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Research Article

The Impact of System Quality and User Satisfaction: The Mediating Role of Ease of Use and Usefulness in E-Learning Systems

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Abstract: The research aims to understand how the system's quality influences users' perceptions of its usability and ease of use, affecting their overall satisfaction with the e-learning system. This analysis provides insights into the factors contributing to a positive user experience and the sustainable use of e-learning platforms. The study employs a quantitative approach with a survey method. The sample comprises 470 students from five universities using e-learning information systems, selected through purposive sampling. Data was collected via a questionnaire survey distributed to respondents and analyzed using Structural Equation Modeling (SEM) with the IBM AMOS Program. The results indicate that System Quality (SYQ) significantly affects Perceived Ease of Use (PEOU) with a probability value of 0.019 ($p < 0.05$), System Quality (SYQ) significantly affects Perceived Usefulness (PU) with a probability value of 0.036 ($p < 0.05$), Perceived Usefulness (PU) significantly affects User Satisfaction (USA) with a probability value of 0.028 ($p < 0.05$), and Perceived Ease of Use (PEOU) significantly affects User Satisfaction (USA) with a probability value of 0.000 ($p < 0.05$). The study concludes that integrating TAM and ISSM provides a comprehensive framework for understanding the factors influencing the sustainable use of e-learning systems. The practical implications of this research underscore the importance of giving e-learning systems that are not only easy to use and useful but also possess high system, information, and service quality to enhance user satisfaction and sustain usage.

Keywords: Educational Technology; Information System Success Model; Structural Equation Model; Technology Acceptance Model

1. Introduction

The development of information technology has transformed various aspects of life, including education, through the implementation of e-learning [1]–[3]. E-learning offers flexibility regarding time and location, improved accessibility, and more interactive learning opportunities than traditional methods [4], [5]. However, the successful implementation of e-learning does not solely depend on the availability of technology but also its acceptance and use by the users [6], [7]. Models such as the Technology Acceptance Model (TAM) have been a foundation for understanding the factors influencing technology acceptance in numerous studies [8].

E-learning has firmly established itself as a crucial and integral element in the global educational paradigm, particularly amid the rapid pace of the digital era. This reflects the education sector's adaptation to the continuously evolving technological landscape, expanding the reach and accessibility of education through digital platforms [9]–[11].

The continuous and dynamic evolution of e-learning demonstrates a profound paradigmatic shift in accessibility and educational methodology, making it an indispensable element in the global education system [12]. This transformation affects how students and educators access information and learn and also permeates the fundamental structure of education, altering how

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education is perceived and practised worldwide [11], [13]. The Technology Acceptance Model (TAM) has been adopted and expanded in several studies to include external factors such as system quality, technical support, and social influence, all of which can affect technology acceptance [14]–[19]. Considering these factors, the TAM has become more robust and relevant for understanding the dynamics of technology acceptance in the rapidly evolving digital era, particularly in education and e-learning.

The Information System Success Model (ISSM) highlights the importance of system quality, information quality, and service quality in assessing the success of information systems [20]. This provides a broader understanding of system success, encompassing aspects such as user satisfaction and the perceived benefits of the system [21]. The model has developed into a leading framework for evaluating information system success and has become a standard in information systems research and evaluation. It focuses on six key dimensions that determine information system success: system quality, information quality, system use, user satisfaction, individual benefits, and organizational benefits. In their model development, William H. DeLone and Ephraim R. McLean emphasized the importance of system quality and information quality as the operational foundations of an information system. They define system quality as the technical aspects of the system, including reliability, ease of use, and available functions. Meanwhile, they describe information quality as the quality of content produced by the system, including its accuracy, relevance, and availability [22], [23]. They argue that both aspects are interrelated and equally important in determining system success.

The Technology Acceptance Model (TAM), developed by Davis in 1989, focuses on two primary constructs: perceived usefulness and perceived ease of use. These constructs are believed to influence users' intentions and behaviors toward technology. However, with the increasing complexity of technology and more diverse usage environments, TAM requires expansion to remain relevant in various contexts [24]. Recent studies show that technology acceptance is influenced not only by perceived ease of use and perceived usefulness but also by external factors such as system quality, information quality, and social interactions [25]. The expansion of TAM also aligns with the application of other models, such as the Information System Success Model (ISSM) introduced by Delone & McLean, 2003 [21]. ISSM emphasizes the importance of system, information, and service quality as determinants of the success of information technology use. In the e-learning context, several studies indicate that system, information, and service quality are crucial in enhancing user satisfaction and promoting continued usage [26]. Therefore, integrating TAM and ISSM can provide a more holistic view of the factors influencing e-learning usage.

