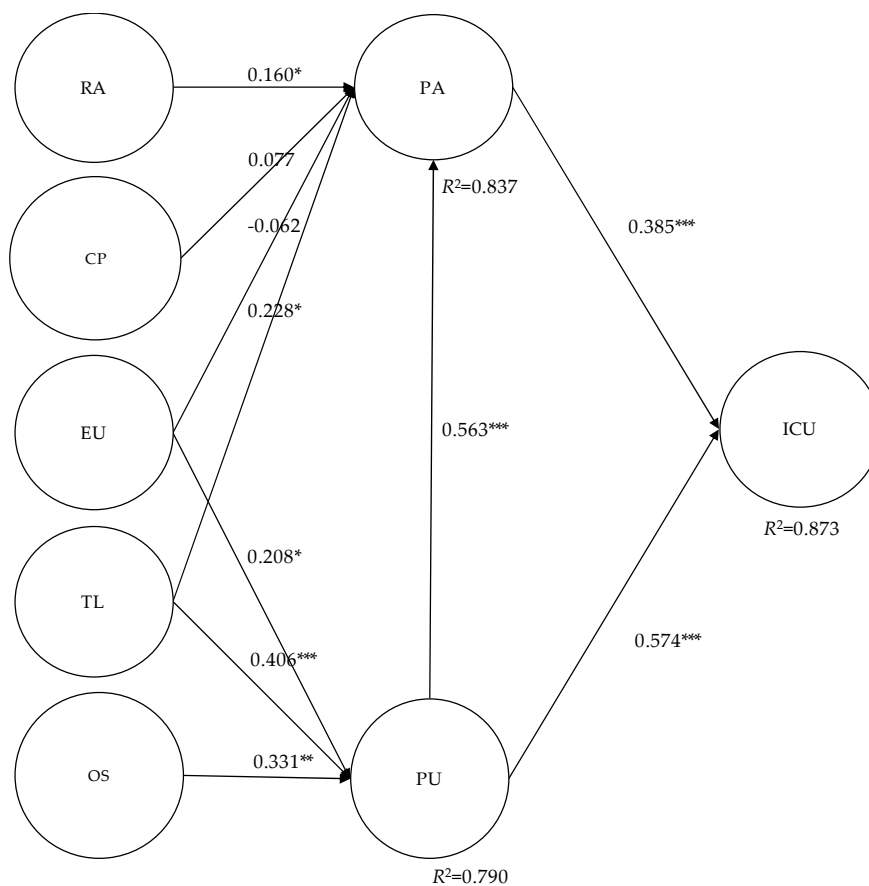
Table 3. Profile of Valid Respondents.

Profile Category	Frequency	Percentage (%)
Gender		
Female	110	34.4%
Male	210	65.6%
Age (years)		
<18	2	0.6
18–22	284	88.8%
23–26	24	7.5%
>26	10	3.1%
Education		
Undergraduate (Day time)	239	70.7%
Undergraduate (Evening)	81	29.3%
Business	122	38.1%
Engineering	198	61.9%

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

Hypothesis	Sample Mean (M)	Std. Dev. (STDEV)	Path Coeff. (β)	t Statistics	p-Values	VIF
H ₁ (RA→PA)	0.157	0.067	0.160	2.403	0.016	4.672
H ₂ (CP→PA)	0.087	0.065	0.077	1.180	0.238	4.309
H ₃ (EU→PA)	−0.061	0.081	−0.062	0.761	0.447	4.105
H ₄ (TL→PA)	0.229	0.115	0.228	1.981	0.048	4.774
H ₅ (EU→PU)	0.207	0.084	0.208	2.485	0.013	3.375
H ₆ (TL→PU)	0.411	0.094	0.406	4.314	0.000	4.204
H ₇ (OS→PU)	0.328	0.106	0.331	3.134	0.002	3.697
H ₈ (PU→PA)	0.556	0.094	0.563	6.018	0.000	4.456
H ₉ (PU→ICU)	0.386	0.061	0.574	6.358	0.000	4.956
H ₁₀ (PA→ICU)	0.574	0.060	0.385	9.555	0.000	4.956

Remark. $R^2_{icu} = 0.873$, $R^2_{pa} = 0.837$, $R^2_{pu} = 0.790$, $Q^2_{icu} = 0.658$, $Q^2_{pa} = 0.967$, $Q^2_{pu} = 0.619$, $SRMR = 0.040$.

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

According to Hair et al. [32], collinearity happens when the correlation coefficients between two indicators are high. High multi-collinearity impacts the estimation of weights and their statistical significances. The VIF of the indicators should be computed to identify the multi-collinearity problem [106]. As advised by Hair et al. [32], the VIF scores have to be less than 5 and even less than 3 in PLS. Based on the initial analysis of possible collinearity, the VIF values corresponding to the hypotheses 1, 2, 3, 4, 8, 9, and 10, which were 5.183 for H₁, 5.162 for H₂, 7.277 for H₃, 5.254 for H₄, 5.865 for H₈, 7.039 for H₉, and 7.039 for H₁₀, exceeded 5.0. Thus, possible collinear indicators were removed and retested for collinearity. At the same time, the conceptual meaning of the constructs was confirmed as not affected. After the removals of ra_3 , cp_4 , cp_6 , eu_1 , eu_2 , eu_3 , eu_4 , eu_7 , tl_4 , pa_1 , pa_5 , pu_1 , and

pu_2 , all the VIF scores ranged from 3.375 to 4.956 (refer Table 4), which are lower than the maximum level (5) of VIF [107]. Thus, the collinearity was confirmed as acceptable according to [64].

Moreover, the explained variances (R^2) for the endogenous dimensions ranged from 0.790 to 0.873 in Table 4, exceeding the minimum of 0.750, as suggested by Hair et al. [108]. Thus, the constructs had an acceptable quality of prediction power. Moreover, this study assessed the quality of the evaluation criteria by calculating the cross-validated predictive relevance of the model based on the value of the cross-validated predictive relevance of the model, based on the value of Stone-Geisser's Q^2 , which ranged from 0.619 to 0.697 (refer Table 4). All the values of Stone-Geisser's Q^2 were above zero, which suggests a good fit in model prediction. In addition, the model fit was tested based on the standardized root mean square residual (SRMR) to evaluate the difference between the observed correlation and the model implied correlation matrix. SRMR is the square root of the sum of the squared differences between the model-implied and the empirical correlation matrices. The value of SRMR was 0.040 in this research, which is less than the maximum level of 0.080 [109]. This result (see Table 4) indicates that the overall model fit was acceptable.

4.3. Hypotheses Test Results

Based on the analytic results being demonstrated in the Table 4, we tested the 10 hypotheses proposed in Figure 2 using the PLS-SEM [15]. This approach avoided two serious problems: unacceptable solutions and factor uncertainties. The value of R^2 represents the amount of variance explained by the independent variables [110]. The estimate of the path coefficient indicates the strength of the relationship between the dependent and independent variables. The value of R^2 and the path coefficients together indicate how well the data support the hypothetical model [111]. Figure 2 illustrates the importance of R^2 and the path coefficients of the proposed research model. The proposed model explained 83.7% of the R^2 variance for the PA, 79.0% of the variance for the PU, and 87.3% of variance for the ICU.

