Original Research Paper

Factors Influencing Student Individual Performance of University XYZ Through the Use of Mobile Learning Management System

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Abstract: This study investigates the impact of unsupervised learning within mobile Learning Management Systems (LMS) on student individual performance at university XYZ, Indonesia. We conducted data collection through online questionnaires distributed to university XYZ students and employed Partial Least Squares Structural Equation Modeling (PLS-SEM) for analysis. Our research extends the information system success model by integrating pedagogical and technological dimensions, specifically examining their influence on student individual performance while considering student satisfaction as a mediating factor. Our findings support six of the seven hypotheses, demonstrating the positive influence of ease of use, course quality, instructional quality, learning quality, and technology quality on user satisfaction and, subsequently, student individual performance. Notably, one hypothesis contradicts prior research, revealing that interaction quality does not significantly impact user satisfaction and, consequently, has no influence on student individual performance. These insights provide guidance for University XYZ in enhancing the quality of its mobile LMS and improving student satisfaction, ultimately leading to better graduate outcomes. Future research can further explore various dimensions of student performance within the mobile LMS context.

Keywords: Learning Management System, User Satisfaction, Individual Performance, E-Learning, M-Learning

Introduction

In this digital era, a multitude of educational institutions have embraced technology to facilitate teaching and learning activities across various electronic devices, including computers, smartphones, and other gadgets. Digital technology also assumes a crucial role in supporting student performance, as highlighted by research indicating the necessity of introducing technology or digital tools to enhance students' academic achievements (Solas and Sutton, 2018). Notably, the incorporation of digital academic technologies has yielded noteworthy improvements in student output quality, time management, teamwork, and study skills.

As an example, digital technology in the field of education, such as blended learning, can assist students in enhancing their academic performance (Iglesias-Pradas *et al*., 2021). Another study also indicates that digital technology

can foster students' enthusiasm, subsequently resulting in a positive impact on student performance due to the desire to gain recognition (Bai *et al*., 2020). Moreover, the COVID-19 pandemic has compelled educational institutions to implement digital technology-based learning, posing a unique challenge for these institutions to create an effective online learning environment (Iglesias-Pradas *et al*., 2021; Rapanta *et al*., 2020).

The Learning Management System (LMS) application serves as an exemplar of technology implementation in the field of education. Statistical data reveals that Moodle emerges as the most widely utilized LMS technology as of 2023, with a steadily increasing trend over the past (BuiltWith, 2023). In the context of Indonesia, the application of LMS has been adopted by educational institutions to support their teaching and learning activities.

For instance, Kampar Kiri Hilir High School in Indonesia employs a web-based LMS developed using

the PHP programming language and MySQL database. This LMS provides essential facilities for disseminating subject matter, assigning tasks, and hosting media discussion forums to facilitate student engagement (Muhardi *et al.*, 2020). In the realm of higher education in Indonesia, the implementation of an online LMS significantly influences the learning process of algorithms and programming for first-year students at Universitas Pendidikan Indonesia. Evidently, 76% of the total respondents, representing 25 out of 32 participants, expressed that learning algorithms and programming via LMS proved beneficial (Al Husaeni and Hadianto, 2022). Similarly, a survey involving 108 students at Padjadjaran University in Indonesia demonstrated that nearly half of the respondents highly appreciated the LMS used. This positive perception indicates that students comprehend the utility of the LMS, experience high levels of satisfaction, and recognize the benefits of this learning approach for their educational journey (Mirawati and Suminar, 2013).

However, despite the widespread adoption and evident advantages of LMS in higher education, there is a concerning phenomenon whereby the utilization of LMS can lead to a decline in student individual performance. This decline is attributed to the fear and depression experienced by students in the e-learning system, arising from limitations in using e-learning and engaging in an online learning environment that lacks supervision. As a consequence, students' academic performance may suffer compared to traditional face-to-face learning settings (Fawaz and Samaha, 2021; Ghosh *et al.*, 2022). Research further supports the notion that face-to-face learning generally yields better student performance, manifested in higher grades, an increased likelihood of achieving passing grades and grade A, and a decreased tendency to withdraw from courses (Altindag *et al.*, 2021). Hence, it becomes imperative to adopt strategic course design approaches that assist students in achieving success in online learning (Crews *et al.*, 2015). Such strategies must address the challenges posed by the e-learning environment and offer support mechanisms to alleviate the adverse impacts on student's emotional well-being and academic progress.

As one of the private universities in Indonesia, university XYZ upholds a vision of becoming a world-class institution that nurtures and empowers society in nation-building and service. The university places a strong emphasis on community empowerment through its educational endeavors. As evidenced by its ranking among the top five universities in Indonesia in 2023 according to UniRank (2023), university XYZ is committed to realizing its vision by leveraging cutting-edge digital technologies, including the implementation of LMS on web and mobile platforms. The mobile LMS application, available for both iOS and Android users, aims to support students' learning activities.

However, an examination of online reviews of the mobile LMS application indicates that students are dissatisfied with its quality. The reported issues include poor user interface and experience, slow application performance leading to force stops, failure of application notifications to appear, inability to download files, and the presence of bugs. Such feedback contradicts University XYZ's vision of providing quality education and producing graduates who can contribute to and empower Indonesian society, partly through the utilization of the mobile LMS as a digital technology. Furthermore, the international accolades earned by the university XYZ demonstrate its status as a prestigious institution and a benchmark for other universities in terms of the quality of education it offers. As such, student dissatisfaction with the mobile LMS is an issue that requires attention.

To address this concern, this study aims to evaluate the factors influencing students' individual performance through the use of mobile LMS applications. It will analyze the relationships between variables that extend the information system success model (Delone and Mclean, 2003) by integrating pedagogical and technological dimensions, specifically examining their influence on student individual performance while considering student satisfaction as a mediating factor (Koh and Kan, 2020; Bossman and Agyei, 2022). The research endeavors to contribute to the enhancement of the University XYZ mobile LMS application and its services, ultimately aiming to improve student performance and elevate the overall quality of University XYZ as a world-class educational institution.

