Expanding The Technology Acceptance Model (TAM) to Examine Faculty Use of Learning Management Systems (LMSs) In Higher Education Institutions

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Abstract

Universities have made a considerable investment in the use of Learning Management Systems (LMSs) to facilitate their teaching learning processes; however these systems are not used by the faculty members to their fullest capabilities. To address this issue, this study investigated factors that affect faculty members' LMSs usage behavior, focusing on user related variables and their pivotal role in determining faculty attitudes toward LMSs. This study offers an empirical evaluation of an extension of Davis's (1989)'s Technology Acceptance Model (TAM) to investigate how faculty members' beliefs and attitudes influence their intention and actual use of LMSs under conditions of non-mandatory use of LMSs in higher education institutions. Data were obtained from 560 faculty members (from two universities) and analyzed using Structural Equation Modeling. The study results revealed that the three proposed external variables: system quality; perceived self-efficacy and facilitations conditions were significant predictors of faculty attitude towards LMSs. Similar to prior research findings, the study results further confirmed the validity of the extended TAM in determining users' technology acceptance behavior. The study also addressed the implications of the findings for researchers and practitioners.

Keywords: learning management systems (LMSs), technology acceptance model (TAM), attitude, usage, Canvas, structural equation modeling

Introduction

Internet based Learning Management Systems (LMSs) (i.e. Moodle, Blackboard, WebCT, Desire2Learn) are popular Internet technologies that have been supporting distance, face-to-face and hybrid/blended teaching-learning processes. (Dahlstrom, Brooks, & Bichsel, 2014; McGill & Hobbs, 2008; Connolly, MacArthur, Stansfield, & McLellan, 2007; El Mansour & Mupinga 2007; DeNeui & Dodge 2006). A LMS can be defined as "a self-contained webpage with embedded instructional tools that permit faculty to

organize academic content and engage students in their learning" (Gautreau, 2011, p.2). By including computer and Internet technologies in the learning processes and by offering multiple teaching learning tools, LMSs provide virtual way of increased and faster communications among students and teachers and offer speed and effectiveness in educational processes. While LMSs offer various supporting features for teaching learning processes, and though universities make considerable investment on LMSs, these are not used by faculty members to their fullest capabilities (Jaschik and Lederman , 2014; Dahlstrom, et. al., 2014; Allen & Seaman, 2010). Pajo and Wallace (2001) stressed that successful integration of technology in teaching depends not only on availability of technology but also on how instructors embrace and use it. Hustad and Arntzen (2013) reported that faculty members mostly use LMSs as supplements to their lectures; synchronous functionalities of LMSs (i.e. Chat, Online discussions) were seldom used by faculty members with no direct contact with the participants. In a survey on faculty attitudes on technology conducted by Jaschik and Lederman (2014), majority of the faculty reported using a LMS, but using limited features: posting course syllabus (78%), recording grades (58%), communicate with students (52%). Only 20% of faculty reported using the LMS to record lecture content. While approximately 99% of higher education institutions have a LMS in place, approximately one-half of faculty report using such systems on a regular basis and the majority of the faculty do not take advantage of advanced LMS capabilities that have potential to improve the student outcomes (Dahlstrom, et. al., 2014). All these findings indicate that to ensure increased use of LMSs by faculty members, more research is required to gain better understanding of the factors that affect faculty members LMSs usage.

The focus of the current study was on faculty perspective of LMS usage. Two major purposes of the study were: (i) to identify the factors that influence faculty members LMS usage behavior and (ii)) to determine the underlying causal relationships among the factors. The core expectation was that understanding the factors that affect faculty members' LMS usage behavior can shed light on the development, selection, training, maintenance and investments on such systems. To this end, the current study utilized Davis's (1989) Technology Acceptance Model (TAM) as a baseline model to predict faculty intention and usage of LMS in higher education institutions. Also, this study proposed an extension of the original TAM by including three external variables: system quality, perceived self-efficacy and facilitating conditions in it and examined its validity in explaining faculty members' LMS usage behavior. By conducting an empirical study among university faculty members, this study presented important findings pertaining to faculty attitude under conditions of non-mandatory use of LMSs. Based on the findings; the significant determinants of LMS usage are discussed.

Literature Review

Learning Management Systems (LMSs) provide tools and functions like course management tools, online group chats and discussions, documents (lecture materials, homework and assignments etc.), power points, video clips uploading, grading and course evaluations to support teaching and learning. Since, LMSs have evolved in a complex way in terms of educational contents, technological resources and interaction possibilities; there is an increasing concern in regard to the quality of the interface and the ways in which tasks are completed in these systems (Freire, Arezes, Campos, Jacobs & Soares, 2012). Freire et.al. (2012) stated that, the definition of the term "usability" varies according to the area in which it is being studied. In the view point of ergonomics, the term "usability" can be defined as "the capacity a system has to offer to the user in carrying out of his tasks, in an effective efficient and satisfactory manner"(Freire et al., 2012, p.1039). They stated that, to evaluate the LMSs' usability: "the users' perspective", not anymore "the systems perspective", is the main point to look at (Freire et al., 2012).

Many of the prior LMSs studies found that, not all the functions of LMSs were equally used by the users, some functions are used more frequently than the other functions (Jaschik & Lederman, 2014, Weaver, Spratt & Nair 2008, Panda & Mishra, 2007, Akpinar, Bal & Simsek, 2004; Woods, Baker & Hopper, 2004). Fathema and Sutton (2013) found document uploading; grade posting and assignments were the most frequently used features of Blackboard learning management systems by faculty members. They reported that according to faculty members specific challenges including system problems and design flaws reduce the overall utilization of the LMS by faculty. Holden and Rada (2011) indicated that, k-12 teachers' technology self-efficacy has effect on teachers' use of technology. Panda and Mishra (2007) found that the significant barriers for e-learning adoption as perceived by faculty members were: poor internet access, lack of training, followed by institutional policy on and instructional design for e-learning. They found personal interest to use technology; intellectual challenge and sufficient provision for

technology infrastructure were the important motivators in e-learning adoption by faculty members. Pajo and Wallace (2001) identified personal barriers (lack of knowledge, skills, training, role models and time), attitudinal barriers (no faith in technology, unwillingness to work with technology, concern about student access) and organizational barriers (inadequate technical support, hardware, software, instructional design, no recognition of the value of online teaching) that impeded that implementation of web-based teaching by university teachers. Moreover, a significant number of prior studies examined students' acceptance of various technologies including LMSs which showed similarities among their findings. For example, Pituch and Lee (2006) found that usefulness and ease of use to be good determinants of the student acceptance and distance learning. Lee, Cheung, and Chen (2005) found that perceived usefulness and perceived enjoyment had an impact on both students' attitude toward and students' intention to use Internet-based learning medium. Pituch and Lee (2006) reported that system characteristics were important determinants of college students' perceived usefulness and perceived ease of use of an e-learning system as well as of their e-learning usage behavior. Saadé, Nebebe, and Tan (2007) found that perceived usefulness had significant effect on university students' attitude toward Multimedia learning Environments (MMLS) and revealed that students' attitudes affect their behavioral Intention to use MMLS. Weaver, et. al., (2008) reported that in using LMS, system quality is important to both the students and faculty. Park (2009) revealed that e-learning self-efficacy and subjective norm play an important role in affecting attitude (students) towards e-learning and behavioral intention to use e-learning.

Technology Acceptance Model

Technology Acceptance Model (TAM) (Figure 1) is based on Ajzen and Fishbein's (1980) Theory of Reasoned Action (TRA). According to TRA, an individual's intention to perform a behavior is a function of his/her attitude toward the act or behavior and social norms. An individual's attitude predicts his/her intention and intention shapes the actual behavior.