The Technology Acceptance Model (TAM) has been adopted and expanded in several studies to include external factors such as system quality, technical support, and social influence, all of which can affect technology acceptance [14]–[19], [27]. By incorporating these factors, the TAM has become more robust and relevant for understanding the dynamics of technology acceptance in the ever-evolving digital era, particularly in education and e-learning.

In addition to quality factors, sustainability has become an essential focus in information technology research. Nikou & Economides [28] expanded TAM by considering continuance intention in e-learning usage, which includes users' perceptions of long-term benefits and satisfaction with the system. This study found that trust, social support, and user experience significantly influence the continuance intention to use e-learning. Similar research suggests that users are more likely to continue using technology if they feel the system sustainably supports their learning goals [29]. Furthermore, the growing concern about sustainability issues, such as the environmental and social impacts of technology use, necessitates adjustments to technology acceptance models. Users are increasingly aware of the environmental impact of their digital activities, so ecological sustainability factors can influence their attitudes toward technology [30]. In the context of e-learning, factors such as energy efficiency, carbon footprint reduction, and support for sustainable education are becoming increasingly relevant in evaluating system success [31].

The use of technology in learning, known as e-learning, has become a significant topic in various studies. Two frameworks frequently used in this context are the Technology Acceptance Model (TAM) and the Information System Success Model (ISSM). TAM is a widely adopted framework for understanding user behavior toward technology, including e-learning. However, a critical analysis of the existing literature suggests that TAM needs further development to explain users' intentions to continue using e-learning sustainably [32]–[40]. Meanwhile, ISSM is a framework that is more focused on the success of information systems, but it has recently begun to be applied in the context of e-learning. The limited literature on the application of ISSM in e-learning raises questions about how effectively this model can measure the success of e-learning. Further research and development of these models are needed to provide a more comprehensive understanding of the factors

influencing e-learning acceptance and success in education.

Studies that combine TAM and ISSM usually focus on a short period, often limited to the initial implementation phase of an information system [29], [41]–[44]. However, in practice, using information systems is a dynamic and ongoing process where user experience evolves, and adaptation to the information system occurs progressively. Therefore, factors such as enhancing user capabilities, adjusting system features to meet changing educational needs, and continuous technical support are also crucial for the sustainable use of such information systems [45], [46].

The integration of TAM and ISSM in the e-learning context can include factors such as e-learning system quality, encompassing aspects like reliability, ease of use, and content availability. User satisfaction is another crucial aspect, reflecting how users feel the e-learning system meets or exceeds their expectations. Additionally, users' intentions to continue using e-learning are a critical component that indicates the likelihood of long-term adoption of the e-learning system [47]–[49].

By combining elements of TAM and ISSM, and considering additional factors such as user satisfaction and intentions, this integrated model will offer a more holistic framework for understanding the factors that influence the acceptance and success of e-learning systems in the long term. Such a model is invaluable for developers and educators in enhancing the design and implementation of effective e-learning systems that meet the needs and expectations of users.

Considering these various factors, this research aims to extend TAM by integrating variables from ISSM and sustainability aspects in e-learning usage. This study is expected to provide a more comprehensive understanding of the determinants of e-learning acceptance and sustained use and serve as a foundation for developing more effective strategies for implementing sustainable e-learning systems.

2. Review of Literature and Hypothesis Development

2.1. System Quality (SYQ)

System quality measures the system's quality, encompassing both software and hardware. System quality refers to the performance of a system, specifically how well the hardware, software, policies, and procedures of an information system can meet users' information needs [20]. It represents the desired characteristics of an information system [21]. System quality is measured subjectively by users, meaning that the assessed quality is perceived as system quality. The indicators for measuring system quality, according to DeLone and McLean, include (1) ease of access; (2) flexibility; (3) fulfillment of user expectations; and (4) the usefulness of specific functions.