Ethical Considerations

This study involved respondents who were students at university XYZ. The involved respondents were duly informed of the purpose, procedures, and benefits of this research. There was no element of coercion in this study and respondents had the right to decline participation. Furthermore, data related to the respondents were treated as confidential and solely utilized for research purposes.

Learning Management System

Learning Management System (LMS) is an online to that assists educational institutions in the creation, implementation, and evaluation of learning systems (Al-Mamary, 2022). The problems faced in traditional classroom learning are limitations in providing a direct learning environment, faster evaluation, and more engagement. In contrast, digital learning technologies and tools including LMS can fill this void (Haleem *et al.*, 2022). LMS as a tool in the learning process offers several benefits so that it can be used to solve problems that often

arise in the learning process (Muhardi *et al*., 2020). To achieve these benefits, LMS has four main features to support the learning process (Aldiab *et al*., 2019).

Firstly, it eliminates physical constraints by facilitating collaboration among students from the same university, regardless of their geographical dispersion and varying time zones, within a unified virtual platform. Secondly, in the contemporary era, the adoption of digital devices among students and teachers in educational settings, as seen in initiatives like Bring Your Own Device (BYOD), has grown significantly. This shift means that computers and laptops are no longer the exclusive means to access LMS among students.

Furthermore, LMS has the potential to create an engaging learning environment, especially for younger learners, through elements like gamification or educational video games. Lastly, LMS can seamlessly integrate with various content types as needed. Application developers continually enhance LMS to attract new customers and ensure the satisfaction of existing ones by introducing new features or improving existing ones in response to customer needs.

In summary, the Learning Management System (LMS) plays a pivotal role in modern education by addressing traditional learning limitations and offering a platform that is accessible, engaging, and adaptable to evolving educational needs.

E-Learning and M-Learning

Learning is a process of acquiring knowledge from experience, formal education, or a combination of both and it plays a crucial role in enhancing an individual's capacity to meet their needs and desires (Singh *et al*., 2017). Mobile learning (m-learning) is a subset of electronic learning (e-learning) that offers enhanced mobility and flexibility in the learning process. This distinction is primarily based on the emphasis on student mobility as a learner within the context of m-learning (Sulisworo *et al*., 2016). Essentially, m-learning facilitates user mobility, enabling them to acquire knowledge to fulfill their individual needs and desires.

In the realm of higher education, various features, barriers, and factors influence the implementation of m-learning (Sophonhiranrak, 2021). These encompass a range of features, including mobile applications (apps), email, social media, Short Message Service (SMS), search engines, video conferencing, educational games, Virtual Learning Environments (VLEs) or mixed reality experiences, podcasts, as well as multimedia content like images and videos.

However, the adoption of m-learning faces several barriers, such as technology-related issues, concerns about internet connection stability, limitations in keyboard functionality and screen size on mobile devices, potential distractions while learning on mobile devices,

security considerations related to free Wi-Fi networks in public places, usability challenges with mobile interfaces and inconveniences associated with issues like rapid battery drainage.

Additionally, the successful implementation of m-learning is influenced by various factors, including the compatibility of mobile applications with users' smartphones and the attitudes of students, teachers, and parents, whether in traditional classroom settings or beyond.

In summary, learning is a pivotal process for acquiring knowledge and fulfilling personal needs and desires. Mobile learning (m-learning) offers enhanced mobility and flexibility within the broader context of electronic learning (e-learning), enabling users to acquire knowledge to meet their unique requirements. In higher education, m-learning is characterized by diverse features, faces multiple implementation barriers, and is influenced by factors such as user attitudes and technological compatibility.

Information System Success Model of LMS

It is important to see the success of LMS from the point of non-economic output. So that the success of LMS can be measured using indirect measures or substitute measures, in the form of perceptions, attitudes, and user behavior. This model is very suitable for measuring the success of LMS which is not fully oriented in the form of cost-benefit analysis. Due to the difficulty in interpreting multidimensional aspects of use (mandatory or non-mandatory, informed, or uninformed, effective, or ineffective, and so on), it is recommended to use intention to use as an alternative in measuring in a particular context (Haryaka *et al*., 2017). This model has three main dimensions including (Delone and Mclean, 2003):

a. Information quality: In the LMS context, several studies consider that information quality is the quality of the content of the courses (Chopra *et al*., 2019; Koh and Kan, 2020; Sun *et al*., 2008). A good LMS has well-designed courses, which also play a role as a factor for someone to use LMS (Sun *et al*., 2008). Therefore, information quality can also be defined as course quality (Bossman and Agyei, 2022)
b. System quality: The ease of accessing LMS is an important factor to support (Parsazadeh *et al*., 2014). Several studies explain system quality as the ability to provide convenience and ease for students in using LMS (Lin, 2007; Parsazadeh *et al*., 2014; Koh and Kan, 2020). The perception of LMS users towards the ease of using LMS is defined as ease of use. Thus, it can be concluded that system quality and ease of use have the same definition in evaluating LMS (Bossman and Agyei, 2022)
c. Service quality: Service quality is defined as administrative support of LMS including student

tracking, course authorization and management, budgeting, and other administrative matters (Ozkan and Koseler, 2009). However, based on previous research, service quality does not have a stronger influence on LMS user satisfaction (Lin, 2007; Ozkan and Koseler, 2009). In fact, research conducted by Koh and Kan (2020) showed that the indicators of service quality were invalid, so service quality was removed from the research model. Therefore, service quality is not used in this study

