

UNDERSTANDING LMS ACCEPTANCE IN VOCATIONAL SECONDARY EDUCATION: EXTENDING THE TECHNOLOGY ACCEPTANCE MODEL USING SEM-GSCA

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ABSTRACT

This study examines vocational secondary school students' acceptance of Learning Management Systems (LMS) by extending the Technology Acceptance Model (TAM) with external factors, including computer self-efficacy (CSE), subjective norm (SN), perceived enjoyment (PE), perceived accessibility (PA), and perceived playfulness (PP). A quantitative cross-sectional survey was conducted with 252 students at one vocational secondary school in Surabaya, Indonesia, and the data were analyzed using SEM-GSCA. The findings showed that PA was the only external factor significantly associated with PEOU, whereas the other external variables showed no significant associations with PU or PEOU. Within the TAM framework, PEOU was significantly associated with PU and ATU, whereas PU emerged as the strongest predictor of both ATU and BI. BI also significantly predicted actual LMS use. In this sample, LMS acceptance was more strongly associated with accessibility and functional utility than with motivational or hedonic factors. The study extends the application of TAM to vocational secondary education and suggests that schools and LMS developers should prioritize accessibility, usability, and pedagogical relevance to support sustainable LMS adoption.

KEYWORDS

Learning Management System, SEM-GSCA, Technology Acceptance Model, Vocational Secondary Education, Post-pandemic Education

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Highlights

- LMS acceptance in vocational education is shaped mainly by usefulness and accessibility.
- Accessible LMS platforms support more efficient access to vocational learning activities.
- Perceived usefulness strengthens students' attitudes and continued LMS engagement.
- Responsible LMS implementation requires pedagogically meaningful digital integration.
- Sustainable LMS adoption supports learning continuity and competency-based education.

INTRODUCTION

The integration of digital technology into education has transformed teaching and learning practices across educational levels. Learning Management Systems (LMS) are among the most widely adopted educational technologies and facilitate online learning activities through web-based platforms that support content delivery, communication, assessment, and learning management (Snoussi, 2019; Al-Fraihat et al., 2020). LMS platforms enable students and teachers to engage in asynchronous and remote learning activities, thereby increasing flexibility and accessibility in educational processes.

The implementation of LMS has been associated with several educational benefits, including improved learning efficiency, increased learner autonomy, and enhanced student engagement (Unlu and Suel, 2014). Previous studies have also reported that students tend to demonstrate more positive learning attitudes when using e-learning platforms due to their perceived usefulness, convenience, and accessibility (Davis, 1989; Mohammadi, 2015). Consequently, LMS adoption has become an important area of research, particularly within the context of technology-enhanced learning environments. Despite the growing body of literature on LMS acceptance, previous findings remain inconsistent regarding the factors

influencing students' acceptance and continued use of LMS platforms. Several studies have reported significant associations between external variables such as self-efficacy, accessibility, enjoyment, and social influence and students' perceptions of LMS usefulness and ease of use (Abdullah and Ward, 2016; Salloum et al., 2019). However, other studies have reported weak or insignificant relationships between these external factors and core Technology Acceptance Model (TAM) constructs (Surjono, Muhtadi and Trilisiana, 2019; Llamas, Vilela-Malabanan and Dinawanao, 2025; Rogers, Mercado and Decano, 2025). These inconsistencies suggest that the relevance of external factors may depend on contextual characteristics, including educational level, learning environment, and patterns of technology usage.

Most prior studies on LMS acceptance have focused primarily on university students, whereas comparatively less attention has been given to vocational secondary school students (Benson et al., 2020; Ahmad et al., 2023). This limitation is important because vocational students have distinct educational characteristics, including practice-oriented learning approaches, task-based instructional activities, and different patterns of digital technology utilization (Sollner et al., 2018; Im, 2021). In vocational education contexts, LMS use may be shaped more strongly by functional and task-related considerations than by psychological or affective factors (Ahmad et al., 2023). Therefore, further investigation is needed to determine whether commonly used external TAM variables remain relevant in vocational secondary education settings. Unlike previous TAM studies that primarily emphasize university students and generalized e-learning environments, this study examines whether external TAM variables remain applicable in vocational secondary education, where learning activities are more practice-oriented and task-driven.

To address this gap, the present study examines LMS acceptance among students at one vocational secondary school in Surabaya, Indonesia using an extended Technology Acceptance Model (TAM). Specifically, this study investigates the influence of external factors, namely computer self-efficacy (CSE), subjective norm (SN), perceived enjoyment (PE), perceived accessibility (PA), and perceived playfulness (PP), on students' perceptions of LMS use (Abdullah and Ward, 2016; Salloum et al., 2019). By examining how students evaluate LMS accessibility, usefulness, and continued use, this study provides insight into factors associated with digital learning acceptance and their implications for efficient and responsible technology integration in vocational education. This study is particularly relevant to efficiency and responsibility in vocational learning because LMS implementation should not only facilitate access to learning activities but also ensure that digital platforms meaningfully support students' academic tasks, learning continuity, and competency-oriented educational needs (Snoussi, 2019; Al-Fraihat et al., 2020). Thus, the study contributes to the contextual application of TAM while offering practical implications for strengthening sustainable LMS implementation in vocational secondary education.

LITERATURE REVIEW

Technology Acceptance Model (TAM) and LMS Acceptance

The TAM, developed by Davis (1989), is one of the most widely used frameworks for explaining technology acceptance behavior. TAM emphasizes two primary determinants of technology adoption: PU and PEOU. PU refers to users' beliefs that technology improves performance, while PEOU reflects the extent to which technology is perceived as easy to use (Davis, 1989).

TAM has been extensively applied in e-learning and learning management system (LMS) research (Lee, Yoon and Lee, 2009; Abdullah and Ward, 2016; Salloum et al., 2019). LMS platforms facilitate learning activities such as content delivery, assessment, communication, and class management through synchronous and asynchronous systems (Al-Adwan et al., 2021). Previous studies generally confirm that TAM effectively explains LMS acceptance in educational settings (Al-Gahtani, 2016; Hanif, Jamal and Imran, 2018; Alshammari, 2020; Gurban and Almogren, 2022). However, the influence of external factors on PU and PEOU remains inconsistent across contexts (Llamas, Vilela-Malabanan and Dinawanao, 2025; Rogers, Mercado and Decano, 2025), indicating that LMS acceptance depends on specific educational environments, including vocational education.

Therefore, this study extends TAM by incorporating five external variables frequently used in e-learning acceptance research: CSE, SN, PE, PA, and PP (Abdullah and Ward, 2016; Salloum et al., 2019) (see Figure 1). The inclusion of these variables enables a more comprehensive understanding of LMS acceptance among vocational secondary school students.

Computer Self-efficacy (CSE)

CSE reflects individuals' confidence in their ability to use digital technologies effectively to accomplish specific tasks (Downey and Kher, 2015). In LMS environments, students with higher self-efficacy tend to perceive learning systems as easier to operate and more beneficial for completing academic activities (Alshammari, 2020; Gurban and Almogren, 2022; Rokhim et al., 2024). Prior studies consistently report positive relationships between CSE, PU, and PEOU in e-learning contexts (Salloum et al., 2019; Arief et al., 2021; Espinosa, Ruiz and Mercado, 2021). Accordingly, the following hypotheses are proposed:

- H1: CSE positively influences PU in LMS use
- H2: CSE positively influences PEOU in LMS use

Subjective Norm (SN)

SN refers to the perceived social influence that encourages individuals to perform or avoid a particular behavior based on the expectations or opinions of significant others, such as teachers, peers, and the surrounding social environment (Ajzen, 1991; Venkatesh and Davis, 2000; Jimenez et al., 2021). In educational technology contexts, SN reflects the extent to which students perceive that important individuals believe they should use an LMS.

