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Determinants of Learning Management Systems Adoption in Nigeria: A Hybrid SEM and Artificial Neural Network Approach

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Abstract

Research has shown that technology, when used prudently, has the potential to improve instruction and learning both in and out of the classroom. Only a handful of African tertiary institutions have fully deployed learning management systems (LMS) and the literature is devoid of research examining the factors that foster the adoption of LMS. To fill this void, the present research investigates the factors contributing to students' acceptance of LMS. Survey data were obtained from registered students in four Nigerian universities (n=1,116); the responses were analyzed using artificial neural network (ANN) and structural equation modeling (SEM) techniques. The results show that social influence, facilitating conditions, system quality, perceived ease of use, and perceived usefulness are important predictors for students' behavioral intention to use LMS. Students' behavioral intention to use LMS also functions as a predictor for actual usage of LMS. Implications for practice and theory are discussed.

Keywords: Technology acceptance model, Nigerian students, learning management systems, higher education, structural equation modeling, artificial neural network.

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INTRODUCTION

The continuous development of Information and Communication Technologies (ICTs) has created new opportunities within the domain of education. ICTs are becoming vital tools in enhancing the quality of learning and teaching (Lin, 2007; Kent, Laslo, & Rafaeli, 2016). As such, there has been an increase in the uptake of eLearning technologies such as learning management systems (LMS) throughout the world in order to create a novel learning strategy and enhance a collaborative and effective learning environment for both students and instructors (Kim and Park, 2017). LMS are web-based applications used to administer courses. They provide the ability to track students' progress and can also serve as content management systems that facilitate access to resources required for courses. Since an LMS is web-based, access to course resources is available for any internet-ready device from anywhere and at any time.

Developing countries are not being left behind as countries such as Indonesia (Kim and Park, 2017), Egypt (Abdel-Wahab, 2008), Jordan (Abbad, Morris and De Nahlik, 2009) and Tanzania (Munguatosha, Muyinda, and Lubega, 2011) have invested significant resources in implementing LMS. The reason for this uptake could be as a result of the benefits of LMS which include enhancing the teaching and learning process (Salloum et al., 2018), providing access to the educational curricula, expanding educational opportunities and reducing the long-term costs of learning (Lwoga, 2014). Other studies have shown that LMS motivate students' interaction with other students and their instructors, and ease communication (Arkorful & Abaidoo, 2015). Additionally, LMS are an effective method of instruction that increases knowledge (Salter, Karia, Sanfilippo, & Clifford, 2014).

In Nigeria, the National Policy on ICT recognizes the importance of ICT in the education sector (NITDA, 2012). Many stakeholders in the Nigeria higher education sector have started to appreciate the effectiveness of integrating technology in teaching and learning (Yakubu, Kah, & Dasuki, 2019). However, just like many developing countries, the uptake of the use of ICTs has been very slow with few universities having incorporated the use of technology, specifically LMS, for teaching and learning (Yakubu et al., 2019). Also, the few institutions that have adopted the use of LMS have opted for proprietary software; this is especially true for public (government-owned) universities. These proprietary systems are designed without taking into consideration, either the pedagogical aspects of eLearning or the student requirements for their learning needs (Eberendu, 2015). This results in the presence of anomalies and a system void of the expected benefits of LMS (Adebayo & Abdulhamid, 2014).

Furthermore, prior research has shown that the implementation and use of LMS in institutions of higher education in developing countries have continued to fail (Eberendu, 2015). Salloum et al. (2018) argue that many students do not persist with learning how to use LMS after the initial experience with using the system. Thus, there is a need to understand the factors that contribute to the students' acceptance of LMS in developing countries after deployment. While there is little existing research investigating this phenomenon in Nigerian universities (Adewole-Odeshi, 2014; Ayodele et al., 2016; Ogunbase, 2014; Olatunbosun et al., 2015), none of these studies has taken into account certain significant and influential factors in the context of eLearning, such as instructor quality, learning value and course quality. Research has shown that these factors contribute to the student's acceptance of eLearning systems (Cheng, 2012; Lwoga, 2014; Ain et al., 2016). The main aim of this study is to identify the factors that facilitate Nigerian students acceptance of learning management systems, based on a conceptual model developed by the authors. The model adopts constructs drawn from renowned technology acceptance theories as well as prior research on the acceptance of eLearning systems.

This study contributes to the literature by identifying the key factors that influence the acceptance of LMS by Nigerian students in tertiary institutions. Practically, findings of the study will guide LMS developers to develop systems that are beneficial to the students and instructors. This research is structured as follows:

1. The literature review section presents a background to the research and reviews previous studies that use established theories to examine the factors that influence LMS acceptance by students.

2. Section 3 discusses the research model, constructs, and hypotheses to be tested by this study.
3. Section 4 presents the methods and materials used to direct the study.
4. Section 5 presents the results of the data analysis.
5. Section 6 provides the discussion, research implications, and limitations of the study.
6. The study concludes with section 7 where the key findings are summarized.

LITERATURE REVIEW

There is a wide range of literature examining the acceptance of e-learning systems such as LMS. Several theories have been postulated to explain why users accept or adopt technology. Theories such as the technology acceptance theory (TAM) (Davis, 1989), unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003), and the DeLone and McLean IS success model (DeLone and McLean, 2003) are the most frequently used theories in explaining the acceptance of technology by users especially in the domain of eLearning systems use.

Technology acceptance model (TAM), by Davis (1989), is one of the most popular models used to explain and predict user acceptance of technology by examining individuals' attitudes and perceptions of technologies. In the context of eLearning, several studies have used the TAM model to investigate the acceptance of eLearning systems, such as (Mohammadi, 2015; Tarhini et al., 2017, Al-Azawei, Parslow, & Lundqvist, 2017; Ibrahim et al., 2017; Rabaa'i, 2016). Another popular model used to explain the acceptance of technology, due to the limitations of TAM in explaining an individuals acceptance of technology, is the unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003). With regards to eLearning applications, UTAUT has also been used extensively in the investigation of students acceptance of eLearning systems (Alshehri et al., 2019; Ain et al., 2016, Salloum & Shaalan, 2018; Yakubu & Dasuki, 2018; Raman, Don, Khalid, & Rizuan, 2014). While the UTAUT model has been empirically validated in various contexts, the model was extended to explain consumers' acceptance and use of technology.

In the extended UTAUT model (Venkatesh et al., 2012), three constructs namely hedonic motivation, habit, and price value were added to the original UTAUT model (Venkatesh et al., 2003) in order to further explain the adoption of technology by individuals. Ain et al. (2016) used the extended UTAUT model to explain students' acceptance of an LMS by replacing the price value construct. Learning value replaced the price value construct because a monetary value could not be attributed to the use of LMS by students. Instead, the value obtained by students includes the time and effort invested in using the LMS.

The DeLone and McLean information systems success model is another frequently used model that attempts to evaluate the success of information systems via different perspectives. Similar to the UTAUT and TAM models, the DeLone and McLean information systems success model has also been applied to the domain eLearning (Lwoga, 2014; Cheng, 2012; Wang et al., 2007; Lin, 2007). Some scholars have further modified the information quality construct in the DeLone and McLean model to course quality in order to explain the influence of quality of the course design and content on the acceptance of LMS (Choi et al., 2007; Lee et al., 2009; Liu et al., 2010). Another quality factor that has been added to both TAM and the DeLone and McLean IS success model is the instructor quality. Several scholars have postulated that the quality of the instructor plays a significant role in influencing the students' acceptance of an eLearning system (Lee et al., 2009; Cheng, 2012; Lwoga, 2014).

Within the context of developing countries, understanding the acceptance of e-learning technologies has been recognized to be complex and critical (Kim and Park, 2017). Factors such as system quality, social influence, performance expectancy, effort expectancy, facilitating conditions, perceived ease of use, perceived usefulness, instructor quality, information quality, and learning value have constrained the widespread adoption and acceptance of LMS (Ain, Kaur, & Waheed, 2016; Ayodele, Oga, Bundot, & Ogbari, 2016; Fathema , Shannon, & Ross, 2015; Yakubu & Dasuki, 2018; Yakubu, Kah, & Dasuki, 2019; Tarhini, Hone, & Liu, 2013; Lwoga, 2014). In the sub-Saharan African context and Nigeria, where this study situates itself, there have been few studies that have examined the acceptance of LMS. In the Nigerian context, some of these studies have adopted the TAM model to highlight the influence of perceived ease of use and perceived usefulness on students' behavioral intention to use LMS (Adewole-Odeshi, 2014; Ogunbase, 2014; Ayodele et al., 2016). Others have adopted the UTAUT to illustrate the influence of technology culturation, power, self-efficacy, and anxiety on students' acceptance of LMS (Nicholas-Omoregbe et al., 2017; Olatubosun et al., 2015).

