

The Mediating Role of Learning Management System Use in Enhancing System Effectiveness

LUBNA A. HUSSEIN¹, KHALID ALQARNI², MOHD F. HILMI¹, MOHAMED F. AGINA^{3,4,5},
NAWAL SHIRAWIA⁶, KHALID I. ABDELREHEEM³, THOWAYEB HASSAN⁷,
MOHAMMAD A. TASHTOUSH^{8,6*}

¹School of Distance Education, Universiti Sains Malaysia,
Penang,
MALAYSIA

²Management Information Systems Department, Faculty of Economics and Administration,
King Abdulaziz University,
Jeddah,
SAUDI ARABIA

³Hotel Management Department, Higher Institute for Specific Studies,
Cairo,
EGYPT

⁴Business Administration Department, Faculty of Business Administration,
Stardom University,
Istanbul,
TURKEY

⁵Mid Ocean University,
Fujairah,
UNITED ARAB EMIRATES

⁶Mathematics Education Department, Faculty of Education & Arts,
Sohar University,
Sohar,
OMAN

⁷Tourism Studies Department, Faculty of Tourism and Hotel Management,
Helwan University,
Cairo,
EGYPT

⁸Department of Basic Science,
AL-Huson University College, AL-Balqa Applied University,
Al Salt,
JORDAN

Abstract: - The increasing prevalence of Learning Management Systems (LMS) in higher education worldwide highlights the importance of investigating LMS effectiveness. This is especially pivotal for the successful execution of the national agenda promoting globalized online education. Given the near-mandatory nature of LMS adoption in higher education, the emphasis shifts from the intention to use the LMS to understanding how the utilization of LMS contributes to its effectiveness. The premise is that students who actively engage with the LMS are likely to perceive it as an effective tool for their educational needs. Therefore, this study aims to construct a model for LMS effectiveness within Malaysian universities, utilizing the Technology Acceptance Model (TAM) with LMS use as the mediating factor. The fundamental TAM factors, along with two additional

elements: student self-efficacy and student attitude have been employed as predictor variables. Our Partial Least Squares analysis results reveal a noteworthy mediating role of LMS use in the relationship between student self-efficacy and LMS effectiveness, as well as between student attitude and LMS effectiveness. Moreover, the impact of LMS use on LMS effectiveness is found to be substantial.

Key-Words: - Mediation Factor, Learning Management System, Student Attitude, Student Self-Efficacy, Learning Management System use, Technology Acceptance Model, Malaysia.

Received: March 29, 2024. Revised: August 24, 2024. Accepted: September 26, 2024. Published: October 24, 2024.

1 Introduction

The Learning Management System (LMS), which contains significant functions towards facilitating student learning, has the potential to increase learning effectiveness because it also gives freedom of learning accessibility irrespective of time and location. The advantages of the LMS include the availability of a flexible set of learning activities in the form of forums, assignments, quizzes, and workshops, the automation of reminders to users such as instructions and important dates, and the compatibility of communication methods among users within the same system, [1], [2]. LMS effectiveness is fundamental to students' motivation in online studies. Different concepts of measurement have been employed to examine the effectiveness of learning technologies including LMS. The performance and actual accomplishment have been used to evaluate LMS effectiveness, [3]. The LMS efficiency has been measured with respect to user-system interaction. The efficiency of the LMS can be measured by the time required to complete the task and accuracy of task completion, [4]. The LMS effectiveness has also been measured in respect of performance and satisfaction, [5]. However, such a measurement is situational and time-bound since it considers only prior experiences and ignores the evaluation of potential learning opportunities and benefits. This study has been carried out to examine the effectiveness of LMS in higher education from the impressions of students towards LMS. The motivation behind the present study is the necessity of attaining LMS effectiveness in the teaching-learning process, [6].

To assess the potential learning opportunities and benefits for learners, researchers have employed students' perception of potential learning of the learning technology. Researchers have considered the perception of potential learning of the technology by students to measure the effectiveness of the technology, [7], [8].

The Technology Acceptance Model (TAM) has been employed in various applications to examine the Educational Technological Systems employment

of Edmodo Content Management Systems (ECMS) in learning platforms, [9] and YouTube as a shot for teaching-learning, [10]. A systematic review of TAM in learning and teaching has concluded that TAM is a prevailing model, [11]. The outcomes of that systematic review of articles also establish that perceived usefulness and perceived ease of use are the antecedent variables that affect acceptance of technology, such as LMS, and both the variables are fundamental in TAM. However, other than the fundamental variables, students' attitudes and students' self-efficacy have also been employed in the TAM framework.

It has been shown that student attitude has a significant effect on LMS use, [12], [13] as well as towards LMS usage behavioral intention, [14], [15]. Meanwhile, student self-efficacy has been found to have a significant influence on LMS use, [16]. In a study where LMS use is considered self-directed learning, student self-efficacy was found to be a driving factor, [17]. Therefore, enhanced student self-efficacy is a factor capable of encouraging LMS use, [18].

E-learning is in the National Key Result Area of the Malaysian Ministry of Higher Education with globalized online education as a national agenda, [19]. For the realization of the success scenario of the globalized online education agenda of Malaysia, it is crucial to observe the LMS effectiveness among students in terms of the potential enhancement of their learning experience and benefits. In a study on LMS effectiveness, it has been asserted that insignificant results of certain variables towards LMS use could be possible because LMS use is almost mandatory for the students, [20]. Nevertheless, further results of that study indicate a significant relationship between LMS use and LMS effectiveness.

