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MCDA Based Framework for Assessing the Quality of Higher Education LMS

Hoor Fatima Yousaf[1], Usama Nasir[2], Hajra Masood[3], Muhammad Abubakar Farooq[4], Haroon Ilyas[5] & Rabia Abbas[6]

[1] Lecturer, Department of Computer Sciences, Bahria University Lahore Campus Lahore, Pakistan Email: hoorfatima.bulc@bahria.edu.pk
[2] Lecturer, Department of Computer Sciences, University of Central Punjab Lahore, Pakistan Email: usama.nasir@ucp.edu.pk
[3] Assistant Professor, Department of Computer Sciences, Bahria University Lahore Campus Lahore, Pakistan Email: hajra.bulc@bahria.edu.pk
[4] Student, Department of Information Technology, Bahria University Lahore Campus Lahore, Pakistan Email: abubakarfarooq123@gmail.com
[5] Departmental Coordinator, Department of Computer Sciences, Bahria University Lahore Campus Lahore, Pakistan Email: sacs.bulc@bahria.edu.pk
[6] Lecturer, Department of Computer Sciences, Rashid Lateef Khan University Lahore Pakistan Email: rabia.abbas@rlku.edu.pk

Abstract

Learning Management Systems (LMS) have become instrumental in revolutionizing educational processes. They provide a comprehensive platform for course management, content delivery, communication, and assessment, profoundly impacting teaching and learning effectiveness. Within higher education institutions, LMSs make substantial contributions to the efficiency and effectiveness of the educational process. For successful E- Learning, the presence of an intuitive and user-friendly Learning Management System (LMS) is imperative. However, there are many quality issues in LMS that were previously overlooked, negatively impacting its quality. This study's primary objective is to assess LMS quality issues through literature. It encompasses a comparative evaluation of various LMS systems, pinpointing issues and quality-related factors, and explores methods to enhance LMS intuitiveness and user-friendliness in the realm of higher education using the Multi Criteria Decision Analysis (MCDA) approach. Following this, the study will reveal the most optimal LMS Quality framework by employing the AHP. On completion our study, it became evident that the newly developed quality assessment scale, built on the foundation of MCDA methods, serves as a valuable tool for educational institutions. This scale facilitates the systematic evaluation of LMS quality but also proves to be readily applicable. It serves as a practical guide for educational institutions aiming to improve their Learning Management System selection and implementation, ultimately enhancing the educational experience for both teachers and students. In essence, our research offers a valuable contribution to the ongoing efforts to improve the efficiency and effectiveness of LMSs in higher education.

Keywords AHP, E-Learning, MCDA, Quality Factors.

Introduction

Education takes on various forms and operates within diverse geographical contexts, and strives to maintain high quality standards across all dimensions of learning. Key stakeholders, including students, instructors, and educational institutions, collectively contribute to this endeavor. Therefore, Educational institutions are now under growing pressure to maintain these quality standards by employing suitable strategies. The main object of conventional and E learning is the quality of LMS, and it is necessary to maintain it. Any deficiency in suitable assessment standards can adversely impact the quality of education. The study collected qualitative data by employing observational methods [1].

The fast growth of IT mainly Internet given boost to E learning. As a result, E learning systems based on web are gain popularity to rich and promote the learning experience. Yet, these systems face limited utilize due to issues like subpar content quality and design. To boost usage, it's vital to pinpoint the factor that most substantial knock on system quality. Study is dedicated to identifying and prioritizing these factors related to e-learning system design quality, employing a hierarchical quality model. Initially, a comprehensive literature conducted to Identification factors the most substantial impact on quality of E learning systems.

Subsequently, only those factors with the greatest impact were considered [2]. There are only two main objectives: firstly, to uncover the disparity in the examination of intended Learning results, there exists relationship between the criteria established by authorization bodies and LMS that are commonly employed for this purpose. These accreditation standards and LMS evaluation practices play a pivotal role in ensuring that educational institutions meet the desired learning outcomes effectively.; and secondly, to introduce a framework for assessing LMS functionality. The findings of this research reveal the absence of a standardized mechanism within existing LMSs for the objective measurement of course and program [3]. To begin, its necessary in the e-learning to assess most appropriate evaluation methods for each educational level. Next, we should delve deeper into examining platforms suitable for e-learning application, focusing on subject specific compatibility. Thirdly, the evaluation criteria employed to assess e-learning utilization can serve as models for innovative and more suitable e-learning formats. Fourthly, it is crucial to steer clear of the numerous challenges that may arise from e- learning adoption. Lastly, exploring emerging trends and addressing challenges is vital for the future implementation of e-learning [3]

E-learning, an alternative not quite the same as the traditional classroom, happens when space, time or both separate the instructor and the student. Regardless of whether online through the Internet or through videoconferencing, distance learning offers instructive freedoms that meet understudies' changing necessities and award them the adaptability of learning whenever, wherever, and at a speed that meets their singular learning styles [4].

