Exploring The Effectiveness of Moodle E-Learning: TAM-Based Study on User Perception and Adoption

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Abstract. E-learning has become an essential tool in higher education, enabling universities to provide accessibility and flexibility in teaching and learning. One of the popular e-learning platforms is Moodle, which many universities in Indonesia use. However, the use of Moodle in universities has not been studied in depth, especially in the context of the effect of e-learning on academic learning. Therefore, this study aims to test Moodle e-learning in the Buddhi Dharma Private University environment located in Tangerang with the Technology Acceptance Model method using five variables Perceive Usefulness (PU), Perceived Ease of Use (PEOU), Attention Towards Using (ATU), Behavioral Intention to Use (BITU), and Actual System Using (ASU). The findings reveal that all hypotheses are supported, with t-statistic values surpassing the t-table and significant p-values. The R-square coefficient of determination results show sufficient predictive power of 44.4% between the PEOU and PU constructs. Substantially, 78.2% of the ATU construct is explained by the PEOU and PU. Meanwhile, the PU and ATU constructs for BITU have a moderate prediction of 70.3%. Likewise, BITU against ASU has a value of 64.5%. This indicates a positive influence of PU, PEOU, ATU, BITU, and ASU on the effective utilization of Moodle.

INTRODUCTION

In 2020 when the Covid-19 was declared a national epidemic, almost all institutions experienced a significant impact, including educational institutions [1]. Large-scale social restrictions are one of the ways the government has set so that the epidemic does not spread more widely [2–4]. The learning process that was initially face-to-face (synchronous) must quickly change to online or asynchronous learning. The e-learning platform is an alternative solution for educational institutions as a bridge between teachers and students so they do not meet face to face and provide teaching and learning processes remotely to minimize the spread of the epidemic.

Information and communication technology has changed the way we access information and learn. E-learning, a form of technology-based learning, has become a significant trend in higher education and has a positive impact [5]. One of the popular e-learning platforms is the Modular Object-Oriented Dynamic Learning Environment, also known as Moodle. This is an open-source learning platform designed to help teachers and students with a strong, safe, and integrated system so that they have a personalized learning environment [6]. Moodle is not only used by

certain institutions but has also been used by many universities worldwide. So far, there have been 242 countries with more than 366 million users and more than 44 million registered lessons. The user increase is quite significant compared to before the Covid-19 pandemic [7]. In Indonesia, 5,547 sites are built based on Moodle [8].

The use of Blended Learning with Moodle at Buddhi Dharma University in Tangerang has been carried out since 2016 and began to be used massively in March 2020 due to the Covid-19 pandemic. Moodle is a Virtual Learning Environment (VLE) where online interactions between instructors and students can be accessed anywhere and anytime. Moodle was developed with pedagogy and technology in mind, had a strong foundation in social constructionist pedagogy, and is an excellent educational tool [9]. This platform is essential in improving the quality, effectiveness, and accessibility of higher education. Moodle is a cost-effective solution for universities looking to implement an e-learning platform, and this platform is cheaper than internally developing software [10]. Moodle has a lot of functionality and flexibility, some advantages such as efficient memory usage and low bandwidth consumption. This platform is very sturdy and has good reliability [11]. In addition, Moodle can be adapted to the needs of users or institutions with a simple interface, has multi-language support, is inexpensive, and has good security features. Several features are available for learning content, chatting, creating discussion forum activities, providing and collecting feedback, assessments, and communicating with participants [12]. Even though Moodle has been designed with a good framework, it is static with minimal functionality [13].

The Moodle and Socrative platforms have been used in chemical engineering study programs. The result is that most students prefer Moodle over Socrative because it is more helpful in acquiring knowledge [11]. Tests or quizzes on Moodle and Socrative can be beneficial tools to enhance the learning experience and improve academic performance, but their effect on academic achievement is not significant [11]. The development of an adaptive e-learning portal with Moodle has been carried out to identify student learning styles with learning materials and the user interface of the system using Fuzzy C-Means grouping students into eight categories, namely Sensing, Intuitive, Global, Sequential, Verbal, Visual, Reflective and Active, the results show that this research can improve the performance of students [13].