Taking into consideration the immense deployment of the LMS and the almost mandatory utilization of the LMS in universities, it is relevant to focus on how the LMS use would lead to LMS effectiveness, where students who embrace the LMS would probably find that the LMS is effective.

Moreover, LMS use has been found to have a significant effect on LMS effectiveness among students, indicating that the effectiveness of learning is the result of higher LMS use, [21]. Therefore, LMS use should be considered as a mediation factor in modeling LMS effectiveness. Hence, the purpose of this study is to determine significant factors that contribute to the LMS effectiveness among university students in Malaysia based on the TAM framework, with LMS use as the mediating factor between the predictor variables and LMS effectiveness.

In this paper, the first section explains the background and motivational aspects of the study. Section 2 provides the theoretical background of the TAM model used in this study, while a detailed description of the proposed research model is given in Section 3, which includes the formulation of hypotheses. Section 4 elaborates on the methods, and the results are explained in Section 5. A discussion of the results pertaining to the formulated hypotheses is given in Section 6, while Section 7 provides a summary, including the implications of the study as well as possible future research.

2 Theoretical Backgrounds

Initially introduced by [22], TAM is a framework for technology adoption. Its initial focus is to predict and assess user willingness to accept technology using two core variables. TAM investigates the relationships between its core variables: perceived usefulness of the technology and perceived ease of use, with user attitude, and with the behavioral intention of technology adoption. In the framework, intention to adopt the technology and user attitude toward the technology is expected to be impacted by both core factors.

In education, there has been a great deal of research studies involving the TAM framework, indicating the immense applicability of the model framework for e-learning in general, [23], [24], [25], [26] and for the LMS, [27], [28], [29]. Several studies on the LMS based on the framework of TAM have been carried out to study usage and adoption in Malaysia, [30], [31]. Therefore, TAM is a credible model for assessing the utilization of technology in the context of education.

3 Research Framework

This study focuses on the mediation effect of LMS use towards the prediction of LMS effectiveness. In the proposed model, LMS effectiveness is the

dependent variable while student self-efficacy, student attitude, and the two core factors of TAM are the predictor variables. LMS use is considered the mediating variable between the four predictor variables and the dependent variable LMS effectiveness. In this study, the predictor variables are utilized as exogenous variables which means that each of them is not influenced by other variables in the framework.

3.1 Learning Management System Effectiveness

Learning effectiveness generally refers to the extent to which learners believe that their knowledge and skills have been developed or enhanced, [32]. Learners anticipate that using LMS will assist them in their pursuit of knowledge more efficiently. The more they perceive the effectiveness of the LMS, the more the motivation of the learners to use the LMS, [33].

Learning effectiveness has been studied extensively and its definition has been operationalized in various ways, from the utilization of actual measures such as assessment marks to perception-based measures. Learners can be asked to give opinions on how effective a certain learning aid is in assisting them with learning, [34]. LMS effectiveness (LE) refers to how well the students believe that they have enhanced their knowledge and skills through the LMS.

In this study, the operational definition of LMS effectiveness is the extent to of learners' believe that the LMS can assist them in acquiring knowledge, skills, and motivation.

3.2 Learning Management System Use

LMS usage typically refers to the extent of learners' usage of the LMS. The basic idea is that the higher the usage of a technological system, the higher the success of system utilization, [35]. With respect to the LMS, the higher the frequency and efficiency of use, the higher the likeliness of improving learning outcomes, [36]. Although LMS use can be measured as the actual use by students, this form of measurement is limited to specific circumstances of student learning. Therefore, this study employs a more general measurement where the operational definition of LMS use (LU) is the extent to which students believe they embrace the use of the LMS.

3.3 Perceived Usefulness

Perceived usefulness refers to the extent of the learners' belief that using the LMS would enhance their learning performance, [37]. Research suggests

that the acceptability of LMS can be greatly influenced by how users view its usefulness in terms of enhancing learning performance and value, [38]. Students will not hesitate to use the LMS if they believe that it will help them achieve their academic goals. Moreover, the utilization of the LMS would be more evident as students recognized its practicality.

The operational concept of perceived usefulness (PU) in this study refers to the degree to which students consider that using an LMS can enhance their learning process and productivity.

The hypothesis relating perceived usefulness and LMS use is formulated as follows:

H1: Perceived usefulness has a positive impact on the learning management system use.

3.4 Perceived Ease of Use

Students' perceived ease of use of the educational learning system is defined as their belief that utilizing it will be simple and won't take unnecessary effort, [26]. Put another way, it's the amount of work they expect to put in to be able to use the LMS. As students become capable of dealing with LMS effortlessly, their LMS use would be enhanced, [37].

In this study, the operational definition of perceived ease of use (PEOU) is the extent to which a student believes that very minimal effort physically and mentally would be involved in using the LMS. The hypothesis relating perceived ease of use and LMS use is formulated as follows:

H2: Perceived ease of use has a positive impact on the learning management system use.

3.5 Student Self-efficacy

High self-efficacy has been found to be important in online learning towards self-directed learning, [39]. Generally, self-efficacy is the degree of students' belief in their capabilities to achieve a specific outcome, [26], [40]. It is considered important towards the embracement of online learning including the LMS, [18], [41].

In this study, the operational definition of student self-efficacy (SSE) is the degree to which students believe in their capabilities and skills to use the LMS towards achieving some specific outcomes. Students with higher level of confidence in their capabilities to achieve their learning outcome through the LMS would have a higher level of LMS use. Therefore, the hypothesis relating student self-efficacy and LMS use is formulated as follows:

H3: Student self-efficacy has a positive impact on the learning management system use.