E-learning is rapidly gaining ground in the field of education. To safeguard the privacy, availability, and integrity of information, proactive measures are essential. During Covid-19, while seeing the significance of the E-Learning, Higher Education Institutes [5] have established this recent norm in education in developing countries. But it can only be done if the LMS will be good enough to use and good from quality perspective. No such study exists that explicitly focuses on the way of life of developing countries. The concentrate on recommended that an all-around planned web based learning environment permits understudies to learn without utilizing remembrance [6].

Since the mid-1990s, numerous Learning Management Systems (LMS) with extensive features have emerged in the market. The increasing complexity of these platforms makes LMS evaluation a challenging and time-consuming task that requires significant knowledge, effort, and resources. Despite advancements, certain quality issues in LMS remain unaddressed [7]. Previous research [8] has focused on assessing the quality of LMS in public universities within developing countries, while private educational institutions have received less attention. Expanding this research to private institutions could help determine whether similar quality-related findings apply. This study utilizes the Analytic Hierarchy Process (AHP) to identify the key quality factors influencing LMS success. The research gap lies in prioritizing these quality factors to improve LMS effectiveness. The objectives behind this study are:

I. To investigate the critical quality issues of LMS with the help of literature
II. To categorize the identified quality issues with quality models
III. Those quality factors will be prioritized by MCDA. After that the quality framework for enhancing the quality of LMS will be exposed with the help of AHP method.

Literature Review

This literature review comprises all the key concepts that are related to our research work and this will also enlighten the maximum related work which has been performed till the date

A. Learning Management System

This era is of technology and technology has taken over a part in everyone's daily activities and as a result causing changes in production process, economic, social trade, structural changes and education activities around the World. The change and increase in technology have changed the education sector in many ways such as it has afflicted the teaching methods, research, academic management activities and many more changes. Throughout the world, universities are now opting to use digital technology for teaching. Learning Management System (LMS) has attained importance in many universities, schools and colleges and is considered very helpful in the learning process [9].

A Learning Management System (LMS) is an online platform specifically designed to manage an organization's digital learning environment [10]. It enables the integration, organization, and standardization of educational processes across different areas within an institution. Currently, Moodle is one of the most widely used and well-known open-source LMS platforms in educational institutions [11]. The term "Moodle" stands for Modular Object-Oriented Distributed Learning Environment. Distance education allows students to learn without being physically present in a traditional classroom setting. It provides the same quality of education online as students would receive if they attended their preferred university. As a result, distance learning is often referred to as a Virtual University [12]. Since Moodle has been chosen as the primary LMS, it is essential to assess its current level of usage. Previous research on Moodle has been extensive, but its application in computer science education remains relatively limited. Therefore, this study aims to explore how Moodle can be utilized for delivering programming-related lectures and whether enhancements can be introduced to improve the learning experience for students and faculty in future education and research.

B. Software Quality Factors

Boehm software quality model was presented in the time of 1978. The model is utilized to address a hierarchical model that designs around significant level qualities, middle level attributes, and crude attributes. These together outcomes into establishment of a top-notch software model.

The DeLone and McLean model is a major contribution to the literature on measuring information system (IS) success, as it was one of the first studies to bring structure to the selection of success measures by IS researchers. The model is based on theoretical and empirical research conducted by various scholars during the 1970s and 1980s [13]. DeLone and McLean identified six key dimensions of IS success: System Quality, Information Quality, Information Use, User Satisfaction, Individual Impact, and Organizational Impact [13].

The ISO 9126 software quality model is an internationally recognized standard that provides a structured approach to evaluating software quality. This model categorizes software assessment into four distinct aspects, each addressing different aspects of evaluation. Dromey (1996) proposed a framework for developing and applying quality models, considering criteria related to requirements, design, and implementation. Similar to other models, his approach defines product quality by linking and integrating various characteristics, sub-characteristics, and influencing factors [14].