The functionality of Moodle was assessed at Kaajani University in Finland, involving lecturers and teaching staff as participants. The Technology Acceptance Model (TAM) was employed to evaluate the acceptance and utilization of this technology, and this model describes the benefits (Perceived Usefulness) and ease (Perceived Ease of Use) of users. As a result, the assignment, feedback, quiz, and workshop modules are essential and widely used, compared to features such as files, folders, pages, URLs, databases, choice, glossary, and the SCORM package, which is also used but to a lesser extent [12].

E-learning or Moodle is an essential tool in improving the quality of learning [14,15]. In the context of using e-learning as a learning medium, it is vital to understand the level of acceptance from a student's perspective. This will help educational institutions optimize the use of e-learning or Moodle to improve the quality of learning and student academic achievement. To understand the effectiveness and perspectives of students on Moodle e-learning as a learning medium, this research will use the Technology Acceptance Model (TAM). TAM is a framework developed to understand the acceptance and use of technology by involving factors such as user perceptions of the usefulness and ease of use [16–18].

Previous research has examined the sustainability of the e-learning system using TAM, and it was found that the PU and PEOU variables affect BITU on the use of e-learning [19]. One private school in Balikpapan uses TAM as a reference. It shows that all variables constructed by TAM have a significant effect except between PEOU and ATU, PU and BITU [20]. Even though there has been previous research on the use of e-learning, several variables do not have a significant effect on users, such as research by [21], which states that PU or benefits variables have only a tiny influence on ATU variables or user attitudes. In addition, there is still a need to understand better the factors that influence the acceptance and use of e-learning, such as the ASU variable or the actual use of the system, which needs to be assessed by assessing student perceptions. ASU is critical to TAM because it serves as an endpoint that validates model predictions [22]. In addition, BITU is a key factor in TAM, which leads to the actual use of the system [23]. Therefore, this study will adopt the Technology Acceptance Model (TAM) as a framework for measuring the effectiveness and perspectives of students at Buddhi Dharma University regarding Moodle-based e-learning.

METHOD

Quantitative research methods were used in this study with case studies in the information system study program at Buddhi Dharma University.

Data Collection

The measurement to test the acceptance of the Moodle system, a questionnaire was developed utilizing Google Forms as the measurement tool and distributed online to students from the 2019 to 2022 batch. The number of registered students in 2019 - 2022 is 163 people. Questionnaires were distributed from May 9th, 2023, in stages to May 27th, 2023, with a total of 114 answered questionnaires. This number aligns with the recommended sample size, which states that the minimum should be five times [24] or ten times the number of indicators [25]. The questionnaire questions totaled 16 and consisted of 5 variables shown in Table 1 below:

TABLE 1. TAM Questionnaire

No	Questions	Variable
1.	Is Moodle e-learning easy for you to understand?	PEOU-1
2.	Does Moodle e-learning provide convenience in the learning process (Discussion forums, Downloading lecture materials, Quizzes, and Upload assignments)?	PEOU-2
3.	Does Moodle e-learning make it easy for you to do learning online?	PEOU-3
4.	Is Moodle e-learning useful for you?	PU-1
5.	Can Moodle e-learning increase effectiveness and efficiency in learning?	PU-2
6.	Does Moodle e-learning provide data and information as needed?	ATU-1
7.	Can Moodle e-learning be used properly and comfortably?	ATU-2
8.	Do you like the appearance (UI) of Moodle e-learning?	ATU-3
9.	Overall, do you like Moodle e-learning?	ATU-4
10.	Are you interested in using Moodle e-learning continuously?	BITU-1
11.	Would you recommend Moodle e-learning to others?	BITU-2
12	Will you try to use Moodle e-learning again in the future?	BITU-3
13	Can Moodle e-learning features help you, especially in the media learning process?	BITU-4
14	Can you use Moodle e-learning according to the stages?	ASU-1
15	Will you use the features of Moodle e-learning more often?	ASU-2
16	Will you repeatedly use Moodle e-learning as a learning medium?	ASU-3

The questionnaire used a Likert scale of 1-5 and was given to students, consisting of the number 1, which indicates strongly disagree, to the number 5, which means strongly agree. This scale is used because it can easily describe users' attitudes, opinions, and perceptions [26].