Complementary Quality Factors of LMS

The following factors act as complementary factors in evaluating the success of LMS. The purpose of these factors is to improve the contextualization of LMS success factors. These factors are instructional quality, interaction quality, and learning quality (Koh and Kan, 2020). This study also includes technology quality as an additional factor in measuring LMS quality because it measures LMS quality in terms of technology tools used by students in using LMS (Bossman and Agyei, 2022), considering the three complementary factors presented by Koh and Kan (2020) only describe pedagogical experiences when using LMS:

a. Instructional quality: It is important to evaluate how successful the technical functionality of the LMS is in supporting student learning and leading to student success (Koh and Kan, 2020). In fact, students in the LMS context act as customers. They demand good instructional quality when using the LMS (Chen *et al.*, 2008). Good instructional quality involves the role of multimedia in providing learning to students (Liaw, 2008)
b. Interaction quality: Previous research explained that LMS consists of a community of inquiry between instructors and students. The challenge of a community of inquiry in LMS is to conceive a teaching presence (Garrison, 2007). In addition, interaction is not only limited between instructors and students but can also occur between students (Chen *et al.*, 2008; Koh and Kan, 2020)
c. Learning quality: It is important to evaluate student LMS satisfaction in terms of motivation and enjoyment in learning as social entities in LMS (Ozkan and Koseler, 2009). Students who are not satisfied with the LMS do not feel motivated to continue learning (Liaw, 2008; Sun *et al.*, 2008). Similarly, Koh and Kan (2020) assessed learning quality in terms of perceived usefulness on learning performance, engagement, and motivation
d. Technology quality: Webster and Hackley (1997); Piccoli *et al.* (2001) show the need for good technology quality in new learning environments.

Technology tools that are user-friendly and have few barriers can make it easier for students to use LMS (Sun *et al.*, 2008). Likewise, good technology quality also plays a role in helping students appreciate LMS (Bossman and Agyei, 2022)

User Satisfaction

Delone and Mclean (2003); Koh and Kan (2020) explained that user satisfaction is driven by quality factors, which then affect users in using the system. In the LMS context, user satisfaction can be measured in the context of user experience, functionality, and usability (Riandi *et al.*, 2021). Pérez-Pérez *et al.*, (2020); Bossman and Agyei (2022) found that it is important for students to feel satisfied with LMS to improve learning outcomes.

Student Individual Performance

Previous studies have shown that student individual performance is always related to student satisfaction (Shih *et al.*, 2006; Abou Naaj *et al.*, 2012; Ifinedo *et al.*, 2018; Alamri, 2019; Pérez-Pérez *et al.*, 2020; Bossman and Agyei, 2022). Thus, it can be concluded that student individual performance is also related to the quality factors of LMS. In the end, student performance is the main consideration for measuring LMS success (Riandi *et al.*, 2021).

The Mobile LMS

University XYZ has implemented a mobile LMS application at the undergraduate and graduate education levels. This application consists of various pages, namely the home page, course page, schedule page, announcement page, and forum page.

Home Page

When opening the mobile LMS application, students are directed to the home page. This page displays the details of the classes that the students will be attending next. Furthermore, the home page also includes navigation options to access other pages. Figure 1 illustrates the home page.

Course Page

On the course page, students can view all the courses they are currently enrolled in for the ongoing academic period or semester, presented in card format. Additionally, students have the option to select past academic periods or semesters to review previously taken courses. By selecting a specific course card, students can access detailed information about the course.

On the course detail page, students can examine each session within the course. They can choose individual sessions to access the topics covered in that particular session and explore detailed course content associated with those topics.
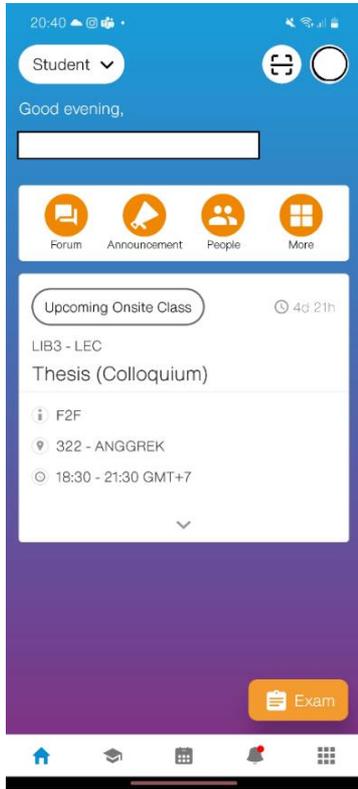
Fig. 1: Home page
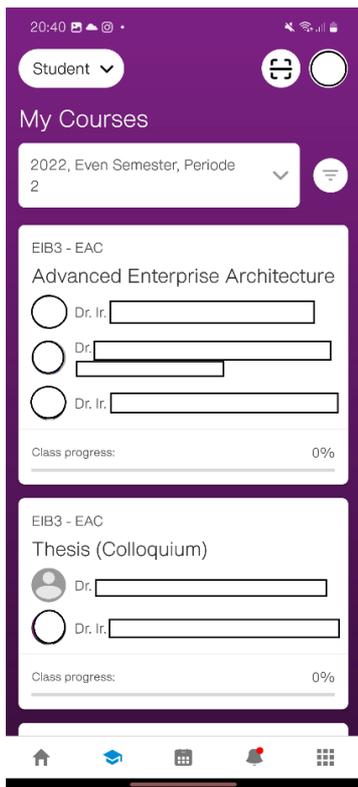

Fig. 2: Course page

Fig. 3: Course detail page

Figure 2 serves as an illustrative representation of the course page within the mobile LMS application. Meanwhile, Fig. 3 represents the course detail page.

Schedule Page

On the schedule page, students have the capability to view their class schedules for the courses they are enrolled in. Additionally, students can select the academic month for a more convenient and organized viewing of their class schedules. Figure 4 represents the user interface of the schedule page within the mobile LMS application.