It is troublesome and, sometimes, difficult to straightforwardly quantify quality factors. In any case, my first objective is to sort out the quality factors that impacts the quality of LMS. After studying literature review the top identified issues were identified that are also mentioned below:

Table 1: Quality factors and sub factors

Factors	Sub-Factors	References
Usability	Customer Satisfaction	[15],[16],[17],[18],[19],[20]
	Ease of Use	[15],[16],[17],[18],[19],[20],[21],[22]
	User Friendly	[15],[16],[17],[18],[19],[20],[23]
	Learnability	[15],[16],[17],[18],[19],[24],[25]
Efficiency	Execution Efficiency	[15],[26],[27],[28],[29],[30]
	Hardware Independence	[15],[26],[30],
	Time Behavior	[15],[26], [29],[30]
Portability	Install Ability	[31],[32],[33]
	Adaptability	[34],[35],[36]
	Flexibility	[37],[38],[39],[40]
Reliability	Maturity	[15], [17],
	Availability	[41],[42],

	Integrity	[43],[44],
Maintainability	Testability	[45]
	Reusability	[46]
	Understandability	[47]

C. The Multi Criteria Decision Analysis (MCDA)

The MCDA involve the regular world issues understanding utilizing both the subjective or quantitative standards in the clear and endless sensitive environment. The primary target is to procure advantageously course, decision, and situation in the midst of various accessible alternatives. This MCDA is widely being appropriate in various regions like education, engineering, evaluation, selection, and others.

The MCDA approach has been isolated into two classes: the first is multi-attribute decision making (MADM) and the second is multi-objective decision making (MODM). The MADM strategies fuse human investments and decisions which is impossible in MODM techniques. MCDA is viewed as a far-reaching phrase for every one of the methodologies that exist and help individuals to choose where exists more than one opposite model as per their tendency. The utilization of MCDA techniques helps in bettering the choice viewpoint and this is finished by making the improvement more explicit and reasoning.

MCDA is considered as one of the advantageous apparatuses in numerous determination issues like education, military, material, and a couple of others. Numerous strategies have been proposed to discover the responses to the multi-measures choice issue to date. A few of the successful MCDA strategies are: AHP, Fuzzy AHP, TOPSIS, ELECTRE, VIKOR. PROMETHEE

D. Analytical Hierarchal Process (AHP)

The Analytical Hierarchal Process (AHP) is one of the systems of multi- criteria-decision analysis and is refined by Saaty. AHP is being utilized by many creators in their exploration work is one of the famous procedures for multi criteria decisions. Saaty in his research paper portrayed AHP as a measurement generic theory. AHP utilizes both discrete and continuous pair correlations with figure the proportion scales. In the ordinary structure, AHP is considered as a system that is non-linear that is utilized for achieving both deductive and inductive thinking by considering various factors in conversation.

The following steps are used to perform the AHP:

I. The created decision goal's evaluation criteria are determined at the first step and then a hierarchical framework is created.
II. The pairwise decision elements are correlated.
III. The relative weights of decision elements are calculated.
IV. Established on the aggregated weight of decision elements, rate the decision alternatives.

AHP has been utilized in pretty much every sort of MCDA because it has adaptability, is not difficult to utilize and simple. The factors can create some turmoil for the individual who doesn't have a lot of information and cause them to believe what factors to incorporate and which to reject. As indicated by Saaty at the phase of creating hierarchies, addressing the issue as efficiently as conceivable requires adding sufficient important subtleties that can clarify the issue just as doesn't make it look more complicated.

E. Mapping Quality Factors with Quality Models

The key quality factors present in all quality models, which are consistently emphasized and play a crucial role in assessing software quality, include Efficiency, Maintainability, Portability, Reliability, and Usability. These factors serve as essential criteria for evaluating software quality [48].