Table 1 outlines a few studies that investigate students' acceptance of eLearning systems in developing countries by adapting the research models described above.

To the best of our knowledge, none of the eLearning acceptance studies within the Nigerian context have examined the effect of instructor quality, learning value, and course quality on the acceptance of LMS in Nigeria. Hence, this study aims at addressing this gap by proposing a model that captures these significant constructs that have been shown to contribute to the acceptance of LMS by students.

Study	Constructs	Context	Sample size	Techniques	Findings
Salloum et al. (2018)	Innovativeness, knowledge sharing, quality, and trust	UAE	251	Structural Equation Modelling	Knowledge sharing and quality in universities was shown to have a positive influence on eLearning acceptance among the students while innovativeness and trust did not.
Mohammadi (2015)	Educational quality, service quality, technical system quality, perceived ease of use,perceived usefulness and content/ information quality	Iran	390	Structural Equation Modelling	Service quality, technical system quality, perceived usefulness, and content/information quality were all found to influence the acceptance of the eLearning system while there was no support for educational quality and perceived ease of use.
Tarhini et al., (2017)	Subjective norms and quality of work-life, perceived usefulness, and perceived ease of use	Lebanon	569	Structural Equation Modelling	Subjective norms and quality of work-life, perceived usefulness, and perceived ease of use all had a positive influence on eLearning acceptance.
Al-Azawei, Parslow, & Lundqvist, (2017)	Perceived usefulness, perceived ease of use, self-efficacy, perceived satisfaction, and learning styles	Iraq	210	Structural Equation Modelling	Perceived usefulness, perceived ease of use, self-efficacy, and perceived satisfaction all had a positive influence on eLearning acceptance. There was no support for learning style.
Ibrahim et al., (2017)	Instructor characteristics, computer self-efficacy, course design, perceived usefulness, perceived ease of use	Malaysia	95	Structural Equation Modelling	Computer self-efficacy and perceived ease of use were determinants of intention to use eLearning while instructor characteristics, course design, and perceived usefulness were found not to influence eLearning use.

Rabaa'i, (2016)	Perceived credibility, satisfaction, subjective norm, self-efficacy, perceived ease of use, perceived usefulness and attitude	Kuwait	515	Structural Equation Modelling	Perceived credibility, satisfaction, subjective norm, self-efficacy, perceived ease of use, perceived usefulness, and attitude positively influenced the students' intention to use Moodle LMS.
Lowga (2014)	Information quality, system quality, service quality, instructor quality, perceived usefulness, and user satisfaction	Tanzania		Structural Equation Modelling	Information quality, system quality, and instructor quality were observed to be predictors of perceived usefulness. Perceived usefulness was observed to be a predictor of user satisfaction but not continued usage of the LMS, while user satisfaction was found to influence continued usage.
Ain et al. (2016	Performance expectancy, effort expectancy, social influence, facilitating conditions, habit, hedonic motivation, and learning value	Malaysia	349	Structural Equation Modelling	Performance expectancy, social influence, and learning value had a positive and significant effect on students' intention towards LMS, while facilitating conditions and behavioral intention were determinants of the LMS use. Effort expectancy, hedonic motivation, and habit were observed not to influence the student's acceptance of an LMS.
Yakubu and Dasuki (2018)	Performance expectancy, effort expectancy, social influence, and facilitating conditions	Nigeria	286	Structural Equation Modelling	Performance expectancy, effort expectancy, and facilitating conditions were observed to influence the students use of the LMS while there was no support for social influence.
Yakubu and Dasuki (2018)	Information quality, system quality, service quality, user satisfaction	Nigeria	366	Structural Equation Modelling	System quality and information quality were found to influence the students' intention to use the LMS

					while there was no support for service quality or user satisfaction.

RESEARCH MODEL AND HYPOTHESES

TAM and UTAUT (including the extended UTAUT) are among the popular theories used to investigate the propensity of technology acceptance among students. In the context of mobile/online banking, the theories overlooked critical factors such as "trust" and "security" (Aboelmaged and Gebba, 2013; Aderonke, 2010; Alalwan et al., 2015; Alsajjan and Dennis, 2006). In the context of LMS, the present paper strives to bridge a similar gap by incorporating constructs also overlooked in prevoious studies such as learning value (Ain et al., 2016), instructor quality (Cheng, 2012; Lwoga, 2014), and course quality (Cheng, 2012). The conceptual model is shown below in Figure 1.

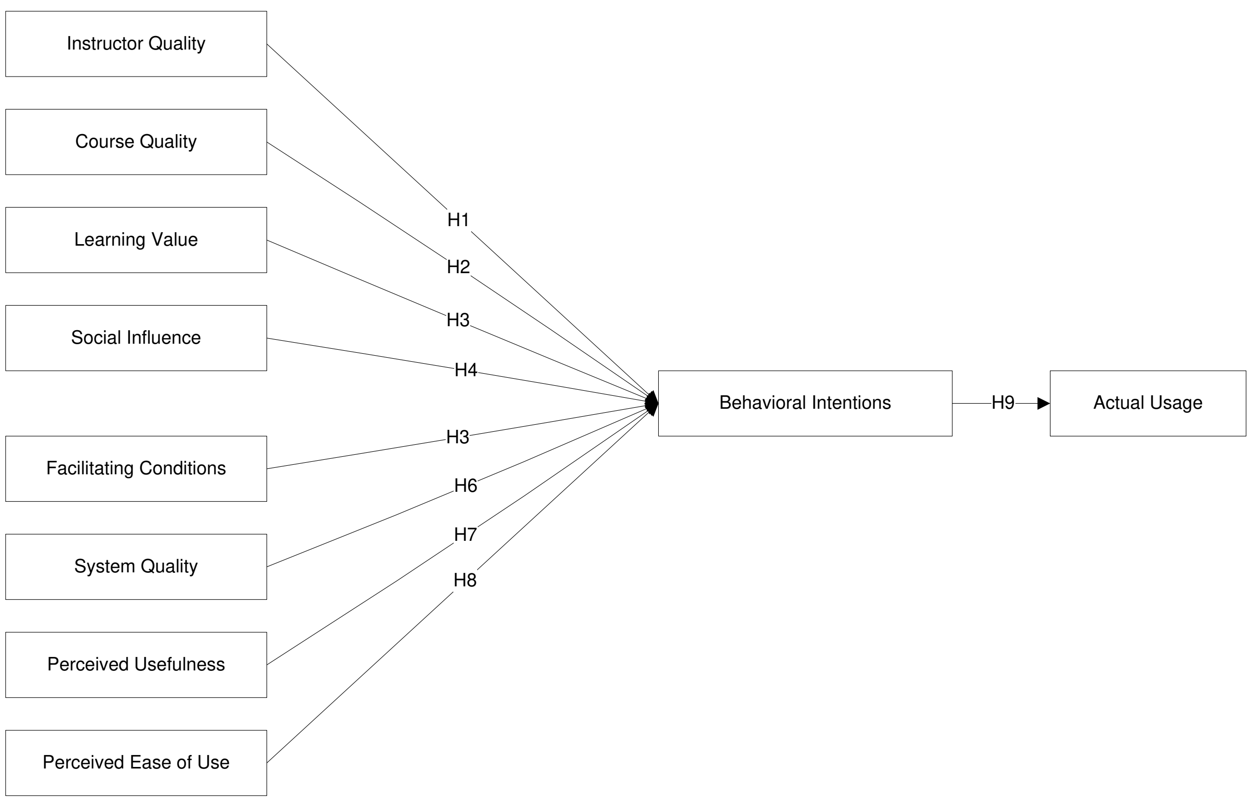

Fig. 1. Research Model

Instructor Quality (IQ)

According to Ozkan and Koseler (2009), the quality of the instructor dictates the learners' attitudes towards an elearning system; this statement is supported by Cheng who states that the instructor *"is the key person that is important to learners' behaviors in the e-learning process"* (Cheng, 2012, p. 369). Prior research has shown that learners' acceptance of eLearning is influenced by the instructors' attitude (Cheng, 2012; Lwoga, 2014; Ozkan & Koseler, 2009). The instructor's attitude towards the eLearning system is made up of the *"instructor's response timeliness, teaching style, and explanation/help towards learners via the eLearning system"* (Cheng, 2012, p. 369). This means that if an instructor can respond to students promptly and is adept at using the eLearning system to aid students to learn, then the students will be more inclined to accept the eLearning system. All 4 universities participating in this study have a considerable amount of experience in the use of LMS for teaching and learning, and as a result, we expect that the instructors will be skilled in using the LMS to teach and also, they will help the students learn how to use the LMS. Thus, the following proposition is derived:

- *H1: The influence of instructor quality on behavioral intention to use the LMS will be positive and significant.*

Course Quality (CQ)

An important measure of the quality of an information system is the output or information that can be obtained from the system in the form of reports (DeLone and McLean, 1992; 2003). The quality of information obtained from an IS system is measured based on *"dimensions such as accuracy, completeness, currency, efficiency, relevance, scope, and timeliness of information"* (Cheng, 2012, p. 365). In the context of eLearning, several authors (Lee et al., 2009; Liu et al., 2010; Cheng, 2012) all agree that these dimensions (accuracy, completeness, currency, efficiency, relevance, scope, and timeliness of information), can also be used to measure the quality of a course, i.e., the content and design of a course. The content of a course includes the relevance, resource quality and how recent the resources are, while the design of the course ensures that the learners' needs are met at different levels and facilitates access to the learning resources. If the course content and design meet the learners' expectations, it is assumed that the learners are more likely to use the eLearning system. Once more, based on the experience in the use of LMS for instruction by the universities in this study, it is expected that the course quality would have been improved upon significantly over time so as to meet the learning needs of the students. Thus this study hypothesizes that:

- *H2: The influence of the course quality on behavioral intention to use the LMS will be positive and significant.*

Learning Value (LV)

We adopt the definition of learning value from Ain et al., (2016), which states that learning value is *"the students' positive perceptions about learning from the LMS influencing their intention to devote more time and effort to explore and obtain the required knowledge from the LMS"* (Ain et al., 2016, p. 6). We also adopted the relationship between LV and the students' behavioral intention to use the LMS as it was observed that learning value has a positive and significant influence on the students' behavioral intention to use the LMS (Ain et al., 2016). Thus we propose that:

- *H3: The influence of learning value on behavioral intention to use the LMS will be positive and significant.*

Social Influence (SI)

Social influence is derived from the UTAUT framework and *"is defined as the degree to which an individual perceives that important others believe he or she should use the new system"* (Venkatesh et al., 2003, p. 451). SI is similar to the social norm construct derived from the TAM model. In the context of eLearning systems, such as an LMS, SI measures the influence of people considered to be important to the students on the students' behavioral intention to use the LMS. The important people include the students' classmates, instructors, and school administration. It is assumed that if the students are encouraged to use the LMS by their classmates, teachers, and the university administration, then they will be more likely to use the LMS. This study adopts the relationship between SI and behavioral intention from the UTAUT model as well as prior research (Raman et al., 2014; Ain et al., 2016). Therefore we propose that:

- *H4: The influence of social influence on behavioral intention to use the LMS will be positive and significant.*

Facilitating Conditions (FC)

Facilitating conditions are an individual's collective perception that the organizational and technological resources required to use a particular technology are available (Venkatesh et al., 2003). Students using the LMS require infrastructures such as internet availability, access to devices, and technical support in using the system. If this infrastructure is not available, then the students will be less inclined to use the LMS. We adopt the relationship between FC and behavioral intention from the UTAUT model which has been corroborated by prior research (Jong, 2009; Raman et al., 2014), where it was observed that FC significantly influences students' behavioral intention to use LMS. Therefore we propose that:

- *H5: The influence of facilitating conditions on behavioral intention to use the LMS will be positive and significant.*

System Quality (SQ)

System quality was derived from the DeLone, and McLean IS success model (DeLone & McLean, 1992; DeLone & McLean, 2003). According to Jalote (2008), the quality of software (in this case, the LMS) can be measured by the following factors: usability, functionality, portability, reliability, maintainability, and efficiency. With regards to eLearning systems, the system quality construct measures the quality of the LMS, such as ease of use, functionality, reliability, and efficiency. Prior studies on the acceptance of eLearning systems have shown that system quality has a causal effect on behavioral intention to use an eLearning system (Ramayaha et al., 2010; Mohammadi, 2015). Therefore, if the LMS is easy to use, reliable, functional, and efficient, then the students are more likely to be encouraged to use the system. On this premise, we pose the following proposition:

- *H6: The influence of system quality on behavioral intention to use the LMS will be positive and significant.*

Perceived Usefulness (PU)

According to Davis (1989), perceived usefulness is defined as the *"degree to which a person believes that using a particular system would enhance his/her job performance"* (Davis, 1989, p. 320). PU is derived from TAM and is similar to the performance expectancy construct in the UTAUT framework. In the context of LMS, it is the degree to which students believe that if they use the LMS, then their learning performance will be enhanced, hence resulting in better grades (Wang et al., 2009). In the context of LMS, prior studies have shown that PU positively and significantly influences students' behavioral intention to use LMS (Lee et al., 2009; Venter et al., 2012; Cheng, 2012). Students will be more inclined to accept and use the LMS if they believe that the LMS will aid in achieving their academic aspirations. In this study, we believe that PU will significantly influence the students' behavioral intention to use the LMS as the students will find the LMS useful to their studies. Therefore, we propose that:

- *H7: The influence of perceived usefulness on behavioral intention to use the LMS will be positive and significant.*

Perceived Ease of Use (PEOU)

Similar to PU, PEOU is also derived from TAM and is defined as *" the degree to which a person believes that using a particular system would be free of physical and mental effort"* (Davis, 1989, p. 320). In the context of eLearning systems such as LMS, PEOU is the degree to which a student believes that the eLearning system will require minimal effort to learn how to use. The system should be intuitive and should not require specialized training before using the system. Cheng (2012) observed that PEOU has a positive and significant influence on behavioral intentions. Thus, this study hypothesizes that:

- *H8: The influence of perceived ease of use on behavioral intention to use LMS will be positive and significant.*

Behavioral Intentions (BI)

Behavioral intention is an individuals' intention to use specific technology for several undertakings. In the context of this study, BI captures students' behavioral intention to use the LMS to perform their learning activities. We propose that once the intention to use the LMS is formed, it would translate to the actual usage of the system. The relationship between BI and actual usage has been established in the following theories: UTAUT (Venkatesh, Davis, & Davis, 2003), TAM (Davis, 1989), the theory of reasoned action (TRA) (Ajzen and Fishbein, 1980) and the theory of planned behavior (TPB) (Ajzen, 1991). Studies based on these theories and in the context of eLearning systems have also supported this significant relationship (Tarhini et al., 2013). Therefore, this study proposes that:

- *H9: The influence of behavioral intention on actual usage to use the LMS will be positive and significant.*

MATERIAL AND METHODS

Participants were drawn from two public and two private-owned universities in the Northern part of Nigeria by using a convenience sampling technique. This sampling approach has the capacity to facilitate data collection in a short duration of time and is the cheapest to implement. In collecting the data required for this study, two methods were used to administer the questionnaires. In the case of the public universities a paper based survey was distributed to the students because the universities do not have a mailing list of their students. Access to the LMS is via a portal where the students log into the portal with a user ID and password. All communication is done while the students are logged into the portal. The distribution of the questionnaires was done by selected administrative staff of the universities who were trained in administering the surveys by the researcher. The training was done in order to meet the regulations stipulated by the research ethics board. The staff were informed of the purpose of the research, and they also ensured that the respondents read and kept a copy of the consent form. Collection of the completed questionnaires was via a ballot styled box to ensure anonymity. A total of 1,000 questionnaires were distributed, and 738 usable responses were received.

An online survey was designed exactly like the paper-based version using the Survey Monkey online tool, and a link to the survey was emailed to the students of the two private universities via the student's affairs office and the student government associations. The questionnaire was configured using the online tool to ensure confidentiality by ensuring that the emails and IP addresses of the responses were not captured. A total of 378 usable responses were received from the online questionnaire. Both sets of questionnaires were structured into three sections. Section 1, the consent form, introduced the study to the respondents stating the purpose of the study and stating what is required of the respondents. It also mentioned the risks and benefits associated with participating in the study. The respondents were informed that participation was voluntary and that the responses would be confidential. Finally, the researcher's contact details were listed in the event the respondents needed further clarification or had questions about the study.

The second section of the questionnaire was used to capture demographic data about the respondents. The demographic data captured included the respondent's age, their level of education (i.e., undergraduate or postgraduate), the length of time they have used the LMS and whether they were trained in using the LMS. Section 3 of the questionnaire employed a 5-point Likert scale to capture the students' perceptions of the ten constructs (See the Appendix section) used in the conceptual model. The scale ranged from 1 (strongly agree) to 5 (strongly disagree). Table 1 below shows the measurement items used in the questionnaire. A total of 1116 responses were gathered from both sets of questionnaires.