System quality refers to a user's perception of a system [50], which is crucial for the success of e-learning. It is measured by the range of software applications and hardware offered [51]. A well-designed system is a trustworthy guide, guiding learners smoothly towards their objectives [52]. System quality significantly impacts the ease of use factor, directly impacting the user's ability to focus on content and absorb knowledge effectively [53]. A high-quality e-learning system should have reliable hardware, user-friendly interfaces, and an intuitive design. It should also be easily accessible, easy to use, and provide appropriate feedback to learners. User satisfaction is a crucial factor in the success of an e-learning system, and prioritizing system quality in design and implementation is essential [53]. Thus, the following hypothesis is presented based on the preceding discussions:

H1: There is a positive relationship between the quality of the system and the perceived ease of use of the e-learning systems.

H2: A positive relationship exists between the system's quality and the e-learning systems' perceived usefulness.

2.2. Perceived Ease of Use (PEOU)

Perceived Ease of Use (PEOU) is one of the critical indicators in the Technology Acceptance Model (TAM) developed by Davis (1989). According to Davis [8], perceived ease of use is defined as "the degree to which an individual believes that using a particular system would be free of physical and mental effort" [54]. This statement can be interpreted as the extent to which an individual believes that using a specific system will be free from physical and mental exertion. Perceived ease of use represents the degree to which a person thinks technology is easy to understand. The indicators for measuring Perceived Ease of Use (PEOU) include how easily a system can be learned, the minimal mental effort required to use it, the speed with which it can be mastered, and how easy it is to remember how to operate it.

PEOU positively affects perceived usefulness [55]. Furthermore, the TAM states that perceived ease of use affects behavioral intention indirectly through perceived usefulness [8]. Thus, perceived usefulness measures the effect of perceived ease of use on behavioral intention [56]. Furthermore, previous studies have investigated and confirmed a direct relationship between perceived usefulness and perceived ease of use on continuance intention [57]–[60]. The study pointed out that perceived

ease of use is an antecedent of user satisfaction [61]. Thus, we propose the following hypotheses:

H3: There is a positive relationship between the Perceived ease of use and the user satisfaction of the e-learning systems.

2.3. Perceived Usefulness (PU)

Perceived Usefulness is the degree to which a person believes using a particular technology will enhance performance [8]. According to Adamson and Shine [62], perceived usefulness is an individual's belief that using a specific technology will improve performance. Perceived Usefulness (PU) is one of the critical indicators in the Technology Acceptance Model (TAM) developed by Davis in 1989. The indicators for measuring Perceived Usefulness (PU) encompass several aspects, such as enhancing job productivity, improving job performance, increasing work effectiveness, and improving work efficiency and quality. It also includes the system's ability to facilitate job tasks, reduce job fatigue, provide opportunities for skill development, increase access to information, and lower the error rate.

These indicators are used to assess the extent to which users believe that technology will provide benefits in improving their job performance and productivity. PU is considered a critical factor in influencing users' intention to accept and use technology, as the more valuable technology is perceived to be, the more likely users are to adopt and utilize it. Davis used perceived usefulness, 1989 [8] as a critical construct in TAM. Some studies have found that perceived usefulness significantly affects attitudes toward the use of e-learning systems [8], [61], [63]. Consequently, the higher the perceived usefulness of the e-learning system, the more positive the intention to use it; therefore, the more likely it is to be used [8], [61]. The studies of AL-Sabawy [64] confirmed that perceived usefulness significantly and directly affects user satisfaction. Thus, we expect the perceived usefulness of Moodle to affect user satisfaction and the intention to continue using it positively. Therefore, we propose the following hypotheses:

H4: There is a positive relationship between the Perceived usefulness (PU) and user satisfaction of the e-learning systems.

2.4. User Satisfaction (USA)

According to Delone & McLean [21], user satisfaction is the overall evaluation of a user's experience using an information system and the potential impact of the information system. Urbach & Müller [65] describe user satisfaction as a dimension for assessing the success of an information system. The indicators for measuring user satisfaction, as proposed by [66], include ease of use, portal design, usefulness, confidentiality, and convenience of access. User satisfaction indicators comprise content, accuracy, ease of use, timeliness, and format [21]. According to Jogiyanto [67], the indicators for measuring user satisfaction are efficiency, effectiveness, and satisfaction, complemented by pride in using the system. Additionally, Urbach & Müller [65] highlight that user satisfaction indicators include efficiency, effectiveness, and overall satisfaction.

3. Material and Methods

3.1. Research Design

This research employs a quantitative approach grounded in a post-positivist paradigm aimed at developing scientific knowledge. This approach involves exploring cause and effect relationships, reducing variables, formulating hypotheses, asking specific research questions, conducting measurements and observations, and testing theories.