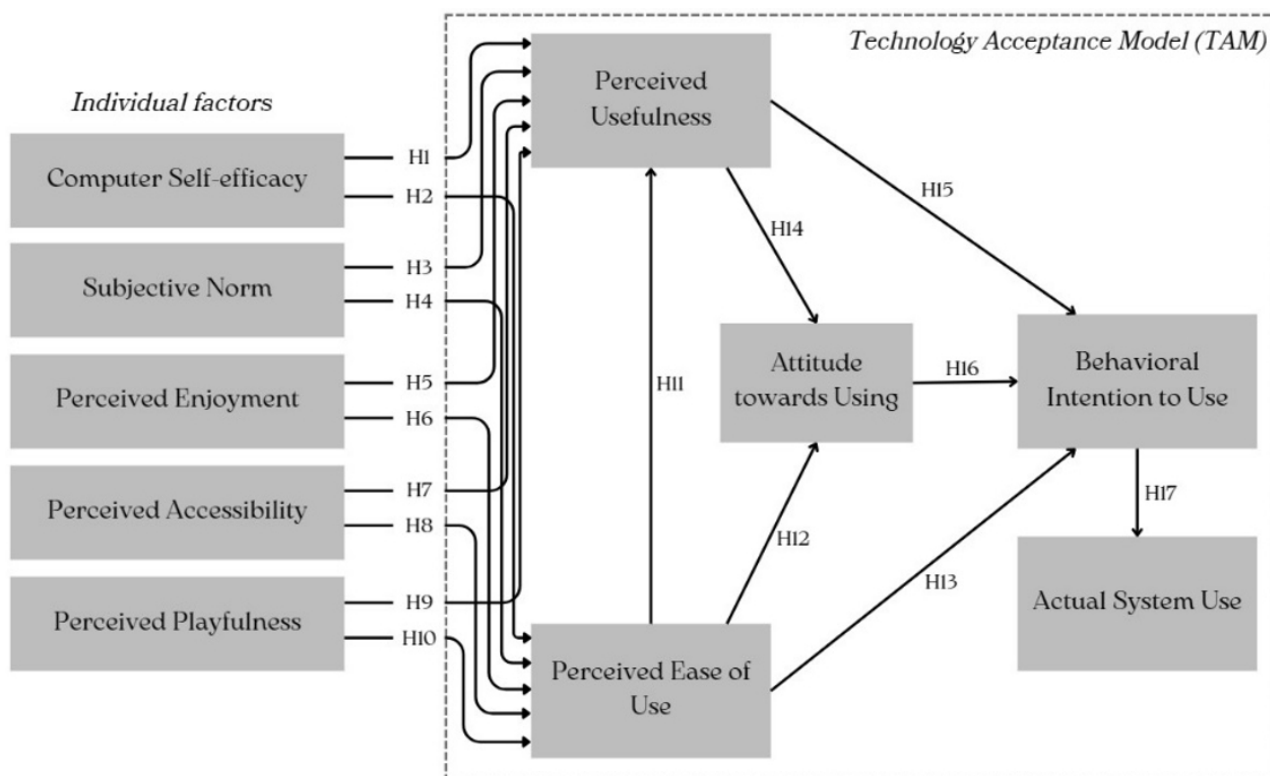


Figure 1: Conceptual LMS Acceptance Model

Prior studies suggest that social influence can shape students' perceptions regarding both the PU and PEOU of e-learning technologies. When students receive positive recommendations or encouragement from peers and instructors, they are more likely to perceive LMS platforms as beneficial and easier to operate (Al-Gahtani, 2016; Khan et al., 2020). Empirical evidence also indicates that subjective norm positively affects PU and PEOU in e-learning environments (Ching-Ter, Hajiyeve and Su, 2017; Revyathi and Tselios, 2019). In vocational education settings, where collaborative learning and teacher guidance remain important, social influence may play a significant role in shaping students' acceptance of LMS use. Accordingly, the following hypotheses are proposed:

- H3: SN positively influences PU in LMS use
- H4: SN positively influences PEOU in LMS use

Perceived Enjoyment (PE)

PE refers to the extent to which individuals perceive the use of a technology system as enjoyable and intrinsically satisfying, regardless of its functional or performance-related outcomes (Venkatesh and Davis, 2000). In e-learning environments, PE reflects students' positive emotional experiences when interacting with an LMS (Cahyanti et al., 2025; Rohana, Nugraha and Koblianska, 2025). Technologies that provide enjoyable and engaging learning experiences are more likely to encourage students' acceptance and continued use (Sorensen, 2019).

Previous studies have consistently reported that PE positively influences students' perceptions of both the PU and PEOU of e-learning systems. Students who experience enjoyment while using LMS platforms tend to perceive the systems as more accessible, easier to operate, and beneficial for supporting their learning activities (Al-Gahtani, 2016; Ching-Ter,

Hajiyeve and Su, 2017). Empirical findings also indicate that PE significantly affects PEOU and PU in various e-learning contexts (Al-Gahtani, 2016; Hanif, Jamal and Imran, 2018; Salloum et al., 2019; Gurban and Almogren, 2022). In vocational education settings, enjoyable learning experiences further enhance students' engagement with technology-based learning activities, particularly when LMS platforms support interactive and practice-oriented instructional processes. Therefore, the following hypotheses are proposed:

- H5: PE positively influences PU in LMS use.
- H6: PE positively influences PEOU in LMS use.

Perceived Accessibility (PA)

PA refers to the extent to which users perceive that information and technological resources can be accessed easily, efficiently, and without significant barriers to support their learning activities (Al-Debei, 2014). In the context of e-learning, accessibility reflects students' ability to access LMS platforms anytime and anywhere using various digital devices and internet connections. High levels of accessibility allow students to obtain learning materials, submit assignments, and participate in online learning activities more conveniently, thereby enhancing their overall learning experience.

Previous studies have demonstrated that accessibility is an important factor influencing students' acceptance of e-learning systems. When LMS platforms can be accessed quickly and reliably, students are more likely to perceive the systems as more useful and easier to use (Almaiah, Jalil and Man, 2016; Revyathi and Tselios, 2019; Salloum et al., 2019). Accessibility also supports learning flexibility, which is particularly important in digital learning environments where students frequently rely on mobile devices and remote access

to participate in educational activities (Revythi and Tselios, 2019). Empirical evidence further indicates that PA positively affects both PU and PEOU in LMS adoption contexts (Almaiah, Jalil and Man, 2016; Revythi and Tselios, 2019; Salloum et al., 2019). In vocational education settings, where students require continuous access to instructional materials and practice-oriented resources, accessibility becomes a critical factor shaping LMS acceptance. Therefore, the following hypotheses are proposed:

- H7: PA positively influences PU in LMS use.
- H8: PA positively influences PEOU in LMS use.