H₁ examined that RA is significantly related to PA toward ICU ($\beta = 0.160$, $p = 0.016$, $p < 0.05$). H₂ examined the effects of CP on PA. CP had a non-significant effect on PA ($\beta = 0.077$, $p = 0.238$, $p > 0.05$). Next, H₃ examined the effects of EU on PA. EU had a non-significant effect on PA ($\beta = -0.062$, $p = 0.447$, $p > 0.05$). H₄ examined the effects of TL on PA. TL had a significant positive effect on PA ($\beta = 0.228$, $p = 0.048$, $p < 0.05$). H₅ examined the effects of EU on PU. EU was shown to have a significant positive effect on PU ($\beta = 0.208$, $p = 0.013$, $p < 0.05$). H₆ examined the TL on PU. TL had a significant positive effect on PU ($\beta = 0.406$, $p = 0.000$, $p < 0.001$). H₇ examined the effects of OS on PU. OS demonstrated a slightly significant positive effect on PU ($\beta = 0.331$, $p = 0.002$, $p < 0.01$). H₈ examined the effects of PU on PA. PU had a significant positive effect on PA ($\beta = 0.563$, $p = 0.000$, $p < 0.001$). Finally, the results showed that PU ($\beta = 0.574$, $p = 0.000$, $p > 0.05$) and PA ($\beta = 0.385$, $p = 0.000$, $p < 0.001$) had a statistically highly significant effect on the ICU. PLS results provided support for H₁, H₄, H₅, H₆, H₇, H₈, H₉, H₁₀, and H₂ and H₃ were not supported. The hypothesis test results are presented in Table 5.

Table 5. Hypothesis Testing Results.

Hypotheses	Results
H ₁ (RA→PA)	Supported
H ₂ (CP→PA)	Not Supported
H ₃ (EU→PA)	Not Supported
H ₄ (TL→PA)	Supported
H ₅ (EU→PU)	Supported
H ₆ (TL→PU)	Supported
H ₇ (OS→PU)	Supported
H ₈ (PU→PA)	Supported
H ₉ (PU→ICU)	Supported
H ₁₀ (PA→ICU)	Supported

Regarding the implications of the research results, the direct, indirect, and total relationships toward the criteria within each dimension are demonstrated in Table 6. Based on the results, the participants' intention to use (ICU) the OSLP can be improved by enhancing RA and TL through the mediation of PA. The participants' intention to use (ICU) the OSLP can also be improved by enhancing EU, TL, and OS through the mediation of both the PU and the PA. Figure 2 and Table 6 demonstrate that TL appears to be the most correlated factor with students' intention of continuous usage of the OSLP. The correlation coefficient between TL and ICU can be calculated through the following path: TL→ICU ($0.406 \times 0.574 + 0.406 \times 0.563 \times 0.385 + 0.228 \times 0.385 = 0.409$). OS appears to be the second most crucial aspect of students' intention to use (ICU), and the correlation coefficient between OS and ICU can be calculated through the following path: OS→ICU ($0.331 \times 0.574 + 0.331 \times 0.563 \times 0.385 = 0.262$). EU is the third most important determinant of students' intention of continuous usage (ICU), and the correlation coefficient between EU and ICU can be calculated through the following path: EU→ICU ($0.208 \times 0.574 + 0.208 \times 0.563 \times 0.385 = 0.164$). RA is the fourth most crucial determinant of students' ICU. The correlation coefficient between RA and ICU was calculated through the following path: RA → ICU ($0.160 \times 0.385 = 0.062$).

Table 6. Direct, Indirect, and Total Effects.

Relationships	Direct	Indirect	Total
RA→ICU	-	0.062	0.062
RA→PA	0.160	-	0.160
CP→ICU	-	0.030	0.030
CP→PA	0.077	-	0.077
EU→ICU	-	0.164	0.164
EU→PA	-0.062	0.117	0.056
EU→PU	0.208	-	0.208
OS→ICU	-	0.262	0.262
OS→PA	-	0.187	0.187
OS→PU	0.331	-	0.331
PA→ICU	0.385	-	0.385
PU→ICU	0.574	0.217	0.791
PU→PA	0.563	-	0.563
TL→ICU	-	0.409	0.409
TL→PA	0.228	0.229	0.457
TL→PU	0.406	-	0.406

5. Discussion

This research used an OSLP called Moodle [5] to help manage many activity modules, such as groups and grouping functionality, assignments and quizzes, asynchronous assignment and synchronous quiz, advanced grading, and user and overview reports. Besides this, Moodle also helps to visualize statistical results with cloud computing systems.

Moodle is an effective learning platform aimed at providing better opportunities to present information and facilitate students learning in acquiring knowledge, skills, and experience. By using Moodle, both teachers and students can quickly start a course, manage the course content, and plan the activities. Moodle can fully support online teaching by uploading audio and video teaching materials, classroom recording videos, micro-courses, and other learning activities. The advantages of using Moodle LMS include sharing course materials with students, announcing messages, collecting course assignments, opening chats, initiating discussions, and providing distance learning anytime and anywhere. In addition, by integrating other community services, such as YouTube, WeChat, and Facebook, teachers can meet students' needs for social learning.

5.1. Discussion of Non-Significant Hypotheses

The following four hypotheses were not supported by the empirical study results. The rationality and consistency with past works are also discussed.

5.1.1. The Perspective of H_2 (CP→PA)

The empirical study results do not support H_2 , which means that CP does not have a significant effect on PA. This study's findings on the hypothesized path between CP and PA (H_2) contradict the results by Chen et al. [112] that compatibility positively affected users' attitude toward use of a virtual store. This finding is also consistent with Lau et al. [113], who found that complexity, relative advantage, compatibility, and observability were significantly correlated with the attitude toward using an online trading system. However, as Taylor and Todd [114] concluded, ease of use and compatibility are not significantly related to attitude. As the current study focused on students who are infrequent users, they have little or no experience with the OSLP, so CP has no significant effect on users' PA toward OSLP usages.

5.1.2. The Perspective of H_3 (EU→PA)

The results indicate that EU does not have a significant positive effect on PA (H_3). The empirical findings suggest that, if potential users find the OSLP easy to use, they may not develop a positive attitude. The analytic results are consistent with the work by Moses et al. [115], who found that EU did not significantly impact the attitude toward laptop use, only perceived usefulness did. The findings were similar for both science and mathematics teachers. The outcome is also consistent with the work by Md Nor. et al. [116], where perceived EU did not directly impact the PA toward using technology. This is contrary to the findings by Kolodinsky et al. [117], Chen et al. [118], Lau et al. [113], and Taylor and Todd [119]. We believe the unsupported hypothesis might be due to the participant selection process in this study. The majority of respondents were engineering majors and business majors (see Table 4). Most were computer literate and very comfortable using technology. Therefore, the issue of ease of use might not have arisen.

5.2. Discussion of Significant Hypotheses Supported by the Empirical Study Results

The following six hypotheses were supported by the empirical study results. The rationality and consistency with past works are also discussed.

5.2.1. The Perspective of H_1 (RA→PA)

RA showed a significant positive effect on PA (H_1). Relative advantage (RA) is the extent to which people believe that innovation is better than the traditional one. In this research, RA was defined as the degree to which a student believes OSLP uses would enrich their performance of learning [120]. The empirical findings suggest that students found the advantages of the OSLP; thus, their attitudes intended to try it. The analytic results of H_1 are consistent with the findings of Nor et al. [82], Surej et al. [121], as well as Gao and Waechter [122]. If students find that the OSLP has an advantage, they would be inclined to try it.

5.2.2. The Perspective of H_4 (TL→PA)

In this research, TL (H_4) had a positive effect on PA. This finding on the hypothesized path between TL and PA (H_4) is consistent with the results of Nor et al. [82], who found that trialability positively affects attitude toward using Internet banking. The findings are also consistent with the results of Karahanna et al. [123], Tan and Teo [124], and Plouffe et al. [125], who found that trialability affects the intentions of PA. The hypothesis is supported because students can try the OSLP freely. These trials will eventually influence students' attitudes toward using OSLPs.

5.2.3. The Perspective of H₅ (EU→PU)

EU showed a significant positive effect on PU (H₅). The empirical findings suggest that potential users may find the OSLP useful if they find it easy to use. The analytic results of H₂ are consistent with the findings of Chen et al. [86], Lee et al. [126], and Kwon et al. The hypothesis is supported that the students who have had prior computer usage training, such as engineering majors and business majors, will find it easier to use the OSLP. Thus, internal and external computer skills training will have positive effects on perceived usefulness.