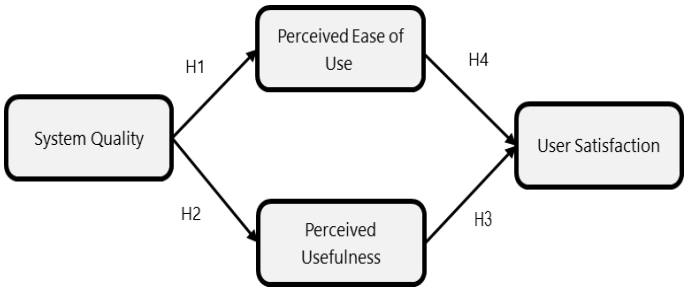

Figure 1. Research Model

The research strategies implemented include experiments and surveys, which heavily rely on statistical data analysis to draw conclusions and validate findings. This research also qualifies as a scientific method because it adheres to scientific principles: empirical, objective, measurable, rational, and systematic. In terms of its execution method, this study is considered survey research.

3.2. Population and Sample

In this study, the target population consists of higher education students in Indonesia who use e-learning information systems in their learning processes. According to the Indonesian Central Statistics Agency, the number of students in Indonesia at the beginning of 2023 reached 7.8 million, comprising approximately 3.3 million in public universities and 4.4 million in private universities [68]. The sample size for this study is 470 respondents, with a margin of error of 4.51% and a confidence level of 97% for the population studied, considering outlier samples during

the structural equation modeling analysis. Based on data from the Higher Education Database Reporting, the population will be drawn from 5 (five) higher education institutions. Therefore, the total population for this study amounts to 166,190 students.

3.3. Research Instruments

Researchers can develop tools, modify existing ones, or utilize established instruments when designing research instruments. In this study, the instrument is crafted by adapting survey items from relevant literature. These items are meticulously reviewed for reliability and validity based on existing research. This involves comprehensively evaluating the survey items to ensure they accurately reflect the concepts intended to be measured and maintain validity and reliability within the research context. This approach ensures that the data collected will provide valid and reliable insights into extending the Technology Acceptance Model (TAM) by integrating variables from the Information Systems Success Model (ISSM) and aspects of sustainability in e-learning. The survey instrument includes 17 measurement items distributed across four constructs: System Quality (SYQ), Perceived Ease of Use (PEOU), Perceived Usefulness (PU), and User Satisfaction (USA).

Table 1. Research Instruments

Variables	Indicators	Statements
System Quality (SYQ)	Adaptability	The design of this E-learning system is well-structured and easy to understand [21]; [69].
	Availability	I can easily use the E-learning system [21]; [2]
	Reliability	This E-learning system is reliable and rarely experiences interruptions [21]; [2].
	Response Time	This E-learning system responds quickly and without lag [21].
	Usability	Offers interactive user-system engagement [21]; [2].
Perceived Ease of Use (PEOU)	Easy to use	Access to this E-learning System is seamless from various devices [70]
	Easy to learn	This E-learning system can be quickly learned by anyone [70]
	Effortless	This E-learning system is designed to be easy to understand [70]
	Quick to learn	It doesn't take long to learn in an e-learning system [70]
	User-friendly	The use of this E-learning system feels comfortable and simple [70]
Perceived Usefulness (PU)	Enhances job productivity	Using E-learning helps save me time [70].
	Improves performance	E-learning helped improve my knowledge [70]; [71].
	Increases effectiveness	The E-learning system is very effective in delivering learning materials [70].
	Improves work efficiency	E-learning systems are very efficient in their use [70].
User Satisfaction (USA)	Repeat Purchases	Delighted to access additional learning materials after using the E-learning system [21].
	Repeat Visits	Motivated to revisit due to high-quality learning materials [21].
	User Surveys	Receives valuable and constructive feedback on learning progress [21]; [72].

3.4. Data Collection

Data is collected by distributing questionnaires to the research sample and gathering information from relevant documents. Researchers ensure that respondents provide complete and accurate responses to each questionnaire item. This is done to ensure that the collected data can be effectively used to analyze the characteristics or behaviors of the studied population. Careful and thorough data collection helps minimize research errors and enhances the reliability and validity of the research findings.