Perceived Playfulness (PP)

PP refers to the extent to which users perceive technology use as enjoyable, engaging, and intrinsically stimulating during the interaction process (Hung, Tsai and Chou, 2016). In e-learning environments, playfulness reflects students' positive experiential responses when using an LMS, particularly when the platform enables interactive, creative, and flexible learning activities. Technologies perceived as playful are more likely to encourage students' active participation and sustained engagement in digital learning processes.

Previous studies have reported that PP significantly influences students' perceptions of e-learning usability and effectiveness. Students who experience enjoyable and interactive learning activities through LMS platforms tend to perceive the systems as easier to use and more beneficial for supporting their learning performance (Salloum et al., 2019; Khoirunisa, Warsono and Mirza. BR, 2023). Empirical evidence also demonstrates that PP positively affects PEOU in LMS adoption contexts (Salloum et al., 2019; Rokhim et al., 2024). In addition, prior research indicates that students who perceive LMS platforms as engaging and enjoyable are more likely to recognize their usefulness for learning activities and skill development (Gurban and Almogren, 2022). In vocational education settings, where instructional activities often emphasize creativity, practice-oriented learning, and interactive tasks, PP may strengthen students' acceptance of LMS use. Therefore, the following hypotheses are proposed:

- H9: PP positively influences PU in LMS use.
- H10: PP positively influences PEOU in LMS use.

Perceived Ease of Use (PEOU)

PEOU refers to the extent to which individuals believe that using a technology system requires minimal effort and is easy to understand and operate (Davis, 1989). In the context of LMS, PEOU reflects students' perceptions regarding the simplicity, flexibility, and convenience of interacting with e-learning platforms during learning activities. Technologies perceived as easy to use are more likely to encourage positive user experiences and continued technology use.

Within the TAM, PEOU is considered a fundamental determinant influencing both perceived usefulness and users' behavioral responses toward technology adoption. Previous studies have consistently shown that students who perceive LMS platforms as easy to use tend to recognize greater usefulness in supporting their learning activities (Al-Gahtani, 2016; Almaiah, Jalil and Man,

2016; Salloum et al., 2019; Rokhim et al., 2024). PEOU reduces the cognitive effort required to operate the system, enabling students to focus more effectively on learning tasks and academic performance.

In addition, prior research indicates that PEOU is positively associated with students' attitudes toward LMS use and their BI to continue using e-learning technologies (Al-Gahtani, 2016; Almaiah, Jalil and Man, 2016; Ching-Ter, Hajiyeve and Su, 2017; Salloum et al., 2019; Alshammari, 2020; Gurban and Almogren, 2022; Rokhim et al., 2024). Students who perceive LMS platforms as simple and user-friendly are more likely to develop favorable attitudes and stronger intentions to continue using LMS platforms (Hanif, Jamal and Imran, 2018; Revythi and Tselios, 2019; Salloum et al., 2019; Gurban and Almogren, 2022). In vocational education contexts, where students often engage in practice-oriented and task-based learning activities, system simplicity and operational convenience become particularly important in shaping LMS acceptance. Therefore, the following hypotheses are proposed:

- H11: PEOU positively influences PU in LMS use.
- H12: PEOU positively influences ATU in LMS use.
- H13: PEOU positively influences BI in LMS use.

Perceived Usefulness (PU)

PU refers to the extent to which individuals believe that using a particular technology can enhance their performance and improve task accomplishment (Davis, 1989). In the context of LMS, PU reflects students' beliefs that LMS platforms effectively support learning activities, improve academic productivity, and facilitate access to educational resources. Technologies perceived as useful are more likely to encourage students' positive attitudes and continued intention to use the system.

Within the TAM, PU is considered one of the strongest predictors of technology acceptance behavior. Previous studies have consistently demonstrated that students who perceive LMS platforms as beneficial for learning tend to develop more favorable attitudes toward e-learning (Gurban and Almogren, 2022; Or, 2024). PU also positively influences students' BI to continue using LMS platforms in educational settings (Al-Gahtani, 2016; Hanif, Jamal and Imran, 2018; Octavia and Nugraha, 2024). Empirical evidence from various e-learning studies further confirms that students are more likely to engage in sustained LMS use when they perceive the technology as effective in supporting their academic activities and learning outcomes (Al-Gahtani, 2016; Ching-Ter, Hajiyeve and Su, 2017; Revythi and Tselios, 2019; Salloum et al., 2019; Gurban and Almogren, 2022; Rokhim et al., 2024).

In vocational education contexts, PU becomes particularly important because students frequently rely on LMS platforms to access instructional materials, complete assignments, and support practice-oriented learning activities. Therefore, students who perceive LMS platforms as beneficial for improving their learning performance are expected to develop more positive attitudes and stronger intentions toward LMS use. Accordingly, the following hypotheses are proposed:

- H14: PU positively influences ATU in LMS use.
- H15: PU positively influences BI in LMS use.

Attitude Towards Using (ATU)

ATU refers to an individual's overall positive or negative evaluation of using a particular technology system (Davis, 1993). In the context of LMS, ATU reflects students' affective responses and evaluations based on their experiences interacting with e-learning platforms during learning activities. More positive attitudes toward LMS use are generally associated with favorable perceptions of technology usefulness, convenience, and learning effectiveness.

Within the TAM, ATU is considered an important determinant of users' BI to adopt and continue using technology. Previous studies have consistently demonstrated that students who develop positive attitudes toward LMS platforms are more likely to report stronger intentions to continue using e-learning systems in the future (Al-Aulamie, 2013; Hanif, Jamal and Imran, 2018; Gurban and Almogren, 2022). Similar findings have also been reported in studies examining e-learning acceptance in higher education and digital learning environments, where positive attitudes significantly influence students' BI in using LMS platforms (Hanif, Jamal and Imran, 2018; Revythi and Tselios, 2019; Salloum et al., 2019; Gurban and Almogren, 2022).

In vocational education settings, students who perceive LMS platforms as supportive, engaging, and beneficial for learning activities develop more favorable attitudes toward technology use, which subsequently strengthens their intention to continue utilizing LMS platforms. Therefore, the following hypothesis is proposed:

- H16: ATU positively influences BI in LMS use.

Behavioral Intention to Use (BI)

BI refers to an individual's motivational tendency or willingness to perform a particular behavior, specifically the intention to adopt and continue using a technology system (Davis, 1989). In the context of LMS, behavioral intention reflects students' readiness and commitment to engage in sustained LMS use for learning activities. BI is considered a key predictor of actual technology usage behavior within the TAM.

Previous studies have consistently demonstrated that students with stronger BI toward e-learning systems are more likely to actively and continuously use LMS platforms in their academic activities (Alshammari, 2020; Gurban and Almogren, 2022). Students who intend to use LMS platforms regularly tend to integrate the technology into their learning routines, including accessing instructional materials, completing assignments, and participating in online discussions. Empirical evidence further confirms that BI significantly influences AU in various e-learning environments (Davis, 1989; Gurban and Almogren, 2022).

In vocational education contexts, students' intention to use LMS platforms becomes particularly important because digital learning systems increasingly support practice-oriented learning activities and flexible access to instructional resources. Therefore, students with stronger BI toward LMS use are expected to demonstrate higher levels of AU. Accordingly, the following hypothesis is proposed:

- H17: BI positively influences AU in LMS use.