3.6 Student Attitude

Student attitude can be defined as the extent of the student's belief that the LMS is capable and useful towards completing their study activities such as exams and assignments, [40], [42].

In the current study, the operational definition of student attitude (SA) is the degree to which students believe in the capabilities and advantages of the LMS and the amount of introductory work required to use the LMS. A student with a high level of confidence in the LMS would believe that LMS use would be useful in their studies. This leads to the following hypothesis relating to student attitude and LMS use is formulated as follows:

H4: SA has a positive impact on the LMS use.

3.7 Formulation of Hypotheses

This study considers the dependent variable, LMS effectiveness, and LMS use, as mediation factors between LMS effectiveness and each of the 4-predictor variables. However, the corresponding hypotheses are formulated as follows:

H5: Learning management system use has a positive impact on learning management system effectiveness.

H6: Learning management system use mediates the relationship between perceived usefulness and learning management system effectiveness.

H7: Learning management system use mediates the relationship between perceived ease of use and learning management system effectiveness.

H8: Learning management system use mediates the relationship between student self-efficacy and learning management system effectiveness.

H9: Learning management system use mediates the relationship between student attitude and learning management system effectiveness.

4 Methodology

In this vein, the target population of the study is LMS users among students at public universities in Malaysia. These universities have been selected where both utilize Moodle-based LMS platforms.

Data has been gathered using a convenience sampling strategy. Convenience sampling is a form of non-probability sampling approach in which the sample is drawn from a group of people who are easy to contact or reach.

To investigate the predictors of LMS effectiveness, an online survey questionnaire has been used in this study. Data collection has been conducted through a GOOGLE form. The links to the form have been shared with the students through

the WhatsApp group of lecturers as well as through emails of the students.

The questionnaire contains two sections: the first section is about the demographic profile of the participants, while the second section is about the responses of the participants regarding key constructs of the research framework.

For Section One, the total of 212 respondents, female and male respondents constitute 66% (n=140) and 34% (n =72) respectively. In terms of age category of the respondents, the youngsters aged 18 to 20 hold the highest percentage at 58.5% (n=124), and the second highest percentage consists of those aged above 24 years old at 29.7% (n=63), while the remaining 11.8% (n=25) are in the age category of 21.

The Second section of the questionnaire focuses on responses regarding the key constructs of the research framework. This section consists of 22 items capturing responses on a seven-point Likert scale ranging from (1) "Strongly disagree" to (7) "Strongly agree". The details of the construct measurement which have been adopted from previous studies are given in Table 1.

5 Findings

The analysis of the data obtained from the questionnaire items has been done using the PLS method. The PLS analysis consists of two steps. In the first step, the measurement model is assessed through several indicators, and this is followed by the assessment of the structural model in the second step, which involves the testing of the formulated hypotheses.

5.1 Measurement Model

The first step in the two-step PLS analysis involves the assessment of the measurement model. The assessment of the individual measurement construct is based upon values of construct main loadings, values of average variance extracted (AVE), values of Cronbach's alpha, and composite reliability (CR).

As a general requirement, all the main loading values should be more than 0.708 while the CR value for each construct should be more than 0.7, [43]. Cronbach's alpha values between 0.8 and 0.9 are considered very well, while values greater than 0.9 are considered exceptional, [44].

The AVE measures the level of variance expressed by a construct in comparison to the level of variance due to measurement error where values above 0.7 are considered very good whereas values

as low as 0.5 are acceptable for indicating convergent validity, [43].

Table 1. Construct Measurement

Construct	Code	Questionnaire Items	Source
Perceived usefulness	PU1	Using LMS will allow me to accomplish learning tasks more quickly.	[37]
	PU2	Using LMS will make it easier to learn course content.	
	PU3	Using LMS will increase my learning productivity.	
	PU4	Using LMS will enhance my effectiveness in learning.	
Perceived ease of use	PEOU1	I find it easy to get LMS to do what I want it to do.	[37]
	PEOU2	My interaction with the LMS is clear and understandable.	
	PEOU3	It is easy for me to become skillful at using the LMS.	
	PEOU4	It is easy to get materials from the LMS.	
Student Self-efficacy	SSE1	I feel confident when using the LMS applications.	[40]
	SSE2	I enjoy using the LMS application and its functionalities.	
	SSE3	LMS has led to an improvement in my learning skills and performance.	
	SSE4	I have a high level of skills in using the internet for LMS.	
Student Attitude	SA1	I believe that LMS is a very useful tool for online courses.	[40]
	SA2	I believe that LMS can be integrated with conventional learning to receive the benefits of both learning methods	
	SA3	The LMS platform provides flexibility toward learning.	
	SA4	I believe a level of training and assistance is required when introduced to LMS.	
LMS Use	LU 1	Using LMS is a good idea.	[36]
	LU 2	Working with LMS is a pleasure.	
	LU 3	I like working with LMS.	
LMS Effectiveness	LE1	The LMS can assist in learning performance.	[7]
	LE2	The LMS can assist learning effectively.	
	LE3	The LMS can assist in learning motivation.	