Technology Acceptance Model (TAM)

TAM is a frequently utilized approach for evaluating a system, which was initially formulated and introduced by Davis [16,17]. The depiction of the TAM model constructs is shown in the research framework shown in Fig. 1.

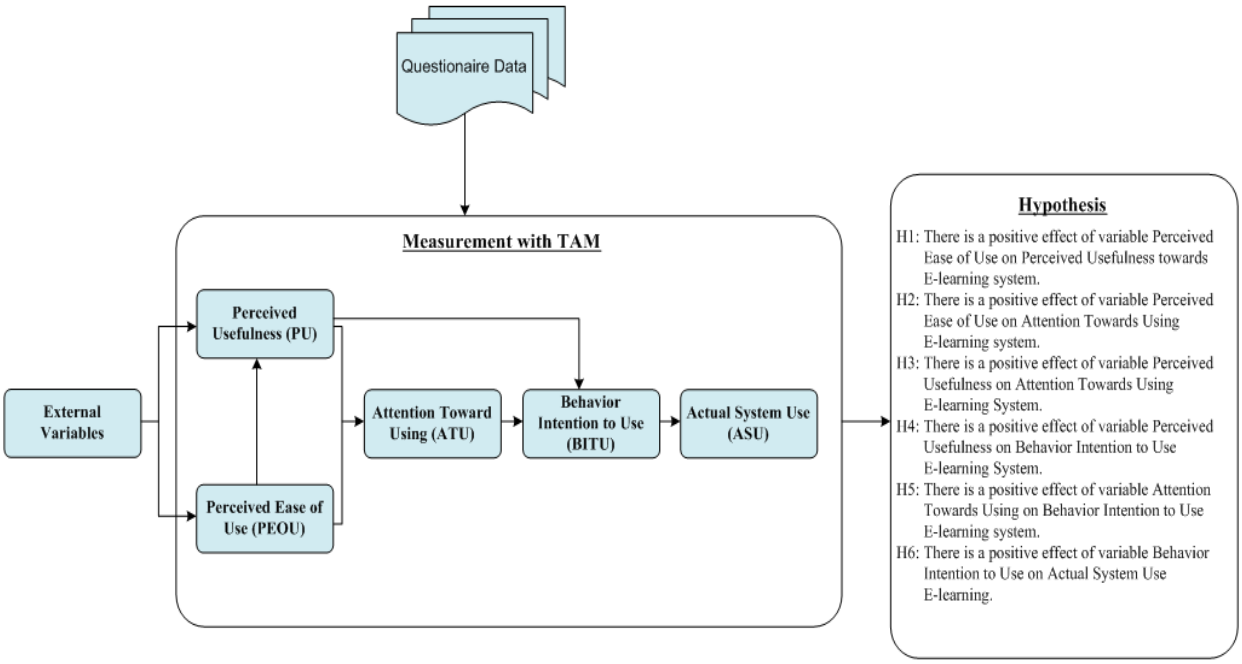

FIGURE 1. Research Framework Construct with Technology Acceptance Model

In Fig. 1 above, data will be obtained from questionnaires that have been distributed and then processed. The critical construct variable in TAM comprises PU, which represents the level of trust perceived by users regarding the system's usefulness in enhancing their work productivity. PEOU pertains to users' perception of how easily they can operate information systems and develop confidence. ATU refers to users' attitude or behavior toward the pleasantness or unpleasantness of the conditions experienced while using the system, including after its use. BITU signifies users' inclinations and intentions to persistently utilize the system with a specific objective or purpose. ASU indicates users' authentic and accurate behavior when utilizing information systems. Based on the variable construct, this study will use five hypotheses, which are as follows:

H1: PEOU influences PU
H2: PEOU influences ATU
H3: PU influences ATU
H4: PU influences BITU
H5: ATU influences BITU
H6: BITU influences ASU

Within the TAM methodology, there are four distinct measurement stages involved. These stages encompass the evaluation of convergent validity, discriminant validity, reliability measurement, and predictive relevance measurement.