The data collection for this study was conducted using a Google Form, which served as the primary instrument for the survey. The survey was distributed through multiple communication channels to ensure broad reach and participation, including email, social media platforms, and other digital communication tools. By leveraging these diverse channels, the study aimed to effectively reach the target respondents, providing a representative sample that reflects the wider student population.

The advantages of online survey data collection include easy access to populations across various regions [73], [74], cost savings in both time and money, ease of data analysis, and assurance that no data will be missed, as all questions can be marked as mandatory.

3.5. Data Analysis

This study's data analysis and hypothesis testing used the Covariance-Based Structural Equation Modeling (CB-SEM) method. SEM is a multivariate analysis method that can be

used to simultaneously describe the linear relationships between observed variables (indicators/manifest variables) and variables that cannot be measured directly (variables) [71]. This approach is suitable for testing complex relationships between multiple variables, allowing for a comprehensive understanding of the factors influencing the sustainable use of e-learning systems.

To ensure the accuracy and reliability of the analysis, preliminary tests for validity and reliability were conducted to ensure that the measurement instruments accurately reflect the constructs being studied. Additionally, descriptive statistics provided a general overview of the data, including the distribution, central tendencies, and variability of the variables involved. These preliminary analyses were conducted using the Statistical Package for the Social Sciences (SPSS), which provides a robust platform for managing and analyzing data effectively. Using CB-SEM and SPSS enabled a thorough and reliable analysis process, ultimately enhancing the validity and credibility of the research findings.

4. Results

4.1. Characteristics of Respondents

The study includes a diverse group of respondents characterized by several demographic factors. These characteristics consist of gender, which allows for understanding any differences in perceptions between male and female participants; age, which provides insights into how various age groups engage with and perceive the e-learning system; and university affiliation, reflecting the participants' varied academic environments and institutional contexts.

Table 2. Characteristic of Respondents

Category	Freq. (n=470)	Percent
Genders		
Man	164	34.89%
Woman	306	65.11%
Age		
18 Years	70	14.89%
19 Years	85	18.09%
20 Years	100	21.28%
21 Years	90	19.15%
22 Years	75	15.96%
23 Years	50	10.64%
University		
UNM Makassar	118	25.11%
Hasanuddin University	94	20.00%
UNISMUH Makassar	71	15.11%
Universitas Negeri Malang	101	21.49%
UIN Makassar	86	18.30%

The analysis of 470 e-learning users reveals vital demographic trends in gender, age, and university affiliation that can inform e-learning strategies. Female users are predominant at 65.11%, with males comprising 34.89%, highlighting the need to engage both genders effectively. Users are predominantly in their early adulthood, ages 19 to 21, indicating that e-learning appeals to those transitioning from adolescence to adulthood, presenting opportunities to tailor content to this demographic's needs.

Regarding university affiliation, the State University of Makassar (UNM), Hasanuddin University, and Universitas Negeri Malang account for a large share of e-learning participants, with 45.11% of respondents coming from the first two universities alone. This indicates a strong potential for further e-learning adoption and expansion at these institutions.

4.2. Goodness of Fit Criteria

In structural or regression models, goodness of fit measures how accurately the model reflects the actual data structure, with a better fit indicating a more adequate representation of variable relationships. According to Garson [75], it is recommended to report only the following model fit indices: CMIN, RMSEA, one or more incremental fit indices (CFI, IFI, NFI, RFI, TLI), one of the parsimony fit indices (PNFI, PCFI, PGFI), and one or more information theory-based indices (absolute fit indices) such as AIC, BIC, CAIC, BCC, ECVI, or MECVI.

Table 3. Goodness of Fit (GOF) Analysis

Category	Threshold	Results	Criterion	Sources
Probability (p)	≥ 0.050	0.344	Fit	[76], [77]
Chi-Square (CMIN/DF)	< 2.000	1.036	Fit	[78], [79]
Goodness of Fit Indices (GFI)	> 0.900	0.963	Fit	[79]
Root Mean Squard Error of Approxiamtion (RMSEA)	< 0.080	0.009	Fit	[79]–[83]
Akaike's Information Criterion (AIC)	AIC Def. < Sat & Ind	436 < 650 & 7508	Fit	[84], [85]