The results of the assessment of the measurement model are tabulated in Table 2. The main loading values of all the construct items utilized in this study have been observed to be more than 0.8 where the minimum value of the main loading is 0.889 and the maximum value is 0.958, which subsequently meets the assessment requirement of more than 0.708. It is also found that all the AVE values of all the constructs are greater than 0.7, which shows that the convergent validity is confirmed. As for Cronbach's alpha, the values observed for each of the six constructs employed in this study are considered exceptional where all of them are found to be greater than 0.9. Meanwhile, for the CR, which is a less biased estimate of reliability than Cronbach's alpha, it has been found that the obtained values are all larger than 0.7, which indicates high levels of internal reliability of the constructs.

Table 2. Results of measurement construct assessment

Construct	Item	Main loading	AVE	Cronbach's alpha	CR
Perceived usefulness	PU1	0.908	0.827	0.93	0.95
	PU2	0.902			
	PU3	0.913			
	PU4	0.916			
Perceived ease of use	PEOU1	0.891	0.821	0.927	0.948
	PEOU2	0.923			
	PEOU3	0.920			
	PEOU4	0.889			
Student self-efficacy	SSE1	0.894	0.818	0.926	0.947
	SSE2	0.913			
	SSE3	0.907			
	SSE4	0.904			
Student attitude	SA1	0.916	0.839	0.936	0.954
	SA2	0.910			
	SA3	0.933			
	SA4	0.905			
LMS use	LU1	0.927	0.877	0.929	0.955
	LU2	0.958			
	LU3	0.923			
LMS effectiveness	LE1	0.940	0.871	0.926	0.953
	LE2	0.943			
	LE3	0.916			

We use the discriminant validity criterion to evaluate the individual measurement construct in relation to other constructs in the same model. The aim is to emphasize the uniqueness of each construct in the suggested model. This investigation employs the, [45] criterion for discriminant validity. Based on the need that a given construct has more

variance with its own indicators than with any other construct in the model, this criterion was developed. The square root of the AVE values for each construct must be greater than the squared correlation values of that construct with any other construct in order to satisfy this criterion, [43].

The obtained square roots of the AVEs for the constructs used in this study are given in bold print in Table 3. It can be observed that each square root value of the AVEs for the respective construct is greater than all the off-diagonal values, indicating that the required discriminant validity has been achieved for each construct.

Table 3. Results of discriminant validity of constructs

Construct	1	2	3	4	5	6
Perceived ease of use	0.906					
Perceived usefulness	0.870	0.910				
Student attitude	0.814	0.808	0.916			
Student self-efficacy	0.837	0.828	0.870	0.905		
LMS effectiveness	0.794	0.809	0.870	0.842	0.936	
LMS use	0.836	0.860	0.800	0.798	0.834	0.933

Note: The values given in bold in the diagonals are the square root of the AVE of the respective construct. All the off-diagonal values represent the squared correlations of the respective pair of constructs

5.2 Structural Model and Hypothesis Testing

The second step in the two-step PLS analysis is the assessment of the structural model. Towards the assessment of path relationship with respect to the formulated hypotheses based on the proposed model, a standard bootstrapping procedure in PLS has been carried out. The hypothesis testing results of H1-H5 are tabulated in Table 4 and the illustration of the path analysis for direct effects is depicted in Figure 1. The exogenous and endogenous variables used in this study have also been clearly illustrated in Figure 1. An exogenous variable has paths leading to other variables but with no paths leading to it while an endogenous variable must have at least one path leading to it. For the endogeneous variables in this study, LU has four direct paths leading to it and LE has one.

From the corresponding t-values in Figure 1, it can be observed that among the four exogenous or predictor variables for LU, three variables are significant. For example, the results for the exogenous variable PU for LU are significant with a t-value of 1.885 ($t > 1.645$; $p < 0.05$). Three direct paths $PU \rightarrow LU$, $SSE \rightarrow LU$, and $SA \rightarrow LU$ are

significant indicating that hypotheses H1, H3, and H4 are supported. As can be seen in Table 4, the three significant predictor variables for LU have positive coefficient values indicating the existence of a positive relationship as stated in the hypotheses. Among them, the variable SA has been found to have the highest coefficient value of +0.477. Effect size can be used to assess the contribution or the strength of the predictor variables towards the endogenous variable. Generally, values of 0.02, 0.15, and 0.35 have been used to categorize effect sizes into small, medium, and large categories, respectively, [46]. Table 4 also tabulates the effect size of the variables with respect to the direct effect on the endogenous variable LU where the three significant predictor variables have been found to be of large effect size with SA having the largest effect size of 0.241 followed by 0.047 for SSE and 0.039 for PU.

It can also be observed from Figure 1 that for the relationship between two endogenous variables LU and LE, the direct path LU → LE is found to be significant with a t-value of 22.267 ($t > 3.092$; $p < 0.001$). Consequently, hypothesis H5 is supported. In terms of effect size, the effect of LU on LE is in the large category where the value is 2.277 as tabulated in Table 4.

Table 4. Hypothesis testing of direct effect

Hypothesis	Path coefficient	Result	Effect size
H1: PU → LU	0.197	H1 Supported*	0.039
H2: PEOU → LU	0.048	H2 Not Supported	0.002
H3: SSE → LU	0.224	H3 Supported*	0.047
H4: SA → LU	0.477	H4 Supported***	0.241
H5: LU → LE	0.834	H5 Supported***	2.277

Note: * $p < 0.05$, $t > 1.645$; ** $p < 0.01$, $t > 2.327$; *** $p < 0.001$, $t > 3.092$ (one-tailed)

For the analysis of the mediation effect of the four relationships in the PLS structural model as hypothesized in hypotheses H6-H9, two mediating relationships of $SSE \rightarrow LU \rightarrow LE$ with t-value of 2.310 ($t > 1.96$; $p < 0.05$) and of $SA \rightarrow LU \rightarrow LE$ with t-value of 6.432 ($t > 2.58$; $p < 0.01$) have been found to be significant. Consequently, hypotheses H8 and H9 are supported as indicated in Table 5. The positive values of 0.187 and 0.398 tabulated in Table 5 for the path coefficients of the mediation effect in the PLS structural model for the two significant mediating relationships indicate the existence of a

positive relationship as formulated in hypotheses H8 and H9, respectively.