Table 1: Demographic information of the respondents (n=1,116)

Demographic Characteristic		Frequency	Percent
Age	Under 25	459	41.1%
	Over 25	657	58.9%
Gender	Male	712	63.8%
	Female	404	36.2%
Level of Study	Undergraduate	630	56.5%
	Postgraduate	486	43.5%
Length of Usage	Less than one year	571	51.2%
	Over one year	545	48.8%
Training	Yes	373	33.4%
	No	743	66.6%

DATA ANALYSIS AND RESULTS

Structural equation modeling versus artificial intelligence technique

According to Henseler et al. (2009), statistical choices should be made based on 3 criteria. One, for theory or hypotheses testing, covariance-based structural equation modeling (CB-SEM) is a better option as it can measure the goodness-of-fit of the data with the model based on parametric statistical calculation. Two, for theory building or exploration with a relatively weak theoretical foundation, partial least square structural equation modeling (PLS-SEM) is a better option. Three, for relational prediction artificial intelligence technique (ANN) would be the better approach. Figure 2 depicts the overlap between the statistical methods. Based on the study's aim, PLS-SEM and ANN seem to be better options.

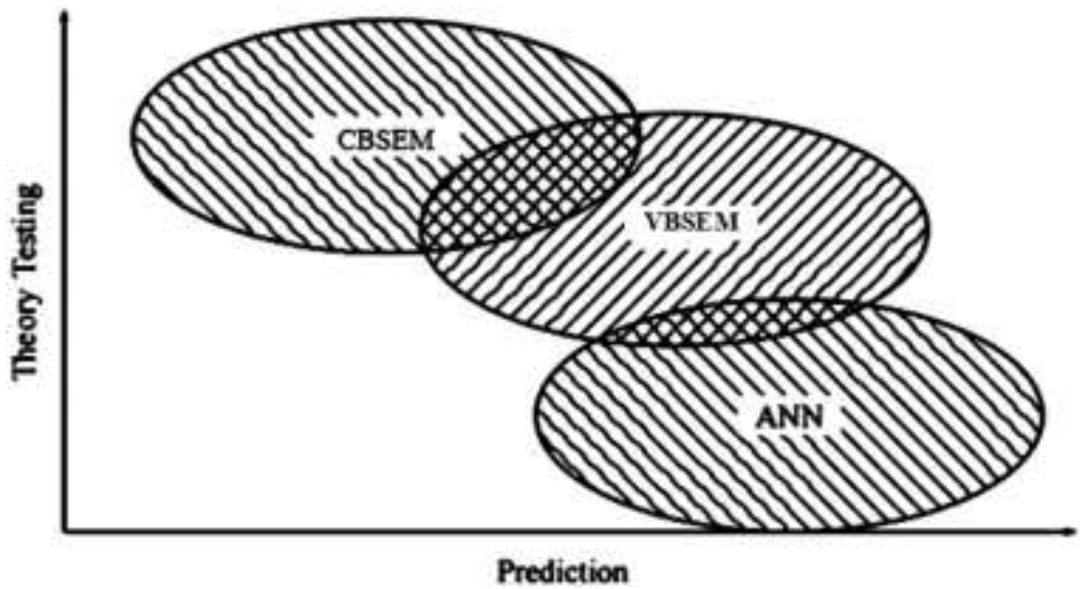

Figure 2: CB-SEM, PLS-SEM, and ANN (Henseler et al., 2009).

PLS-SEM analysis

SmartPLS (Version 3) software was utilized for data analysis, more specifically, PLS-SEM technique. The measurement model was run and the coefficients of retained items' outer loadings, construct reliability, convergent and divergent validity were assessed. Scale items with low factor loadings were discarded. The retained items' outer loadings exceeded the threshold >.50 (See figure 3) and are statistically significant (see figure 4). The constructs' Cronbach's alpha and composite reliability (CRs) exceeded the threshold value of 0.7; and the average variance extracted (AVE) exceeded the threshold value of 0.5 (Hair et al., 2010). Fornell and Larcker (1981) asserted that validity can still be inferred if the CR is above .70 even if the AVE value is below the 0.5 threshold as seen for the learning value construct. Drawing on this evidence, we concluded that scale reliability and convergent validity for the constructs had been established. As for discriminant validity, the Heterotrait-monotrait (HTMT) ratio and the Fornell–Larcker criterion was assessed; the HTMT ratio of correlation was acceptable below 1 (Henseler et al., 2015) and AVEs were higher than the squared inter-construct correlations (Fornell and Larcker, 1981). See Table 2.

Table 2: Reliability, convergent and divergent validity

Instruments		1	2	3	4	5	6	7	8	9	10	α	CR	AVE	R^2
1.	Instructor Quality	***.82***	.26	-.03	.08	.04	-.03	.09	.16	.08	.07	.87	.91	.67	-
2.	Course Quality	.35	***.86***	.01	.05	.09	-.09	-.21	-.07	-.05	.02	.89	.92	.73	-
3.	Learning Value	.64	.37	***.69***	.08	.40	.06	.02	.09	.09	.05	.60	.72	.48	-
4.	Social Influence	.09	.06	.13	***.86***	.06	.35	-.02	.42	.40	.12	.88	.92	.74	-
5.	Facilitating Conditions	.07	.10	.46	.07	***.85***	-.01	.05	.01	.14	.20	.87	.91	.72	-
6.	System Quality	.06	.12	.08	.41	.05	***.82***	.11	.20	.12	.01	.84	.89	.68	-
7.	Perceived Usefulness	.12	.24	.08	.06	.06	.13	***.81***	.15	.18	.09	.83	.88	.66	-
8.	Perceived Ease of Use	.20	.17	.23	.51	.04	.24	.18	***.77***	.48	.11	.77	.85	.59	-
9.	Behavioral Intentions	.09	.05	.09	.44	.15	.14	.21	.57	***.85***	.19	.87	.91	.73	***.31***
10.	Actual Usage	.09	.05	.17	.14	.24	.03	.11	.14	.22	***.92***	.83	.92	.85	***.04***

Note: α, Cronbach's alpha ≥ .70; CR, composite reliability ≥ .70; AVE, average variance extracted ≥ .50;

Heterotrait-monotrait (HTMT) ratios are below the diagonal; Values above the diagonal in bold are squared inter-construct correlations for the Fornell–Larcker criterion