5.2.4. The Perspective of H₆ (TL→PU)

TL (H₆) also showed a positive effect on PU. As students can use the OSLP without buying any license, trialability is not an issue of concern, although it cannot be excluded. This study's findings on the hypothesized path between TL and PU (H₆) are consistent with the result of Oh et al. [28]. The hypothesis is supported because trialability offers opportunities for relevant experiences, so the students may have already experimented with the functionality of the OSLP. The more times they experiment with using the OSLP, the more useful the students may consider it to be.

5.2.5. The Perspective of H₇ (OS→PU)

As hypothesized in H₇, OS had a significant positive effect on PU. The OSLP's functions are observable, so students can learn by using it. This study's findings on the hypothesized path between OS and PU (H₇) are consistent with those of Rogers et al. [9] and Al-Rahmi et al. [127]. The hypothesis is supported because the results of the innovation are observable to the users, who may find the OSLP useful.

5.2.6. The Perspective of H₈ (PU→PA)

The results indicated that PU had a positive impact on PA (H₈), suggesting that potential users may consider continuing to use the OSLP if they find it useful. This study's findings on the hypothesized path between PU and PA (H₈) are consistent with the results of Chau et al. [128], Mengli et al. [129], Chau et al. [128], Oh et al. [28], and Yaghoubi et al. [130]. The hypothesis is supported because the OSLP will continue to adopt specific technologies and obscure variations in individual perceptions and attitudes, while highlighting their usefulness at different stages of the continuing education process [26,111].

5.2.7. The Perspective of H₉ (PU→ICU)

PU was also found to have a positive impact on ICU, which is consistent with the hypothesis in H₉. If this is the case, PU will positively affect the behavioral intention to use the course website. This study's findings on the hypothesized path between PU and ICU (H₉) are consistent with the results of Chang et al. [22], Yaghoubi et al. [130], and Chau et al. [128]. The hypothesis is supported because the students find the OSLP useful, so they may use it continuously.

5.2.8. The Perspective of H₁₀ (PA→ICU)

Our results strongly supported H₁₀—namely, that PA positively and significantly affected the ICU. The intention, in turn, determined users' attitudes towards using new technologies. Therefore, before accepting and adopting new technology, a positive attitude towards the OSLP should be formed. This study's findings on the hypothesized path between PA and ICU (H₁₀) are consistent with the results of Davis et al. [69], Chen et al. [86], Chau et al. [128], and Hamari et al. [36], etc. The hypothesis is supported because appraisals of outcome-desire units lead to specific emotions, and in turn, stimulate coping responses of intentions directed toward specific actions [131].

5.3. Limitations and Possibilities for Future Study

This study was the first step in investigating the OSLP and education. Some limitations need to be addressed, as discussed in this section. At first, the non-significant hypotheses and further research possibilities will be discussed. Following that, the cross-country analysis of factors influencing the OSLP adoption will be discussed. Finally, the OSLP adoption in educational and other fields will be discussed.

5.3.1. Non-Significant Hypotheses

According to Johnson [132], statistically insignificant hypothesis results are worth further investigation. Box [133] explained that statistical tests can play a useful role in diagnostic checks and evaluations of tentative statistical models. Even for this application, competing tools are superior. Information criteria, such as Akaikes, provide objective measures for selecting among different models fit to a dataset. Bumham and Anderson [134] provided a detailed overview of model selection procedures based on information criteria. However, it is not advisable to select the “best” model and proceed as if that model was correct. Therefore, other research tools can be adopted to verify whether these unsupported paths are validated by investigating insignificant hypotheses with different research designs.

5.3.2. Cross Country Analysis of Factors Influencing OSLP Adoption

Due to the trend to accommodate an increasing number of international students who have diverse linguistic, social, economic, and cultural backgrounds, the crucial amendments to impart quality education for almost everyone possible are urgent. Several studies have addressed the need to investigate factors influencing OSLP adoption across countries. There is evidence that adoption rates differ significantly across countries with similar economic situations. Van Ark et al. [135], Mante-Meijer et al. [21], and Erumban et al. [136] suggested that it is useful to derive a framework of how the differences in national cultures transformed into the differences observed in ICT adoption across countries at the macro level. However, these differences in the variances are not consistent across countries. Therefore, the results of the findings confirm the hypotheses and conclude that OSLP adoption decisions across countries are significantly associated with the outcome factors.

5.3.3. OSLP Adoption in Educational and Other Fields

The impact of learning technology is expanding rapidly. According to Kaware et al. [137], nowadays, ICT plays a crucial role in the process of integrating technology into educational activities. Modern ICT has brought about a revolution in various fields affecting our day-to-day activities. Therefore, investigating the principles of OSLP adoption in educational and other fields as well as learning tools is vital to the success of the fields of study.

6. Conclusions

This study has contributed to research and practice in OSLP adoption and acceptance. Based on the empirical study results, TL, OS, EU, and RA are the factors most related to the diffusion and acceptance of OSLP innovations. In light of these findings, the study has offered suggestions to practitioners from different communities to improve their performance concerning the adoption and continuous usage of OSLPs. This study aimed to determine the factors that affect the diffusion and adoption of OSLPs. Our findings suggested that PU has the most significant positive impact on using a new OSLP; it also showed a significant positive effect on PA that results in ICU. According to the results of the empirical study, educators, computer centers, and university IT departments should focus on TL, OS, EU, and RA to enhance the PU as well as the PA, and thus, continuous usage. To improve the generalization, future studies should extend the examination to students in other disciplines and various types of OSLPs. Ultimately, the defined policies can be used to evaluate other innovations

and new technologies in general, especially OSLPs for education, based on the analytical framework proposed and confirmed in this research.

Author Contributions: C.-Y.H. conceptualized the original design, coordinated the project, revised and finalized the work. H.-Y.W. wrote the draft. C.-L.Y. and S.J.H.S. re-analyzed the theoretic framework based on the advice of the reviewer and revised the empirical study results. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

To test the normality of the data sample, the method proposed by Kim [93]—the Kolmogorov–Smirnov (KS) test—was introduced to assess the normality of the sample data. The sample data can be considered to have normal distribution when the p -value is larger than 0.05 in the KS test results. In addition, when the sample size is medium ($50 < n < 300$), the null hypothesis can be rejected when the absolute value of Z_{skewness} or Z_{kurtosis} is over 3.29. The distribution of the sample can be concluded to be non-normal. As shown in Table A1, most of the 47 variables deviated significantly from normality. Based on these non-normal distributional characteristics, PLS-SEM is an adequate research method for this work.

Table A1. Skewness, kurtosis, and normality test results.