Announcement Page

On the announcement page, students can access announcements related to their coursework. Students also receive notifications on their smartphones when new announcements are made. Figure 5 displays the user interface of the announcement page within the mobile LMS application.

Forum Page

The forum feature is available for each course within the mobile LMS application. Both students and instructors have the capability to create discussion threads. Within each thread, students and instructors can engage in discussions related to the course material by posting replies. Figure 6 presents the user interface of the forum feature.
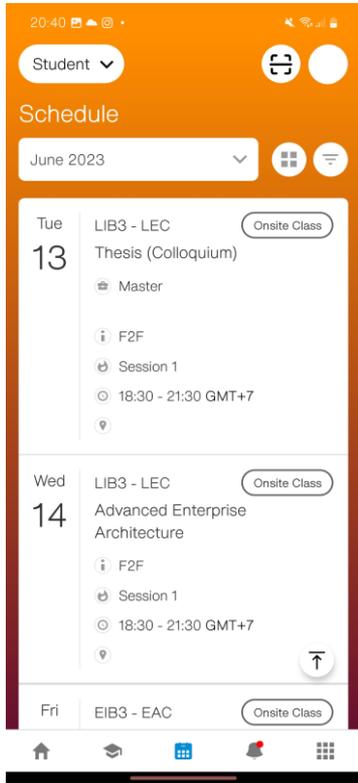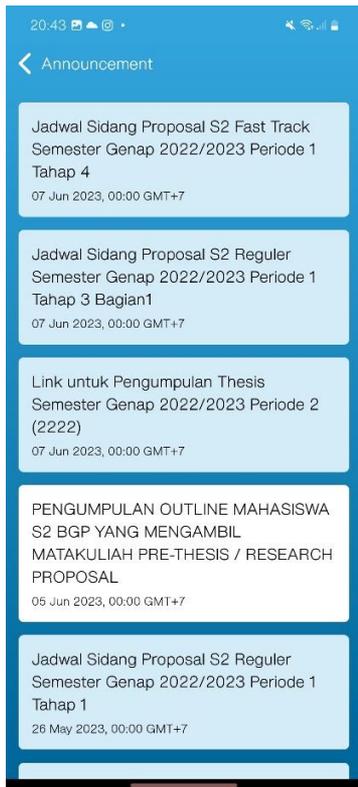
Fig. 4: Schedule page
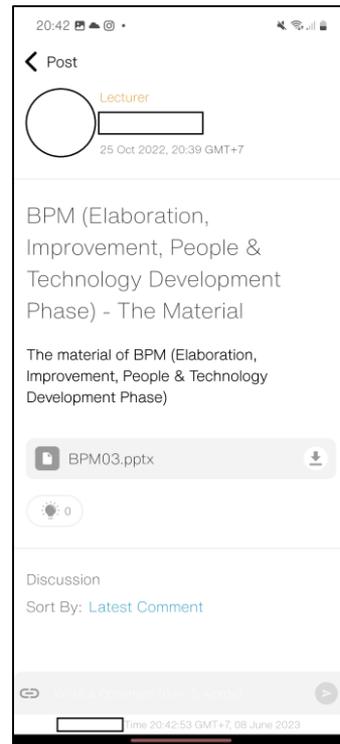

Fig. 5: Announcement page

Fig. 6: Forum page

Materials and Methods

This research was conducted by reviewing previous studies related to user satisfaction with LMS and student performance through the use of LMS. In a detailed examination, a review of prior research concerning user satisfaction and student performance was conducted through the exploration of articles in the Scopus database using the keywords "LMS, online learning, satisfaction, and performance".

The data was collected using quantitative methods through a questionnaire distributed online using a Likert-scale to perform calculations at 5-point intervals. Research respondents were undergraduate and graduate students at the university XYZ who had used the mobile LMS application. Table 1 describes the scale.

This study used Slovin's formula with a margin of error of 10% for calculating the number of samples. The total population of Android and iOS devices that use the mobile LMS application is 84.000. Therefore, based on calculations, the minimum sample size obtained is 398. Slovin's formula was employed in this research to obtain a sample, as the population was excessively large, rendering it impractical to sample every member of the population.

Table 1: Likert-scale

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
Score	1	2	3	4	5

In order to ensure data quality in the data collection process, we ensured that the questionnaires distributed were accurately targeted towards the specific demographic, namely the students of university XYZ who have utilized the mobile LMS application. Furthermore, when formulating statements for the indicators, we employed easily comprehensible language to facilitate the ease of questionnaire completion by the respondents.

To perform data analysis, this study used PLS-SEM, while the software used is smart PLS 3. The evaluation of the results of PLS-SEM can be done in outer model (measurement) evaluation and inner model (structural) evaluation. The PLS-SEM method, executed through the utilization of smart PLS3 software, was employed in this research due to its proficiency in assessing relationships among latent variables. This approach facilitated the statistical hypothesis testing for this study. Moreover, it allowed for the visualization of a path model, applying SEM in a visual manner to illustrate hypotheses and interrelationships among variables (Hair *et al.*, 2016; Haryaka *et al.*, 2017).