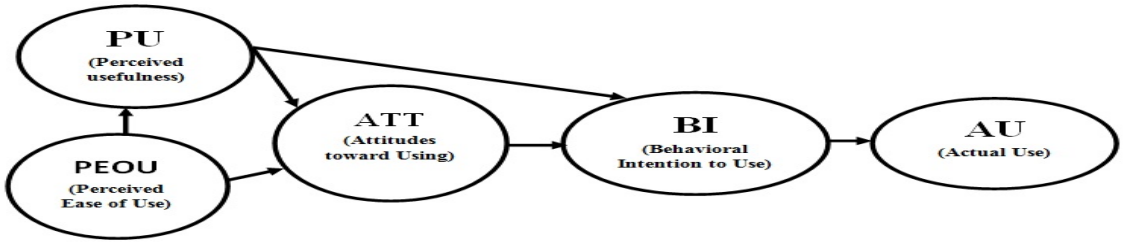

Figure 1. Technology Acceptance Model (TAM) (Davis, Bagozzi & Warshaw, 1989, p.985).

TAM (Davis, 1989) claims that, Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) are the two fundamental determinants of user acceptance of technology (Davis, 1989). PEOU is defined as "the degree to which a person believes that using a particular technology would be free from effort" (Davis 1989, p.320). PU is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, p.320). TAM claims that PU will be influenced by PEOU: when users' find a technology "easy to use", then they perceive the technology as a "useful one". TAM offers the causal relationships of these two fundamental constructs (PEOU and PU) with three other constructs "attitude toward using (ATT)", "behavioral intention to use (BI)" and "actual use (AU)". ATT is defined as "an individual's positive or negative feeling about performing the target behavior (e.g., using a system)" (Fishbein & Ajzen 1975, p.216). According to TAM, both PEOU and PU influence the users' attitude toward using a technology. It claims that if users find a technology useful and easy to use than they develop a positive attitude toward this technology. The fourth construct, "Behavioral Intention (BI)", is defined as the degree to which a person has formulated conscious plans to perform or not perform some specified future behavior (Davis, 1989). TAM claims, PU and ATT directly influences BI. If users find a specific technology as a useful one (PU) then they develop a positive intention of using it. Similarly users' positive attitude toward a specific technology leads them developing an intention to use this technology. TAM suggests users' behavioral intention (BI) shapes their actual use of the technology (AU). If users have intention to use a specific technology then they use it.

TAM is chosen to use in this study because prior research has found TAM as the most influential, commonly employed, and highly predictive model of IT adoption (Adams, Nelson & Todd, 1992; Davis, et

al., 1989; Venkatesh & Davis, 2000 ; Lee, Kozar, & Larsen, 2003; Venkatesh & Bala, 2008). Though TAM was designed to study technology acceptance decisions across different organizational settings and users' population, research on TAM's application in education was limited in past (Teo, Lee & Chai, 2008). Recently, adopting TAM as an explanatory tool in investigating e-learning processes has become a trend (Park, 2009). This study delved more deeply to the TAM research by applying it in the education sector. Also, it contributed to the TAM literature by proposing an extension of the original TAM framework. The study examined the effect of three external variables on the five original TAM constructs. A discussion of the research model and hypotheses follows.

Research Model and Research Hypotheses

In order to provide a better understanding to the exploration of LMS acceptance amongst faculty members three factors "System quality", "perceived self-efficacy" and "facilitating conditions" were incorporated as external variables in the original TAM. The proposed model (as depicted in Figure 2) was used to explore the effects of the proposed external variables on faculty members LMS usage behavior. In the next section, brief definitions and the inferences of the proposed three factors as antecedents of LMS usage and related hypotheses are presented.

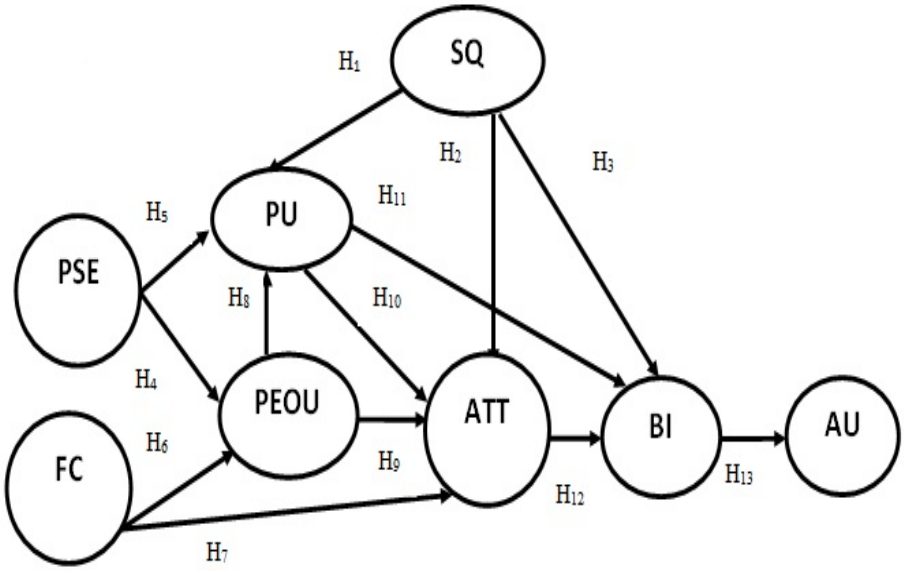

Figure 2. Proposed research model for faculty acceptance of LMSs.

Note: SQ= System Quality, PSE= Perceived Self-efficacy, FC= Facilitating Conditions, PEOU= Perceived Ease of Use, PU= Perceived Usefulness, ATT= Attitude Toward Using, BI= Behavioral Intention to use, AU= Actual Use

System Quality (SQ)

System Quality (SQ) in the Internet environment measures the desired characteristics (usability, availability, reliability, adaptability, and response time) of an e-commerce system (i.e. LMS) (Delone & Mclean, 2003). In this study, SQ is defined as the quality related to the functions, speed, features, contents, interaction capability of LMS. Prior research found 'System Quality had significant effect on perceived usefulness (PU) of a wide variety of information systems including various e-learning systems including LMS and Information and Communication Technology (ICT) (Fathema & Sutton, 2013, Park, Nam, & Cha ,2012; Condie & Livingston, 2007; Pituch & Lee 2006; Russell, Bebell & O'Connor, 2003).Furthermore, studies have reported SQ's significant positive effect on users' attitudes (ATT) toward using different types of technologies (i.e. LMS, Internet protocol television) (Fathema & Sutton, 2013, Dong Hee, 2009), and on users' behavioral intentions (BI) to use technologies, specifically in the context of LMS, mobile learning and various e-commerce systems(Fathema & Sutton, 2013, Park et.

al.,2012;Delone & Mclean, 2003). Based on prior literature, three hypotheses were formulated about the relationship of SQ with perceived usefulness (PU), attitude toward using (ATT) and behavioral intention to use (BI). The theme behind these hypotheses is, if a system has all the expected characteristics in it, then users will (i) find it as a useful system (ii) develop a positive attitude toward the system and (iii) develop a positive intention to use the system.