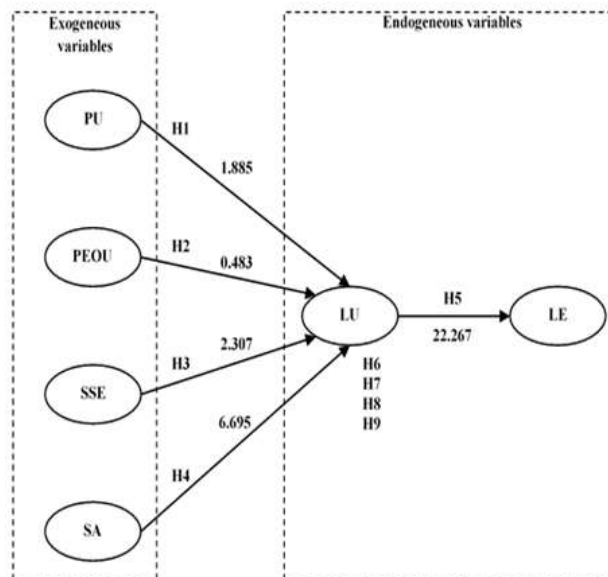


Fig. 1: PLS-Path analysis results of t-value

Table 5. Hypothesis testing of mediation effect

Hypothesis	Path coefficient	Result
H6: PU → LU → LE	0.164	H6 Not Supported
H7: PEOU → LU → LE	0.040	H7 Not Supported
H8: SSE → LU → LE	0.187	H8 Supported*
H9: SA → LU → LE	0.398	H9 Supported**

Note: * $p < 0.05$, $t > 1.96$, ** $p < 0.01$, $t > 2.58$ (two tailed)

To measure the predictive accuracy of the structural model, coefficient of determination values widely known as R^2 are obtained for the two endogenous variables LU and LE. The value of R^2 ranges from 0 to 1 where values higher than 0.75 are considered indicators of substantial predictive accuracy, and lower values which are higher than 0.5 are considered indicators of moderate accuracy while lower values that are higher than 0.25 are considered indicator of weak accuracy, [43]. Based on the results portrayed in Table 6, the predictive accuracy for LU has been found to be substantial accuracy while for LE it is considered moderate. The predictive accuracy for mediator variable LU shows that the predictor variables used in this study can explain 80% of the variance in LU; the remaining 20% could be due to other variables not included in this study. For the dependent variable LE, the resulting predictive accuracy indicates that the variables under study contribute to 69.5% of the

variance in LE; the remaining 30.5% may be due to other variables not included in this study.

Table 6. Predictive accuracy of endogenous variables

Endogenous Variable	R ²	Level of Accuracy
LMS usage (LU)	0.8	Substantial
LMS efficiency (LE)	0.695	Moderate

6 Discussion

In the first step of the two-step PLS analysis procedure of the proposed relationship model for LMS effectiveness, the measurement model has been successfully established with each individual construct having a high level of internal reliability and with the required discriminant validity. The second step of the procedure, which establishes the structural model, yields results pertaining to the testing of the formulated hypotheses.

For the direct effects of the relationship of the predictor variables with LMS use, results indicate that hypotheses H1, H3, and H4 are supported, which implies that three predictor variables are significant. Perceived usefulness, one of the TAM core variables, has a positive impact on LMS use by the students, while there is no evidence for the effect of perceived ease of use, the other TAM core variable, towards LMS use. In addition, there is a significant impact of student self-efficacy on LMS use. However, according to the effect size of the large category, student attitude has a significantly larger impact. Further results of direct effects also indicate that hypothesis H5 is supported, indicating that LMS use has a positive impact on LMS effectiveness. This implies that when students embrace the system, they will find the LMS more effective.

The findings in this research are like several studies on LMS usage. Student attitude has been found to be significant in distance learning in Malaysia, [31], while student self-efficacy has a significant effect in distance learning in Australia, [39]. Regarding the predictor variable perceived usefulness, similar significant findings have been found in studies on behavioral intention to use LMS in Uganda [47], the Philippines [48], Iran [49] and Turkey [41] giving support to the results of this research. For perceived ease of use, similarly, this variable has been found to be insignificant for the study on LMS in Uganda, [47]. Interestingly, a similar finding has been observed for this variable in the well-known study from the 1980s on behavioral intention to use certain computer software, where it has been suggested that the insignificance is due to

the familiarity of the students with that computer software, [50]. In this research, the demographic data indicate that 70.3% of the respondents are of age below 24. As such, the respondents would belong to the generation of “digital natives,” consisting of youngsters whose lives has been integrated with digital devices and technologies, [19]. Therefore, for this research, the insignificance of perceived ease of use is probably also due to the familiarity of the respondents with technologies including the LMS. However, several studies have reported perceived ease of use as significant towards intention to use the LMS, [41], [48], contradicting the results in this research.