MATERIALS AND METHODS

Participants

This study employed a quantitative cross-sectional survey design to examine students' acceptance of LMS use in vocational secondary education. A cross-sectional approach was considered appropriate because the study aimed to investigate the relationships among TAM constructs and external variables at a specific point in time within an authentic educational setting (Creswell and Creswell, 2018). The research was conducted at a vocational secondary school in Surabaya, East Java, Indonesia, within the Economics and Business expertise area and included the E-commerce and Marketing, Office Management and Business Services, and Accounting programs.

The selected school was considered suitable for this study because it had systematically implemented LMS-based learning across multiple subjects and vocational study programs. Students regularly engaged with digital learning technologies through both synchronous and asynchronous instructional activities, including accessing learning materials, participating in classroom discussions, and submitting assignments online. This educational context provided a relevant setting for examining LMS acceptance among vocational secondary school students. This vocational education setting was selected because vocational students typically participate in practice-oriented and technology-supported learning activities, which may shape their perceptions and acceptance of educational technologies differently from those of students in general secondary or higher education contexts (Sánchez-Prieto et al., 2019; Almaiah, Al-khasawneh and Althunibat, 2020).

The study focused specifically on students who actively used the LMS as part of their regular learning activities. To ensure that respondents had sufficient experience with LMS use, only students who reported using the LMS for at least 10 hours per week were included. Weekly LMS-use time was self-reported in the questionnaire. The 10-hour threshold was used operationally in this study to identify relatively experienced users and should not be interpreted as a validated cut-off. Because this inclusion criterion conditions the sample on relatively high LMS exposure, the findings, including the BI→AU relationship, apply primarily to active/high-exposure users and should not be generalized to students with limited LMS exposure.

Data were collected using an online questionnaire distributed through Google Forms. Participation in the study was voluntary, and respondents were informed that all responses would remain anonymous and confidential. The data were used solely for academic research purposes. Ethical considerations throughout the research process followed principles of voluntary participation, informed consent, and participant confidentiality in educational research (Creswell and Creswell, 2018).

Table 1 presents the demographic characteristics and LMS usage profile of the 252 vocational secondary school students who participated in this study. Female students constituted the majority of the sample (59.5%), while male students accounted for 40.5%. In terms of grade level, most respondents were enrolled in Grade XI (48.4%), followed by Grade X (30.6%) and Grade XII (21.0%).

Variables	Category	Frequency
Gender	Female	150
	Male	102
Grade Level	Grade X	77
	Grade XI	122
	Grade XII	53
Programs	E-commerce and Marketing	48
	Office Management and Business Services	134
	Accounting	70
The Use of LMS Platform	LMS Portal Developed by Schools	135
	Moodle	58
	Google Classroom	48
	Multiple LMS	11
Weekly LMS Usage Time	10–15 hours	103
	16–20 hours	106
	More than 20 hours	43

Table 1: Respondent Demographic and LMS Profile

Regarding academic specialization, the respondents predominantly came from the Office Management and Business Services program (53.2%), followed by Accounting (27.8%) and E-commerce and Marketing (19.0%). Concerning LMS usage, the majority reported using LMS platforms developed internally by the school (53.6%), while others reported Moodle (23.0%), Google Classroom (19.0%), or multiple LMS platforms (4.4%). Regarding LMS engagement intensity, most students reported using an LMS for 16–20 hours per week (42.1%), followed by 10–15 hours (40.9%), while 17.1% reported more than 20 hours weekly. The study therefore involved students with substantial self-reported exposure to digital learning. Because the AU construct was measured through the questionnaire, it represents self-reported LMS use rather than objective usage-log data. Analyses pooled students across platform types and did not estimate platform-specific effects; this heterogeneity should be considered when interpreting the findings.

Instruments

The research instrument consisted of a structured questionnaire adapted from previous studies on e-learning acceptance and the TAM, particularly the instrument developed by Salloum et al. (2019). The questionnaire measured ten constructs, namely PEOU, PU, ATU, BI, AU, CSE, SN, PE, PA, and PP; the items are presented in Appendix 1.

A total of 44 measurement items were used to assess the proposed constructs. All items were evaluated using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Prior to data collection, the questionnaire items were reviewed and adapted to ensure their suitability for the vocational secondary education context and LMS-based learning environments.

Data Analysis

Data were analyzed using Structural Equation Modeling–Generalized Structured Component Analysis (SEM-GSCA) with GSCA Pro version 1.2.1. SEM-GSCA was selected because it is appropriate for analyzing complex predictive models involving multiple latent constructs and moderate

sample sizes (Hwang and Takane, 2004). Compared with covariance-based SEM, GSCA provides greater flexibility regarding multivariate normality assumptions and enables component-based estimation of latent variables while using a component-based estimation framework (Hwang, Ho and Lee, 2010). In addition, GSCA is considered suitable for exploratory and prediction-oriented research models, particularly in studies examining behavioral and educational technology acceptance (Solimun and Fernandes, 2017).

The analysis procedure consisted of three stages. First, overall model fit was evaluated to assess the compatibility between the proposed research model and the observed data. Model fit evaluation in GSCA commonly involves several goodness-of-fit indices, including FIT, AFIT, GFI, and SRMR, which collectively indicate the adequacy of the overall model (Hwang and Takane, 2004). Second, the measurement model was assessed through convergent validity, discriminant validity, indicator loading significance, and internal consistency reliability to ensure the adequacy and consistency of the measurement indicators (Hair and Alamer, 2022). Convergent validity was evaluated using factor loadings and Average Variance Extracted (AVE), while reliability was assessed using Cronbach’s alpha and composite reliability values.

Third, the structural model was evaluated using path coefficients, Variance Inflation Factor (VIF), coefficient of determination (R^2), and effect size (f^2) to examine the relationships among constructs and the explanatory power of the proposed model. Path coefficient analysis was conducted to test the proposed hypotheses, while VIF values were used to identify potential multicollinearity issues among predictor constructs (Hair and Alamer, 2022). Furthermore, R^2 and f^2 values were interpreted to assess the explanatory performance and substantive contribution of the exogenous variables on endogenous constructs within the extended Technology Acceptance Model (TAM).

RESULTS

Evaluation of Model Fit

The overall model fit was evaluated prior to examining the measurement and structural models. In SEM-GSCA, model

fit assessment is commonly conducted using the Goodness-of-Fit Index (GFI), Standardized Root Mean Square Residual (SRMR), and FIT indices to determine the extent to which the proposed model adequately represents the observed data (Hwang and Takane, 2004).

As presented in Table 2, the model demonstrated an acceptable level of fit. The GFI value (0.964) exceeded the recommended threshold of 0.95, while the SRMR value (0.074) remained below the maximum acceptable threshold of 0.08, indicating satisfactory model fit. Furthermore, the overall FIT value

of 0.815 suggests that the proposed model explained 81.5% of the total variance across indicators and latent constructs. The measurement model showed a high explanatory contribution (FITm = 0.927), whereas the structural model demonstrated a moderate explanatory level (FITs = 0.296). Overall, these findings indicate that the proposed SEM-GSCA model provided an acceptable basis for subsequent measurement- and structural-model evaluation. According to Hwang, Cho and Choo (2024), acceptable SEM-GSCA model fit is generally indicated by high GFI values and low SRMR values.