H_1: System Quality (SQ) of LMS has a significant positive effect on the perceived usefulness (PU) of LMS

H_2: SQ of LMS has a significant positive effect on faculty members' attitudes (ATT) toward using LMS

H_3: SQ of LMS has a significant positive effect on faculty members' behavioral intention (BI) of using LMS

Perceived Self-efficacy (PSE)

Perceived Self-efficacy (PSE) is defined as "an individual's judgment of his or her capability to organize and execute the courses of action required to attain designated types of performances. It is not concerned with the skills one has, but with the judgments of what one can do with whatever skills one possesses" (Bandura, 1986, p.391). In the LMS usage context, PSE indicates a faculty member's judgment or the confidence of his/her own capability of operating/ navigating/ working with LMS. In general, users with higher perceived self-efficacy develop stronger perceptions of perceived ease of use (PEOU) and perceived usefulness (PU) of a system. In contrast, if an individual perceives himself/ herself as less capable of using a system (i.e. LMS) than he/she will find the system as 'less useful' and 'difficult to use'. Prior research has reported that users' PSE has significant positive effect on the PEOU of LMS, e-learning or mobile learning systems (Fathema & Sutton, 2013, Park et. al.,2012; Yuen & Ma, 2008, Ong & Lai, 2006; Roca, Chiu & Martinez, 2006; Pituch & Lee, 2006; Grandon, Alshare, & Kwan, 2005; Ong, Lai, &Wang, 2004). In addition, research findings have supported PSE's significant positive effect on PU of different types of information systems including various computing technologies and e-learning systems (Compeau, Higgins & Huff., 1999; Ong, et.al., 2004; Ong & Lai, 2006). Drawings from these findings two hypotheses were examined:

H_4: Faculty members' perceived self-efficacies (PSE) have significant positive effects on their perceived ease of use (PEOU) of LMS

H_5: Faculty members' PSEs have significant positive effects on their perceived usefulness (PU) of LMS

Facilitating Conditions (FC)

Facilitating conditions (FCs) are the factors (Ngai, Poon & Chan, 2007) that can be stated as "perceived enablers or barriers in the environment that influence a person's perception of ease or difficulty of performing a task" (Teo, 2010). Venkatesh and Bala (2008) elaborated it as "FCs are related to individuals' control beliefs regarding the availability of organizational resources and support structures to facilitate the use of a system". Here in LMS context, FCs indicates the availability of the related resources i.e technical help, internet infrastructure, hardware, software, training, online help to work with Canvas. Previous studies on teachers' acceptance of various technologies (Teo, 2010, Teo et. al., 2008, Panda & Mishra, 2007, Pajo & Wallace, 2001) have reported that FC is a key belief that influences user adoption of technology. Teo et. al (2008) and Teo (2010) revealed FC's significant effect on perceived ease of use (PEOU), in terms of pre-service teachers' computing technology acceptance behavior. Furthermore, Teo (2010) reported FC's significant effect on pre-service teachers' attitude (ATT) towards using computer technology. Ngai et.al, (2007) studied students' attitude and reported that facilitating conditions (FC) significantly affect university students' LMS acceptance behavior by influencing on the perceived ease of use (PEOU) and students' attitude (ATT) toward using LMS. Therefore, the current study proposed two hypotheses to examine the effect of facilitating conditions (FC) on the PEOU and ATT in the context of faculty attitudes toward LMS.

H_6: FC has a significant positive effect on faculty members' PEOU of LMS

H_7: FC of LMS has a significant positive effect on faculty members' attitude (ATT) toward using LMS.

Hypotheses related to five original TAM constructs

Applying the arguments claimed by TAM (Davis, 1989) regarding the technology adoption behavior and considering the prior TAM based research findings; the following hypotheses for LMS usage by faculty members were examined in the current study.

H_8: Faculty members' PEOU of LMS has a significant positive effect on their perceived usefulness (PU) of LMS

H_9: Faculty members' PEOU of LMS has a significant positive effect on their attitudes toward using LMS (ATT).

H_{10}: Faculty members' PU of LMS has a significant positive effect on their ATT toward LMS use

H_{11}: PU has a significant positive effect on faculty members' behavioral intention (BI) to use LMS

H_{12}: Faculty members' ATT toward using LMS have a significant positive effect on their BI of using LMS

H_{13}: Faculty members' BI toward using LMS will have a significant positive effect on their actual use (AU) of LMS.

Method

This study, approved by the Institutional Review Board (IRB), was focused on Canvas: a newly introduced LMS which was launched to post-secondary institutions in February 2011. Together with the standard features of LMSs, Canvas provides advanced options like learning outcomes, peer review, migration tools, e-portfolios, screen sharing and video chat etc. Canvas is currently used by more than 300 colleges, universities and school districts (www.instructure.com).

Data were collected from individuals with teaching responsibilities (faculty members and graduate teaching assistants) from two universities in the United States. Using a purposive sampling method, two universities were selected on the basis of their similarity in the institutional characteristics and LMS adoption background. Both of the universities were public, land grant, research universities and have had Blackboard as their LMS before they adopted Canvas. In both of the universities, faculty members have the flexibility to use none, some, or all of the available features of Canvas and they are allowed to use any other software over and beyond Canvas in facilitating their teaching-learning activities.

Procedures

Using a web-based survey, data were collected from the two universities from January- April, 2013. The email addresses of the faculty members were collected from the university websites. An email invitation including the survey link was directly sent to the faculty members and Graduate Teaching Assistants (GTAs) irrespective of whether they used Canvas or not in January 2013. Later, two reminder emails (one in February 2013 and another in March 2013) were sent to fill-in the survey. Survey participation was voluntary and no incentive was offered to the participants. Data collection was anonymous and no identifiable information was collected. There were three parts in the survey. The first part included the survey information letter and consent agreement, second part included questions related to Canvas usage and the third part covered the demographic information. The survey items in the second part were randomized to avoid potential order effects. The survey items were reviewed by two content experts and the survey was pilot tested. The final survey questionnaire was composed of 28 Likert scale items on eight constructs (SQ, PSE, FC, PEOU, PU, ATT, BI, and AU). All constructs (except the self-developed construct ATT) were adapted from prior studies (Table 1). However, the items were re-worded to make them relevant to the specific context of the study. All internal consistency reliabilities (based on Cronbach' alphas) for all eight scales ranged from .870 to .963 (Table 1) and were considered to be good (Hair, Anderson,Tatham, & Black, 1998).

Table 1.

Measurement Scales (Items, Reliability and Sources)

Scale	Total Items	Reliability (α)	Adapted from
*System Quality (SQ)	4	0.870	Liaw(2008)
*Perceived *Self Efficacy (PSE)	3	0.930	Liaw(2008)
*Facilitating Conditions(FC)	3	0.883	Teo (2010)
*Perceived Ease of Use (PEOU)	4	0.934	Venkatesh and Davis (2000)
*Perceived Usefulness (PU)	4	0.963	Venkatesh and Davis (2000)
*Attitude toward Using (ATT)	4	0.963	Self-developed
Behavioral Intention (BI)	3	0.898	Liaw(2008)
**Actual Use (AU)	3	0.875	Malhotra and Galletta, (1999)

Note.

*All Items for SQ, PSE, FC, PEOU, PU, ATT and BI were measured on a 7-point Likert scale from 1 being *strongly disagree* to 7 being ' *strongly agree*.'
**Items for AU were measured on a 7-point Likert scale from 1 being Not at all to 7 being to a great extent

Data collection

In total, 560 individuals completed the survey with an average response rate of 24%. The response rate was low, because it was the percentage of the 2330 faculty members and GTAs (both Canvas users and non-users) to whom the survey invitations were sent. Out of the 560 respondents 298 (53.21%) were male and 262 (46.79%) were female. Most of the respondents (30.18%) were at the age range of 51-60. The descriptive statistics of the respondents' demographics are presented in Table 2.

Table 2.

Demographics (Gender, Age, Academic Rank)

Variable	Total	%
Gender		
Male	298	53.21%
Female	262	46.79%
Age Range		
30 or less	86	15.36%
31-40	125	22.32%
41-50	108	19.29%
51-60	169	30.18%
61-70	67	11.96%
70 and up	5	0.89%

Academic Rank		
Graduate Teaching Assistant	77	13.75%
Instructor	40	7.14%
Lecturer	43	7.68%
Assistant Professor	108	19.29%
Associate Professor	153	27.32%
Professor	104	18.57%
Other	35	6.25%

Data Analysis

Following Anderson and Gerbing's (1988) recommendations, a two-step approach for Structural Equation Modeling (SEM) has been used for data analysis. At the first step, a Confirmatory Factor Analysis (CFA) was conducted to develop the measurement model. To examine the causal relationships among all constructs, the proposed structural model was tested using SEM. The software program Analysis of Moment Structures (AMOS) and part of the Statistical Package for the Social Sciences (SPSS) software (Arbuckle, 2007) were used to conduct the CFA and SEM. SEM was chosen to use because it simultaneously analyses the paths in the model and tests the goodness of fit of the model. CFA was employed to measure the construct validity of the instrument used in the study. SEM techniques using AMOS graphics were employed to evaluate the fit of both the measurement and structural components of the proposed model.