For the indirect effect or the mediating effect of LMS use on LMS effectiveness, hypotheses H8 and H9 are supported. Therefore, the mediation of LMS use between student self-efficacy and LMS effectiveness as well as between student attitude and LMS effectiveness are significant. Since hypotheses H6 and H7 are not supported, it is concluded that the indirect relationships of perceived usefulness and perceived ease of use with the mediation of LMS use are insignificant in predicting LMS effectiveness.

7 Conclusion and Future Suggestions

This study has modeled the effectiveness of the LMS among university students based on the framework of TAM with LMS use as the mediation factor. LMS use has been found to have a significant effect in the mediation of two predictor variables with the LMS effectiveness, where the two predictor variables are student self-efficacy and student attitude. In other words, student self-efficacy and student attitude influence LMS use, which in turn, influences LMS efficiency. While student attitude has the highest effect on LMS use, perceived ease of use is deemed insignificant. Results also indicate that there is an insignificant mediation effect of LMS use between each of the two core variables of TAM and LMS efficiency.

Since LMS use yields not only a significant positive impact but also a large impact on LMS effectiveness, this immensely strengthens the implication that the more the students embrace the LMS, the more they will find it effective. The implication is crucial to Malaysia as well as other developing countries towards understanding the relevancy of having students embrace the use of the LMS towards instilling student’s belief of the effectiveness of the LMS in their universities This understanding is deemed crucial for the success of

the national agenda of globalized online education in Malaysia.

The resulting predictive accuracy for the LMS effectiveness obtained in this study indicates that approximately 30.5% of the variance of LMS effectiveness may be due to other variables that are not used in the study, thus giving the opportunity for further research in determining other variables contributing to LMS effectiveness.

For this study, the participants in LMS are students from public universities in Malaysia. Our suggestion for future researchers is to utilize cross-sectional surveys containing a larger population of students from a variety of developing nations.

Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this work, the authors used QuillBot to improve some sentences that needed improvement after the proofreading to make the manuscript easy to be read and understand. After using this tool or service, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication.

References:

- [1] Al-Handhali, B. A., Al Rasbi, A. T., & Sherimon, P. C. (2020). Advantages and disadvantages of learning Management System (LMS) at AOU Oman. *International Journal of Technology*, 1(2), 222-228.
- [2] Wardat, Y., Tashtoush, M., Alali, R., Saleh, S. (2024). Artificial Intelligence in Education: Mathematics Teachers' Perspectives, Practices and Challenges. *Iraqi Journal for Computer Science and Mathematics*, 5(1), 60-77.
- [3] Joshi, D., & Tejwani, S. (2020). Effectiveness of Developed Learning Management System in Terms of Achievement of B. Ed. Teacher Trainees. In *Role of ICT in Higher Education* (263-271). Apple Academic Press. DOI: 10.1201/9781003130864-21.
- [4] Alomari, M. M., El-Kanj, H., Alshdaifat, N. I., & Topal, A. (2020). A framework for the impact of human factors on the effectiveness of learning management systems. *IEEE Access*, 8, 23542-23558. <https://doi.org/10.1109/ACCESS.2020.2970278>.
- [5] Furqon, M., Sinaga, P., Liliasari, L. L., & Riza, S. L. (2023). The Impact of Learning Management System (LMS) Usage on Students. *TEM Journal*, 12(2), 1082-1089. <https://doi.org/10.18421/TEM122-54>.
- [6] Muruthy, A. E., & Yamin, F. M. (2017). The Perception and Effectiveness of Learning Management System (LMS) Usage among the Higher Education Students. *Journal of Technology and Operations Management*, 12(1), 86-98.
- [7] Wang, Y., Wang, Y., Lin, H., & Tsai, T. (2019). Developing and validating a model for assessing paid mobile learning app success. *Interactive Learning Environments*, 27(4), 458-477. <https://doi.org/10.1080/10494820.2018.1484773>.
- [8] Tashtoush, M., Wardat, Y., & Elsayed, A. (2023). Mathematics Distance Learning and Learning Loss during COVID-19 Pandemic: Teachers' Perspectives. *Journal of Higher Education Theory and Practice*, 23(5) 162-174. <https://doi.org/10.33423/jhetp.v23i5.5933>.
- [9] Zain, F. M., Hanafi, E., Don, Y., Yaakob, M. F. M., & Sailin, S. N. (2019). Investigating Student's Acceptance of an EDMODO Content Management System. *International Journal of Instruction*, 12(4), 1-16. <https://doi.org/10.29333/iji.2019.1241a>.
- [10] Maziriri, E. T., Gapa, P., & Chuchu, T. (2020). Student Perceptions Towards the use of YouTube as An Educational Tool for Learning and Tutorials. *International Journal of Instruction*, 13(2), 119-138. <https://doi.org/10.29333/iji.2020.1329a>.
- [11] Granić, A., & Marangunić, N. (2019). Technology Acceptance Model in Educational Context: A Systematic Literature Review. *British Journal of Educational Technology*, 50(5), 2572-2593. <https://doi.org/10.1111/bjet.12864>.
- [12] Govender, I., & Grange, R. I. Evaluating the early adoption of Moodle at a higher education institution. 14th European Conference on e-Learning (p. 230). Academic Conferences International Limited, Hatfield, United Kingdom 29-30 October 2015, [Online]. <https://www.h2020.md/en/14th-european-conference-e-learning-ecel-2015-hatfield-uk> (Accessed Date: May 13, 2024).
- [13] Mundir & Umiarso. (2022). Students' Attitudes toward Learning Management System (LMS) During Covid-19 Pandemic: A Case Study. *Lentera Pendidikan: Jurnal Ilmu*