Fit Index	Obtained Value	Interpretation
FIT	0.815	Good
FITm	0.927	Excellent
FITs	0.296	Moderate
GFI	0.964	Good fit
SRMR	0.074	Acceptable fit

Table 2: SEM-GSCA Model Fit Indices

Evaluation of Measurement Model

The measurement model was assessed to evaluate the validity and reliability of the constructs used in this study. The assessment included indicator reliability, convergent validity, discriminant validity, and internal consistency reliability. Specifically, the analysis examined indicator loadings, Average Variance Extracted (AVE), Fornell–Larcker criterion, Heterotrait–Monotrait ratio (HTMT), composite reliability (CR), and Cronbach’s alpha values.

All indicators demonstrated acceptable standardized loadings ranging from 0.539 to 0.860. In addition, all bootstrap confidence intervals excluded zero, indicating that the indicators significantly represented their respective latent constructs. These findings support satisfactory indicator reliability and construct relevance.

Table 3 presents the indicator loading estimates, standard errors, and 95% confidence intervals for all indicators. The strongest loading was observed for PE4 (loading = 0.860), indicating that PE4 was the most representative indicator of the PE construct. Meanwhile, PEOU3 and SN4 showed relatively lower but still acceptable loading values, suggesting that these indicators contributed moderately to their respective constructs.

Convergent validity was subsequently evaluated using AVE values. As presented in Table 4, several constructs, namely SN, PA, PP, ATU, and AU, reported AVE values below the recommended threshold of 0.50. Nevertheless, this condition remains acceptable because all constructs demonstrated composite reliability values above 0.70, consistent with the recommendation of Fornell and Larcker (1981) that convergent validity is still considered adequate when composite reliability exceeds the acceptable level (see Table 4). Overall, composite reliability values ranged from 0.731 to 0.856, while Cronbach’s alpha values ranged from 0.700 to 0.846, indicating satisfactory internal consistency reliability across all constructs. Discriminant validity was first examined using the Fornell–Larcker criterion, as presented in Table 5. After recalculating the diagonal values as the square roots of the AVEs reported in Table 4, the criterion was not satisfied for several construct pairs, indicating notable overlap among some theoretically related variables. Because the Fornell–Larcker criterion has limited

sensitivity in variance- and component-based structural equation modelling, HTMT was also examined as a complementary criterion (Henseler, Ringle and Sarstedt, 2015). Accordingly, discriminant validity is interpreted cautiously rather than as unequivocally established for all construct pairs.

As presented in Table 6, most HTMT values were below the commonly recommended threshold of 0.90. However, the HTMT value between PU and ATU was 0.919 and therefore did not meet the stricter 0.90 criterion. This result indicates substantial overlap between perceived usefulness and attitude toward use, which is theoretically plausible within TAM but should nevertheless be considered when interpreting paths involving these constructs. The measurement model therefore showed broadly distinguishable constructs overall, with the PU–ATU distinction requiring particular caution.

Evaluation of Structural Model

The structural model was evaluated by examining multicollinearity, explanatory power, effect size, and the significance of the hypothesized relationships among constructs. The assessment included Variance Inflation Factor (VIF), coefficient of determination (R^2), effect size (f^2), and path coefficient estimates obtained through bootstrap resampling.

First, multicollinearity was assessed using the Variance Inflation Factor (VIF). As presented in Table 7, all VIF values ranged from 1.815 to 4.900, which remained below the recommended threshold of 5.00 (Hair, Ringle and Sarstedt, 2011; Hair et al., 2017). SEM is equivalent to carrying out covariance-based SEM (CB-SEM). These findings indicate that none of the reported VIF values exceeded the prespecified threshold of 5.00.

The explanatory power of the model was then evaluated using the coefficient of determination (R^2), as reported in Table 4. The results showed that the model explained 75.2% of the variance in ATU, 72.3% of the variance in PU, 63.9% of the variance in BI, 44.9% of the variance in PEOU, and 30.2% of the variance in AU. These findings suggest that the proposed model possesses moderate to substantial explanatory power, particularly in explaining students’ attitudes and perceived usefulness of LMS usage in vocational education contexts.

Construct	Item	Loadings		
		Estimate	SE	95% CI
Computer self-efficacy (CSE)	CSE1	0.715	0.039	[0.640, 0.793]
	CSE2	0.693	0.047	[0.584, 0.755]
	CSE3	0.714	0.051	[0.631, 0.816]
	CSE4	0.726	0.035	[0.654, 0.793]
	CSE5	0.697	0.039	[0.615, 0.788]
Subjective norm (SN)	SN1	0.625	0.060	[0.525, 0.743]
	SN2	0.583	0.076	[0.477, 0.787]
	SN3	0.783	0.073	[0.662, 0.917]
	SN4	0.543	0.058	[0.433, 0.635]
Perceived enjoyment (PE)	PE1	0.741	0.039	[0.666, 0.820]
	PE2	0.627	0.050	[0.542, 0.721]
	PE3	0.810	0.032	[0.747, 0.870]
	PE4	0.860	0.026	[0.812, 0.907]
	PE5	0.629	0.049	[0.528, 0.724]
Perceived accessibility (PA)	PA1	0.754	0.035	[0.688, 0.823]
	PA2	0.701	0.058	[0.582, 0.795]
	PA3	0.610	0.053	[0.505, 0.723]
	PA4	0.635	0.058	[0.519, 0.741]
	PA5	0.774	0.044	[0.693, 0.869]
Perceived playfulness (PP)	PP1	0.613	0.057	[0.465, 0.728]
	PP2	0.657	0.055	[0.560, 0.768]
	PP3	0.765	0.049	[0.668, 0.862]
	PP4	0.698	0.076	[0.550, 0.841]
	PP5	0.595	0.051	[0.501, 0.699]
Perceived ease of use (PEOU)	PEOU1	0.712	0.040	[0.644, 0.809]
	PEOU2	0.785	0.054	[0.688, 0.909]
	PEOU3	0.539	0.064	[0.413, 0.662]
	PEOU4	0.767	0.054	[0.661, 0.862]
Perceived usefulness (PU)	PU1	0.699	0.037	[0.632, 0.799]
	PU2	0.799	0.050	[0.714, 0.891]
	PU3	0.738	0.042	[0.668, 0.836]
	PU4	0.746	0.039	[0.678, 0.840]
Attitude towards using (ATU)	ATU1	0.679	0.041	[0.619, 0.774]
	ATU2	0.757	0.060	[0.662, 0.901]
	ATU3	0.675	0.045	[0.580, 0.766]
	ATU4	0.694	0.052	[0.603, 0.798]
Behavioral intention to use (BI)	BI1	0.709	0.045	[0.629, 0.788]
	BI2	0.716	0.042	[0.636, 0.797]
	BI3	0.722	0.036	[0.656, 0.791]
	BI4	0.734	0.052	[0.650, 0.841]
Actual system use (AU)	AU1	0.700	0.049	[0.597, 0.779]
	AU2	0.591	0.069	[0.417, 0.689]
	AU3	0.751	0.047	[0.677, 0.852]
	AU4	0.724	0.050	[0.624, 0.827]

Table 3: Measurement Item Factor Loadings

Construct	AVE	CR	Cronbach's Alpha	R ²
Computer self-efficacy (CSE)	0.503	0.835	0.828	
Subjective norm (SN)	0.410	0.731	0.700	
Perceived enjoyment (PE)	0.547	0.856	0.846	
Perceived accessibility (PA)	0.487	0.825	0.812	
Perceived playfulness (PP)	0.447	0.800	0.785	
Perceived ease of use (PEOU)	0.500	0.797	0.780	0.449
Perceived usefulness (PU)	0.557	0.834	0.822	0.723
Attitude towards using (ATU)	0.493	0.795	0.781	0.752
Behavioral intention to use (BI)	0.519	0.812	0.802	0.639
Actual system use (AU)	0.482	0.787	0.767	0.302

Note: AVE = Average Variance Extracted; CR = Composite Reliability. AVE values below 0.50 were considered acceptable because CR values exceeded 0.70.