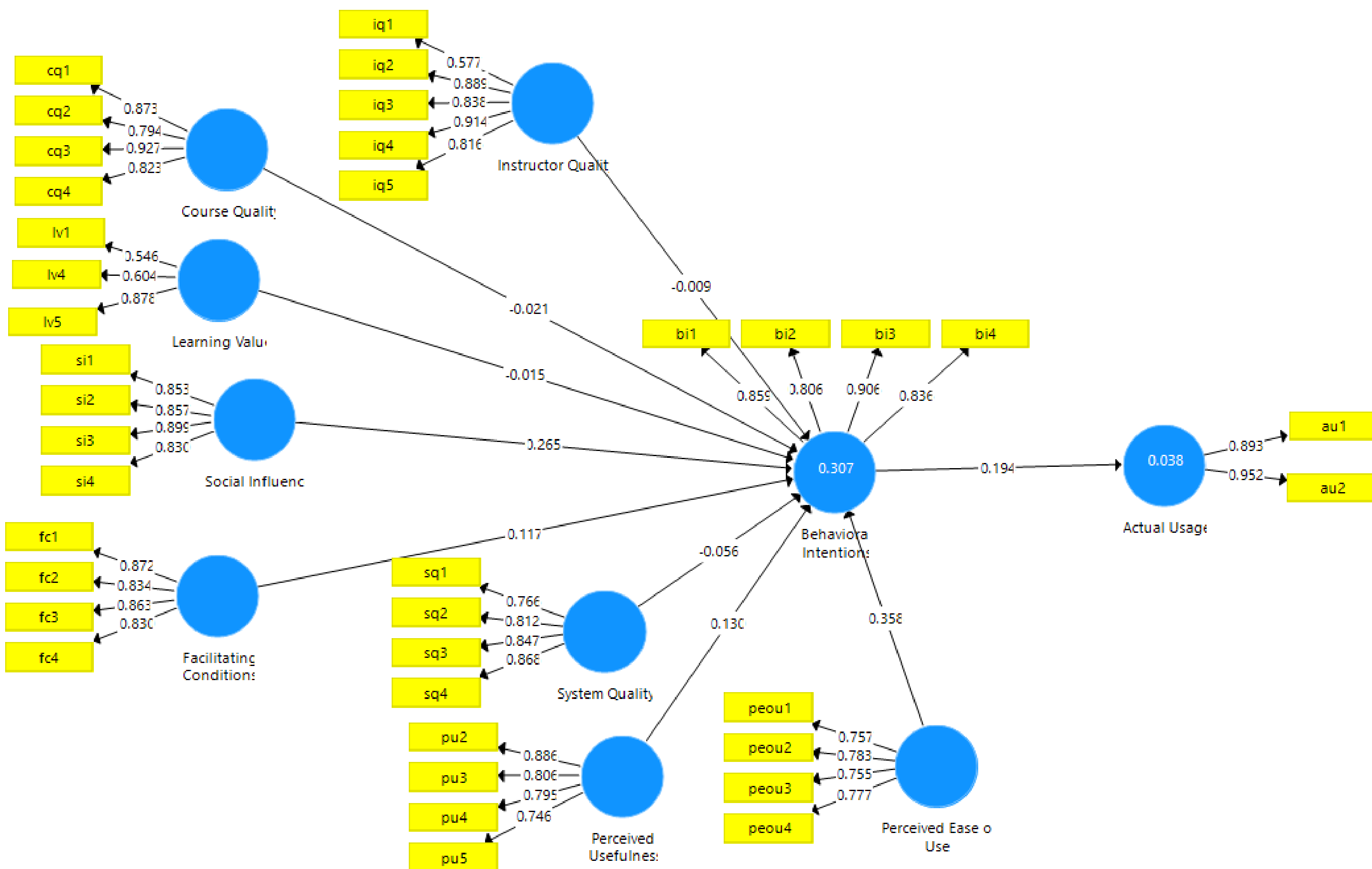

Figure 3: Model with factor loadings, beta coefficients, and R2 values

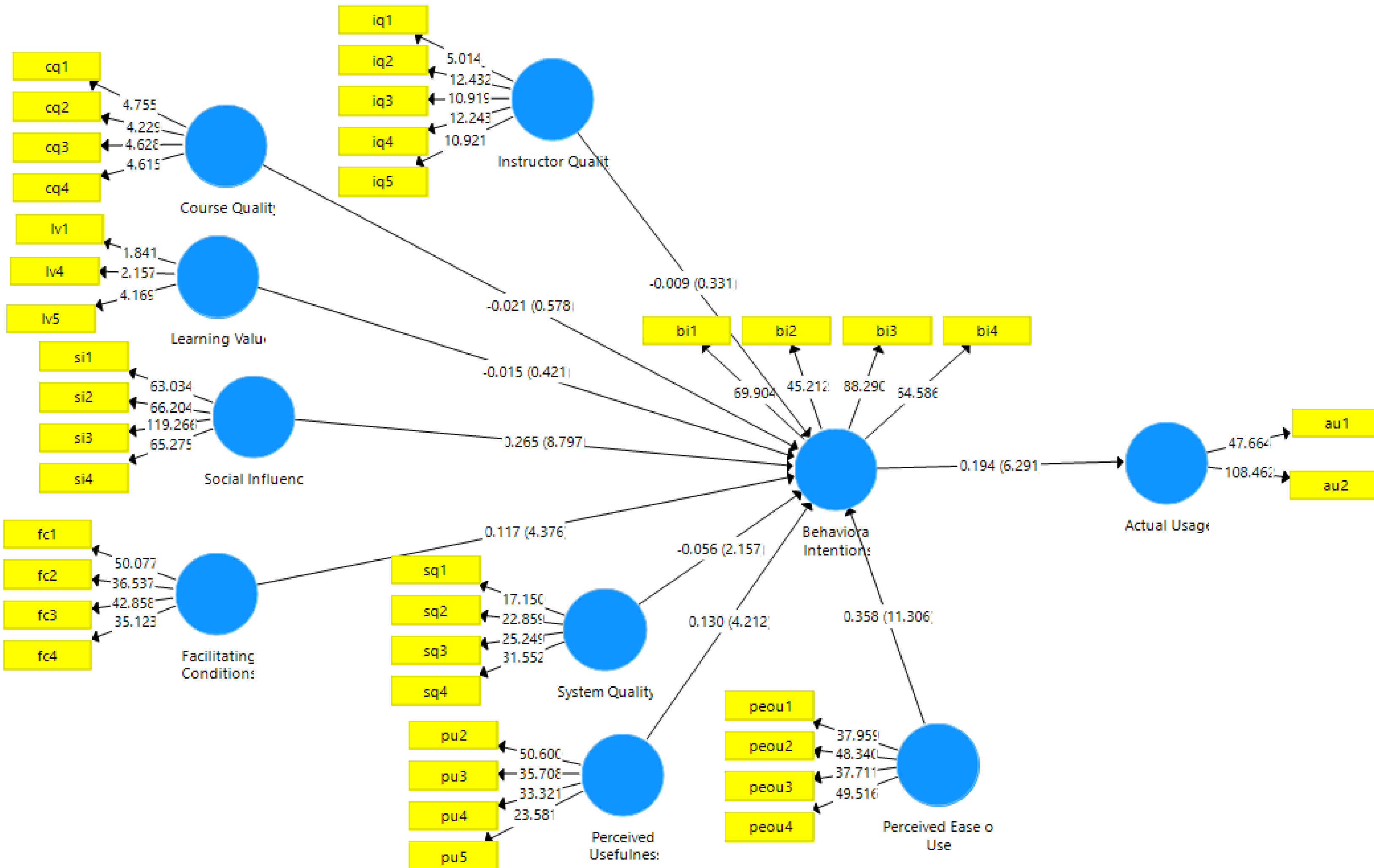

Figure 4: Model with t-values and beta coefficients

Results from PLS-SEM analysis revealed that instructor quality, course quality and learning value did not exert significant impacts on behavioral intentions respectively (β = -.009, ρ = .741), (β = -.021, ρ = .564), (β = -.015, ρ = .674). Thus, H1, H2 and H3 did not receive empirical support. Social influence and facilitating conditions exerted significant impacts on behavioral intentions respectively (β = .265, ρ = .000), (β = .117, ρ = .000), which lend empirical support to **H4** and **H5**. Contrary to the initial prediction, system quality exerted a significant negative impact on behavioral intentions (β = -.056, ρ = .031). Thus, H6 did not receive empirical support. Perceived usefulness and perceived ease of use exerted significant impact on behavioral intentions (β = .130, ρ = .000), (β = .358, ρ = .000). Finally, behavioral intentions exerted a significant impact on actual usage (β = .194, ρ = .000). Thus, **H7, H8** and **H9** gained empirical support. See Figures 3 and 4 for further details.

Predictive analytics with ANN

PLS-SEM highlighted important links and significant associations between the variables. The associations between instructor quality, course quality, learning value, and behavioral intention were ignored due to lack of significance. Artificial neural networks (ANN) are information processing systems that are comprised of information processing units (also known as ""cells," "neurons""). These units are divided into three layers, namely: the input layer that accepts input data, the hidden layer where data are processed, and the output layer for outcome generation. ANN has the capability to model complex interactions in comparison to traditional methods such as regression, CB-SEM and PLS-SEM (Hew et al., 2017), by detecting non-linear relationships that are hidden in case data, and can further apply these relationships to a new dataset (Abubakar, 2019; de la Paz-Marín et al., 2012).

ANN is lenient in nature with no mandate for factor loadings, normality assumptions, linearity, homoscedasticity, and sample size (Abubakar, 2018; de la Paz-Marín et al., 2012). ANN are characterized by high predictive accuracy and validity (Abubakar et al., 2017). They display fast learning and accurate predictions, and can acquire new learning and store this memory (Abubakar et al., 2019). They have high fault tolerance, can accommodate samples with variations (Li et al., 2015), and are robust against noisy or missing data (Abubakar, 2019; Göçken et al., 2016). These attractive features of ANN largely insulate the method from traditional statistical flaws and myths. A (3:2 hidden nodes) Multi-Layer Perceptron ANN model based on Resilient Backpropagation with Weight Backtracking algorithm was developed using the neuralnet package in R studio. Logistic function was used as the activation function for both the hidden and the output layer, while Sum Squared Errors (SSE) was used as the differentiable error function.

The algorithm can minimize error until the ANN learns through the learning process. During the training process, random synaptic weights were assigned to the connections, and the aim is to adjust them to obtain the minimal error. 75% of the data was used for taining, and 25% for testing. The synaptic weights of the input nodes on the hidden and output nodes are shown in Figure 5 and 6.