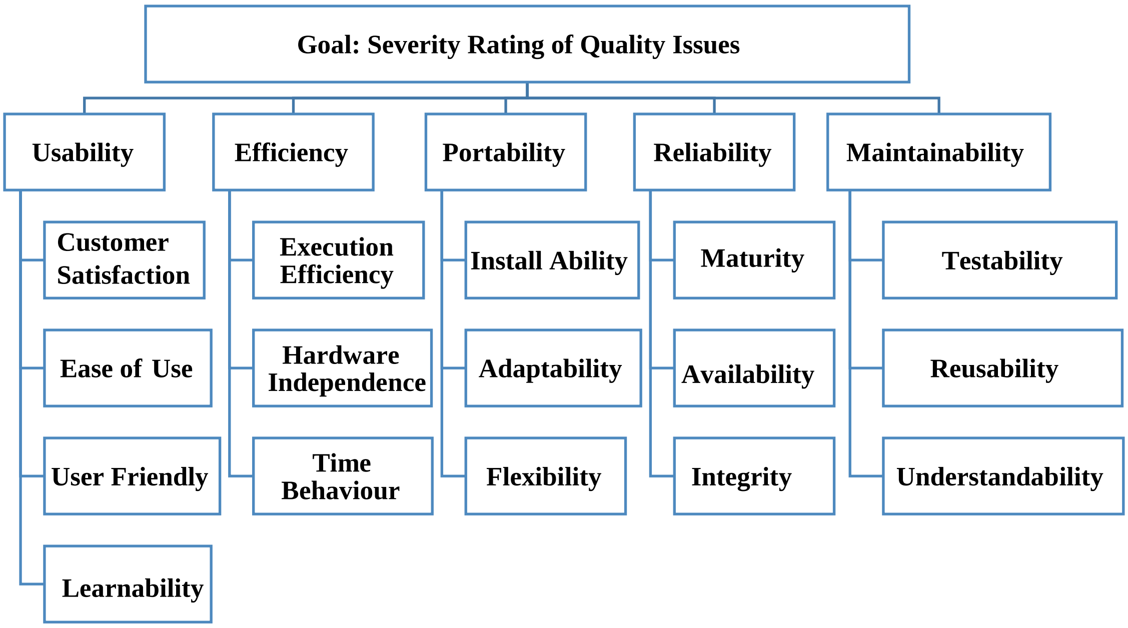

Figure 1: Quality Factors for Severity Ranking

Models Software Quality	Boehm	McCall	Furps	ISO9126	Dromey
Testability	✔	✔		✔	
Correctness		✔			
Efficiency	✔	✔	✔	✔	✔
Understandability	✔			✔	
Reliability	✔	✔	✔	✔	✔
Flexibility		✔	✔		
Functionality			✔	✔	✔
Human Engineering	✔				
Integrity		✔		✔	
Interoperability		✔		✔	
Maturity					✔
Maintainability	✔	✔	✔	✔	✔
Changeability	✔				
Portability	✔	✔		✔	✔
Reusability		✔			✔
Usability		✔	✔	✔	✔

Table 2: Mapping Quality Factors with quality Models

Research Methodology

For the research purpose, the congregation process of the background knowledge comprises of different stages. To set the research in motion, first, the research gap is distinguished from the literature review and then other steps are performed. The research process in this study consists of five phases. The first phase involves a literature review and. In second phase, quality issues are mapped with quality models. After analysing and diagnosing the quality issues, the third step comprises classifying the identified issues into criteria and main criteria and this is achieved by the literature review help. The second phase consists of ranking the quality factors into local and global ranks using the AHP method and the fourth and final phase comprises creating a framework with the rankings obtained from phase 2.

Data Findings and Discussion

The research findings comprise of three-phases. The first phase comprises the quality factors of LMS through literature; the second phase consists of applying the AHP, the third phase the framework development based on the overall results obtained.

A. Participants

In this turn, 08 specialists were chosen as experts of LMS, and they were picked in the first round of the AHP. They participated in this research intentionally with consent. There are three female participants: one is a student with 1-5 years of LMS experience, another is some alumni with 5-10 years of LMS experience, and the third is a teacher with 5-10 years of LMS experience. Moreover, there are five male participants: one is a student with 1-5 years of LMS experience, another is some alumni with 1-5 years of LMS experience, two are teachers, both with 1-5 years of LMS experience, and one more is a student with 1-5 years of LMS experience.

The AHP order comprises of five main criteria and every criterion having a couple of sub-criteria. The members were approached to pick the pairwise examination. By utilizing the questionnaire, the members look at the general significance of the choice options of pairwise concerning criteria and the objective clarified underneath in Figure. Every participant is mentioned to enter his/her decisions and makes an unmistakable, recognizable commitment to the issue. Participants don't need to concede to the general significance of the criteria or the rankings of the other options. As displayed in below Figure, the first level of the hierarchy is the goal of the project; the second level represents the criteria based on which the projects are to be evaluated, the third level represents the sub-criteria. Table 1 explains brief roles and responsibilities of each factor/ player.