- Tarbiyah dan Keguruan*, 25(1), 68-81.
<https://doi.org/10.24252/lp.2022v25n1i6>.
- [14] Hussein, Z. (2017). Leading to intention: The role of attitude in relation to technology acceptance model in e-learning. *Procedia Computer Science*, 105, 159-164.
<https://doi.org/10.1016/j.procs.2017.01.196>.
- [15] Cavus, N., Mohammed, Y. B., & Yakubu, M. N. (2021). Determinants of Learning Management Systems during COVID-19 Pandemic for Sustainable Education. *Sustainability*, 13(9), 1-23.
<https://doi.org/10.3390/su13095189>.
- [16] Kundu, A. (2020). Toward a framework for strengthening participants' self-efficacy in online education. *Asian Association of Open Universities Journal*, 15(3), 351-370.
<https://doi.org/10.1108/AAOUJ-06-2020-0039>.
- [17] Fang, C., Kayad, F., & Misieng, J. (2019). Malaysian Undergraduates' Behavioural Intention to Use LMS: An Extended Self-Directed Learning Technology Acceptance Model (SDLTAM). *Journal of ELT Research: The Academic Journal of Studies in English Language Teaching and Learning*, pp.8-25.
https://doi.org/10.22236/JER_Vol4Issue1pp8-25.
- [18] Alshammari, S. H. (2020). The Influence of Technical Support, Perceived Self-efficacy, and Instructional Design on Students' Use of Learning Management Systems. *Turkish Online Journal of Distance Education (TOJDE)*, 21(3), 112-141.
<https://doi.org/10.17718/tojde.762034>.
- [19] Ministry of Higher Education Malaysia. (2015). Ministry Education Blueprint (2015-2025). In Putrajaya: Ministry of Higher Education Malaysia, [Online].
<https://www.um.edu.my/docs/um-magazine/4-executive-summary-pppm-2015-2025.pdf>. (Accessed Date: May 16, 2024).
- [20] Chaw, L. Y., & Tang, C. M. (2018). What makes learning management systems effective for learning? *Journal of Educational Technology Systems*, 47(2), 152-169.
<https://doi.org/10.1177/0047239518795828>.
- [21] Nawaz, S. (2019). Effectiveness of LMS: Moodle Perspective from Southeastern University of Sri Lanka. *International Journal of Grid and Distributed Computing*, 12(3), 172-189.
- [22] Davis, F. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319-340.
<https://doi.org/10.2307/249008>.
- [23] Mailizar, M., Burg, D., & Maulina, S. (2021). Examining university students' behavioural intention to use e-learning during the COVID-19 pandemic: An extended TAM model. *Education and Information Technologies*, 26, 7057-7077.
<https://doi.org/10.1007/s10639-021-10557-5>.
- [24] Hussein, L., & Hilmi, M. (2022). Intention to Continue Using Online Learning among Malaysian University Students. *Asian Journal of University Education*, 18(4), 998-1009.
<https://doi.org/10.24191/ajue.v18i4.20009>.
- [25] Abuhassna, H., Yahaya, N., Zakaria, M., Zaid, N.M., Samah, N. A., Awae, F., Nee, C. K., & Alsharif, A. H. (2023). Trends on using the technology acceptance model (TAM) for online learning: a bibliometric and content analysis. *International Journal of Information and Education Technology*, 13(1), 131-14.
- [26] Al-Adwan, A.S., Li, N., Al-Adwan, A., Abbasi, G. A., Albelbisi, N. A., & Habibi, A. (2023). Extending the Technology Acceptance Model (TAM) to Predict University Students' Intentions to Use Metaverse-Based Learning Platforms. *Education and Information Technologies*, 28, 15381-15413.
<https://doi.org/10.1007/s10639-023-11816-3>.
- [27] Hanafi, Y., Murtadho, N., Ikhsan, M. A., Diyana, T. N., & Sultoni, A. (2019). Student's and Instructor's Perception toward the Effectiveness of E-BBQ Enhances Al-Qur'an Reading Ability. *International Journal of Instruction*, 12(3), 51-68.
<https://doi.org/10.29333/iji.2019.1234a>.
- [28] Fearnley, M. R., & Amora, J. T. (2020). Learning Management System Adoption in Higher Education Using the Extended Technology Acceptance Model. *IAFOR Journal of Education: Technology in Education*, 8(2), 89-106.
<https://doi.org/10.22492/ije.8.2.05>.
- [29] Legramante, D., Azevedo, A., & Azevedo, J.M. (2023). Integration of the technology acceptance model and the information systems success model in the analysis of Moodle's satisfaction and continuity of use. *International Journal of Information and Learning Technology*, 40(5), 467-484.
<https://doi.org/10.1108/IJILT-12-2022-0231>.
- [30] Hwa, S. P., Hwei, O. S., & Peck, W. K. (2015). Perceived Usefulness, Perceived Ease of Use and Behavioural Intention to Use a