Variable	Mean	Median	Min	Max	Standard Deviation	Excess Kurtosis	Skewness
<i>ra</i> ₁	3.944	4.000	2.000	5.000	0.785	−1.105	−0.018
<i>ra</i> ₂	3.816	4.000	2.000	5.000	0.750	−0.868	0.139
<i>ra</i> ₃	3.725	4.000	1.000	5.000	0.829	0.152	−0.210
<i>ra</i> ₄	3.728	4.000	1.000	5.000	0.793	−0.225	−0.002
<i>cp</i> ₁	3.722	4.000	1.000	5.000	0.795	0.390	−0.208
<i>cp</i> ₂	3.647	4.000	1.000	5.000	0.812	−0.061	0.028
<i>cp</i> ₃	3.684	4.000	1.000	5.000	0.801	−0.176	−0.029
<i>cp</i> ₄	3.731	4.000	1.000	5.000	0.808	0.306	−0.222
<i>eu</i> ₁	3.825	4.000	1.000	5.000	0.810	0.738	−0.448
<i>eu</i> ₂	3.781	4.000	1.000	5.000	0.772	−0.287	−0.092
<i>eu</i> ₃	3.700	4.000	1.000	5.000	0.785	−0.104	−0.038
<i>icu</i> ₁	3.656	4.000	1.000	5.000	0.863	0.286	−0.271
<i>icu</i> ₂	3.678	4.000	1.000	5.000	0.810	0.260	−0.164
<i>icu</i> ₃	3.663	4.000	1.000	5.000	0.825	0.150	−0.142
<i>icu</i> ₄	3.691	4.000	1.000	5.000	0.811	0.238	−0.155
<i>icu</i> ₅	3.663	4.000	1.000	5.000	0.854	0.482	−0.258
<i>icu</i> ₆	3.669	4.000	1.000	5.000	0.842	0.583	−0.257
<i>os</i> ₁	3.819	4.000	1.000	5.000	0.839	0.590	−0.507
<i>os</i> ₂	3.650	4.000	1.000	5.000	0.842	0.224	−0.180
<i>os</i> ₃	3.675	4.000	1.000	5.000	0.822	0.391	−0.216
<i>os</i> ₄	3.862	4.000	1.000	5.000	0.818	0.160	−0.361
<i>os</i> ₅	3.684	4.000	1.000	5.000	0.812	0.214	−0.135
<i>pa</i> ₁	3.697	4.000	1.000	5.000	0.821	0.149	−0.136
<i>pa</i> ₂	3.709	4.000	1.000	5.000	0.810	0.782	−0.343
<i>pa</i> ₃	3.700	4.000	1.000	5.000	0.809	0.313	−0.220
<i>pu</i> ₁	3.737	4.000	1.000	5.000	0.825	0.454	−0.316
<i>pu</i> ₂	3.706	4.000	1.000	5.000	0.807	0.523	−0.240
<i>pu</i> ₃	3.744	4.000	1.000	5.000	0.846	0.272	−0.293
<i>pu</i> ₄	3.694	4.000	1.000	5.000	0.840	0.505	−0.324
<i>pu</i> ₅	3.716	4.000	1.000	5.000	0.827	0.380	−0.259
<i>tl</i> ₁	3.763	4.000	1.000	5.000	0.787	0.483	−0.250
<i>tl</i> ₂	3.741	4.000	1.000	5.000	0.821	0.518	−0.340
<i>tl</i> ₃	3.744	4.000	1.000	5.000	0.812	0.591	−0.343
<i>tl</i> ₄	3.678	4.000	1.000	5.000	0.802	0.122	−0.156

Table A2. Measurement validation.

Latent Variables	Items	Factor Loading	Cronbach's Alpha	Dijkstra-Henseler's Rho	CR	AVE	Redundancy
RA			0.915	0.920	0.940	0.797	N.A.
	<i>ra</i> ₁	0.846					
	<i>ra</i> ₂	0.910					
	<i>ra</i> ₃	0.897					
	<i>ra</i> ₄	0.917					
CP			0.943	0.944	0.959	0.853	N.A.
	<i>cp</i> ₁	0.916					
	<i>cp</i> ₂	0.942					
	<i>cp</i> ₃	0.925					
	<i>cp</i> ₄	0.912					
EU			0.917	0.917	0.948	0.858	N.A.
	<i>eu</i> ₁	0.927					
	<i>eu</i> ₂	0.939					
	<i>eu</i> ₃	0.912					
TL			0.913	0.914	0.939	0.793	N.A.
	<i>tl</i> ₁	0.917					
	<i>tl</i> ₂	0.903					
	<i>tl</i> ₃	0.873					
	<i>tl</i> ₄	0.867					
OS			0.933	0.935	0.949	0.789	N.A.
	<i>os</i> ₁	0.873					
	<i>os</i> ₂	0.919					
	<i>os</i> ₃	0.916					
	<i>os</i> ₄	0.857					
	<i>os</i> ₅	0.874					
PA			0.936	0.937	0.959	0.887	0.658
	<i>pa</i> ₁	0.933					
	<i>pa</i> ₂	0.944					
	<i>pa</i> ₃	0.984					
PU			0.953	0.953	0.964	0.842	0.697
	<i>pu</i> ₁	0.889					
	<i>pu</i> ₂	0.915					
	<i>pu</i> ₃	0.922					
	<i>pu</i> ₄	0.931					
	<i>pu</i> ₅	0.930					
ICU			0.954	0.954	0.963	0.812	0.619
	<i>icu</i> ₁	0.900					
	<i>icu</i> ₂	0.922					
	<i>icu</i> ₃	0.914					
	<i>icu</i> ₄	0.900					
	<i>icu</i> ₅	0.903					
	<i>icu</i> ₁	0.900					

Table A3. Discriminant validity-Fornell-Larcker Criterion.

Latent Variables	RA	CP	EU	ICU	OS	PA	PU	TL
RA	0.893							
CP	0.850	0.924						
EU	0.787	0.796	0.926					
ICU	0.768	0.753	0.760	0.901				
OS	0.773	0.747	0.788	0.846	0.888			
PA	0.802	0.765	0.764	0.898	0.867	0.942		
PU	0.787	0.759	0.801	0.918	0.834	0.893	0.918	
TL	0.795	0.759	0.816	0.818	0.834	0.844	0.853	0.890

Table A4. Discriminant validity—Loading and Cross-loading Criterion.

	RA	CP	EU	ICU	OS	PA	PU	TL
<i>ra</i> ₁	0.846	0.653	0.658	0.586	0.630	0.642	0.619	0.642
<i>ra</i> ₂	0.910	0.733	0.697	0.673	0.678	0.726	0.689	0.698
<i>ra</i> ₃	0.897	0.804	0.700	0.718	0.703	0.711	0.715	0.734
<i>ra</i> ₄	0.917	0.833	0.750	0.753	0.742	0.777	0.776	0.758
<i>cp</i> ₁	0.785	0.916	0.728	0.657	0.671	0.671	0.667	0.666
<i>cp</i> ₂	0.796	0.942	0.751	0.698	0.702	0.708	0.694	0.730
<i>cp</i> ₃	0.785	0.925	0.703	0.692	0.664	0.700	0.693	0.699
<i>cp</i> ₄	0.775	0.912	0.756	0.731	0.721	0.744	0.745	0.707
<i>eu</i> ₁	0.739	0.732	0.927	0.681	0.725	0.700	0.721	0.732
<i>eu</i> ₂	0.723	0.738	0.939	0.716	0.758	0.706	0.754	0.775
<i>eu</i> ₃	0.724	0.740	0.912	0.714	0.705	0.715	0.750	0.759
<i>tl</i> ₁	0.672	0.662	0.680	0.900	0.767	0.810	0.813	0.733
<i>tl</i> ₂	0.731	0.713	0.728	0.922	0.818	0.857	0.829	0.765
<i>tl</i> ₃	0.700	0.704	0.725	0.914	0.757	0.805	0.852	0.752
<i>tl</i> ₄	0.720	0.689	0.672	0.900	0.775	0.858	0.844	0.803
<i>os</i> ₁	0.673	0.652	0.672	0.903	0.738	0.750	0.812	0.691
<i>os</i> ₂	0.650	0.646	0.628	0.866	0.712	0.769	0.811	0.671
<i>os</i> ₃	0.610	0.578	0.649	0.699	0.873	0.704	0.676	0.691
<i>os</i> ₄	0.718	0.676	0.687	0.771	0.919	0.801	0.741	0.754
<i>os</i> ₅	0.719	0.693	0.720	0.819	0.916	0.821	0.791	0.769
<i>pa</i> ₁	0.682	0.646	0.692	0.692	0.857	0.729	0.708	0.713
<i>pa</i> ₂	0.695	0.714	0.743	0.763	0.874	0.785	0.779	0.768
<i>pa</i> ₃	0.763	0.728	0.689	0.830	0.811	0.933	0.814	0.786
<i>pu</i> ₁	0.765	0.711	0.737	0.867	0.834	0.944	0.865	0.805
<i>pu</i> ₂	0.738	0.723	0.731	0.839	0.804	0.948	0.844	0.795
<i>pu</i> ₃	0.725	0.684	0.712	0.821	0.756	0.805	0.889	0.795
<i>pu</i> ₄	0.725	0.706	0.717	0.854	0.761	0.855	0.915	0.777
<i>pu</i> ₅	0.698	0.692	0.764	0.812	0.756	0.806	0.922	0.779
<i>icu</i> ₁	0.730	0.713	0.766	0.848	0.783	0.807	0.931	0.794
<i>icu</i> ₂	0.731	0.686	0.717	0.875	0.771	0.825	0.930	0.768
<i>icu</i> ₃	0.741	0.697	0.748	0.735	0.765	0.787	0.779	0.917
<i>icu</i> ₄	0.698	0.660	0.741	0.706	0.715	0.731	0.721	0.903
<i>icu</i> ₅	0.675	0.644	0.715	0.672	0.726	0.705	0.742	0.873
<i>icu</i> ₆	0.713	0.697	0.702	0.793	0.760	0.778	0.790	0.867