Category	Threshold	Results	Criterion	Sources
Consistent Information Akaike index (CAIC)	CAIC Def.< Sat & Ind	971 < 2319 & 7639	Fit	[84], [85]
Tucker Lewis Index (TLI)	> 0.900	0.999	Fit	[79], [86]
Comparative Fit Index (CFI)	> 0.900	0.999	Fit	[79], [83], [87]
Incremental Fit Index (IFI)	> 0.900	0.999	Fit	[79], [88]
Parsimony Normed Fit Indices (PNFI)	> 0.500	0.714	Fit	[83], [89]
Parsimony Compaeative Fit Indices (PCFI)	> 0.500	0.736	Fit	[83], [89]

Based on the Goodness of Fit (GOF) analysis, it can be concluded that the model demonstrates a solid and satisfactory fit across a range of criteria, indicating that it is well-suited for the data. The absolute fit measures, such as the p-value, CMIN/DF, GFI, and RMSEA, all meet or exceed their respective threshold values, confirming the model's adequacy in representing the data. Incremental fit indices, including the TLI, CFI, and IFI, all show high scores well above the standard threshold, further supporting the model's strong fit. The parsimony fit indices, PNFI and PCFI, also exceed the required benchmarks, reinforcing the model's appropriateness. These results collectively suggest that the model effectively captures the underlying structure of the data, making it reliable for analysis and interpretation.

4.3. Research Hypothesis Testing

To test the hypotheses regarding causality developed in this model, the null hypothesis, which states that the regression coefficient between relationships is equal to zero, must be tested by examining the Standardized Regression Weights in the Critical Ratio (C.R) column produced by AMOS software. The C.R value is compared to the critical value of ± 2.56 at a significance level of 0.05. If the Critical Ratio (C.R) for the causal relationship between variables exceeds the crucial value of ± 2.56 or if the probability value (P) is less than 0.05, then the null hypothesis (H0) is rejected, and the alternative hypothesis (H1) is accepted. The results of the Standardized Regression Weights are as follows:

Table 4. Goodness of Fit (GOF) Analysis

			S.E.	C.R.	Prob.	Estimate	Results
Perceived ease of use	<--	System Quality	0.148	2.340	0.019	0.072*	Significance
Perceived Usability	<--	System Quality	0.168	2.094	0.036	0.164*	Significance
User Satisfaction	<--	Perceived Usability	0.046	2.195	0.028	0.019*	Significance
User Satisfaction	<--	Perceived ease of use	0.061	6.463	0.000	0.475**	Significance

Note: *p<0.05; **p<0.001)

This study highlights the significant interrelationships among variables influencing the sustainable use of e-learning systems. System Quality has a positive and significant effect on Perceived Ease of Use, with a path coefficient of 0.072, a standard error (S.E.) of 0.148, and a critical ratio (C.R.) of 2.340, with a p-value of 0.019 ($p < 0.05$). This finding indicates that the better the system quality, the easier it is for users to perceive the use of the system.

System Quality significantly affects Perceived Usefulness, as indicated by a path coefficient of 0.164, an S.E. of 0.168, and a C.R. of 2.094, with a p-value of 0.036 ($p < 0.05$). This result suggests that an improvement in system quality contributes to an increased perception of the usefulness of the e-learning system.

Perceived Usefulness also significantly impacts User Satisfaction, with a path coefficient of 0.019, S.E. of 0.046, and C.R. of 2.195, supported by a p-value of 0.028 ($p < 0.05$). Meanwhile, Perceived Ease of Use has a highly significant positive impact on User Satisfaction, demonstrated by a path coefficient of 0.475, S.E. of 0.061, C.R. of 6.463, and a p-value of 0.000 ($p < 0.05$).

The findings reveal that System Quality is vital in shaping Perceived Ease of Use and Perceived Usefulness, influencing User Satisfaction. The implications of these findings suggest that to promote the sustainable use of e-learning systems, prioritizing the development of high system quality is essential, focusing on enhancing ease of use and perceived usefulness for users.

5. Discussion

This finding is consistent with the proposed hypothesis that the higher the system quality, the more positively the user perceives the system's ease of use. System quality aspects such as reliability, access speed, security, and user-friendly interfaces significantly contribute to the

perception of ease of use. System reliability ensures that users can access the e-learning platform without interruption, while fast access speeds enhance system efficiency. Strong security increases user trust in the platform, and an intuitive user interface facilitates daily navigation and operations.

These findings align with the Technology Acceptance Model (TAM) proposed by Davis (1989), which states that perceived ease of use is one of the main determinants of technology acceptance and use. This study supports that theory by demonstrating that system quality is essential in shaping the perception of ease of use.