First, the impact of social influence, facilitating conditions, system quality, perceived ease of use and perceived usefulness on behavioral intention was modeled (See figure 5). The Mean Square Error (MSE) for linear modeling is .27, and for cross-validation is .29, while the value for the neural network model seems better at .05. The training process needed 3,484 steps until all absolute partial derivatives of the error function were smaller than 0.010.

Subsequently, the impact of behavioral intention on actual usage was modelled (See figure 6). The MSE for linear modeling is .35, and cross-validation is .39, while the value for the neural network model seems better at .04. The training process needed 58 steps until all absolute partial derivatives of the error function were smaller than 0.010.

Alice (2015) and Abubakar (2019) suggested that the distribution of the generalized weights is easy and useful in interpreting the nature of the effects. Figure 7 presents the distribution of the generalized weights. The estimated weights show that the predictor variables exerted non-linear effects on the response variables. The present outcome did not only provide support for PLS-SEM findings regarding the influence of social influence, facilitating conditions, perceived ease of use and perceived usefulness on behavioral intention, but also contradicts the findings in PLS-SEM which shows that system quality has a negative influence on behavioral intention. ANN shows that system quality can have both negative and positive impact on behavioral intention. Finally, the influence of behavioral intention on actual usage of LMS was confirmed.

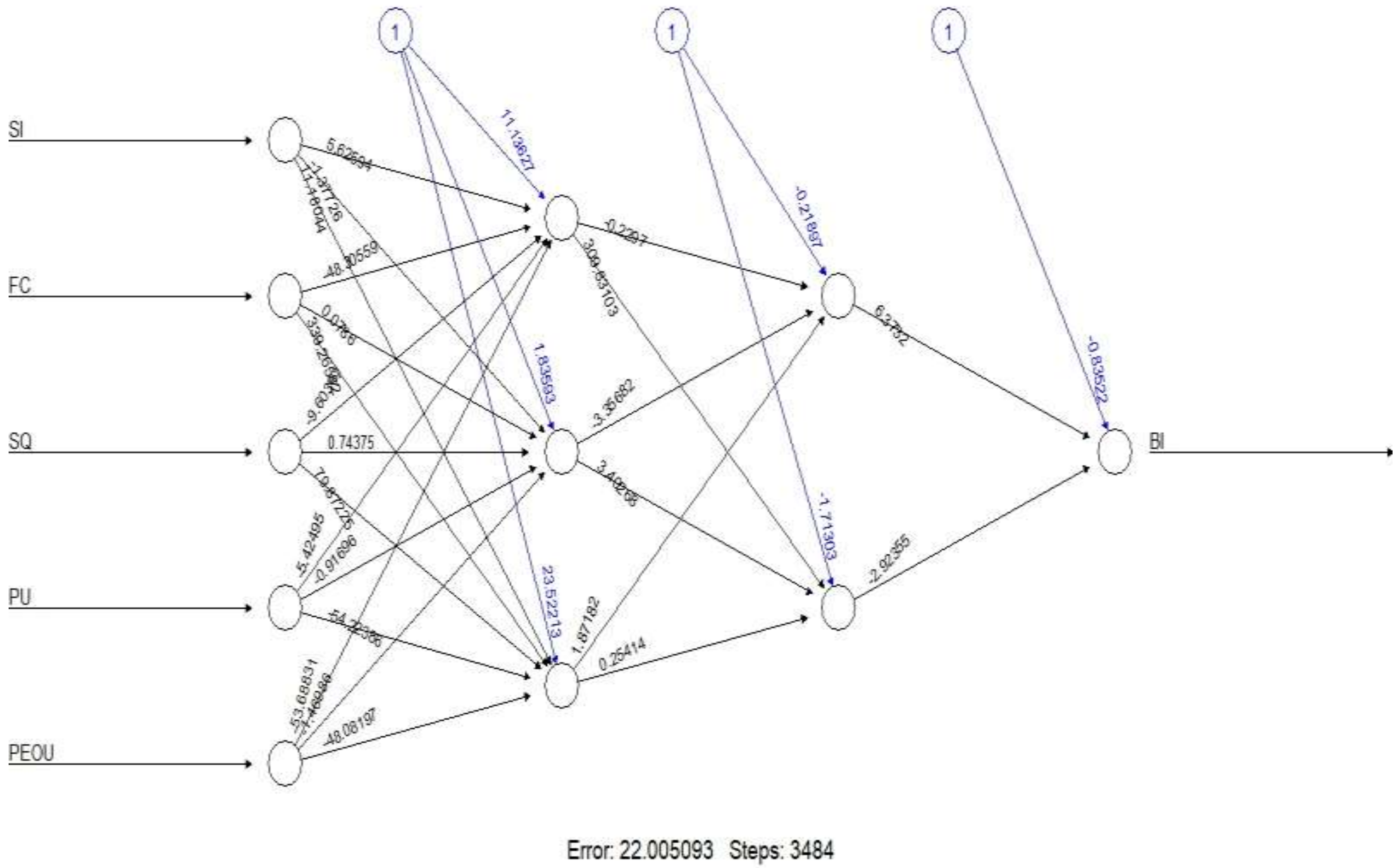

Figure 5: Neural network model 1

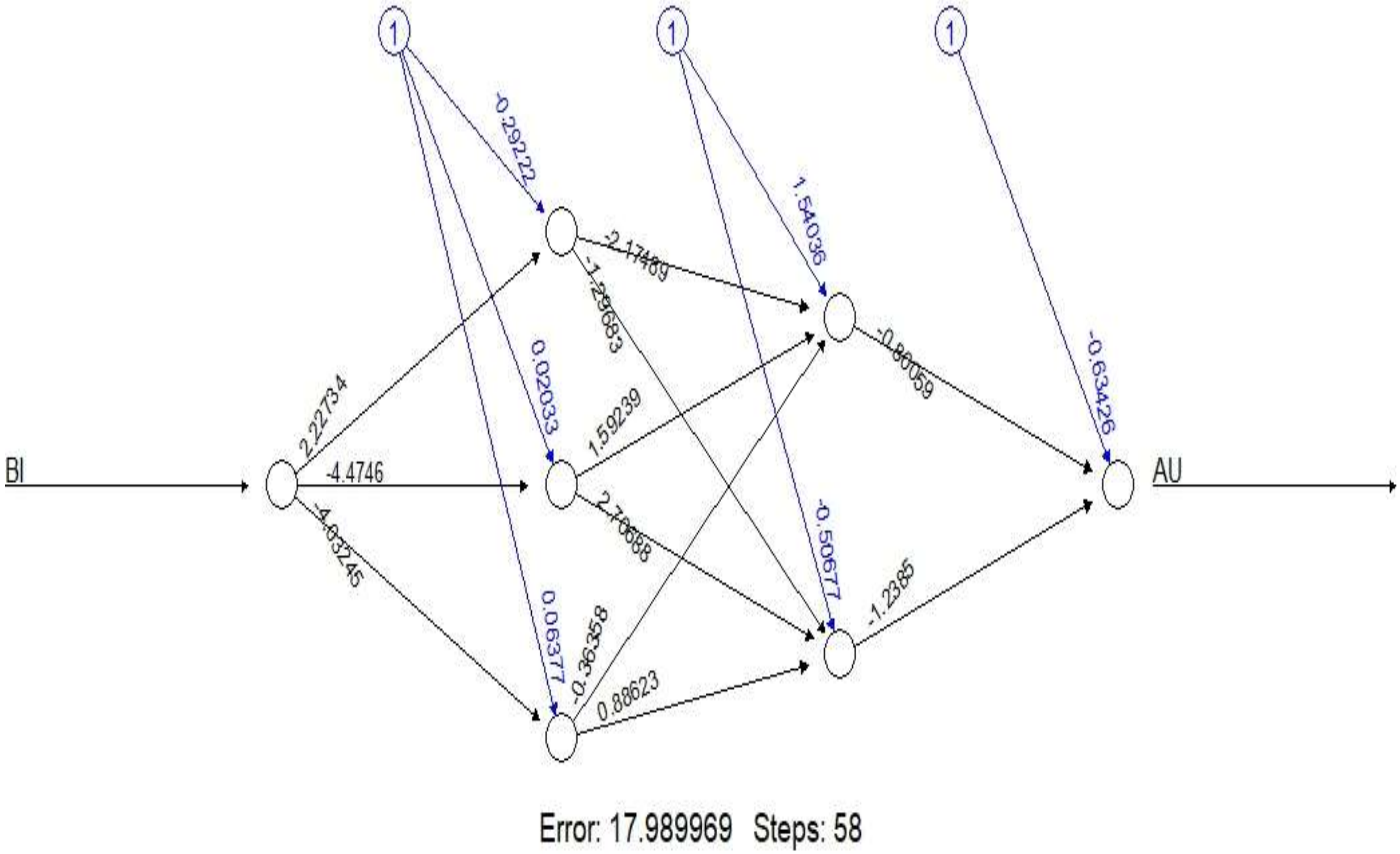

Figure 6: Neural network model 2

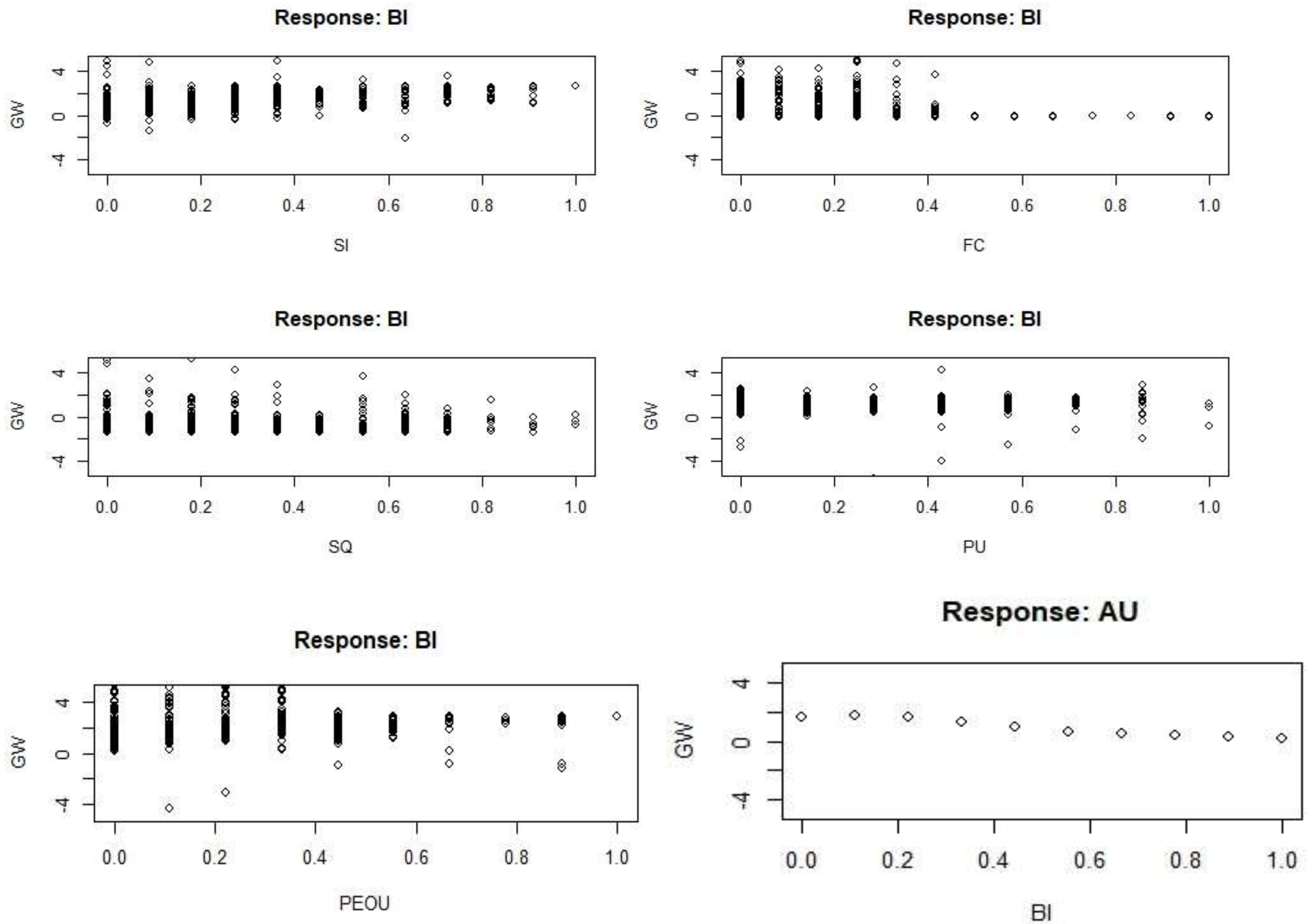

Figure 7: Distributed weights of neural network 1 and 2

To avoid over-fitting, a 10-fold cross-validation modeling with a ratio of 75:25 data for training and testing was used to examine the accuracy of the model. The MSE of the networks reported in Table 3 is closer to .000, which signals model reliability in terms of predictive validity. In sum, **H4, H5, H6, H7, H8, and H9** received empirical support.

Table 3. Neural network 1 and 2 - MSEs

Output node: Behavioral Intentions			**Output node: Actual Usage**		
Network	Training	Testing	Network	Training	Testing
1	0.054	0.058	1	0.042	0.039
2	0.053	0.059	2	0.041	0.044
3	0.052	0.053	3	0.044	0.016
4	0.052	0.051	4	0.041	0.045
5	0.052	0.064	5	0.040	0.049
6	0.054	0.062	6	0.039	0.052
7	0.051	0.054	7	0.043	0.017
8	0.054	0.053	8	0.039	0.050
9	0.051	0.048	9	0.041	0.019
10	0.053	0.057	10	0.044	0.015
Mean MSE	***0.053***	***0.055***	**Mean MSE**	***0.042***	***0.035***

DISCUSSION

In this study, a total of nine hypotheses were tested out of which we found support for six of the relationships between the constructs. Figure 1 indicates that there are 8 independent variables which are hypothesized to influence the students' behavioral intentions to use an LMS. 5 of these relationships were supported. The strongest influence on behavioral intentions was the perceived ease of using the LMS (PEOU). The statistically significant relationship between PEOU and BI supports similar findings, also in similar contexts (Mbengo, 2014; Al-Azawei, Parslow, & Lundqvist, 2017; Ibrahim et al., 2017). Nigerian students, therefore, attribute their intention to use the LMS mainly to the ease of using the system. Scholars have claimed PEOU and similar constructs would be more salient for inexperienced users (Venkatesh et al., 2003). This corroborates our findings as a higher percentage of the users claim to have used the LMS for under 1 year. Our findings on the relationship between PEOU and BI indicate that the LMS is easy to use.