Data Screening and Normality test

No missing data were found since the survey software (Qualtrics.com) prevented to record any partially completed survey. Since the data did not meet the univariate and multivariate normality assumptions, a Bollen-Stine bootstrap method was used for inference of exact measurement and structural model (Byrne, 2009). The overall LMS usage was measured using eight constructs and 28 variables. The respondents were asked to rate their responses on 7 point Likert scales with 1 being the lowest rating and 7 being the highest. As shown in Table 3, the mean scores of all the items ranged from 4.23 to 5.56 (neutral to agree) and the standard deviations of the scores ranged from 1.36 to 2.23, indicating that on average faculty members are neutral or agreed on the statements.

Table 3.

Mean and Standard Deviation of the measurement Constructs and Items

Constructs and Items	Mean	SD	Constructs and Items	Mean	SD
System Quality (SQ)	4.93	1.48	Perceived Usefulness (PU)	4.74	1.68
Perceived Self Efficacy (PSE)	4.98	1.51	Behavioral Intention (BI)	5.25	1.48
Facilitating Conditions(FC)	5.27	1.51	Attitude toward Using (ATT)	4.92	1.70
Perceived Ease of Use(PEOU)	4.59	1.61	Actual Use (AU)	4.94	2.10

CFA

CFA was used to test the factorial structure of the hypothesized eight factor measurement model (Figure 3). All these factors were allowed to correlate. Each of the 28 measures was allowed to load only on the main factor of interest not on any other factors.

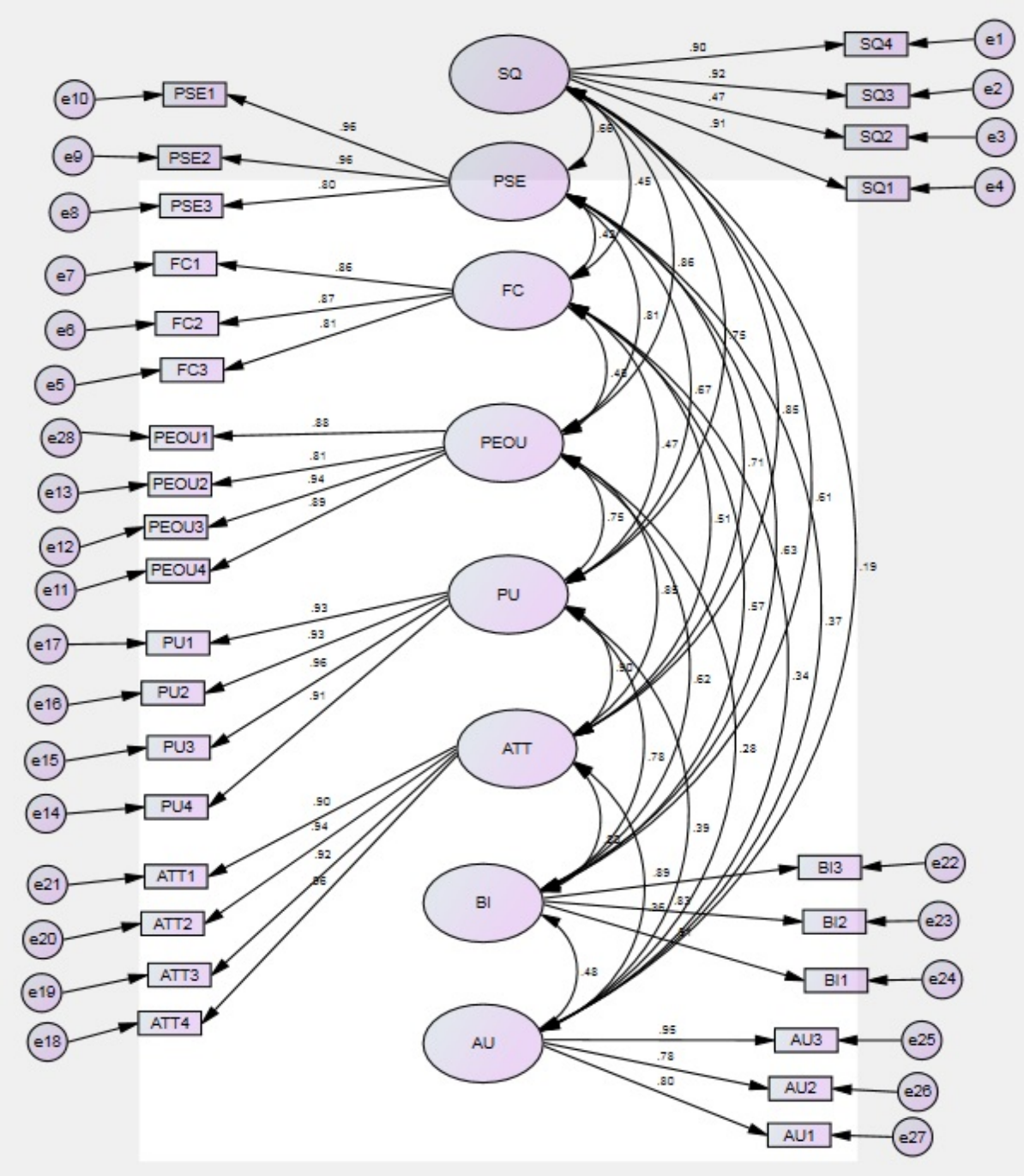

Figure 3 The hypothesized eight factor CFA model for faculty attitude toward LMSs.

Note: SQ= System Quality, PSE= Perceived Self-efficacy, FC= Facilitating Conditions, PEOU= Perceived Ease of Use, PU= Perceived Usefulness, ATT= Attitude Toward Using, BI= Behavioral Intention to use, AU= Actual Use

Bivariate Correlations and factor loadings

To investigate the linearity between the observed variable, bivariate Pearson correlation coefficient was computed. All of the inter-item correlation values of the indicators of each of the eight constructs were significant and in medium to high levels ranging from (.42 to .92) (Cohen, 1988), indicating that the items and constructs were interrelated to each other and the linearity assumption between indicator and latent

variables were met. All indicators significantly loaded onto the respective factors and the loadings were fair to excellent ranging from 0.473 to .962 (Tabachnick & Fidell, 2007). Also, the unstandardized parameter estimates and the critical ratios for all 28 items were found significant which supported the items and their relationships with their relative latent constructs. Model fit was assessed. Except for χ^2, all fit indices reached recommended level of fit: (χ^2 = 1076.694, df = 322, p <.001, CMIN/DF= 3.344, RMSEA = 0.06, SRMR = 0.0431, CFI= 0.958, IFI=. 958, NFI= 0.941, TLI= .95, AIC= 1244.694). Since χ^2 is sensitive to large sample size, with a large sample of 560 participants, it was not unusual to get a significant value. Also, for sample size greater than 250, significant χ^2value is acceptable (Hair, Black, Bablin, & Anderson, 2006). Therefore, the significant χ^2 value is acceptable for this study. Since the fit indices met the recommended level of fit, the CFA results provided strong support for the reliability and the original eight factors structure of the measurement items (28 items measuring eight latent constructs) in evaluating the faculty attitude toward LMS use.