Fig. 7: Research model

Table 2: Displays the indicators employed in this study

Variable	Source	Code	Indicator
Ease of use	Bossman and Agyei (2022); Koh and Kan (2020)	EU1	The mobile LMS application is easy to navigate on a smartphone
		EU2	The text and graphics on the mobile LMS application is easy to understand
		EU3	The font used in the mobile LMS application is easy to see on the screen
		EU4	I can easily find the information I'm looking for on the mobile LMS app
		EU5	I can learn to operate the mobile LMS application easily
Course quality	Koh and Kan (2020); Bossman and Agyei (2022)	CQ1	The mobile LMS application clearly explains the learning outcomes of the courses
		CQ2	The mobile LMS application provides simplified access to supplementary materials for each course module
		CQ3	Course content on the mobile LMS application has better quality compared to other sources
		CQ4	Course content in the mobile LMS application is an integral part of my learning regarding the modules in the course
		CQ5	The mobile LMS application design is effective in helping to understand the module content in courses
Instructional quality	Koh and Kan (2020)	IUQ1	The mobile LMS application is a time saver for myself
		IUQ2	The mobile LMS application can access lecture material anytime and anywhere
		IUQ3	I can take the test using the mobile LMS application
		IUQ4	I can learn from my friends through the mobile LMS application
		IUQ5	I can communicate with my friends through the mobile LMS application

Table 2: Continue

Interaction quality	Koh and Kan (2020)	IAQ1	The mobile LMS application provides a good environment for discussing and collaborating with my friends
		IAQ2	Discussions through the mobile LMS application are fun
		IAQ3	Communicating with my lecturers using the Mobile LMS application is important to me
		IAQ4	Communicating with my friends using the Mobile LMS application is important to me
		IAQ5	The mobile LMS application supports interactivity between students and lecturers through the forum feature
Learning quality	Koh and Kan (2020)	LQ1	The mobile LMS application has the potential to make the learning process more interesting and motivating
		LQ2	I feel that the mobile LMS application is a good educational portal that enhances my learning
		LQ3	The mobile LMS application has a conducive and enjoyable environment for overall learning
		LQ4	The mobile LMS application helps me to become more familiar with learning content
		LQ5	I can study in a variety of different formats (audio, visual, text) on the mobile LMS application
Technology quality	Bossman and Agyei (2022)	TQ1	I feel that the information technology equipment needed to use the mobile LMS application is easy to use
		TQ2	I feel that the information technology tools needed to use the mobile LMS application have many useful functions
		TQ3	I feel the information technology equipment required to use the mobile LMS application is flexible
		TQ4	I feel that the information technology equipment needed to use the mobile LMS application is easily available
User satisfaction	Koh and Kan (2020); Bossman and Agyei (2022)	SAT1	I am satisfied with the use of the mobile LMS application
		SAT2	If I were given the choice, I would continue to use the mobile LMS application
		SAT3	I will continue to learn to use the mobile LMS application
		SAT4	The mobile LMS application met my expectations
		SAT5	I feel happy with the mobile LMS application after using it
Individual performance	Bossman and Agyei (2022)	IP1	I experienced an increase in grades in courses after using the mobile LMS application
		IP2	Using the mobile LMS application encourages me to learn from other sources in addition
		IP3	My knowledge regarding lecture material has increased after using the mobile LMS application
		IP4	I experienced an increase in my GPA as a result of studying through the mobile LMS application
		IP5	Given the choice, I would like University XYZ to continue implementing the mobile LMS application

Research Model

Based on previous research that has been discussed in the literature review, to determine the factors that influence student individual performance through the use of the university XYZ mobile LMS application, in this study we used three types of variables, namely independent variables, mediating variables and dependent variable which refers to the LMS research model by Koh and Kan, 2020; Bossman and Agyei (2022). Figure 7 represents the research model used in this study.

Hypothesis

Based on the research model in Fig. 7, the following are the hypotheses made in this study.

Ease of Use with User Satisfaction

Lin (2007) research highlights "system quality" and its impact on user satisfaction in online learning systems. Similarly, Parsazadeh *et al.* (2014) found that "ease of access" significantly affects user satisfaction in e-learning systems at a Malaysian university. Koh and Kan (2020) emphasize the importance of "system quality" in learning management systems, also noting its significant influence on user satisfaction. In a related context, Bossman and Agyei (2022) study in Ghana identifies "ease of use" as a key driver of student satisfaction. Collectively, these studies underscore the substantial influence of "ease of use" on user satisfaction, supporting the first hypothesis:

H_1: Ease of use influences user satisfaction in university XYZ mobile LMS application

Course Quality with User Satisfaction

Sun *et al.* (2008) examined factors influencing e-learning success and found that course quality and flexibility were critical components affecting user satisfaction. Similarly, Chopra *et al.* (2019) focused on information quality within Coursera, highlighting its impact on user satisfaction.

Koh and Kan (2020) investigated factors affecting student satisfaction in arts education using LMS and identified information quality as a significant driver of user satisfaction. In Ghana, Bossman and Agyei (2022) found course quality to be a key factor influencing user satisfaction in e-learning.

In conclusion, these studies collectively emphasize the substantial impact of course quality on user satisfaction, thereby supporting the second hypothesis:

H_2: Course quality influences user satisfaction in university XYZ mobile LMS application

Instructional Quality with User Satisfaction

Chen *et al.* (2008) studied factors impacting user satisfaction in e-learning at the national Sun Yat-sen cyber-university, emphasizing the crucial role of "instruction".

In a similar vein, Liaw (2008) examined blackboard e-learning system user satisfaction and highlighted the significant influence of "multimedia instruction."

Koh and Kan (2020) investigated the connection between technical and instructional quality factors and user satisfaction, finding that "instructional quality" has a significant impact.

From these studies, we can summarize the third hypothesis as follows:

H_3: Instructional quality influences user satisfaction in university XYZ mobile LMS application

Interaction Quality with User Satisfaction

Garrison (2007) research underscores the importance of interactions in e-learning, highlighting a community of inquiry involving instructors and students. This is linked to Chen *et al.* (2008) study at the national Sun Yat-sen cyber-university, which found that "interaction" significantly affects user satisfaction.

Additionally, Koh and Kan (2020) research emphasizes the role of "interaction quality" in learning management systems, encompassing both student-to-student and student-to-instructor interactions. Their findings confirm the significant influence of interaction quality on user satisfaction.