References

1. Daradoumis, T.; Bassi, R.; Xhafa, F.; Caballé, S. A review on massive e-learning (mooc) design, delivery and assessment. In Proceedings of the 2013 Eighth International Conference on P2P, Parallel, Grid, Cloud and Internet Computing, Compiegne, France, 28–30 October 2013.
2. Kravari, K.; Bassiliades, N. A survey of agent platforms. *J. Artif. Soc. Soc. Simul.* **2015**, *18*, 11. [\[CrossRef\]](#)
3. Alharbi, S.; Drew, S. Using the technology acceptance model in understanding academics' behavioural intention to use learning management systems. *Int. J. Adv. Comput. Sci. Appl.* **2014**, *5*, 143–155.
4. Paulsen, M.F. Online education systems: Discussion and definition of terms. *NKI Distance Educ.* **2002**, *202*, 1–8.
5. The Moodle Project. Moodle docs 3.9. Available online: https://docs.moodle.org/39/en/Main_page (accessed on 9 June 2020).
6. Luk, C.H.; Ng, K.K.; Lam, W.M. The Acceptance of Using Open-Source Learning platform (Moodle) for Learning in Hong Kong's Higher Education. In *International Conference on Technology in Education, Proceedings of the ICTE: International Conference on Technology in Education, Hong Kong, China, 9–11 January 2018*; Cheung, S.K.S., Lam, J., Li, K.C., Au, O., Ma, W.K.W., Ho, W.S., Eds.; Springer: Berlin/Heidelberg, Germany, 2018.

7. Sarraf, M.; Elbasir, M.; Alnaeli, S. Towards a quality model of technical aspects for mobile learning services: An empirical investigation. *Comput. Hum. Behav.* **2016**, *55*, 100–112. [CrossRef]
8. Durana, P.; Valaskova, K.; Vagner, L.; Zadnanova, S.; Podhorska, I.; Siekelova, A. Disclosure of strategic managers' factotum: Behavioral incentives of innovative business. *Int. J. Fin. Stud.* **2020**, *8*, 17. [CrossRef]
9. Rogers, E.M. *Diffusion of Innovations*, 4th ed.; Simon and Schuster: New York, NY, USA, 2010; pp. 1–519.
10. Moore, G.C.; Benbasat, I. Development of an instrument to measure the perceptions of adopting an information technology innovation. *Inf. Syst. Res.* **1991**, *2*, 192–222. [CrossRef]
11. Davis, F.D. A Technology Acceptance Model. for Empirically Testing New End-User Information Systems: Theory and Results. Ph.D. Thesis, Sloan School of Management, Massachusetts Institute of Technology, Cambridge, MA, USA, 1985.
12. Lee, Y.; Kozar, K.A.; Larsen, K.R. The technology acceptance model: Past, present, and future. *Commun. Assoc. Inf. Syst.* **2003**, *12*, 752–780. [CrossRef]
13. Pattanayak, D.; Koilakuntla, M.; Punyatoya, P. Investigating the influence of TQM, service quality and market orientation on customer satisfaction and loyalty in the indian banking sector. *Int. J. Qual. Rel. Mgt.* **2017**, *34*, 362–377. [CrossRef]
14. Durana, P.; Zauskova, A.; Vagner, L.; Zadnanova, S. Earnings drivers of Slovak manufacturers: Efficiency assessment of innovation management. *Appl. Sci.* **2020**, *10*, 4251. [CrossRef]
15. Ringle, C.M.; Wende, S.; Becker, J.M. Smartpls 3. Bönningstedt: SmartPLS. Available online: <http://www.smartpls.com> (accessed on 31 July 2020).
16. Bonardi, J.P.; Durand, R. Managing network effects in high-tech markets. *Acad. Manag. Perspect.* **2003**, *17*, 40–52. [CrossRef]
17. Boudreau, K.J.; Jeppesen, L.B. Unpaid crowd complementors: The platform network effect mirage. *Strateg. Manag. J.* **2015**, *36*, 1761–1777. [CrossRef]
18. Yoffie, D.B.; Kwak, M. With friends like these: The art of managing complementors. *Harv. Bus. Rev.* **2006**, *84*, 88–98. [PubMed]
19. Goldie, J.G.S. Connectivism: A knowledge learning theory for the digital age? *Med. Teach.* **2016**, *38*, 1064–1069. [CrossRef] [PubMed]
20. Mante-Meijer, E.; Haddon, L.; Concejero, P.; Klammer, L.; Heres, J.; Ling, R.; Thomas, F.; Smoreda, Z.; Vrieling, I. *Checking it Out with the People—ICT Markets and Users in Europe*; EURESCOM: Heidelberg, Germany, 2001.
21. Potkonjak, V.; Gardner, M.; Callaghan, V.; Mattila, P.; Guetl, C.; Petrović, V.M. and Jovanović, K. Virtual laboratories for education in science, technology, and engineering: A review. *Comput Educ* **2016**, *95*, 309–327. [CrossRef]
22. Chang, S.C.; Tung, F.C. An empirical investigation of students' behavioural intentions to use the online learning course websites. *Br. J. Educ. Technol.* **2008**, *39*, 71–83. [CrossRef]
23. Kuo, Y.F.; Yen, S.N. Towards an understanding of the behavioral intention to use 3G mobile value-added services. *Comput. Hum. Behav.* **2009**, *25*, 103–110. [CrossRef]
24. Chae, M.; Kim, J.; Kim, H.; Ryu, H. Information quality for mobile internet services: A theoretical model with empirical validation. *Electron. Mark.* **2002**, *12*, 38–46. [CrossRef]
25. Lien, C.H.; Wen, M.J.; Huang, L.C.; Wu, K.L. Online hotel booking: The effects of brand image, price, trust and value on purchase intentions. *Asia Pac. Manag. Rev.* **2015**, *20*, 210–218.
26. Mohammadyari, S.; Singh, H. Understanding the effect of e-learning on individual performance: The role of digital literacy. *Comput. Educ.* **2015**, *82*, 11–25. [CrossRef]
27. Al-Qeisi, K.; Dennis, C.; Alamanos, E.; Jayawardhena, C. Website design quality and usage behavior: Unified theory of acceptance and use of technology. *J. Bus. Res.* **2014**, *67*, 2282–2290. [CrossRef]
28. Oh, S.; Ahn, J.; Kim, B. Adoption of broadband internet in Korea: The role of experience in building attitudes. *J. Inf. Technol.* **2003**, *18*, 267–280. [CrossRef]
29. Premkumar, G.; Roberts, M. Adoption of new information technologies in rural small businesses. *Omega* **1999**, *27*, 467–484. [CrossRef]
30. Venkatesh, V.; Bala, H. Technology acceptance model 3 and a research agenda on interventions. *Decis. Sci.* **2008**, *39*, 273–315. [CrossRef]
31. Gefen, D.; Rigdon, E.E.; Straub, D. Editor's comments: An update and extension to SEM guidelines for administrative and social science research. *Manag. Inf. Syst. Q.* **2011**, *35*, 3–4. [CrossRef]