SEM

This study was intended to simultaneously examine the direct and indirect relationships among the constructs of the proposed model and to test the fit between the proposed model and the obtained data (Figure 4). For its ease and wide applicability in modeling multivariate relations (Byrne, 2009), SEM with AMOS 18(Arbuckle, 2007) was chosen to do the analyses.

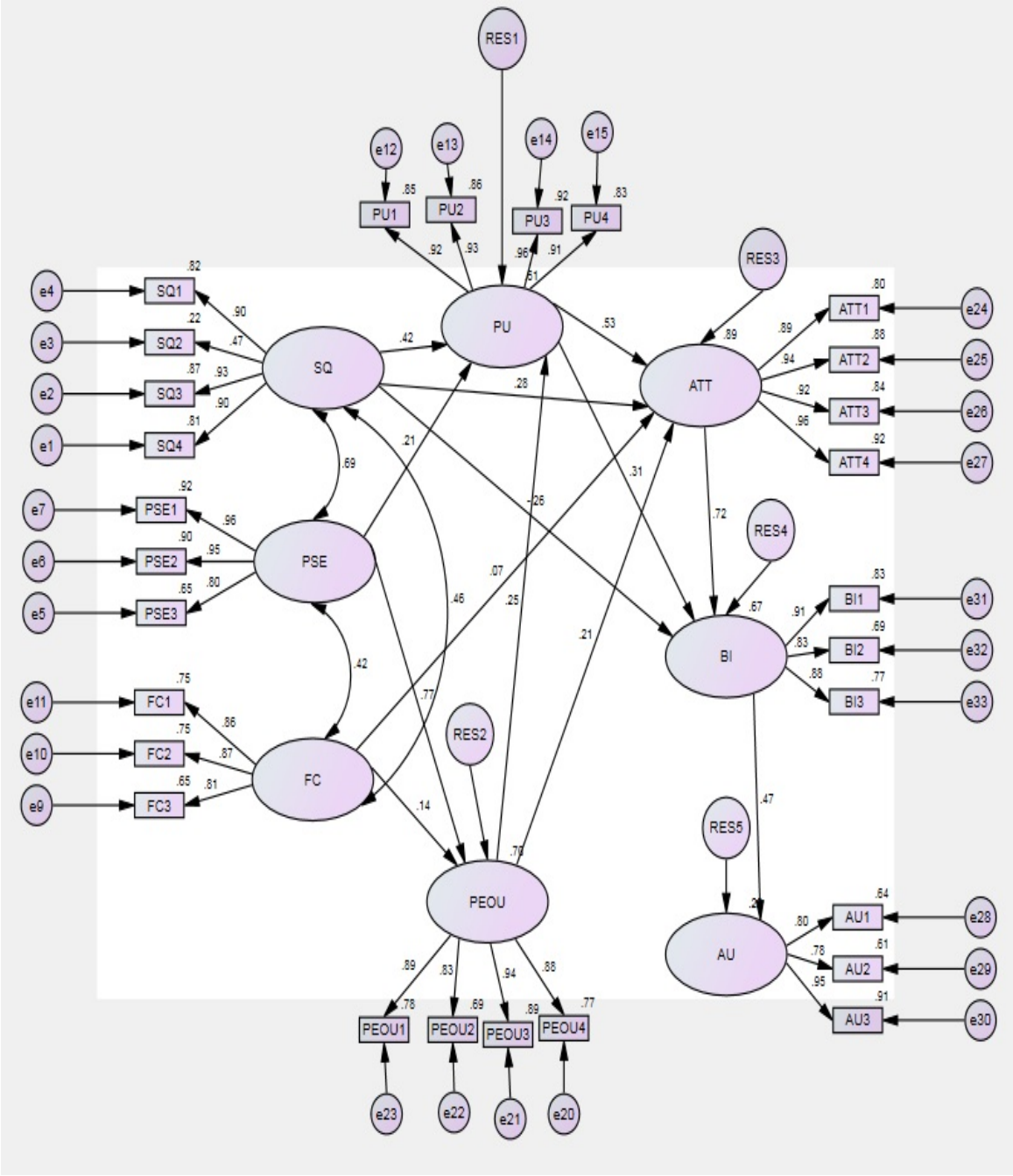

Figure 4. Hypothesized structural model of Faculty attitude toward LMSs (Canvas).

Note: SQ= System Quality, PSE= Perceived Self-efficacy, FC= Facilitating Conditions, PEOU= Perceived Ease of Use, PU= Perceived Usefulness, ATT= Attitude Toward Using, BI= Behavioral Intention to use, AU= Actual Use

Relationships among the latent constructs (Bivariate Correlations)

The bivariate relationships indicated that all of the variables were significantly correlated with each other at the 0.01 level. The correlations among the latent constructs ranged from .191 to .885 and no multi-collinearity was found among the latent variables (Table 4).

Table 4

Correlations among the eight latent constructs

	SQ	PSE	FC	PEOU	PU	ATT	BI	AU
System Quality (SQ)	1							
Perceived Self Efficacy (PSE)	.625**	1						
Facilitating Conditions (FC)	.417**	.404**	1					
Perceived Ease of use (PEOU)	.776**	.772**	.407**	1				
Perceived Usefulness (PU)	.691**	.657**	.440**	.709**	1			
Attitude Toward Technology (ATT)	.758**	.678**	.467**	.768**	.885**	1		
Behavioral Intentions (BI)	.573**	.611**	.515**	.589**	.758**	.783**	1	
Actual use (AU)	.191**	.373**	.319**	.266**	.398**	.368**	.479**	1

**. Correlation is significant at the 0.01 level (2-tailed).

The results indicated the fit indices for the research model as: χ^2 = 1436.851, *df*= 334, *p* <.001, CMIN/DF= 4.302, SRMR= 0.077, CFI= 0.938, IFI= .938, NFI= 0.921, TLI= .93, RMSEA =0.077, AIC= 1636.851. Except for the χ^2 and RMSEA, all the fit indices met the recommended level of acceptable fit. Though all the path coefficients demonstrated significance (p<.05), the SEM results showed the effect of SQ on BI was in contrast to what was hypothesized. Therefore, the path was removed from the model and the model was revised and tested again. It showed a good fit comparative to the proposed model, but not at an acceptable level (χ^2 = 1436.823, *df*= 335, *p* <.001, CMIN/DF= 4.34, SRMR= 0.713, CFI= 0.937, IFI= .937, NFI= 0.92, TLI= .929, RMSEA =0.077, AIC= 1636.851). The modification indices indicated adding a path from SQ to PEOU would notably improve the values of the fit indices. In practical, it makes sense that if LMS maintains a high quality than it will be easier to use. Therefore, if the quality of LMS goes up than faculty members will perceive it as an easier system to use. So the suggested change was made by adding a path from SQ to PEOU. The fit indices (χ^2 = 1205.409, *df*= 334, *p* <.001, CMIN/DF= 3.609, SRMR= 0.0593, CFI= 0.951, IFI= .951, NFI= 0.934, TLI= .945, RMSEA =0.068, AIC= 1405.409) except for χ^2 and RMSEA indicated a good model fit. After this modification was made, the path from FC to PEOU became statistically insignificant (p >.05). One possible reason for this insignificant path could be the operational definition of the term 'facilitating conditions' which explained the concept in terms of technical help and support in general for all sorts of technology use not specific to LMS use. Also, some prior studies reported facilitating conditions did not affect the ease of use of technology. (i.e. Karahanna & Straub 1999, Thompson, Higgins & Howell, 1991). Therefore, this insignificant path was removed from the model and the model was tested again. After the third modification, the SEM results showed the fit indices (except for χ^2) of the model met the acceptable cut-off values (χ^2 = 1205.745, *df*= 335, *p* <.001, CMIN/DF= 3.599, SRMR= .0595, CFI= 0.951, IFI= .951, NFI= 0.934, TLI= .945, RMSEA =0.068, AIC= 1403.745 Also the results indicated that the structural model fits the data fairly well. The χ^2value showed statistically significant value; however it is acceptable with a large data set of 560 samples (Hair et al, 2006). So, the third revised model was chosen to be the final model (Figure 5). The fit indices considered to test the models are depicted in Table 5. Overall, the model fitted the data well and showed a high predictive power in determining the faculty attitudes (ATT) toward LMS, the behavioral intention (BI) of faculty members to use LMS and the actual use (AU) of LMS by faculty members.