The next most significant factor in influencing Nigerian students' intention to use the LMS is the social influence on the students. The students believe that people they regard as important encourage them to use the LMS. Similar to the PEOU construct, SI has been shown to be more salient to inexperienced users (Venkatesh et al., 2003), which is in agreement with our findings where the higher percentage of the student sample used in this study have used the LMS for under 1 year. However, this relationship contradicts the findings by Yakubu and Dasuki (2018) where an insignificant association was observed between SI and BI, the authors attributed this to the mandatory use of LMS in the university by all instructors claiming that the usage of the LMS was not dependent on referral by the student's colleagues or instructors. The differing results could be due to the fact that 2 out of the 4 universities in this study allow instructors to choose if they want to use the LMS or not, i.e. voluntary use of the LMS. Also, in one of the universities in this study, there are, 2 LMS for the instructors to choose from. Thus instructors will use the LMS they feel comfortable with and likewise encourage their students to use the LMS.

Perceived usefulness was observed to positively predict the student's behavioral intention to use the LMS. Thus, the students believe that the LMS is useful for their studies and this encourages them to use the LMS; this finding is consistent with prior research (Cheng, 2012; Alharbi & Drew, 2014). Functionalities such as submitting assignments and access to learning resources make the LMS a useful tool for achieving learning outcomes. The students also find the tracking features of the LMS beneficial as they can use it to know where and how they can improve their scores to attain their desired grades and also to be aware of modules that need to be completed or revised.

Our findings also show that the quality of the system has a positive and significant influence on students' behavioral intention to use the LMS. The system quality captures the functionality, reliability, and efficiency of the LMS. Thus, students attribute the use of the LMS to these features. If the system were unreliable, nonfunctional, or inefficient, students would be less inclined to use the LMS as a lot of effort will be required to use the system. This is in agreement with Ramayah et al., (2010) who states that a good system is essential to sustain the use of eLearning applications.

The final positive and significant relationship with BI was observed by facilitating conditions. This means that the students believe that the existence of organizational and technological infrastructure plays an important role in influencing their intention to use the LMS. Facilities such the technical help desk support, internet access, and the availability of devices encourage the students to use the LMS. Our finding is supported by similar studies that examine the acceptance of eLearning systems by students (Raman et al., 2014; Salloum & Shaalan, 2018).