In summary, these studies collectively establish the critical role of interaction quality in LMS, forming the basis for the fourth hypothesis:

H_4: Interaction quality influences user satisfaction in university XYZ mobile LMS application

Learning Quality with User Satisfaction

Ozkan and Koseler (2009) highlight the significance of recognizing students as social entities within the e-learning system and the importance of affective aspects like motivation and enjoyment in the learning process. Their study demonstrates that learning quality significantly influences student satisfaction.

Moreover, studies by Liaw, 2008; Sun *et al.* (2008) also indicate that practical perceptions and motivation regarding the LMS experience have a significant impact on user satisfaction. Similarly, Koh and Kan (2020) research, which explores factors influencing student satisfaction with LMS, underscores the substantial influence of learning quality on user satisfaction.

In conclusion, based on the reviewed research, it can be concluded that learning quality significantly affects user satisfaction. Therefore, the fifth hypothesis can be defined as follows:

H_5: Learning quality influences user satisfaction in university XYZ mobile LMS application

Technology Quality with User Satisfaction

Research conducted by Webster and Hackley, 1997; Piccoli *et al.* (2001) demonstrates the significant impact of technology quality on user satisfaction in e-learning. Additionally, Sun *et al.* (2008) study underscores the importance of user-friendly e-learning tools to facilitate users' experience, especially considering their limited barriers (Amoroso and Cheney, 1991).

Similarly, Bossman and Agyei (2022) research examines the influence of e-learning on user satisfaction among distance education students in Ghana, with their findings indicating the significant impact of technology quality.

Based on the research, it can be concluded that technology quality significantly affects user satisfaction. Therefore, the sixth hypothesis can be defined as follows:

H$_6$: Technology quality influences user satisfaction in university XYZ mobile LMS application

User Satisfaction with Individual Performance

Shih *et al.* (2006) research reveals those high levels of satisfaction lead to the attainment of learning objectives. Furthermore, Abou Naaj *et al.* (2012) argue that satisfaction with the LMS positively impacts motivation, consequently enhancing user success.

Another study by Alamri (2019) in Saudi Arabia explores the relationship between satisfaction and academic performance in students participating in the flipped classroom model. Their findings demonstrate that the connection between satisfaction and performance synergizes students' learning experiences. Ifinedo *et al.* (2018) also investigate the impact of user satisfaction on e-learning user performance, revealing a positive relationship.

Similarly, Bossman and Agyei (2022) examine the link between satisfaction and performance in e-learning system users, finding that satisfaction positively influences student performance.

Based on the reviewed research, it can be concluded that user satisfaction significantly affects individual performance. Therefore, the seventh hypothesis can be defined as follows:

H$_7$: User satisfaction influences individual performance in university XYZ mobile LMS application

Results and Discussion

Based on the distribution of questionnaires, the study gathered data from 403 respondents, consisting of undergraduate and graduate students at university XYZ who utilized the mobile LMS application. The purpose of gathering demographic information about

the research sample is to ascertain the characteristics of the respondents, who are students of university XYZ. This information serves as a foundational consideration in the context of developing the mobile LMS application, aimed at enhancing student performance and elevating the overall quality of university XYZ as a world-class institution.

Consequently, the study plans to re-test the validity after removing these two indicators. Table 3 presents the detailed results of the convergent validity test.

Table 3: Convergent validity test

Variables	Indicator	Loading factor	AVE	Description
Ease of use	EU1	0.738	0.522	Valid
	EU2	0.616		Valid
	EU4	0.760		Valid
	EU5	0.764		Valid
Course quality	CQ1	0.700	0.527	Valid
	CQ2	0.718		Valid
	CQ3	0.764		Valid
	CQ4	0.702		Valid
	CQ5	0.741		Valid
Instructional quality	IUQ1	0.672	0.587	Valid
	IUQ3	0.753		Valid
	IUQ4	0.789		Valid
	IUQ5	0.840		Valid
Interaction quality	IAQ1	0.815	0.654	Valid
	IAQ2	0.852		Valid
	IAQ3	0.795		Valid
	IAQ4	0.845		Valid
	IAQ5	0.729		Valid
Learning quality	LQ1	0.784	0.578	Valid
	LQ2	0.765		Valid
	LQ3	0.769		Valid
	LQ4	0.775		Valid
	LQ5	0.707		Valid
Technology quality	TQ1	0.767	0.580	Valid
	TQ2	0.792		Valid
	TQ3	0.733		Valid
	TQ4	0.753		Valid
User satisfaction	SAT1	0.811	0.617	Valid
	SAT2	0.761		Valid
	SAT3	0.775		Valid
	SAT4	0.792		Valid
	SAT5	0.790		Valid
Individual performance	IP1	0.837	0.614	Valid
	IP2	0.737		Valid
	IP3	0.854		Valid
	IP4	0.813		Valid
	IP5	0.662		Valid

Table 4: Discriminant validity test (cross-loading)