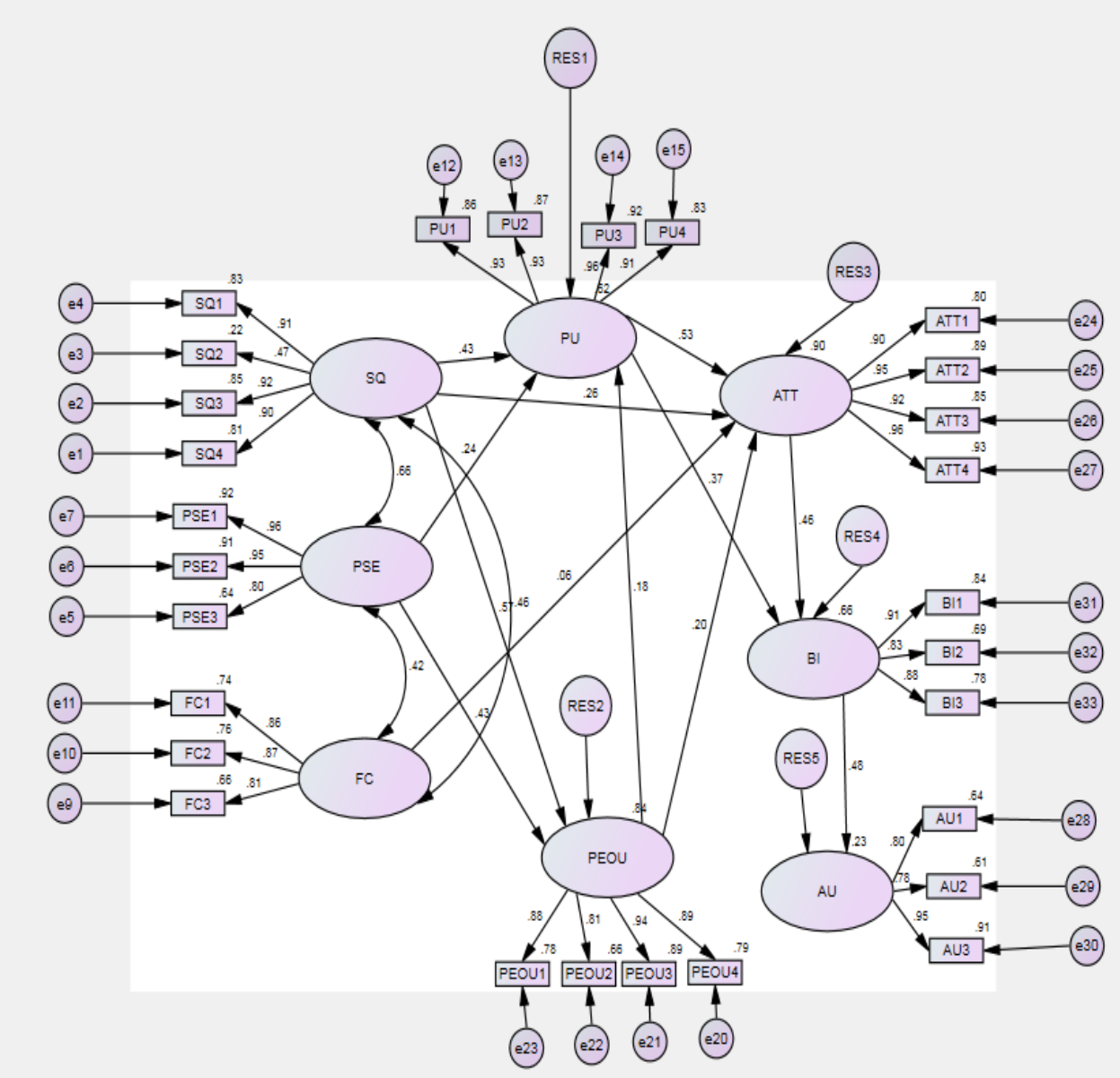

Figure 5. The structural model for f faculty attitudes toward LMSs.

Note: SQ= System Quality, PSE= Perceived Self-efficacy, FC= Facilitating Conditions, PEOU= Perceived Ease of Use, PU= Perceived Usefulness, ATT= Attitude Toward Using, BI= Behavioral Intention to use, AU= Actual Use

Table 5

Fit Indices of the Proposed Measurement Model

	Recommended Level of Fit	Proposed Model	Modification: 1 (Removed insignificant Path : SQ→BI)	Modification:2 (Added significant path :SQ →PEOU)	Modification:3 (Removed insignificant path: FC → PEOU)
Absolute fit indices					
Chi-Square	Significant at p<0.05	1436.851 df=334, p=0.000	14533.823 df=335 p=.000	1205.409 df=334, p=.000	1205.745 df=335 p =.000
Relative Chi-Square (CMIN/DF)	2~5 , <5, (Bentler,1990)	4.302	4.34	3.609	3.599
RMSEA (Root Mean Square of Error Estimation)	<=0.06 (Joreskog &Sorbom,1993)	0.077	0.077	0.068	0.068
SRMR (Standardized Root Mean Residual)	<=.80 (Teo, 2012)	0.0719	0.713	0.0593	0.0595
Incremental fit indices					
CFI (Comparative Fit Index)	>=.90 (Browne & Cudeck,1992)	0.938	0.937	0.951	0.951
IFI (Incremental Fit Index)	>=.90 (Bentler,1990)	0.938	0.937	0.951	0.951
NFI (Normed Fit Index)	>=.95 good, .90 to .95 acceptable,(Bentler,1990)	0.921	0.92	0.934	0.934
TLI (Tucker Lewis Index)	>=.95 Or >=.90 ((Marsh, Hau, & Wen, 2004)	0.93	0.929	0.945	0.945
Parsimonious fit Index					
AIC (Akaike Information Criterion)	Smaller value better fit	1636.851	1651.823	1405.409	1403.745

Hypotheses testing results

The SEM results revealed that all of the three proposed external variables (SQ, PSE and FC) have significant effect on faculty attitudes toward LMS use. Out of the proposed 13 hypotheses, 11 were supported. The results indicated that, the first external construct SQ significantly affects PU and ATT. Therefore hypotheses H_1 and H_2 were supported. However, no significant effect of SQ on BI was found, so hypothesis H_3 was rejected. Also, the results revealed a new significant path from SQ to PEOU with a regression weight of .567 indicating that SQ significantly affects PEOU. As expected, the second external construct PSE was found to be significant determinant of PEOU and PU. Thus, both of the proposed hypotheses H_4 and H_5 were supported. No significant of FC on PEOU was found. Therefore hypothesis H_6 was rejected. FC was found to be significant determinant of ATT, supporting hypotheses H_7. Also, all the proposed hypotheses (H_8, H_9, H_{10}, H_{11}, H_{12}, and H_{13}) were supported by the SEM results indicating the relationships among the original TAM constructs (as proposed) were significant. The influences of each of the exogenous variables on the endogenous variables were assessed as well. To do so, the standardized total effects, direct and indirect effects associated with each of the eight variables were tested. Table 6 shows the results of the hypotheses tests including the regression weights of each of the 11 significant paths as well as the regression weight of the new significant path from SQ to PEOU. Each of these regression weights represents the determinant's direct effect on the respective endogenous variable. All these regression weights (ranging from .184 to .567) of the significant paths are considered to be medium to large as recommended by Cohen (1988).