32. Hair Jr, J.F.; Hult, G.T.M.; Ringle, C.; Sarstedt, M. *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*, 2nd ed.; Sage Publications: Thousand Oaks, CA, USA, 2017.
33. Ringle, C.M.; Sarstedt, M.; Straub, D. Editor's comments: A critical look at the use of PLS-SEM in "mis quarterly". *Manag. Inf. Syst. Q.* **2012**, *36*, 3–4. [[CrossRef](#)]
34. Fathema, N.; Shannon, D.; Ross, M. Expanding the technology acceptance model (TAM) to examine faculty use of learning management systems (LMSS) in higher education institutions. *J. Online Learn. Teach.* **2015**, *11*, 210–232.
35. Rezaei, J.; Nispeling, T.; Sarkis, J.; Tavasszy, L. A supplier selection life cycle approach integrating traditional and environmental criteria using the best worst method. *J. Clean. Prod.* **2016**, *135*, 577–588. [[CrossRef](#)]
36. Hamari, J.; Koivisto, J. Social motivations to use gamification: An empirical study of gamifying exercise. In Proceedings of the 21st European Conference on Information Systems, Utrecht, The Netherlands, 6–8 June 2013.
37. Scott, J.E.; Walczak, S. Cognitive engagement with a multimedia ERP training tool: Assessing computer self-efficacy and technology acceptance. *Inform. Manag.* **2009**, *46*, 221–232. [[CrossRef](#)]
38. Kim, D.; Chun, H.; Lee, H. Determining the factors that influence college students' adoption of smartphones. *J. Assoc. Inf. Sci. Technol.* **2014**, *65*, 578–588. [[CrossRef](#)]
39. Tsai, C.W.; Shen, P.D.; Tsai, M.C.; Chen, W.Y. Exploring the effects of web-mediated computational thinking on developing students' computing skills in a ubiquitous learning environment. *Interact. Learn. Environ.* **2017**, *25*, 762–777. [[CrossRef](#)]
40. Manuel, P.M.; Pilar, A.M.; Dolores, R.M.M.; Dorado, M.; Sara, P.; Pilar, M.J.M. Characterization of biodiesel using virtual laboratories integrating social networks and web app following a ubiquitous-and blended-learning. *J. Clean. Prod.* **2019**, *215*, 399–409. [[CrossRef](#)]
41. Conrad, C.; Poole, M.S. *Strategic Organizational Communication: In a Global Economy*, 7th ed.; John Wiley & Sons: West Sussex, UK, 2012.
42. Mayntz, R.; Hughes, T. *The Development of Large Technical Systems*; Routledge: New York, NY, USA, 2019.
43. Hwang, G.J.; Lai, C.L.; Liang, J.C.; Chu, H.C.; Tsai, C.C. A long-term experiment to investigate the relationships between high school students' perceptions of mobile learning and peer interaction and higher-order thinking tendencies. *Educ. Technol. Res. Dev.* **2018**, *66*, 75–93. [[CrossRef](#)]
44. Bhattacharjee, A. Understanding information systems continuance: An expectation-confirmation model. *Manag. Inf. Syst. Q.* **2001**, *25*, 351–370. [[CrossRef](#)]
45. Davis, F.D. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *Manag. Inf. Syst. Q.* **1989**, *13*, 319–340. [[CrossRef](#)]
46. Fishbein, M.; Ajzen, I. *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research*; Addison-Wesley: Reading, MA, USA, 1977.
47. Yan, Z. *Encyclopedia of Cyber Behavior*; IGI Global: Hershey, PA, USA, 2012.
48. Torres-Coronas, T. *Social E-Enterprise: Value Creation through ICT: Value Creation through ICT*; Information Science Reference: Hershey, PA, USA, 2012.
49. Chesbrough, H.; Vanhaverbeke, W.; West, J. *Open Innovation: Researching a New Paradigm*; Oxford University Press: Oxford, UK, 2006.
50. Bogers, M.; Zobel, A.K.; Afuah, A.; Almirall, E.; Brunswicker, S.; Dahlander, L.; Frederiksen, L.; Gawer, A.; Gruber, M.; Haefliger, S.J.I.; et al. The open innovation research landscape: Established perspectives and emerging themes across different levels of analysis. *Ind. Innov.* **2017**, *24*, 8–40. [[CrossRef](#)]
51. Bogers, M.; Afuah, A.; Bastian, B. Users as innovators: A review, critique, and future research directions. *J. Manag.* **2010**, *36*, 857–875. [[CrossRef](#)]
52. Piller, F.; West, J. Firms, users, and innovation. *New Front. Open Innov.* **2014**, *29*, 29–49.
53. Fleming, L.; Waguespack, D.M. Brokerage, boundary spanning, and leadership in open innovation communities. *Organ. Sci.* **2007**, *18*, 165–180. [[CrossRef](#)]
54. West, J.; Lakhani, K.R. Getting clear about communities in open innovation. *Ind. Innov.* **2008**, *15*, 223–231. [[CrossRef](#)]
55. Saebi, T.; Foss, N.J. Business models for open innovation: Matching heterogeneous open innovation strategies with business model dimensions. *Eur. Manag. J.* **2015**, *33*, 201–213. [[CrossRef](#)]
56. Han, K.; Oh, W.; Im, K.S.; Chang, R.M.; Oh, H.; Pinsonneault, A. Value cocreation and wealth spillover in open innovation alliances. *Manag. Inf. Syst. Q.* **2012**, *36*, 291–315. [[CrossRef](#)]

57. Kozaris, I.A. Platforms for e-learning. *Anal. Bioanal. Chem.* **2010**, *397*, 893–898. [[CrossRef](#)] [[PubMed](#)]
58. Boggs, S.; Shore, M.; Shore, J. Using e-learning platforms for mastery learning in developmental mathematics courses. *Math. Comp. Edu.* **2004**, *38*, 213.
59. Traylor, R.L.; Heer, D.; Fiez, T.S. Using an integrated platform for learning/spl trade/to reinvent engineering education. *IEEE Trans. Educ.* **2003**, *46*, 409–419. [[CrossRef](#)]
60. Othman, C.N.; Bakar, M.S.N.A.; Muda, M.R.; Farooqui, M.; Muhsain, S.N.F. Development of a One Stop Distance Virtual Learning (DVL) Program for Diploma of Pharmacy Students During Hospital Attachment. In *Envisioning the Future of Online Learning*; Springer: Singapore, 2016; pp. 433–445.
61. Ahn, J.Y.; Edwin, A. An e-learning model for teaching mathematics on an open source learning platform. *Int. Rev. Res. Open Distrib. Learn.* **2018**, *19*, 255–267. [[CrossRef](#)]
62. Matotek, J. Using Moodle in Teaching Mathematics in Croatian Education System. In *Higher Goals in Mathematics Education*; Kolar-Begovic, Z., Kolar-Super, R., Eds.; Element: Zagreb, Croatia, 2015; pp. 130–140.
63. Claudy, M.C.; Garcia, R.; O'Driscoll, A. Consumer resistance to innovation—A behavioral reasoning perspective. *J. Acad. Mark. Sci.* **2015**, *43*, 528–544. [[CrossRef](#)]
64. Shiau, W.L.; Chau, P.Y. Understanding behavioral intention to use a cloud computing classroom: A multiple model comparison approach. *Inf. Manag.* **2016**, *53*, 355–365. [[CrossRef](#)]
65. Zhang, X.; Yu, P.; Yan, J.; Spil, I.T.A. Using diffusion of innovation theory to understand the factors impacting patient acceptance and use of consumer e-health innovations: A case study in a primary care clinic. *BMC Health Serv. Res.* **2015**, *15*, 71. [[CrossRef](#)]
66. Taherdoost, H. A review of technology acceptance and adoption models and theories. *Procedia Manuf.* **2018**, *22*, 960–967. [[CrossRef](#)]
67. Wang, X.; Yuen, K.F.; Wong, Y.D.; Teo, C.C. An innovation diffusion perspective of e-consumers' initial adoption of self-collection service via automated parcel station. *Int. J. Logist. Manag.* **2018**, *29*, 237–260. [[CrossRef](#)]
68. Agarwal, R.; Prasad, J. The role of innovation characteristics and perceived voluntariness in the acceptance of information technologies. *Decis. Sci.* **1997**, *28*, 557–582. [[CrossRef](#)]
69. Davis, F.D.; Bagozzi, R.P.; Warshaw, P.R. User acceptance of computer technology: A comparison of two theoretical models. *Manag. Sci.* **1989**, *35*, 982–1003. [[CrossRef](#)]
70. Agag, G.; El-Masry, A.A. Understanding consumer intention to participate in online travel community and effects on consumer intention to purchase travel online and WOM: An integration of innovation diffusion theory and tam with trust. *Comput. Hum. Behav.* **2016**, *60*, 97–111. [[CrossRef](#)]
71. Scherer, R.; Siddiq, F.; Tondeur, J. The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education. *Comput. Educ.* **2019**, *128*, 13–35. [[CrossRef](#)]
72. Marangunić, N.; Granić, A. Technology acceptance model: A literature review from 1986 to 2013. *Univ. Access Inf. Soc.* **2015**, *14*, 81–95. [[CrossRef](#)]
73. Legris, P.; Ingham, J.; Colletette, P. Why do people use information technology? A critical review of the technology acceptance model. *Inf. Manag.* **2003**, *40*, 191–204. [[CrossRef](#)]
74. King, W.R.; He, J. A meta-analysis of the technology acceptance model. *Inform. Manag.* **2006**, *43*, 740–755. [[CrossRef](#)]
75. Sharp, J.H. Development, extension, and application: A review of the technology acceptance model. *Inf. Syst. Educ. J.* **2006**, *5*, 3–11.
76. Shiau, S.J.H.; Huang, C.Y.; Yang, C.L.; Juang, J.N. A derivation of factors influencing the innovation diffusion of the OpenStreetMap in STEM education. *Sustainability* **2018**, *10*, 1–29. [[CrossRef](#)]
77. Tung, F.C.; Chang, S.C.; Chou, C.M. An extension of trust and TAM model with IDT in the adoption of the electronic logistics information system in his in the medical industry. *Int. J. Med. Inform.* **2008**, *77*, 324–335. [[CrossRef](#)]
78. De Sousa Monteiro, B.; Gomes, A.S.; Neto, F.M.M. Youubi: Open software for ubiquitous learning. *Comput. Hum. Behav.* **2016**, *55*, 1145–1164. [[CrossRef](#)]
79. Shaikh, A.A.; Karjaluoto, H. Mobile banking adoption: A literature review. *Telemat. Inform.* **2015**, *32*, 129–142. [[CrossRef](#)]
80. Park, Y.; Chen, J.V. Acceptance and adoption of the innovative use of smartphone. *Ind. Manag. Data Syst.* **2007**, *107*, 1349–1365. [[CrossRef](#)]