1) Normalized Eigen Vector and Criteria Weights

In the wake of framing the pairwise comparison matrices, the following stage is to figure a normalized eigenvector which shows the general commitment of one component over the other. The criteria and sub- criteria weights are determined by testing the consistency ratio of every member's data. Testing the consistency ratio (CR) of the participant's data while computing the criteria weights is vital in AHP. The below tables show the priority weights of the main criteria as given by every participant, where CI alludes to the consistency index, RI is the random consistency, λmax is the greatest eigenvalue and CR consistency ratio which is acceptable.

Criteria	First Expert	Second expert	Third Expert	Fourth Expert	Fifth Expert	Sixth Expert	Seventh Expert	Eight Expert
Usability	0.29	0.18	0.08	0.42	0.04	0.20	0.03	0.44
Efficiency	0.24	0.27	0.11	0.42	0.04	0.20	1.10	0.26
Portability	0.31	0.08	0.58	0.04	0.25	0.20	1.15	0.06
Reliability	0.12	0.36	0.13	0.06	0.37	0.20	1.12	0.18
Maintainability	0.04	0.11	0.11	0.05	0.30	0.20	1.60	0.05
RI	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12

CI	0.06	0.04	0.03	0.04	0.05	0.00	0.11	0.03
CR	0.05	0.04	0.03	0.03	0.05	0.00	0.09	0.03

Table 3: Normalized criteria Weights

2) Ranking the factors based on priority weights

The last step incorporates the positioning of criteria and sub-criteria dependent on their priority weights. These weights were then parted into "local weights" and "global weights". Local weights allude to the priority weights concerning the first progressive level, while "global weights" are the priority weights concerning the highest hierarchical level, which demonstrates the goal.

To lead an overall ranking of the sub-classes, AHP consolidates the priority weights of the measurement with the comparison ratings for factor to track down the local and global ranking [80]. This is performed by the following equation:

Global weights=∑ (Local weight for dimension i x local weight for factor j concerning dimension i).

The below Table shows the overall local and global rankings of the main criteria and sub-criteria.

Dimension	Priority weight	Factors	Local weightage	Local Rank	Global weightage	Global Rank
Usability	0.210	Customer Satisfaction	0.470	1	0.0987	**9**
		Ease of Use	0.210	2	0.0441	**14**
		Learnability	0.200	3	0.0420	**15**
		User Friendly	0.130	4	0.0273	**16**
Efficiency	0.330	Time Behavior	0.390	1	0.1287	**3**
		Execution Efficiency	0.320	2	0.1056	**7**
		Hardware Independence	0.290	3	0.0957	**10**
Portability	0.334	Install Ability	0.400	1	0.1320	**1**
		Flexibility	0.380	2	0.1254	**4**
		Adaptability	0.220	3	0.0726	**13**
Reliability	0.318	Maturity	0.390	1	0.1248	**5**
		Integrity	0.350	2	0.1120	**6**
		Availability	0.260	3	0.0832	**12**
Maintainability	0.308	Reusability	0.410	1	0.1312	**2**
		Testability	0.310	2	0.0992	**8**
		Understandability	0.280	3	0.0896	**11**

Table 4: local and Global Weights

Proposed Framework for Enhancing the Quality of LMS

After the cautious estimations of the information accumulated from the experts of AHP, Portability has the first ranking and hence the most important main factor/criteria affecting the quality of LMS. The sub-criterion of the Portability is Install Ability, Flexibility and Adaptability ranked respectively. The second factor/criteria affecting the quality most is the Efficiency, and its sub-criteria are ranked as Time Behaviour, Execution Efficiency, and Hardware Independence which are ranked in the order defined. The third factor/criteria are Reliability, and its sub-criteria are ranked as Maturity, Integrity, and Availability. The fourth factor/criteria affecting the quality most is the

Maintainability and its sub-criteria are ranked as Reusability, Testability, and Understandability which are ranked in the order defined. The Fifth factor/criteria are Usability, and its sub-criteria is ranked as Customer Satisfaction, Ease of Use, User Friendly and Learnability.