This research also aligns with the study by AL-Hawamleh [26], which shows that the quality of e-learning systems available on platforms and courses positively impacts perceived ease of use. In other words, when e-learning systems are well-designed, such as having an intuitive interface, clear information, and easily accessible features, users (in this case, students) tend to perceive the system as easy to use.

Another study by Alyoussef [90] indicates that high system quality significantly contributes to perceived ease of use. This study highlights the importance of the fit between tasks and technology in enhancing e-learning acceptance. Furthermore, Sayaf [88] research shows that system, information, and service quality significantly and positively affect users' perceived usefulness.

System quality refers to the fundamental features of a system that contribute to producing relevant and helpful information for users. In the context of technology adoption, R.-F. Chen & Hsiao [91] conducted a study examining the influence of system quality on user adoption in a medical system environment. The study's results show that system quality significantly affects perceived ease of use, which, in turn, plays an essential role in influencing users' intentions to adopt the system.

Moreover, several other studies have also identified a positive relationship between system quality and perceived ease of use. Ahn et al. [92] found that good system quality can enhance users' perceptions of ease when shopping online. Liao & Tsou [93] also support this finding, asserting that system quality increases user trust and their readiness to use information technology platforms.

These findings align with studies that demonstrate the importance of system quality in influencing the perceived usefulness of e-learning systems. Research conducted by Al-Hawamleh [26] shows that the quality of the e-learning system, including the quality of information on the platform and courses, positively affects users' perceived usefulness. This indicates that the better the quality of the e-learning system, the higher the perceived usefulness of the system by users. The research results confirm that the quality of information on the platform and courses significantly influences perceived usefulness. When the information presented in the e-learning system is considered high-quality (e.g., relevant, accurate, and easily accessible), users tend to find the system beneficial.

These findings are consistent with technology acceptance theories, such as the Technology Acceptance Model (TAM), which states that the system's quality strongly influences perceptions of a system's usefulness. Users are more likely to accept and use technology if they perceive it benefits them. Therefore, this study proves that high-quality e-learning systems positively impact users' perceived usefulness. This is important to ensure that e-learning systems are technically well-designed and provide adequate and helpful information to users, thereby supporting broader and more effective system use.

Another study by Alyoussef [90] shows that a high-quality e-learning system, which includes reliability, responsiveness, ease of use, and the quality of learning materials, contributes positively to users' perceived usefulness. In this context, students or e-learning users are more likely to perceive the platform as more useful if the system can provide high-quality services. This positive perception of usefulness can increase the acceptance and use of e-learning in higher education, as students feel the platform effectively supports their learning process. The findings of this study support the importance of system quality aspects in influencing user acceptance and satisfaction with e-learning technology in higher education.

Research conducted by Sayaf [94] shows that the relationship between system quality, information quality, and service quality significantly and positively affects users' perceived usefulness. The study emphasizes the importance of these three quality dimensions as critical factors in enhancing the perceived effectiveness of the system. System quality, which includes reliability and efficiency, is crucial in strengthening users' perceptions of the system's functionality and value. Information quality, involving accuracy and relevance, and service quality, including technical support, also significantly contribute to assessing the system's usefulness. Thus, these findings affirm that improving quality in these three aspects is crucial in developing systems to increase technology adoption based on perceived usefulness.

Perceived usefulness is a crucial aspect of the acceptance and use of technology. In e-learning, perceived usefulness refers to how the system helps users achieve their academic goals. Users' satisfaction increases When they feel the e-learning system provides significant benefits. This can be observed from improvements in system reliability, service quality, ease of use, and achievement of academic goals.

Several studies highlight the impact of perceived usefulness on user satisfaction with e-learning systems. For instance, research by Al-Hawamleh [26] shows that when users perceive the e-learning system as highly beneficial, they are more satisfied. Users who experience tangible benefits from the system, such as enhanced learning efficiency and easy access to course materials, will likely be confident with the system. For example, suppose the e-learning system allows students to access learning resources anytime and anywhere and helps them understand the material better. In that case, they will be satisfied with their learning experience through the system.

Another study by Legramante et al. [95] demonstrates that the perceived usefulness of the e-learning system positively impacts user satisfaction. Perceived usefulness refers to how users feel using the e-learning system will improve their performance or help them achieve their learning goals more effectively.