81. Al-Hujran, O.; Al-Debei, M.M.; Chatfield, A.; Migdadi, M. The imperative of influencing citizen attitude toward e-government adoption and use. *Comput. Hum. Behav.* **2015**, *53*, 189–203. [[CrossRef](#)]
82. Nor, K.M.; Pearson, J.M. The influence of trust on internet banking acceptance. *J. Internet Bank. Commer.* **2015**, *12*, 1–10.
83. Abdullah, F.; Ward, R.; Ahmed, E. Investigating the influence of the most commonly used external variables of tam on students' perceived ease of use (PEOU) and perceived usefulness (PU) of e-portfolios. *Comput. Hum. Behav.* **2016**, *63*, 75–90. [[CrossRef](#)]
84. Sánchez-Prieto, J.C.; Olmos-Migueláñez, S.; García-Peñalvo, F.J. MLearning and pre-service teachers: An assessment of the behavioral intention using an expanded TAM model. *Comput. Hum. Behav.* **2017**, *72*, 644–654.
85. Lee, Y.H.; Hsieh, Y.C.; Hsu, C.N. Adding innovation diffusion theory to the technology acceptance model: Supporting employees' intentions to use e-learning systems. *J. Educ. Technol.* **2011**, *14*, 124–137.
86. Chen, J.V.; Yen, D.C.; Chen, K. The acceptance and diffusion of the innovative smart phone use: A case study of a delivery service company in logistics. *Inf. Manag.* **2009**, *46*, 241–248. [[CrossRef](#)]
87. Ali, F.; Rasoolimanesh, S.M.; Sarstedt, M.; Ringle, C.M.; Ryu, K. An assessment of the use of partial least squares structural equation modeling (PLS-SEM) in hospitality research. *Int. J. Contemp. Hosp. Manag.* **2018**, *30*, 514–538. [[CrossRef](#)]
88. Hair, J.F.; Risher, J.J.; Sarstedt, M.; Ringle, C.M. When to use and how to report the results of PLS-SEM. *Eur. Bus. Rev.* **2019**, *31*, 2–24. [[CrossRef](#)]
89. Seluakumaran, K.; Jusof, F.F.; Ismail, R.; Husain, R. Integrating an open-source course management system (Moodle) into the teaching of a first-year medical physiology course: A case study. *Adv. Physiol. Educ.* **2011**, *35*, 369–377. [[CrossRef](#)] [[PubMed](#)]
90. Kock, N.; Hadaya, P. Minimum sample size estimation in PLS-SEM: The inverse square root and gamma-exponential methods. *Inf. Syst. J.* **2018**, *28*, 227–261. [[CrossRef](#)]
91. Faul, F.; Erdfelder, E.; Buchner, A.; Lang, A.G. Statistical power analyses using g* power 3.1: Tests for correlation and regression analyses. *Behav. Res. Methods* **2009**, *41*, 1149–1160. [[CrossRef](#)] [[PubMed](#)]
92. Valls Martínez, M.D.C.; Ramírez-Orellana, A. Patient satisfaction in the Spanish national health service: Partial least squares structural equation modeling. *Int. J. Environ. Res. Public Health* **2019**, *16*, 4886. [[CrossRef](#)] [[PubMed](#)]
93. Kim, H.Y. Statistical notes for clinical researchers: Assessing normal distribution (2) using skewness and kurtosis. *Restor. Dent. Endod.* **2013**, *38*, 52–54. [[CrossRef](#)]
94. Jarvis, C.B.; MacKenzie, S.B.; Podsakoff, P.M. A critical review of construct indicators and measurement model misspecification in marketing and consumer research. *J. Consum. Res.* **2003**, *30*, 199–218. [[CrossRef](#)]
95. Gudergan, S.P.; Ringle, C.M.; Wende, S.; Will, A. Confirmatory tetrad analysis in PLS path modeling. *J. Bus. Res.* **2008**, *61*, 1238–1249. [[CrossRef](#)]
96. Barclay, D.; Higgins, C.; Thompson, R. The partial least squares (PLS) approach to causal modeling: Personal computer adoption and use as an illustration. *Tech. Stud.* **1995**, *2*, 285–309.
97. Bagozzi, R.P.; Yi, Y. On the evaluation of structural equation models. *J. Acad. Mark. Sci.* **1988**, *16*, 74–94. [[CrossRef](#)]
98. Gefen, D.; Straub, D.; Boudreau, M.C. Structural equation modeling and regression: Guidelines for research practice. *Commun. Assoc. Inf. Syst.* **2000**, *4*, 7. [[CrossRef](#)]
99. Ali, Z.; Sun, H. and Ali, M. The impact of managerial and adaptive capabilities to stimulate organizational innovation in SMEs: A complementary PLS-SEM approach. *Sustainability* **2017**, *9*, 2157. [[CrossRef](#)]
100. Chin, W.W. How to Write Up and Report PLS Analyses. In *Handbook of Partial Least Squares*; Esposito, V.V., Chin, W., Eds.; Springer: Berlin/Heidelberg, Germany, 2010; pp. 655–690.
101. Moon, J.W.; Kim, Y.G. Extending the TAM for a world-wide-web context. *Inform. Manag.* **2001**, *38*, 217–230. [[CrossRef](#)]
102. Liu, Y.; Li, H. Mobile internet diffusion in china: An empirical study. *Ind. Manag. Data Syst.* **2010**, *110*, 309–324. [[CrossRef](#)]
103. Chen, J.L. The effects of education compatibility and technological expectancy on e-learning acceptance. *Comput. Educ.* **2011**, *57*, 1501–1511. [[CrossRef](#)]
104. Malek, A.M.; Mat, N.K.N. Modeling the antecedents of internet banking service adoption (IBSA) in Jordan: A structural equation modeling (SEM) approach. *J. Internet Bank. Commer.* **1970**, *16*, 1–15.