Convergent Validity

Convergent Validity involves evaluating the strength or weakness of the relationship or correlation between variables as depicted in the path diagrams. During this stage, two benchmarks are utilized: Outer Loading (indicator results) and average variance extract (AVE), representing each variable's value. The Outer Loading measurement is considered valid if the value exceeds 0.7, while the AVE is deemed valid if it surpasses 0.5. The formula for calculating AVE is as follows [27]:

$$\boldsymbol{AVE} = \frac{\sum_{i=1}^{n} \boldsymbol{\lambda_i^2}}{\boldsymbol{n}} \quad (1)$$

Description:
n = The number of indicators that have been tested
λ = Factor Loading value

Discriminant Validity

The measurement of Discriminant Validity can be assessed through two criteria, namely Fornell-Larcker and Cross-Loading. Fornell-Larcker examines the relationship between a variable and itself or with other variables (correlation of latent variables). It is considered valid when the relationship value between variables is greater when compared to the relationship with other variables. On the other hand, Cross-Loading measures the relationship or correlation between indicators and each variable. It is considered valid if the indicators demonstrate a stronger correlation with their respective variable compared to the correlation value with other variables [27,28].

Reliability Measurement

Reliability assessment of the questionnaire questions is essential to ensure accuracy, and it can be achieved by evaluating the reliability level. This Reliability Measurement can be deemed valid by considering two factors: Cronbach's alpha value, which should exceed 0.6, and the Composite Reliability value, which should surpass 0.7. The following formula is used to calculate Cronbach's alpha [27]:

$$\alpha = \frac{n\bar{r}}{1+\bar{r}(n-1)} \quad (2)$$

Description:
n = The number of indicators that have been tested
$\bar{r}$ = Correlation value between the indicators and the variables under examination.

Furthermore, the formula used to calculate the Composite Reliability (CR) values is as follows:

$$CR = \frac{\sum_{i=1}^{n} \lambda_i^2}{\sum_{i=1}^{n} \lambda_i^2 + \sum_{i=1}^{n} Var(e_i)} \quad (3)$$

Description:
n = The number of indicators that have been tested
λ = Factor Loading value
Var (e_i) = The error variance of each indicator

Predictive Relevance

Determination of Q-square or Stone-Geisser Q^2 is a statistical technique used in Partial Least Squares Structural Equations Modeling (PLS-SEM), is utilized to evaluate the predictive significance of latent variables. Its primary focus is to examine the impact of independent variables on the dependent variable in order to assess their influence [29,30]. Q^2 values are greater than 0 (zero) indicates that the model has a predictive relevance value. Meanwhile, if the Q^2 value is less than 0 (zero), then the model has no or less predictive relevance. The Q^2 quantity is $0 < Q^2 < 1$, where the closer to 1, the better the model. Here is the formula for determining Q^2:

$$Q^2 = 1 - \left(\frac{SSE}{SSO}\right) \quad (4)$$

Description:
Q^2 = Predictive Relevance
SSE = Structural Simultaneous Estimation
SSO = Structural Simultaneous Omission

RESULTS AND DISCUSSION

Results

The results of the questionnaires collected were then processed using Smart PLS [31]. The initial step involves constructing a Path Diagram based on the hypothesis and conducting an analysis using the PLS algorithm calculations. The outcomes of these calculations are presented in Fig. 2 below:

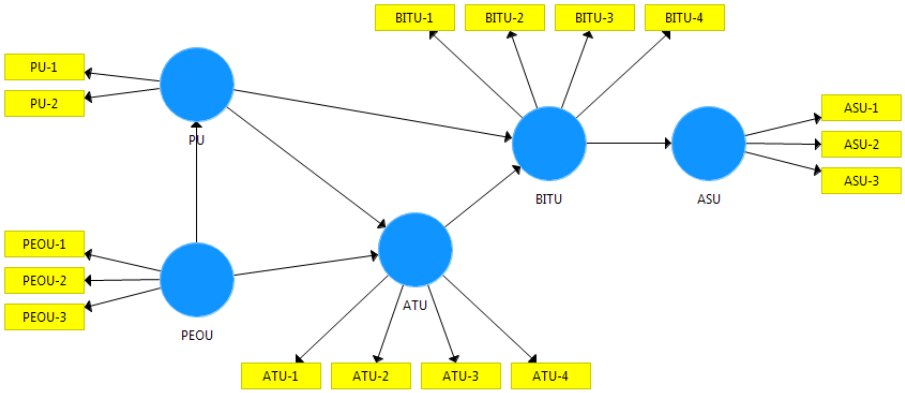

FIGURE 2. Path Diagram

Observing Fig. 2 provided above, it is evident that one independent variable, namely PEOU, impacts two other variables, namely PU and ATU. On the other hand, the dependent variables comprise PU, ATU, BITU, and ASU, as other variables influence these four variables. Specifically, PU is influenced by PEOU, the ATU variable is influenced by both PEOU and PU, PU and ATU influence the BITU variable, and BITU affects the ASU variable. Outer Loading indicates the analysis of the convergent validity level test values greater than 0.7 and AVE values exceeding 0.5, as per formula (1). The corresponding results are displayed in Table 2 below:

TABLE 2. Outer Loading Value

Variable	ASU	ATU	BITU	PEOU	PU	Result
ASU-1	0.890					Valid
ASU-2	0.887					Valid
ASU-3	0.890					Valid
ATU-1		0.809				Valid
ATU-2		0.809				Valid
ATU-3		0.684				Unvalid
ATU-4		0.838				Valid
BITU-1			0.879			Valid
BITU-2			0.859			Valid
BITU-3			0.883			Valid
BITU-4			0.849			Valid
PEOU-1				0.872		Valid
PEOU-2				0.875		Valid
PEOU-3				0.833		Valid
PU-1					0.921	Valid
PU-2					0.926	Valid

In the table above, the ATU-3 value of 0.684 does not reach 0.7, so it needs to be eliminated so that the convergent test becomes valid [25]. The calculation results are recalculated as shown in Fig. 3, and all Outer Loading results are valid for the AVE value shown in Table 3 below:

TABLE 3. Average Variance Extract Value

Variable	AVE
ASU	0.790

ATU	0.701
BITU	0.753
PEOU	0.740
PU	0.853

The next stage will be a discriminant test, the Fornell-Larcker criterion value with the AVE root value shown in yellow, where the value must be greater than the other adjacent values shown in Table 4 below:

TABLE 4. Fornell-Larcker Criterion

Variable	ASU	ATU	BITU	PEOU	PU
ASU	0.889				
ATU	0.768	0.837			
BITU	0.803	0.828	0.868		
PEOU	0.621	0.786	0.606	0.860	
PU	0.678	0.824	0.756	0.663	0.924

To perform a reliability test using formulas (2) and (3) by looking at the values in Cronbach's Alpha and Composite Reliability (CR) shown in Table 5 below:

TABLE 5. Cronbach's Alpha and Composite Reliability Values

Variable	Cronbach's Alpha	Composite Reliability (CR)
ASU	**0.868**	**0.919**
ATU	**0.787**	**0.875**
BITU	**0.891**	**0.924**
PEOU	**0.824**	**0.895**
PU	**0.828**	**0.921**

The reliability test results were declared valid because the Cronbach alpha column value exceeded 0.6 and the CR value exceeded 0.7. Reliability can be measured with Cronbach's Alpha and CR. However, CR is considered better in estimating the internal consistency of a construct [32]. Furthermore, to evaluate the predictive relevance of the latent variable, the R-square value must be known in advance [33]. The R-square value is obtained based on the calculation of the PLS algorithm and is presented in Fig. 3 below:

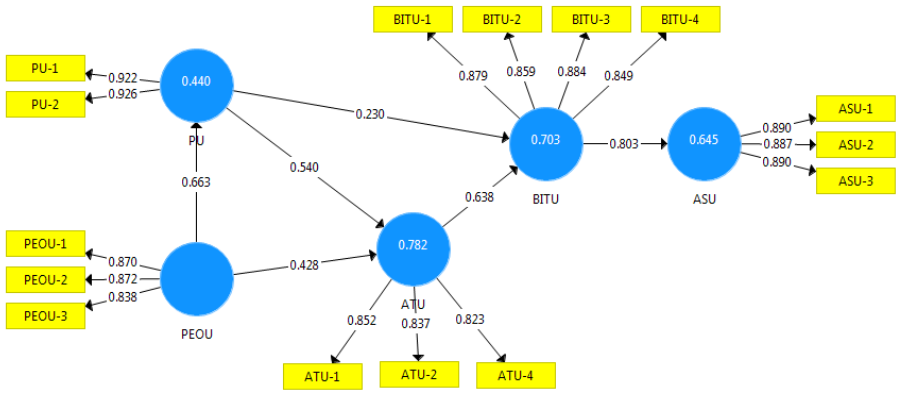

FIGURE 3. Cross-Loading and R-square Value

Based on the results of the construct, it can be seen that the R-square value is found in each existing dependent variable and is presented in Table 6 below:

TABLE 6. R-square Value

Variable	R-square	Consideration
ASU	0.645	Moderate
ATU	0.782	Substantial
BITU	0.703	Moderate
PU	0.440	Weak

Followed by calculating the predictive relevance of latent variables using formula (4), and the following results are presented in Table 7:

TABLE 7. Predictive Relevance Q^2

	SSO	SSE	Q^2	Predictive Relevance
ASU	342	174.417	0.490	Medium
ATU	342	159.277	0.534	Large
BITU	456	219.271	0.519	Large
PU	228	143.555	0.370	Medium

With a Q^2 value between the range 0.370 to 0.534, it can be concluded that the statistical model used in this study has moderate and high predictive value.

Discussion

Research on e-learning has previously been carried out in Indonesian sports education, where the results of measurements of PU did not significantly influence students' attitudes ATU toward e-learning [21]. In contrast to what was done by Mailizar [34], where the convenience PEOU and usefulness principle PU of e-learning significantly affect students' attitudes in using e-learning.

We test the hypothesis to prove this, where the t-statistic and p-value must be known first through bootstrapping results. The results of hypothesis testing are shown in Table 8 below:

TABLE 8. T-statistik and P-value

Variable	t-statistics	p-values
PEOU -> PU	9.637	0.000
PEOU -> ATU	6.394	0.000
PU -> ATU	8.894	0.000
PU -> BITU	2.212	0.027
ATU -> BITU	6.768	0.000
BITU -> ASU	18.563	0.000

t-table 5% = 1.98 [35,36]

Based on the table above, all hypotheses can be accepted because the t-statistic value > t-table where the t-table value uses Degree of Freedom (df) = 109 with a significant value of 95% and all p-values <0.05. The t-statistic value of 9,637 > 1.98 indicates a significant positive effect of the PEOU variable on the PU in using Moodle. The t-statistic value of 6.394 > 1.98 indicates a significant positive impact of the PEOU variable on the ATU in using Moodle. The t-statistic value of 8,894 > 1.98 means a significant positive effect of the PU variable on the ATU in using Moodle. The t-statistic value of 2.212 > 1.98 indicates a significant positive influence of the PU variable on BITU to use Moodle. The t-statistic value is 6.768 > 1.98, meaning that ATU variables significantly influence BITU

to use Moodle. The t-statistic value of 18,563 > 1.98 indicates a significant positive effect of the BITU variable to use Moodle on ASU.

CONCLUSION

Based on the results of Technology Acceptance Testing processing, it can be concluded that out of a total of sixteen questions there is only one question regarding the Moodle user interface which is invalid, this means that the university needs to make the UI appearance of Moodle more attractive so that it will improve user experience and comfort. In addition, in this study it was found that all measurements of the hypothesis were well received, where the test results exceeded the t-table and p-values. The R-square coefficient of determination results show sufficient predictive power of 44.4% between the PEOU and PU constructs. Substantially, 78.2% of the ATU construct is explained by the PEOU and PU constructs. Meanwhile, the PU and ATU constructs for BITU have a moderate prediction of 70.3%. Likewise, BITU against ASU has a value of 64.5%.

Thus, the results of this study indicate that perceived usefulness, perceived ease of use, and attention towards using have a significant positive influence on student behavior and actual use of the system in Moodle as an e-learning platform at Buddhi Dharma University. We conclude that the background of system users also has an influence on acceptance of Moodle e-learning, such as how often users access and use the system, how familiar users are with Moodle, and in this case it is inseparable from the user's attitude and intention in using it. Suggestions for further research can be to use TAM to test ordinary users or those with non-technical backgrounds and the effect of e-learning on the academic achievement index.

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