Further research by Ran [96], which integrates the Technology Acceptance Model (TAM), Information System Success Model (ISSM), and Expectation Confirmation Model (ECM) to analyze factors influencing users' continued intention to use food delivery apps from a herd behavior perspective, finds a significant and positive relationship between perceived usefulness and user satisfaction. This study emphasizes that features enhancing usefulness, such as relevant menu recommendations and real-time order tracking, are crucial for supporting positive perceptions of the app. These findings offer valuable insights for developers and marketers in the digital food service industry, highlighting that improving perceived usefulness can directly contribute to user satisfaction and continued usage intentions.

When users perceive that the e-learning system is beneficial and helps them achieve their goals more efficiently, they will feel more satisfied with their experience. Perceived usefulness can encompass various aspects, such as ease of accessing course materials, speed in obtaining necessary information, and support in completing academic tasks. This strong sense of benefit enhances user satisfaction as they perceive significant added value from using the e-learning system. Therefore, improving perceived usefulness is critical to increasing overall user satisfaction.

This hypothesis asserts that the higher the users' perception of the ease of use of an e-learning system, the greater their satisfaction with its use. In other words, when users find the e-learning system easy to use, intuitive, and not requiring excessive effort to interact with, they tend to be more satisfied with their experience.

Perceived ease of use is a crucial dimension in the Technology Acceptance Model (TAM). In the context of e-learning, perceived ease of use includes factors such as clarity of instructions, intuitive navigation, alignment with previous user experience, and operational simplicity of the system. When users perceive the system as easy to use, their satisfaction increases, positively impacting the adoption and use of the technology.

These findings are consistent with recent research by Al-Hawamleh [26], which found that perceived ease of use significantly impacts user satisfaction. Users who find the e-learning system easy to use tend to be more satisfied. An intuitive and user-friendly system reduces technology's stress and frustration, enhancing user satisfaction. For example, if the user interface is well-designed and system navigation is easy to understand, users will feel comfortable and satisfied with their e-learning experience.

Additionally, research by Ran [96], which integrates the Technology Acceptance Model (TAM), Information System Success Model (ISSM), and Expectation Confirmation Model (ECM) to analyze factors affecting users' continued intention to use food delivery apps from a herd behavior perspective, found a significant and positive relationship between perceived ease of use and user satisfaction. This study emphasizes that when users find an app easy to use, they will likely be more satisfied, encouraging continued use. These findings highlight the importance of intuitive user interface design and seamless user experience as key factors in app development strategies. In a broader theoretical framework, this suggests that integrating elements from TAM, ISSM, and ECM can provide a more holistic understanding of how perceived ease of use can drive user satisfaction, ultimately contributing to continued use intentions. This study contributes to the literature by showing that user satisfaction is not only a result of the app's functional benefits but is also significantly influenced by the perceived ease of operation.

One of the key findings of this study is the positive and significant relationship between perceived ease of use and user satisfaction. This reinforces the core concept of TAM, which proposes that when users find a system or technology easy to use, they are more likely to be satisfied. In the context of this research, the results indicate that ease of use significantly enhances employee satisfaction with internet use in organizations. This is important because user satisfaction is often a significant predictor of successful technology implementation within organizations and a critical factor in broader and more sustainable technology adoption.

6. Conclusion

Based on the analysis, it can be concluded that System Quality plays a crucial role in influencing both the

perceived ease of use and perceived usefulness of an e-learning system. A reliable and easy-to-use system enhances user experience, facilitates interaction, and makes the platform more beneficial, underscoring the importance of prioritizing technical aspects and maintaining high system quality in designing and developing practical, sustainable e-learning systems. Moreover, Perceived Usefulness significantly impacts User Satisfaction, emphasizing the need for e-learning systems to offer valuable features and functionalities. Ensuring that users perceive the system as applicable is essential for enhancing satisfaction. Perceived Ease of Use contributes significantly to fostering sustained engagement by making learning more seamless and enjoyable.

These findings highlight the importance of integrating technical robustness with intuitive design to promote positive user experiences and sustainable adoption of e-learning systems. By balancing functionality and ease of use, this research contributes meaningfully to developing more effective e-learning strategies and enriches the literature on technology adoption and information systems. It provides a solid foundation for enhancing IT usage within organizations or institutions, ensuring the continued success and sustainability of e-learning platforms on a broader scale.

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