Table 6.

Hypotheses Testing Results

Hypotheses	Path	Support	Regression weight
$H_{1:}$	SQ→PU	Yes	0.432**
$H_{2:}$	SQ→ATT	Yes	0.263**
$H_{3:}$	SQ→BI	No	_
New path	*SQ→PEOU*	Yes	0.567**
$H_{4:}$	PSE→PEOU	Yes	0.435**
$H_{5:}$	PSE→PU	Yes	0.239**
$H_{6:}$	FC→PEOU	No	_
H_7	FC→ATT	Yes	0.062**
$H_{8:}$	PEOU→PU	Yes	0.184*
$H_{9:}$	PEOU→ATT	Yes	0.20**
$H_{10:}$	PU→ATT	Yes	0.53**
$H_{11:}$	PU→BI	Yes	0.31**

$H_{12:}$	ATT→BI	Yes	0.72**
$H_{13:}$	BI→AU	Yes	0.47**

*P<.05, ** P<.001

Note: SQ= System Quality, PSE= Perceived Self-efficacy, FC= Facilitating Conditions, PEOU= Perceived Ease of Use, PU= Perceived Usefulness, ATT= Attitude Toward Using, BI= Behavioral Intention to use, AU= Actual Use

All three exogenous variables (SQ, PSE and FC) were found statistically significant determinants of the five endogenous variables (PEOU, PU, ATT, BI and AU) (Figure 6).

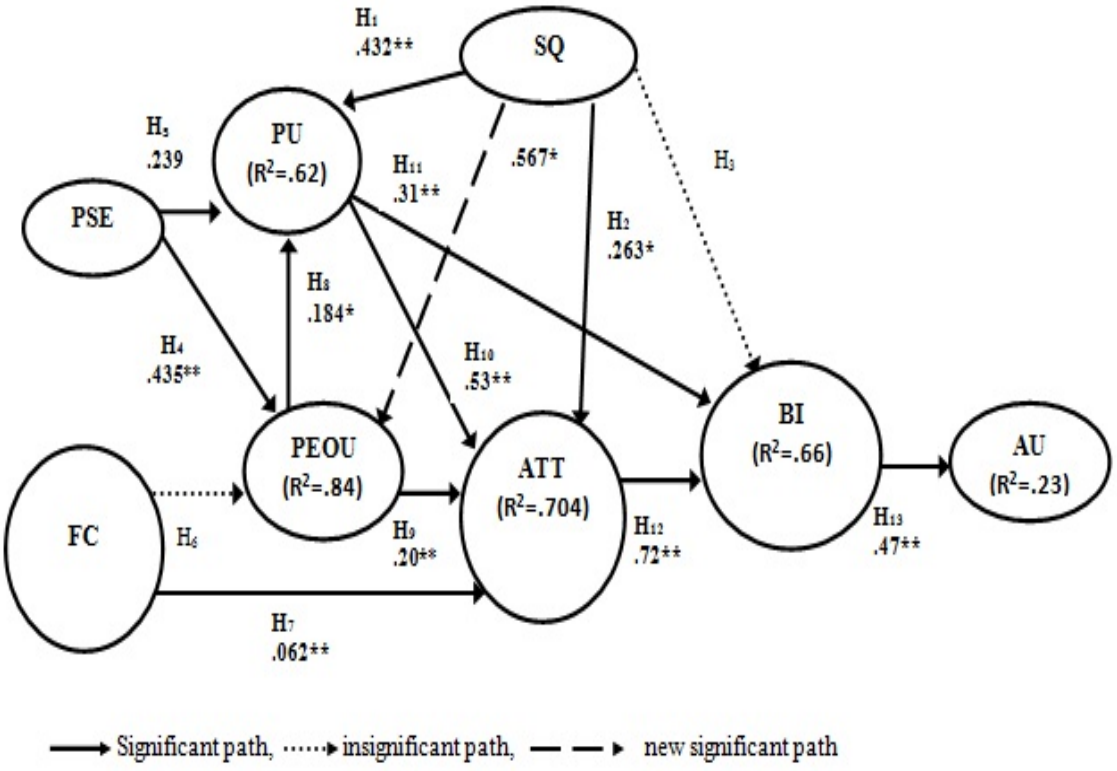

Figure 6. Results of the structural model for faculty attitudes toward LMS.

Note: SQ= System Quality, PSE= Perceived Self-efficacy, FC= Facilitating Conditions, PEOU= Perceived Ease of Use, PU= Perceived Usefulness, ATT= Attitude Toward Using, BI= Behavioral Intention to use, AU= Actual Use

The endogenous variable PU was found to be significantly determined by three variables SQ (β = .432, p <.001), PSE (β = .239, p <.001) and PEOU (β = .184, p <.05), resulting in an R^2 of .62, which means that the SQ, PSE and PEOU jointly accounted for 62% of the variance in PU. Similarly, PEOU was significantly determined by PSE (β = .435, p <.001) and SQ (β = .567, p <.001) resulting in an R^2 of .84, indicating 84% of the variance of PEOU is explained by FC and PSE. ATT was significantly determined by SQ (β = .263, p <.001), FC (β = .062, p <.05), PU (β = .53, p <.001) and PEOU (β = .20, p <.001) resulting in an R^2 of .704 indicating 70.4% of the variance in ATT is explained by these four (SQ, FC, PU and PEOU) variables. BI was found to be significantly determined by PU (β = .31, p <.001) and ATT (β = .72, p <.001), resulting in an R^2 of .66, which means that PU and ATT accounted for 66% of the variance in BI. Finally AU was significantly determined by BI (β = .47, p <.001), resulting in an R^2 of .23 which

indicates that 23% of the variance in AU is accounted by BI (Figure 6).Therefore, the results indicated that the extended technology acceptance model had high predictive power in determining the faculty member's LMS usage behavior.

Discussion and Conclusion

This study identified the factors that influence faculty members' attitudes toward LMS and determine the underlying causal relationships among the factors using the proposed extension of original TAM framework. By collecting data from a sample of 560 faculty members from two universities in the US, the study results generally supported the proposed model with minor revisions and confirmed the significant influence of perceived self-efficacy (PSE), systems quality (SQ) and facilitating conditions (FC) on the use of LMS by faculty members in higher educational institutions.

The results of this study revealed that system quality (SQ) had significant positive effect on perceived ease of use (PEOU) and perceived usefulness (PU) of LMS. This indicates that faculty members place emphasis on the quality issues (i.e., functions, contents, navigation speed, and interaction capability) of LMS. Also the results indicated SQ had significant positive effect on faculty members' attitude towards LMS. These findings are in line with recent LMS studies that reported several system issues like: suitability of design in screen and system, easiness of course procedure, interoperability of system, easiness of instruction management and appropriateness of multimedia use, flexibility of interaction and test, learner control, variety of communication and test types and user accessibility as important LMS features that directly or indirectly benefit LMS or e-learning users and influence their attitudes towards LMS (Fathema & Sutton, 2013; Kim & Leet, 2008; Weaver et. al,2008; Panda & Mishra, 2007; Pituch & Lee, 2006; Russell, et.al.,2003).

Consistent with the findings of previous studies, faculty perceived self-efficacy (PSE) was also found to be a significant factor in determining their usage of technology (Holden & Rada, 2011, Panda & Mishra, 2007, Pajo & Wallace, 2001). In addition, PSE was found to be a significant determinant of perceived ease of use (PEOU) (Yuen & Ma, 2008; Roca, et.al., 2006; Pituch & Lee, 2006; Ong & Lai, 2006; ;Grandon et.al., 2005; Ong et. al., 2004) and perceived usefulness (PU) (Ong & Lai, 2006; Ong, et.al., 2004). These findings indicated that faculty members with higher self-efficacy find LMS useful and easy to use comparative to faculty members with lower self-efficacy. In other words, faculty members who are confident about their LMS skills (i.e. operating basic features, LMS functions, online learning contents) perceive LMS as a useful technology to use and experience lower complexity using it. Consequently, confident faculty members use LMS more than the less confident ones.