Table 4: Construct Reliability, Validity, and R-square

	CSE	SN	PE	PA	PP	PU	PEOU	ATU	BI	AU
CSE	0.709									
SN	0.730	0.640								
PE	0.663	0.775	0.740							
PA	0.657	0.60	0.680	0.698						
PP	0.627	0.760	0.842	0.742	0.669					
PU	0.641	0.713	0.681	0.653	0.697	0.746				
PEOU	0.543	0.551	0.539	0.614	0.497	0.792	0.707			
ATU	0.703	0.717	0.749	0.682	0.731	0.881	0.762	0.702		
BI	0.589	0.585	0.672	0.691	0.691	0.768	0.660	0.786	0.720	
AU	0.538	0.543	0.619	0.437	0.539	0.534	0.410	0.595	0.561	0.694

Note: Diagonal values are the recalculated square roots of AVE; off-diagonal values are inter-construct correlations. Several construct pairs do not satisfy the Fornell–Larcker criterion.

Table 5: Fornell-Larcker Discriminant Validity Matrix

Construct	CSE	SN	PE	PA	PP	PU	PEOU	ATU	BI	AU
CSE	-	0.789	0.691	0.685	0.664	0.664	0.567	0.734	0.610	0.581
SN	0.789	-	0.845	0.656	0.832	0.760	0.591	0.779	0.634	0.609
PE	0.691	0.845	-	0.702	0.886	0.704	0.557	0.778	0.696	0.667
PA	0.685	0.656	0.702	-	0.795	0.683	0.649	0.716	0.716	0.476
PP	0.664	0.832	0.886	0.795	-	0.734	0.527	0.779	0.733	0.583
PU	0.664	0.760	0.704	0.683	0.734	-	0.821	0.919	0.796	0.574
PEOU	0.567	0.591	0.557	0.649	0.527	0.821	-	0.796	0.695	0.438
ATU	0.734	0.779	0.778	0.716	0.779	0.919	0.796	-	0.820	0.648
BI	0.610	0.634	0.696	0.716	0.733	0.796	0.695	0.820	-	0.601
AU	0.581	0.609	0.667	0.476	0.583	0.574	0.438	0.648	0.601	-

Note: Heterotrait–Monotrait ratio. Values below 0.90 are preferred; PU–ATU = 0.919 exceeds this stricter criterion and should be interpreted cautiously.

Table 6: HTMT Discriminant Validity Matrix

Relationship	VIF	Effect Size (f^2)
CSE → PEOU	2.196	0.039
CSE → PU	2.264	0.006
SN → PEOU	3.180	0.070
SN → PU	3.300	0.012
PE → PEOU	3.889	0.002
PE → PU	3.892	0.011
PA → PEOU	2.635	0.186
PA → PU	2.919	0.001
PP → PEOU	4.871	0.017
PP → PU	4.900	0.041
PEOU → PU	1.815	0.327
PEOU → ATU	2.464	0.044
PEOU → BI	2.635	0.006
PU → ATU	2.464	0.950
PU → BI	4.425	0.023
ATU → BI	4.025	0.123
BI → AU	N/A	0.459

Note: VIF was not applicable for BI → AU because AU was predicted by a single construct; therefore, multicollinearity assessment was not required for this relationship.

Table 7: Collinearity and Effect Size

Table 8 presents the structural path estimates, bootstrap standard errors, confidence intervals, and hypothesis testing results. The findings indicate that PA showed a significant positive association with PEOU ($\beta = 0.396$, 95% CI [0.150,

0.694]), whereas the paths from CSE, SN, PE, and PP to PEOU and PU were not statistically significant. Thus, PA was the only external factor in the model that showed a statistically significant direct association with PEOU.

Hypothesis	Relationship	β	SE	95% CI	Results
H1	CSE → PU	0.075	0.088	[-0.120, 0.242]	Not Supported
H2	CSE → PEOU	0.194	0.111	[-0.038, 0.385]	Not Supported
H3	SN → PU	0.108	0.117	[-0.105, 0.386]	Not Supported
H4	SN → PEOU	0.257	0.141	[-0.134, 0.455]	Not Supported
H5	PE → PU	0.102	0.106	[-0.104, 0.301]	Not Supported
H6	PE → PEOU	0.040	0.149	[-0.214, 0.334]	Not Supported
H7	PA → PU	0.020	0.082	[-0.143, 0.181]	Not Supported
H8	PA → PEOU	0.396	0.134	[0.150, 0.694]	Supported
H9	PP → PU	0.198	0.135	[-0.076, 0.450]	Not Supported
H10	PP → PEOU	-0.128	0.196	[-0.608, 0.173]	Not Supported
H11	PEOU → PU	0.496	0.088	[0.312, 0.681]	Supported
H12	PEOU → ATU	0.206	0.109	[0.034, 0.415]	Supported
H13	PEOU → BI	0.079	0.102	[-0.137, 0.284]	Not Supported
H14	PU → ATU	0.698	0.104	[0.418, 0.862]	Supported
H15	PU → BI	0.432	0.157	[0.111, 0.692]	Supported
H16	ATU → BI	0.331	0.147	[0.071, 0.624]	Supported
H17	BI → AU	0.550	0.056	[0.413, 0.645]	Supported

Table 8: Structural Path Hypothesis Testing

Furthermore, PEOU was significantly associated with PU ($\beta = 0.496$, 95% CI [0.312, 0.681]) and ATU ($\beta = 0.206$, 95% CI [0.034, 0.415]). However, the direct relationship between PEOU and BI was not statistically significant. This finding indicates that PEOU did not show a significant direct association with BI in the specified model; any indirect association through other TAM constructs was not tested in the reported analysis.

The results also showed that PU was significantly associated with both ATU ($\beta = 0.698$, 95% CI [0.418, 0.862]) and BI

($\beta = 0.432$, 95% CI [0.111, 0.692]). In addition, ATU was positively associated with BI ($\beta = 0.331$, 95% CI [0.071, 0.624]), and BI significantly predicted AU ($\beta = 0.550$, 95% CI [0.413, 0.645]). These findings are consistent with several central relationships proposed in the TAM, particularly the important role of PU and BI in predicting actual technology usage behavior.

The effect size analysis (f^2), presented in Table 7, further revealed that most external factors demonstrated relatively small effects on PU and PEOU. In contrast, several structural relationships

showed moderate to large effects, particularly the influence of PU on ATU ($f^2 = 0.950$), BI on AU ($f^2 = 0.459$), and PEOU on PU ($f^2 = 0.327$). These findings indicate that internal TAM constructs contributed more strongly to LMS acceptance behavior than the external variables included in the present study.

Interestingly, several external variables commonly found significant in prior TAM studies did not demonstrate significant effects in the present study. In this sample, practical utility and accessibility showed stronger direct relationships with the core TAM constructs than the social and affective external variables examined. Thus, the structural model results demonstrate that LMS acceptance among vocational secondary school students was more strongly associated with functional TAM constructs than with social influence or enjoyment-related factors.