An unexpected result was the insignificant relationship between learning value (LV) and students' behavioral intention to use the LMS. Our result conflicts with the observed relationship in the study by Ain et al. (2016). Based on the measurement items for LV used in this study, and adapted from Ain et al. (2016), the students in our study do not believe that using the LMS enables them to decide their learning pace, increase their knowledge or control their success in the course. They also do not believe that the LMS facilitates the sharing of knowledge with others using the discussion forums. The insignificant relationship between LV and BI is possibly due to the fact that 2 of the universities in this study only use the LMS to host the learning resources for the courses. The LMS does not really offer a student-centered learning approach. Therefore, they do not really see the value of the LMS, especially for students who are used to using physical learning resources such as books.

Course quality (CQ), which should be an important factor that influences the students to use the LMS, was observed to have an insignificant relationship with the students' behavioral intention to use the LMS, indicating that the students perceive that they do not have access to updated resources, and to flexible and learner-centered courses (Cheng, 2012). Similar to the insignificant relationship between LV and BI, this finding is attributed to the fact that the LMS is used as a content management system where learning resources are placed on the LMS for students to access without screening for the appropriateness of the content.

The third insignificant relationship was observed between instructor quality (IQ) and BI. Cheng (2012) attributes this to the teaching style and timely response to the learners using the eLearning system. We believe this is based on the stagnated style of teaching witnessed in Nigerian higher education institutions. This is supported by claims made by Gengle, Abel & Mohammed (2017) that teachers in Nigeria need to adopt different teaching strategies to improve students performance. Higher education institutions need to concentrate on training instructors in how to use LMS. This will enable the instructors to engage their students by using the LMS to provide timely responses to assist them(Cheng, 2012; Lee 2010), and to provide an interactive learning atmosphere for them through the use of a variety of multimedia resources and interactive teaching styles.

Implications for Practice

The results of this study provide a few managerial implications for university administrators, instructors, eLearning managers, and software developers. These implications will aid in motivating the students to use LMS in Nigerian higher education institutions. Firstly, the results show that software quality, perceived ease of use, and perceived usefulness of the LMS were significant in influencing the students' behavioral intention to use the LMS. This suggests that the eLearning system designers should take into consideration the functionality and the user interface as well as the students' interactivity on the system when designing or updating LMS. Also, regular surveys should be carried out to improve the current designs as the students' learning needs will change over time. Instructors should be aware of, and learn to use, the majority of the functionality of the LMS and also be able to integrate some of these functionalities into their curriculum so as to motivate the students' use of the LMS.

Secondly, the findings from this study indicate that both the instructor quality and course quality have an insignificant relationship with the students' behavioral intention to use the LMS suggesting that the students do not agree that the instructors' response via the LMS and attitude towards the LMS contributes to their usage of the system. The university administration, therefore, need to ensure that the instructors are trained properly in using the LMS. The training should be done by pedagogy experts who will emphasize during the training that the instructors use the LMS to motivate the students to achieve the learning outcomes of the course. Furthermore, university administrators should encourage instructors to attend workshops and conferences centered on the use of eLearning systems. Finally, the quality assurance department should evaluate the instructors based on their use of the LMS and the quality of their courses hosted on the LMS.

In addition, we observed that facilitating conditions have a causal effect on the students' behavioral intention to use the learning management system. This means that the universities have the organizational and technological infrastructure required to support the use of the LMS. University administrators, therefore, should ensure that devices such as laptops and desktops are made available for the use of the LMS by students who do not have access to internet-ready devices. Also, there should be a help desk support team in place, e.g. an instructional technology unit, where training and support can be rendered to users of the LMS. The LMS developers can incorporate intuitive online help services and tutorials to support the students' use of the LMS when the help desk team is not available.

The fourth implication is based on the significant relationship between social influence and students' behavioral intention, and the insignificant relationship of learning value on behavioral intention to use the LMS. The students attribute their use of the LMS to the influence of their peers, instructors, and the university management system. Universities need to adopt policies that enforce and monitor the use of LMS in a way that will encourage both students and instructors to see the value that can be gained by using the LMS.

Limitations and Further Research

The cross-sectional and self-reported nature of survey data restricts our ability to draw causal inferences. Future studies may utilize qualitative or mixed-method approaches for a deeper understanding. Although multiple approaches such as assurance of confidentiality and anonymity of the respondents, and the use of artificial intelligence approaches were used to overcome the potential threats of common method bias, future studies are encouraged to use longitudinal design or multiple data sources to eradicate this tendency. The respondents are students from 2 Nigerian private universities, which limits our ability to generalize the findings for public university students in other African or developing countries. Future research may test and validate the model in different cultural settings or countries. This study did not consider perceived enjoyment, user satisfaction, and attitude towards technology; this may be a fruitful research avenue.

CONCLUSION

This study has examined the factors that have contributed to the acceptance of LMS in 4 universities in Nigeria. The study proposed a model to identify students' acceptance of learning management systems. Survey data collected from 1,116 students were analyzed using artificial neural network (ANN) and structural equation modeling (SEM) techniques. The findings of the study show that social influence, facilitating conditions, system quality, perceived ease of use, and perceived usefulness are important predictors for students' behavioral intention to use LMS. Students' behavioral intention to use LMS also functions as a predictor for actual usage of LMS. In sum, this study adds to our understanding of the factors that influence students to use the LMS, specifically in Nigeria. Also, the results will also help university administrators, governing bodies such as the National University Commission (NUC), the Tertiary Education Trust Fund (TETFund) and software developers to plan, develop and implement LMS for higher education institutions in Nigeria. This could be a giant step towards improving the quality of instruction and learning in institutions of higher learning in Nigeria.

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Appendix I: Research instruments

Instructor Quality (Cheng, 2012; Lwoga, 2014)

IQ1 The instructor communicates well via the LMS.

IQ2 The instructor's attitude is beneficial to my learning via the LMS.

IQ3 The instructor promptly responds to me via the LMS.

IQ4 The instructor frequently updates resources for learners on the LMS.

IQ5 the instructor is knowledgeable in using the LMS.

Course Quality (Cheng, 2012)

CQ1 The level of difficulty of using the learning content is appropriate.

CQ2 The delivery schedule of the learning content is flexible.

CQ3 The LMS can provide me with individualized learning management.

CQ4 The LMS often provides updated information.

CQ5 The LMS provides me with sufficient learning content.

Learning Value (Ain et al., 2016)

LV1 Learning via the LMS is worth more than the time and effort given to it.

LV2 In less time, the LMS allows me to quickly and easily share my knowledge with others (e.g., discussion forums, blogs, etc.). ***

LV3 The LMS gives me the opportunity to decide about the pace of my own learning.***

LV4 The LMS gives me the opportunity to increase my knowledge and to control my success (e.g., via quizzes and assignments/ assessments, etc.).

LV5 Using the LMS offers access to updated curriculum.

Social Influence (Venkatesh et al., 2003)

SI1 My instructors encourage me to use the LMS.

SI2 My classmates encourage me to use the LMS.

SI3 The university management encourages me to use the LMS.

SI4 Generally speaking, I do what my lecturer thinks I should do.

Facilitating Conditions (Venkatesh et al., 2003)

FC1 I have the resources necessary to use the LMS (e.g., technology and time).

FC2 I have the knowledge necessary to use the LMS.

FC3 The LMS is not compatible with other systems I use.

FC4 A specific person or group is available to assist me with issues I have with the LMS.

System Quality (Lwoga, 2014)

SQ1 The functionality of the LMS allows me to complete my learning tasks

SQ2 Overall, the LMS is highly reliable with minimal downtime

SQ3 It is easy to learn how to use the LMS

SQ4 The LMS is efficient in allowing me to complete my tasks

Perceived Usefulness (Davis, 1989)

PU1 Using the LMS will allow me to accomplish learning tasks more quickly***

PU2 Using the LMS will improve my learning performance

PU3 Using the LMS will increase my learning productivity

PU4 Using the LMS will enhance my effectiveness in learning

PU5 Using the LMS will be useful in my studies

Perceived Ease of Use (Davis, 1989)

PEOU1 My interaction with the LMS is clear and understandable.

PEOU2 It would be easy for me to become skillful at using the LMS.

PEOU3 I find the LMS easy to use.

PEOU4 Learning to operate the LMS is easy for me.

Behavioral Intentions (Venkatesh et al., 2003)

BI1 I intend to use the LMS this semester.

BI2 I predict I will use the LMS next semester.

BI3 I plan to use the LMS frequently for my coursework.

BI4 When given a chance I will always try to use the LMS.

Actual Usage (Venkatesh et al., 2003)

AU1 I use the LMS frequently.

AU2 I depend on the LMS for my studies.

AU3 I use many functions of the LMS.***

Note: *** deleted due to low factor loading.