The study also revealed a weak positive effect of facilitating conditions (FC) on attitudes (ATT) toward using technology and perceived ease of use (PEOU). It could be possible that faculty members develop positive attitudes toward LMS if adequate facilitating conditions (i.e., adequate guidance on LMS use, personal/ group assistance, specialized instructions concerning LMS use)) are available. Another possible explanation of finding a weak relationship can be, if LMS quality is really high and faculty members have high self-efficacy than they do not care as much about or have a need for the availability of facilitating conditions (facilities, training etc.) for using LMS. This finding contradicts McGill, Klobas, and Renzi, (2011), who reported no effect on facilitating conditions on LMS utilization by instructors. However, the current findings partially support Teo (2010) f where he reported that facilitating conditions had significant positive effects on ATT and PEOU. Also the current findings are alignment with Panda and Mishra's (2007) findings that indicated inadequate FC is one of the most important barriers of LMS usage by faculty members.

Findings from the current study also support research pertaining to the strong relationships among PU, PEOU and ATT in the context of teachers' technology usage. In line with prior findings, perceived usefulness (PU) of LMS was significantly determined by the perceived ease of use (PEOU) of LMS and faculty members behavioral intention (BI) to use LMS was significantly determined by the perceived usefulness (PU) of the LMS (Hu, Clark & Ma, 2003). In addition, this study revealed significant effects of perceived usefulness (PU) (Holden & Rada, 2011) and perceived ease of use (PEOU) (Lee, Hsieh and Chen 2013) on faculty attitudes (ATT) toward LMS. The positive effect of ATT on BI (Farahat, 2012) and positive effect of BI on AU (Wang & Wang 2009) are also supported. These findings further validated

Davis's (1989) claim. In the context of LMS usage, Davis's (1989)'s claims can be restated as: first faculty members evaluate how easy or difficult it is to work with the LMS, then they look at the usefulness of it for them. If they find it as an 'easy to use' and 'useful' technology for them then they develop a positive attitude towards it. The positive attitudes lead them to develop a positive intention to use it. Finally their positive intention influences their actual use of LMS. Hence, all original TAM constructs significantly predicted intention to use LMS and actual use of LMS. Also, the three external constructs: system quality, perceived self-efficacy and facilitating conditions directly or indirectly influenced faculty members' attitude towards LMS, behavioral intention to use LMS and their actual use of LMS. These provide support for the validity of the proposed extension of original TAM in explaining faculty attitude toward LMSs.

Implications

The results provide important issues to be considered to ensure increased use of LMS by faculty members in higher education. Based on the study results, we would offer the following recommendations:

The study found that system quality is a strong salient factor that shapes faculty member's LMS use. Therefore, LMS designers and university policy makers should concentrate more efforts on the quality improvement of LMS to make it more usable to the faculty members. User-friendliness, easy accessibility and reliability are important areas to focus on. The interface, features, functions, contents, navigation speed, interaction capability etc., of the LMS should be periodically monitored and improved according to the faculty members need. To maintain better quality, a continuous quality improvement process should be conducted which will collect feedback from the LMS users about the quality issues, problems and recommendation for improvement and will plan for LMS improvement actions accordingly. It is important to ensure that universities periodically collect information from LMS users (i.e. faculty members' and students) about their experiences with LMS usage, problems they are facing and their recommendations about improvement of LMS. Based on the information collected, universities should improve and update LMS so that it can support the users more efficiently.

The study results revealed that self-efficacy was significant and salient factor in determining users' acceptance of LMS. Therefore, once a new LMS is adopted, it is important to inform the faculty members about the features, usefulness, and technical issues of it so that they can gain an in-depth understanding of the features of the LMS and feel confident using it. Fathema and Sutton (2013) reported that faculty members would like universities to offer extensive training, workshops and awareness programs on LMS features, usage and benefits to help increase the faculty use of LMSs. Moreover, in a recent national survey, 57% of faculty indicated that they would be more effective if they were better skilled in using LMS technology in their courses (Dahlstrom, et. al., 2014). In the same study, faculty members also indicated that they would be motivated to learn and use LMS more if they are aware that there is clear evidence of the positive impact of such technology on student learning. Therefore, to increase faculty self-efficacy and to ensure increased use of LMS by faculty, universities should offer periodic training programs and extended online help for LMS use. These would help faculty members get more hands-on experiences, gain improved skills and become more competent in using LMS which in turn, will increase their LMS use.

Our results indicated that, though not extensive, facilitating conditions had a weak influence on faculty attitudes toward LMS. Therefore, universities need to pay attention to ensure availability of reliable network access and technological support to ensure smooth running of LMS. Also universities should provide extensive online and face-to-face support and guidance for faculty members to ensure faculty members positive attitudes toward LMS which will in turn ensure extended use of LMS by them (Panda & Mishra, 2007, Hustad & Arntzen, 2013).

Limitations and future directions

The study has some limitations. The study is based on a single LMS example. Using a purposive sampling approach, data were collected only from two universities; therefore results of the study may be restricted to the particular settings. Replication of this study in other settings and sample groups would help understanding the implications of this extended TAM. Future researchers should strongly consider evaluating the impact of the three significant external variables (system quality, perceived self-efficacy and facilitating conditions) on acceptance and usage behavior of different populations and different LMSs.

A follow-up qualitative study to know more about the faculty members' perspectives about LMS would be an important future research direction.

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Appendix

Measurement items in the Survey Questionnaire

System Quality (SQ)	
SQ1	I am satisfied with the CANVAS functions
SQ2	I am satisfied with the Internet Speed
SQ3	I am satisfied with the CANVAS content
SQ4	I am satisfied with CANVAS interaction
Perceived Self-Efficacy (PSE)	
PSE1	I feel confident using CANVAS features
PSE2	I feel confident operating CANVAS functions
PSE3	I feel confident using Online learning content in CANVAS
Facilitating conditions (FC)	
FC1	When I need help to use CANVAS guidance is available to me
FC2	A specific person / group is available for assistance with any difficulties related with CANVAS use

FC3	Specialized instruction concerning CANVAS use is available to me
Perceived Ease of Use (PEOU)	
PEOU1	My interaction with CANVAS is clear and understandable
PEOU2	Interacting with CANVAS does not require a lot of my mental effort
PEOU3	I find CANVAS to be easy to use
PEOU4	I find it easy to get CANVAS to do what I want it to do
Perceived Usefulness (PU)	
PU1	Using CANVAS improves my performance as a faculty member
PU2	Using CANVAS in my job increases my productivity
PU3	Using CANVAS enhances my effectiveness in my job
PU4	I find CANVAS to be useful in my job
Attitude toward Using (ATT)	
ATT1	I think it is worthwhile to use CANVAS
ATT2	I like using CANVAS
ATT3	In my opinion, it is very desirable to use CANVAS for academic and related purposes
ATT4	I have a generally favorable attitude toward using CANVAS
Behavioral Intention to Use (BI)	
BI1	I intend to use the functions and content of CANVAS to assist my academic activities
BI2	I intend to use the functions and content of CANVAS as often as possible
BI3	I intend to use the functions and content of CANVAS in the future
Actual Use (AU)	
AU1	Overall to what extent do you use CANVAS?
AU2	To what extent did you use CANVAS last month?
AU3	To what extent did you use CANVAS last week?

Source: Fathema, N. (2013). *Structural Equation Modeling (SEM) of an extended Technology Acceptance Model (TAM) to report web technology adoption behavior in higher education institutions* (Ph.D thesis). Auburn University, Auburn, AL, United States.