DISCUSSION

Re-examining TAM Relationships in Vocational LMS Adoption

The findings support several core relationships in the TAM proposed by Davis (1989), particularly those among PEOU, PU, ATU, BI, and AU. PEOU was significantly associated with PU and ATU, indicating that students who perceive LMS platforms as easy to operate are more likely to recognize their academic value (Revythi and Tselios, 2019; Alshammari, 2020; Gurban and Almogren, 2022).

However, the direct relationship between PEOU and BI was not significant. In the present sample, usability was not a significant direct predictor of BI, which may reflect the participants' substantial prior exposure to digital technologies and online platforms (Revythi and Tselios, 2019; Hai et al., 2022; Kazu and Yalçin, 2022; Al-Adwan et al., 2023). This interpretation should be treated as context-specific rather than as evidence of a general post-pandemic change in the role of PEOU.

Conversely, PU emerged as the strongest predictor of ATU and BI, indicating that perceived usefulness was strongly associated with favorable attitudes and behavioral intention in this sample (Al-Gahtani, 2016; Almaiah, Jalil and Man, 2016; Salloum et al., 2019). The relationship between ATU and BI was also significant, indicating that more favorable attitudes were associated with stronger intentions to continue using LMS platforms (Hanif, Jamal and Imran, 2018; Muhaimin et al., 2019; Salloum et al., 2019). Furthermore, BI significantly predicted AU, supporting previous TAM studies that identify intention as the strongest predictor of actual LMS adoption behavior (Salloum et al., 2019; Alshammari, 2020; Gurban and Almogren, 2022).

Thus, the findings suggest that TAM remains highly relevant for explaining LMS adoption in vocational secondary education. Within this sample, PU showed a stronger direct association with BI than PEOU. This pattern suggests that perceived functional value may be particularly salient in this vocational school context.

Limited Direct Effects of Motivational External Factors

The results showed that the motivational external factors—CSE, SN, PE, and PP—did not have statistically significant direct

paths to PU or PEOU. Accordingly, these variables contributed limited direct explanatory value in the present model.

CSE was found to have no significant effect on either PU or PEOU. While earlier studies identified self-efficacy as an important predictor of e-learning acceptance (Al-Gahtani, 2016; Salloum et al., 2019), the present findings align with more recent studies showing weaker effects among technologically experienced students (Hanif, Jamal and Imran, 2018; Revythi and Tselios, 2019). One possible explanation is that students in this setting already had substantial familiarity with smartphones and digital platforms, reducing variation in basic technological confidence.

Similarly, SN did not significantly influence students' LMS perceptions. Unlike findings during the COVID-19 pandemic, where social influence strongly shaped online learning adoption (Salloum et al., 2019; Khan et al., 2020), One possible explanation is that LMS use was already embedded in formal learning routines, which may have reduced the additional contribution of perceived social influence.

PE and PP were also insignificant predictors, supporting studies suggesting that students may view LMS platforms primarily as functional academic tools rather than entertainment-oriented environments (Jiang et al., 2021; Rokhim et al., 2024). In vocational education, students may prioritize task completion, efficiency, and academic performance over emotional engagement. Moreover, the structured and assessment-oriented nature of institutional LMS platforms may limit pleasurable or playful learning experiences.

Taken together, these findings are consistent with an LMS environment that was relatively established among the participating students. The present cross-sectional design did not compare pandemic and post-pandemic cohorts and therefore cannot determine whether the role of motivational factors changed over time. Comparisons with earlier pandemic-period studies should consequently be interpreted as contextual contrasts rather than evidence of a temporal decline or shift in these factors.

The findings therefore suggest that the motivational TAM extensions examined here had limited direct explanatory contribution in this single-school, high-exposure sample. Functional considerations and accessibility were more strongly associated with LMS acceptance than the social and enjoyment-related external variables examined. These results support context-sensitive interpretation of technology-acceptance models in vocational secondary education rather than a general claim that motivational factors have become less important over time.

Accessibility as the Primary Driver of LMS Ease of Use

PA emerged as the only external factor that significantly influenced PEOU, although it did not significantly affect PU. This pattern suggests that accessibility was more closely related to perceived ease of use than to perceived educational value in the specified model. Students who reported greater accessibility also tended to report greater ease of use, whereas the direct PA–PU path was not significant. These findings are consistent with previous studies showing that PA positively affects PEOU

(Almaiah, Jalil and Man, 2016; Hanif, Jamal and Imran, 2018; Revyathi and Tselios, 2019; Salloom et al., 2019), while its relationship with PU remains weak or inconsistent (Park, 2009; Park, Nam and Cha, 2012; Solichin and Wijaya, 2021).

In vocational learning environments, students regularly use LMS platforms to access materials, submit assignments, and complete assessments within limited instructional time. Consequently, stable connectivity, device compatibility, and smooth system access may contribute to perceptions of PEOU. This finding aligns with TAM, which emphasizes that users' perceptions of system simplicity influence PEOU evaluations (Davis, 1989). The result can also be interpreted through Task–Technology Fit (TTF) theory, which argues that technology adoption increases when system features effectively support task completion (Goodhue et al., 1995). In this study, accessibility was associated with ease of use but did not show a significant direct path to perceived usefulness. This pattern is consistent with accessibility functioning as an enabling condition for routine academic activities. Nevertheless, accessibility alone does not necessarily enhance students' beliefs that the LMS improves learning quality or academic performance.

The findings imply that schools and LMS developers should prioritize digital infrastructure, responsive system design, and cross-device accessibility to reduce technological barriers. Nevertheless, technical accessibility alone is insufficient to strengthen PU. LMS platforms must also provide pedagogically meaningful learning experiences, collaborative activities, and authentic vocational tasks to ensure sustainable student acceptance.

LMS Use in an Institutionally Embedded Digital Learning Context

A notable finding of this study is the non-significant relationship between PEOU and BI, which contrasts with the original assumptions of TAM (Davis, 1989). In the present sample, PEOU was not a significant direct predictor of BI. This pattern is consistent with some studies conducted in digitally experienced learning contexts (Revyathi and Tselios, 2019; Hai et al., 2022; Al-Adwan et al., 2023), but the current cross-sectional data do not demonstrate that the role of ease of use has changed over time or specifically because of the post-pandemic context.

This finding can be explained by the characteristics of today's students, who are highly familiar with digital technologies and online platforms (Larionova et al., 2018; Kazu and Yalçin, 2022). Given their reported level of LMS exposure, participants may have perceived LMS operation as relatively routine. Where LMS use is institutionally required for accessing materials, submitting assignments, and completing assessments, continued use may occur even when the platform is not perceived as particularly easy or enjoyable (Hai et al., 2022; Al-Adwan et al., 2023).

The findings further indicate that BI was more strongly associated with PU and ATU than with PEOU. This suggests that perceived educational value and favorable attitudes may be more salient for BI than interface simplicity in this sample (Ni and Cheung, 2023; Barz et al., 2024). The findings are compatible with an institutionally embedded digital-learning

context in which pedagogical relevance may be important alongside technological convenience.