105. Shih, T.Y. Key factors of marketing strategies of mobile service innovations. *Int. J. Innov. Learn.* **2014**, *16*, 448–466. [\[CrossRef\]](#)
106. O'Brien, R.M. A caution regarding rules of thumb for variance inflation factors. *Qual. Quant.* **2007**, *41*, 673–690. [\[CrossRef\]](#)
107. Montgomery, D.C.; Peck, E.A.; Vining, G.G. *Introduction to Linear Regression Analysis*, 4th ed.; John Wiley & Sons: Hoboken, NJ, USA, 2012.
108. Hair Jr, J.F.; Sarstedt, M.; Hopkins, L.; Kuppelwieser, V.G. Partial least squares structural equation modeling (PLS-SEM). *Eur. Bus. Rev.* **2014**, *2*, 106–121. [\[CrossRef\]](#)
109. Hu, L.T.; Bentler, P.M. Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification. *Psychol. Methods* **1998**, *3*, 424. [\[CrossRef\]](#)
110. Wu, J.-H. and Wang, Y.-M. Measuring kms success: A respecification of the Delone and Mclean's model. *Inform Manag.* **2006**, *43*, 728–739. [\[CrossRef\]](#)
111. Tao, Z.; Zhang, B.; Lai, I.K.W. Perceived online learning environment and students' learning performance in higher education: Mediating role of student engagement. In Proceedings of the International Conference on Technology in Education, Hong Kong, China, 9–11 January 2018.
112. Gillenson, M.L.; Sherrell, D.L. Enticing online consumers: An extended technology acceptance perspective. *Inf. Manag.* **2002**, *39*, 705–719.
113. Lau, A.S. Strategies to motivate brokers adopting on-line trading in Hong Kong financial market. *Rev. Pacific Basin Financ. Mark. Policies* **2002**, *5*, 471–489. [\[CrossRef\]](#)
114. Taylor, S.; Todd, P. Decomposition and crossover effects in the theory of planned behavior: A study of consumer adoption intentions. *Int. J. Res. Mark.* **1995**, *12*, 137–155. [\[CrossRef\]](#)
115. Moses, P.; Wong, S.L.; Bakar, K.A.; Mahmud, R. Perceived usefulness and perceived ease of use: Antecedents of attitude towards laptop use among science and mathematics teachers in Malaysia. *Asia Pac. Educ. Res.* **2013**, *22*, 293–299. [\[CrossRef\]](#)
116. Nor, K.M.; Pearson, J.M.; Ahmad, A. Adoption of internet banking theory of the diffusion of innovation. *Int. J. Mgt. Stud.* **2010**, *17*, 69–85.
117. Kolodinsky, J.M.; Hogarth, J.M.; Hilgert, M.A. The adoption of electronic banking technologies by us consumers. *J. Mark.* **2004**, *22*, 238–259. [\[CrossRef\]](#)
118. Chen, N.S.; Huang, H.Y.; Shih, Y.C. Factors affecting usage of web-based teachers' training in elementary and high school. In Proceedings of the International Conference on Computers in Education, Auckland, New Zealand, 3–6 December 2002.
119. Taylor, S.; Todd, P. Assessing it usage: The role of prior experience. *Manag. Inf. Syst. Q.* **1995**, *19*, 561–570. [\[CrossRef\]](#)
120. Al-Rahmi, W.M.; Yahaya, N.; Alamri, M.M.; Alyoussef, I.Y.; Al-Rahmi, A.M.; Kamin, Y.B. Integrating innovation diffusion theory with technology acceptance model: Supporting students' attitude towards using a massive open online courses (MOOCs) systems. *Interact. Learn. Environ.* **2019**, *27*, 1–13. [\[CrossRef\]](#)
121. John, S.P. The integration of information technology in higher education: A study of faculty's attitude towards it adoption in the teaching process. *Contad. Adm.* **2015**, *60*, 230–252.
122. Gao, L.; Waechter, K.A. Examining the role of initial trust in user adoption of mobile payment services: An empirical investigation. *Inform. Syst. Front.* **2017**, *19*, 525–548. [\[CrossRef\]](#)
123. Karahanna, E.; Straub, D.W.; Chervany, N.L. Information technology adoption across time: A cross-sectional comparison of pre-adoption and post-adoption beliefs. *Manag. Inf. Syst. Q.* **1999**, *23*, 183–213. [\[CrossRef\]](#)
124. Tan, M.; Teo, T.S. Factors influencing the adoption of internet banking. *J. Assoc. Inf. Syst.* **2000**, *1*, 5. [\[CrossRef\]](#)
125. Plouffe, C.R.; Hulland, J.S.; Vandenbosch, M. Richness versus parsimony in modeling technology adoption decisions—Understanding merchant adoption of a smart card-based payment system. *Inf. Syst. Res.* **2001**, *12*, 208–222. [\[CrossRef\]](#)
126. Lee, Y.C. The role of perceived resources in online learning adoption. *Comput. Educ.* **2008**, *50*, 1423–1438. [\[CrossRef\]](#)
127. Al-Rahmi, W.M.; Yahaya, N.; Aldraiweesh, A.A.; Alamri, M.M.; Aljarboa, N.A.; Alturki, U.; Aljeraiwi, A.A. Integrating technology acceptance model with innovation diffusion theory: An empirical investigation on students' intention to use e-learning systems. *IEEE Access* **2019**, *7*, 26797–26809. [\[CrossRef\]](#)
128. Chau, P.Y.; Hu, P.J.H. Information technology acceptance by individual professionals: A model comparison approach. *Decis. Sci.* **2001**, *32*, 699–719. [\[CrossRef\]](#)

129. Ma, M. A study on factors affecting consumers' attitude towards online shopping and online shopping intention in Bangkok, Thailand. In Proceedings of the 7th International Conference on Innovation and Management, Wuhan, China, 4–5 December 2010.
130. Yaghoubi, N.M.; Bahmani, E. Factors affecting the adoption of online banking: An integration of technology acceptance model and theory of planned behavior. *Int. J. Bus. Manag.* **2010**, *5*, 159–165. [[CrossRef](#)]
131. Bagozzi, R.P. On the concept of intentional social action in consumer behavior. *J. Consum. Res.* **2000**, *27*, 388–396. [[CrossRef](#)]
132. Johnson, D.H. The insignificance of statistical significance testing. *J. Wildl. Manag.* **1999**, *63*, 763–772. [[CrossRef](#)]
133. Ljung, G.M.; Box, G.E. Analysis of variance with autocorrelated observations. *Scand. J. Stat.* **1980**, *7*, 172–180.
134. Anderson, T.B.; Stanley, R.G. Field Trip Road Log: Geology and Tectonics of the Gualala Block. In *Geology and Tectonics of the Gualala Block, Northern California*; Elder, W.P., Ed.; The Pacific Section, SEPM Society for Sedimentary Geology: Los Angeles, CA., USA, 1998; pp. 213–222.
135. Van Ark, B.; Inklaar, R.; McGuckin, R.H. ICT and productivity in Europe and the united states where do the differences come from? *CESifo Econ. Stud.* **2003**, *49*, 295–318. [[CrossRef](#)]
136. Erumban, A.A.; De Jong, S.B. Cross-country differences in ICT adoption: A consequence of culture? *J. World Bus.* **2006**, *41*, 302–314. [[CrossRef](#)]
137. Kaware, S.S.; Sain, S.K. ICT application in education: An overview. *Int. J. Mult. App. Stud.* **2015**, *2*, 25–32.



© 2020 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).