	CQ	EU	IAQ	IP	IUQ	LQ	SAT	TQ
CQ1	0.700	0.472	0.464	0.500	0.519	0.503	0.507	0.438
CQ2	0.718	0.509	0.413	0.476	0.448	0.558	0.542	0.475
CQ3	0.764	0.430	0.589	0.582	0.566	0.579	0.599	0.472
CQ4	0.702	0.461	0.483	0.468	0.497	0.573	0.514	0.459
CQ5	0.741	0.526	0.510	0.516	0.523	0.636	0.580	0.529
EU1	0.467	0.738	0.348	0.359	0.353	0.441	0.475	0.488
EU2	0.408	0.616	0.258	0.329	0.271	0.360	0.384	0.396
EU4	0.551	0.760	0.436	0.409	0.453	0.516	0.545	0.490
EU5	0.468	0.764	0.321	0.339	0.303	0.453	0.495	0.483
IAQ1	0.566	0.436	0.815	0.588	0.629	0.570	0.599	0.502
IAQ2	0.609	0.444	0.852	0.629	0.689	0.613	0.598	0.505
IAQ3	0.533	0.359	0.795	0.571	0.616	0.545	0.509	0.449
IAQ4	0.536	0.310	0.845	0.608	0.703	0.550	0.530	0.412
IAQ5	0.496	0.375	0.729	0.516	0.548	0.576	0.505	0.470
IP1	0.616	0.381	0.684	0.837	0.668	0.619	0.600	0.448
IP2	0.446	0.287	0.489	0.737	0.475	0.522	0.449	0.353
IP3	0.619	0.404	0.621	0.854	0.619	0.655	0.650	0.460
IP4	0.547	0.365	0.632	0.813	0.637	0.535	0.580	0.418
IP5	0.492	0.491	0.381	0.662	0.426	0.564	0.588	0.558
IUQ1	0.542	0.536	0.418	0.484	0.672	0.567	0.563	0.513
IUQ3	0.522	0.290	0.587	0.526	0.753	0.470	0.465	0.390
IUQ4	0.552	0.320	0.677	0.577	0.789	0.555	0.528	0.463
IUQ5	0.535	0.318	0.730	0.632	0.840	0.552	0.569	0.423
LQ1	0.611	0.386	0.546	0.610	0.556	0.784	0.564	0.508
LQ2	0.608	0.513	0.498	0.579	0.482	0.765	0.595	0.543
LQ3	0.586	0.470	0.570	0.564	0.550	0.769	0.552	0.548
LQ4	0.657	0.537	0.551	0.563	0.582	0.775	0.620	0.546
LQ5	0.520	0.437	0.523	0.513	0.509	0.707	0.532	0.474
SAT1	0.628	0.560	0.538	0.608	0.555	0.628	0.811	0.552
SAT2	0.537	0.479	0.500	0.549	0.485	0.545	0.761	0.529
SAT3	0.582	0.493	0.571	0.610	0.564	0.583	0.775	0.509
SAT4	0.587	0.515	0.499	0.550	0.545	0.582	0.792	0.547
SAT5	0.637	0.553	0.564	0.591	0.595	0.621	0.790	0.597
TQ1	0.454	0.493	0.398	0.372	0.386	0.466	0.509	0.767
TQ2	0.536	0.527	0.493	0.498	0.506	0.585	0.574	0.792
TQ3	0.477	0.410	0.464	0.417	0.409	0.513	0.488	0.733
TQ4	0.522	0.527	0.408	0.461	0.483	0.531	0.544	0.753

Based on the outcomes of the validity test, which involved the removal of the EU3 and IUQ2 indicators, it can be inferred that all remaining indicators were valid, as their loading factor values exceeded 0.5. In this study, a discriminant validity test was also conducted to determine the extent of differentiation between one construct and another. Discriminant validity can be measured using cross-loading. The condition for discriminant validity is met if the correlation between indicators and the measured variable has a higher value compared to the correlation between indicators and other variables (Hair, 2009). The results of the discriminant validity test are presented in Table 4. Based on the data in Table 4, it is evident that the correlations between the indicators and the measured variable have higher values compared to the correlations between the indicators and other variables. Therefore, it can be concluded that the research model in this study meets the criteria for discriminant validity.

To assess convergent validity, the study followed Hair (2009) recommendation by examining the loading factor values of each indicator and the Average Variance Extracted (AVE) values of each variable. According to Hair (2009), a minimum loading factor of 0.5 for each indicator and a minimum AVE value of 0.5 for each variable are required to establish questionnaire validity. However, during the validity check, it was observed that the indicators EU3 and IUQ2 did not meet the validity criteria, as their loading factor values were below 0.5 (0.465-0.487, respectively). As a result, the AVE for the ease of use and instructional quality variables fell below 0.5 (0.452-0.494, respectively), thereby failing the convergent validity test.

Following the validity test, a reliability assessment was conducted, considering two parameters: Cronbach's alpha and composite reliability. The minimum acceptable value for both Cronbach's alpha and composite reliability is 0.6. The results of the reliability test are presented in Table 5.

Table 5: Reliability test

Variables	Cronbach's Alpha	Composite Reliability
Ease of use	0.693	0.812
Course quality	0.775	0.847
Instructional quality	0.762	0.849
Interaction quality	0.867	0.904
Learning quality	0.817	0.819
Technology quality	0.759	0.847
User satisfaction	0.845	0.890
Individual performance	0.840	0.888

According to the reliability test outcomes presented in Table 5, the values of Cronbach's alpha and composite reliability for each variable exceed 0.6, indicating the reliability of each variable. Additionally, hypothesis testing was conducted, analyzing the p-values. Hypotheses were considered accepted if the p-value was less than 0.05, indicating a significant relationship between variables. The results of the hypothesis test are presented in Table 6.

The survey also revealed that Android-based smartphones were the most commonly used devices to access the mobile LMS application, accounting for 61% of respondents. Regarding the frequency of usage, 40.4% of students accessed the mobile LMS application more than four times per week, while 24.1% accessed it three times per week, 16.1% four times per week, 14.1% two times per week, and 5.2% only once per week.