The findings may also be considered in relation to the broader normalization of digital learning in secondary education discussed in prior literature. Pandemic-era LMS use often occurred under emergency remote-learning conditions, whereas later studies have described more institutionally embedded forms of digital learning (Hermanto et al., 2021). The present results are compatible with this broader context, but they do not themselves establish a pandemic-to-post-pandemic shift because no temporal comparison was conducted.

From a practical perspective, these findings suggest that schools and LMS developers should move beyond focusing exclusively on usability improvements. Although user-friendly design remains important, educational institutions should prioritize the development of pedagogically meaningful digital learning experiences that enhance students' academic engagement and perceived learning benefits. Teachers should integrate interactive learning activities, collaborative projects, authentic vocational tasks, and reflective learning opportunities into LMS environments to strengthen students' intrinsic motivation and sustained behavioral intention. Simultaneously, LMS developers should design platforms that support adaptive learning, communication, feedback mechanisms, and vocationally relevant learning simulations to ensure that LMS usage is perceived as educationally valuable rather than merely administratively driven.

Practical and Pedagogical Implications

The findings highlight several important implications for LMS implementation in vocational secondary education. First, PU emerged as the strongest predictor of students' ATU and BI, indicating that students who perceived greater academic benefits also reported more favorable attitudes and stronger behavioral intentions. This finding reinforces prior studies emphasizing that sustainable LMS adoption depends largely on perceived instructional value and performance enhancement (Davis, 1989; Al-Adwan et al., 2023; Ni and Cheung, 2023).

Pedagogically, teachers play a central role in transforming LMS platforms from administrative tools into meaningful learning environments. When LMS use is limited primarily to material distribution and assessment activities, opportunities for deeper student engagement may be reduced. Therefore, teachers should integrate more interactive approaches, such as collaborative learning, project-based activities, reflective discussions, and authentic vocational simulations, to strengthen students' perceptions of usefulness and engagement (Teo et al., 2018; Al-Rahmi et al., 2020; Barz et al., 2024; Halomoan et al., 2026).

The findings regarding accessibility also generate practical implications for educational policymakers and school administrators. Because PA was significantly associated with PEOU, schools should ensure that students have stable internet access, compatible digital devices, and reliable technological infrastructure. Accessibility issues remain particularly important in vocational education contexts because students frequently rely on digital systems for both theoretical and practice-oriented learning activities. Schools should therefore invest in sustainable digital infrastructure development,

including high-speed internet connectivity, technical support services, and device availability to minimize technological barriers that may disrupt learning continuity. In addition, LMS developers should prioritize responsive interface design, mobile compatibility, simplified navigation systems, and lightweight platform architecture to accommodate diverse learning conditions and technological resources (Revythi and Tselios, 2019; Salloum et al., 2019).

Another important implication concerns the changing role of motivational external factors in post-pandemic learning environments. The non-significant paths from PE and PP suggest that entertainment-related perceptions had limited direct explanatory value in the present model, whereas functionality and accessibility were more prominent. Nevertheless, this does not imply that engagement-oriented features are unimportant. Rather, gamification and interactive elements should be integrated strategically to support meaningful learning experiences instead of functioning merely as entertainment components. LMS developers and educators should therefore consider incorporating adaptive feedback systems, achievement tracking, interactive multimedia content, and collaborative learning spaces that align with vocational learning objectives while maintaining students' engagement and attention (Hamari, Koivisto and Sarsa, 2014; Wang and Lin, 2021).

The findings suggest that institutional LMS implementation should be accompanied by attention to students' perceptions of educational value. In the model, BI was more strongly associated with PU and ATU than with PEOU. Therefore, schools should avoid treating LMS implementation merely as a compliance-oriented administrative policy. Instead, educational stakeholders should develop comprehensive digital learning ecosystems that cultivate students' autonomy, self-regulated learning skills, and active participation in online learning environments. Such an approach is particularly important in vocational education because students are expected to develop technological adaptability and lifelong digital competencies relevant to future workforce demands (OECD, 2021).

Finally, the findings have broader implications for efficient and responsible LMS implementation in vocational education. The present study directly measured technology-acceptance constructs rather than learning efficiency, learning continuity, competency attainment, academic performance, or vocational readiness. Accordingly, the empirical results support recommendations concerning accessibility, perceived usefulness, attitudes, intention, and self-reported use. Potential contributions of accessible and pedagogically meaningful LMS platforms to learning continuity or competency-oriented education should be understood as literature-informed implications rather than outcomes demonstrated by the current data (Snoussi, 2019; Al-Fraihat et al., 2020).

Limitations and Future Research

This study has several limitations that should be considered when interpreting the findings. First, the research was conducted in a single vocational secondary school in Surabaya, Indonesia, within the Business and Economics expertise area, specifically involving students from Office Management and Business

Services, Accounting, and E-commerce and Marketing programs. This specific context limits generalizability to other schools, regions, educational levels, vocational fields, and cultural settings. Second, the cross-sectional design captured students' LMS acceptance at a single point in time and therefore cannot establish temporal change or post-pandemic trends. Third, the study focused only on selected external TAM variables, namely CSE, SN, PE, PA, and PP, which may not fully represent the broader contextual factors influencing LMS acceptance. Fourth, eligibility required at least 10 hours of self-reported LMS use per week, so the sample represents relatively active/high-exposure users and may have restricted variability in the AU construct. Fifth, students reported using different LMS platforms, but platform-specific effects were not modelled, and AU was based on self-report rather than objective usage logs. Finally, several constructs showed AVE values below 0.50 and the discriminant-validity analyses indicated overlap among some constructs, particularly PU and ATU; paths involving these constructs should therefore be interpreted cautiously.

Future research should extend the present model by involving multiple vocational schools and broader geographical contexts to improve the external validity of the findings. Longitudinal studies are also recommended to examine changes in students' LMS acceptance and use patterns over time, particularly as digital learning becomes increasingly embedded in vocational education. In addition, future studies may employ mixed-methods approaches to capture students' experiences more deeply and incorporate additional variables, such as instructional quality, digital learning readiness, self-regulated learning, institutional support, LMS design quality, and differences among LMS platforms, to provide a more comprehensive understanding of sustainable LMS adoption in vocational secondary education.

CONCLUSION

This study found that, within the participating vocational school, LMS acceptance was more strongly associated with accessibility and perceived usefulness than with the motivational or hedonic external factors examined. By extending the TAM with selected external variables, the findings show that PU remains central in forming students' ATU and BI, while PA was the only external factor with a significant direct association with PEOU. These results highlight the salience of functional value and accessibility in this specific vocational school context.

The study contributes to the application of TAM by showing that CSE, SN, PE, and PP had limited direct explanatory contribution in this institutionally embedded vocational-school context. In this context, usefulness and accessibility showed more prominent associations with LMS acceptance than the motivational external factors examined. This finding highlights the need to interpret technology acceptance theories more contextually, particularly in vocational education where digital tools are expected to support practical, task-based, and performance-oriented learning.

Practically, the findings suggest that LMS implementation should address more than digital access alone. Schools,

teachers, and LMS developers should ensure that LMS platforms are reliable, pedagogically meaningful, and aligned with vocational learning needs. Responsible LMS integration should aim to reduce operational barriers and support useful learning activities while preserving students' engagement with academic tasks. The present study did not directly measure competency attainment or learning outcomes; therefore, any contribution of LMS implementation to competency-oriented education remains a broader pedagogical implication rather than an empirical outcome demonstrated here.

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