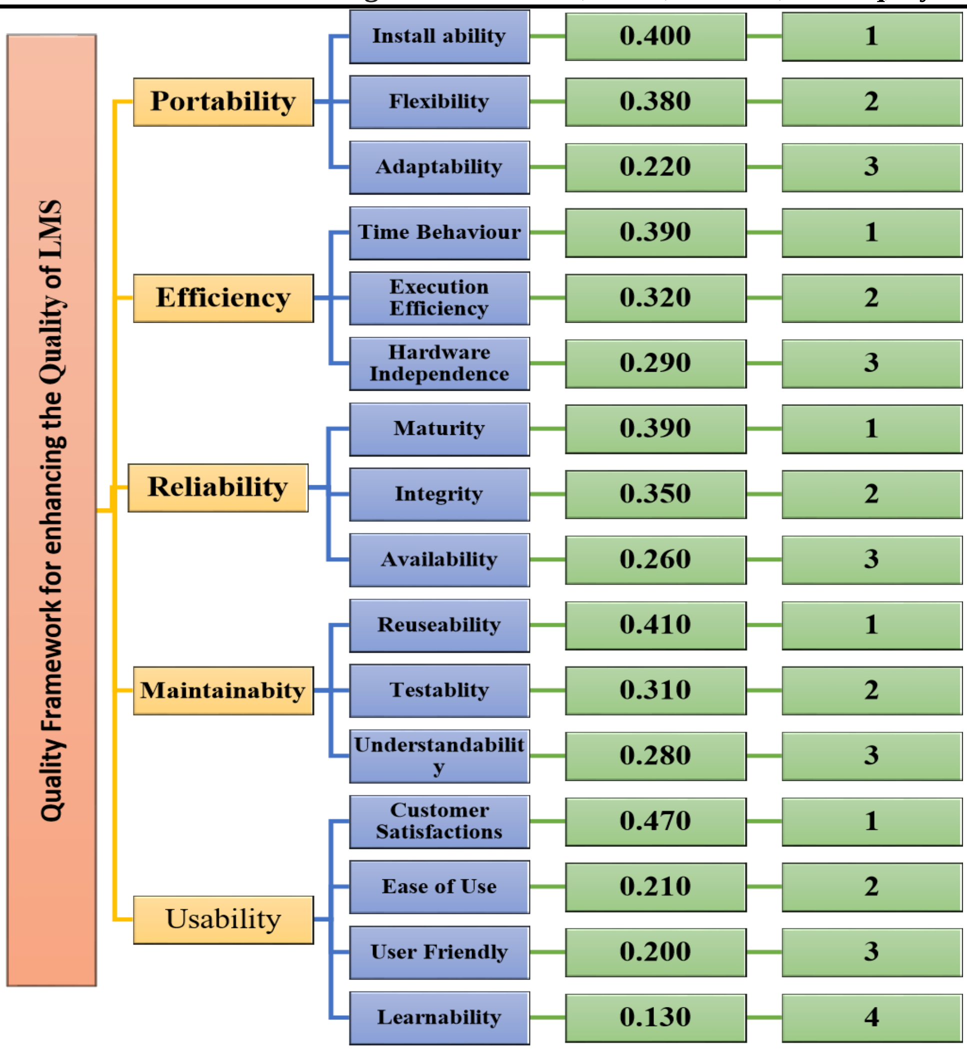

Figure 2: Quality Framework for enhancing the Quality of LMS

Conclusion and Implications

Research focuses on developing a system to enhance the quality of Learning Management Systems (LMS). The findings offer valuable insights for improving the overall quality of LMS platforms. Through a thorough literature review, key issues affecting LMS quality were identified. These issues were categorized into criteria and sub-criteria based on existing literature

The Analytical Hierarchy Process (AHP) was employed in this research to assess and rank the quality factors affecting Learning Management Systems (LMS), with input from 10 expert participants. These participants, including experienced teachers, current students, and alumni, all had prior experience using LMS platforms. AHP is a structured decision-making method that helps prioritize multiple criteria by breaking down complex decisions into a hierarchical structure. In this study, AHP was used to rank the main criteria and sub-criteria influencing LMS quality. The process involved creating pairwise comparison matrices. The analysis was based on expert opinions from 10 participants, who were experienced LMS users such as teachers, students, and alumni.

The combined use of AHP resulted in a comprehensive ranking of the five key factors influencing LMS quality: Usability, Efficiency, Portability, Reliability, and Maintainability. These factors, along with their sixteen sub criteria, were ranked in both local and global contexts, offering a robust framework for enhancing LMS quality.

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