Based on the conducted hypothesis testing, six out of the seven hypotheses were supported. Specifically, H_1 (ease of use → user satisfaction), H_2 (course quality → user satisfaction), H_3 (instructional quality → user satisfaction), H_5 (learning quality → user satisfaction), H_6 (technology quality → user satisfaction) and H_7 (user satisfaction → individual performance) were all accepted. The fourth hypothesis (H_4: Interaction quality → user satisfaction) was the only one that was rejected, indicating that interaction quality does not significantly influence user satisfaction. The T-statistic values for all hypotheses, except H_4, exceeded 1.96, implying that ease of use, course quality, instructional quality, learning quality, and technology quality have a significant impact on user satisfaction. Moreover, user satisfaction was found to have the most significant effect on individual performance, as evidenced by a high t-statistic value of 29.58:

H_1: Results reveal that ease of use significantly influences user satisfaction, consistent with prior studies (Lin, 2007; Parsazadeh *et al*., 2014; Koh and Kan, 2020; Bossman and Agyei, 2022). This underscores the substantial impact of user-friendliness on student satisfaction when using the mobile LMS application

H_2: Findings indicate that course quality significantly impacts user satisfaction, aligning with prior research (Sun *et al*., 2008; Chopra *et al*., 2019; Koh and Kan, 2020; Bossman and Agyei, 2022). It underscores that course design and content quality significantly affect the satisfaction of university XYZ students using the Mobile LMS application

H_3: Results demonstrate a significant relationship between instructional quality and user satisfaction, in line with prior LMS and e-learning research (Chen *et al*., 2008; Liaw, 2008; (Koh and Kan, 2020). This highlights the substantial influence of the technical functional quality of the mobile LMS application on student satisfaction

H_5: Testing reveals that learning quality significantly influences user satisfaction, consistent with previous research (Ozkan and Koseler, 2009; Liaw, 2008; Sun *et al*., 2008; (Koh and Kan, 2020). It emphasizes the importance of motivation and enjoyment in learning using the mobile LMS application for student satisfaction

H_6: Results indicate a significant relationship between technology quality and user satisfaction, aligning with prior studies on technological equipment quality and LMS satisfaction (Webster and Hackley, 1997; Piccoli *et al*., 2001; Sun *et al*., 2008; Bossman and Agyei, 2022). This suggests that the quality of technological equipment used in the mobile LMS application significantly affects student satisfaction

H_7: Findings show that user satisfaction has a significant relationship with individual performance, in accordance with prior research exploring this link through LMS use (Shih *et al*., 2006; Abou Naaj *et al*., 2012; Alamri, 2019; Ifinedo *et al*., 2018; Bossman and Agyei, 2022). This underscores how student satisfaction with the mobile LMS application significantly influences student individual performance

Table 6: Hypothesis result

Hypothesis	T-statistics (|O/STDEV|)	P-value	Result
H_1: Ease of use → user satisfaction	4.192	0.000	Accepted
H_2: Course quality → user satisfaction	3.526	0.000	Accepted
H_3: Instructional quality → user satisfaction	3.159	0.002	Accepted
H_4: Interaction quality → user satisfaction	1.728	0.085	Rejected
H_5: Learning quality → user satisfaction	2.955	0.003	Accepted
H_6: Technology quality → user satisfaction	3.434	0.001	Accepted
H_7: User satisfaction → individual performance	29.580	0.000	Accepted

The majority of respondents were female students, accounting for 56.1% of the sample. In terms of age distribution, students between 20-30 years old comprised the largest group at 55.8%, followed by those under 20 years old at 40.4% and students over 30 years old at 3.7%. Furthermore, undergraduate students constituted the majority of respondents, making up 85.1% of the sample.

Interaction quality is not a significant influencing variable on user satisfaction (H_4). Thus, this finding contradicts previous research (Garrison, 2007; Chen *et al*., 2008; Koh and Kan, 2020), which has indicated that interaction quality is a supportive factor for user satisfaction. This suggests that the mobile LMS application is not being used as a space for interaction among students with instructors and fellow students.

Conclusion

Based on the results of hypothesis testing, the following conclusions and implications arise from each hypothesis. Firstly, the ease of using the mobile LMS application significantly and positively affects student satisfaction, indicating that a user-friendly interface enhances overall satisfaction. Secondly, course quality also significantly and positively impacts user satisfaction, suggesting favorable perceptions of course design and content. Thirdly, instructional quality significantly influences user satisfaction, demonstrating effective teaching and instruction. Fourthly, learning quality has a significant positive impact on user satisfaction, reflecting heightened motivation and enjoyment. Fifthly, technology quality significantly affects user satisfaction, highlighting user-friendly technology tools. Sixthly, user satisfaction significantly and positively influences student individual performance, emphasizing its role in academic achievement. Lastly, interaction quality, concerning the facilitation of interactions, does not significantly affect user satisfaction.

The study's findings indicate that various LMS quality factors significantly influence user satisfaction, which in turn positively impacts student individual performance, aligning with prior research (Koh and Kan, 2020; Bossman and Agyei, 2022). Considering these outcomes, recommendations for enhancing the mobile LMS application at University XYZ include improving course content and instructional quality by integrating multimedia and interactive elements and introducing gamification for heightened motivation.

The practical implications of this research are that University XYZ can utilize these findings as a foundation for evaluating and enhancing its mobile LMS application with the aim of improving student performance. This may contribute to enhancing University XYZ's reputation as a high-quality educational institution and have a positive impact on the growth in the number of students enrolling each year due to improved educational quality.

As one of the top five universities in Indonesia, this research can also contribute to other universities in Indonesia in enhancing the quality of their education, thus indirectly serving to produce high-quality graduates to advance the nation. This is because, in an indirect manner, university XYZ sets a benchmark for other universities to enhance the quality of their education through their respective LMS platforms.

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Author's Contributions

Stanley Limonthy: Written the abstract, introduction, literature review, and data analysis.

Evaristus Didik Madyatmadja: Designed the research framework and presented recommendations based on research found.

Ethics

This article is original and has not been previously published. The corresponding author has reviewed and accepted this manuscript and there are no ethical issues associated with this article. All respondents in this research were provided with clear and concise information about the study's purpose and procedures. Informed consent was obtained from all respondents and they were assured that their participation was voluntary. Therefore, respondents had the right to decline participation. Furthermore, data related to the respondents were treated as confidential and solely utilized for research purposes.

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