- Learning Management System among Students in a Malaysian University. *International Journal of Conceptions on Management and Social Sciences*, 3(4), 29-35.
- [31] Annamalai, N., Ramayah, T., Kumar, J. A., & Osman, S. (2021). Investigating the Use of Learning Management System (LMS) for Distance Education in Malaysia: A Mixed-Method Approach. *Contemporary Educational Technology*, 13(3), 1-15. <https://doi.org/10.30935/cedtech/10987>.
- [32] Hu, P. J. H., & Hui, W. (2012). Examining the role of learning engagement in technology-mediated learning and its effects on learning effectiveness and satisfaction. *Decision Support Systems*, 53(4), 782-792. <https://doi.org/10.1016/j.dss.2012.05.014>
- [33] Dulkaman, N. S., & Ali, A. M. (2016). Factors influencing the success of learning management system (LMS) on students' academic performance. *IYSJL*, 1(1), 36-49.
- [34] Xu, D., Huang, W., Wang, H., & Heales, J. (2014). Enhancing e-learning effectiveness using an intelligent agent-supported personalized virtual learning environment: An empirical investigation. *Information & Management*, 51(4), 430-440. <https://doi.org/10.1016/j.im.2014.02.009>.
- [35] DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean Model of Information Systems Success: A Ten-Year Update. *Journal of Management Information Systems*, 19(4), 9-30. <https://doi.org/10.1080/07421222.2003.11045748>.
- [36] Abdekhoda, M., Dehnad, A., Ghazi, Mirsaeed, S., Gavgani, Z. (2016). Factors influencing the adoption of E-learning in Tabriz University of Medical Sciences. *Medical Journal of the Islamic Republic of Iran*, 30(1), 1156-1162.
- [37] Yalcin, M. E., & Kutlu, B. (2019). Examination of students' acceptance of and intention to use learning management systems using extended TAM. *British Journal of Educational Technology*, 50(5), 2414-2432. <https://doi.org/10.1111/bjet.12798>.
- [38] Ain, N., Kaur, K., & Waheed, M. (2016). The influence of learning value on learning management system use: An extension of UTAUT2. *Information Development*, 32(5), 1306-1321. <https://doi.org/10.1177/0266666915597546>.
- [39] Prior, D. D., Mazanov, J., Meacheam, D., Heaslip, G., & Hanson, J. (2016). Attitude, digital literacy and self-efficacy: Flow-on effects for online learning behavior. *The Internet and Higher Education*, 29, 91-97. <https://doi.org/10.1016/j.iheduc.2016.01.001>.
- [40] Patel, N. M., Kadyamatimba, A., & Madzvamuse, S. (2017). Investigating Factors Influencing the Implementation of e-learning at Rural Based Universities. *Information Technology Journal*, 16(3), 101-113, [Online]. <https://scialert.net/abstract/?doi=itj.2017.101.113> (Accessed Date: April 2, 2024).
- [41] Findik-Coşkunçay, D., Alkiş, N., & Özkan-Yildirim, S. (2018). A Structural Model for Students' Adoption of Learning Management Systems: An Empirical Investigation in the Higher Education Context. *Educational Technology & Society*, 21(2), 13-27, [Online]. <https://www.jstor.org/stable/26388376>. (Accessed Date: March 28, 2024).
- [42] Claar, C., Dias, L. P., & Shields, R. (2014). Student acceptance of learning management systems: a study on demographics. *Issues in Information Systems*, 15(1), 409-417. https://doi.org/10.48009/1_iis_2014_409-417.
- [43] Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, 31(1) 2-24. <https://doi.org/10.1108/EBR-11-2018-0203>.
- [44] Nawi, F., Tambi, A., Samat, M., Mustapha, W. (2020). A Review on the Internal Consistency of a Scale: The Empirical Example of The Influence of Human Capital Investment on Malcom Baldrige Quality Principles in TVET Institutions. *Asian People Journal*, 3(1), 19-29. <https://doi.org/10.37231/apj.2020.3.1.121>.
- [45] Fornell, C., & Larcker, D. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18(1), 39-50. <https://doi.org/10.1177/002224378101800104>
- [46] Cohen, J. (1992). A power primer. *Psychological Bulletin*, 112(1), 155-159. <https://doi.org/10.1037/0033-2909.112.1.155>.
- [47] Munabi, S., Aguti, J., & Nabushawo, H. (2020). Using the TAM Model to Predict Undergraduate Distance Learners Behavioural Intention to Use the Makerere University Learning Management System. *Open Access Library Journal*, 7(9), 1-12.
- [48] Navarro, M., Prasetyo, Y., Young, M., Nadlifatin, R., & Redi, A. (2021). The Perceived Satisfaction in Utilizing Learning Management System among Engineering

Students during the COVID-19 Pandemic: Integrating Task Technology Fit and Extended Technology Acceptance Model. *Sustainability*, 13(9), 1-18.

<https://doi.org/10.3390/su131910669>.

- [49] Ashrafi, A., Zareravasan, A., Savoji, S.R., & Amani, M. (2020). Exploring factors influencing students' continuance intention to use the learning management system (LMS): a multi-perspective framework. *Interactive Learning Environments*, 30(8), 1475-1497.
- [50] Davis, F., Bagozzi, R., & Warshaw, P. (1989). User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. *Management Science*, 35(8), 982-1003. <https://doi.org/10.1287/mnsc.35.8.982>.

Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

The authors equally contributed in the present research, at all stages from the formulation of the problem to the final findings and solution.

Sources of Funding for Research Presented in a Scientific Article or Scientific Article Itself

No funding was received for conducting this study.

Conflict of Interest

The authors have no conflicts of interest to declare.

Creative Commons Attribution License 4.0 (Attribution 4.0 International, CC BY 4.0)

This article is published under the terms of the Creative Commons Attribution License 4.0

https://creativecommons.org/licenses/by/4.0/deed.en_US