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Assessing the Essential Features of ICT-Based LMS for Performance Enhancement

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***Abstract*— Transformation has been happening in every field with the help of Information and Communication Technology (ICT). ICT is revolutionizing every aspect of an education sector in this digital era. To enhance the sustainability of higher education it is very much required to integrate ICT-based tools. In accordance with the above context this paper is written with the focus on assessing the key features of ICT-based Learning Management Systems (LMS) so as to enhance the efficiency of teaching-learning process in higher education. This paper also provides the current applicability of the identified features in present LMS systems with a tool-wise comparison.**

Keywords- ICT, digital era, sustainability, LMS, teaching-learning process

I. INTRODUCTION

Learning Management System (LMS) is an important tool for the development of curriculum design, management of students' learning and their motivation to learn. LMS is also useful in the development of student assessment. LMS can manage all teaching and learning processes of registration, scheduling, checking availability of content, tracking the performance of the learner and issuing reports about it, facilitating communication among teachers and learners, etc. [1].

Learning management systems are of two types: proprietary systems and open-source systems. Blackboard, Desire2Learn and eCollege are examples for proprietary systems whereas moodle and sakai are the best examples for the open-source systems. Each of the learning management system has got innumerable features such as: grades, calendar, wiki, lessons and workshop, chat and messages, forum, notes and resources, online examinations, assessment, quizzes, uploading and sharing notes, reporting etc. [2]. The initial versions of an LMS focused on organizing and managing course content and learners. In the initial stage all the LMS were stand-alone systems which support the educational and administrative needs of the institution. The Introduction of Web 2.0 technologies brought about tremendous changes in the Learning Management Systems. It facilitates the usage of wikis, blogs, RSS, 3D virtual learning etc. It has made substantial changes in the student attitude from passive to active learners. LMS gives access to synchronous as well as asynchronous learning resources and activities. The current LMSs are hosted in the cloud, which makes the institutions and companies free from installing and maintaining in-house systems. Many of the current LMS provides features like mobile learning, virtual class room, video conferencing etc.

The ability to access the instructional components and contents from any location makes LMS user friendly and convenient. The new generation LMS reduces the time and cost in delivering the instructional content and make it affordable. They are capable of accommodating frequent changes happening in the technology changes without reworking with the entire system. It has the ability to use instructional components in various applications [3].

II. THEORETICAL BACKGROUND

The active learning environments using ICT enabled LMS have evolved over a period of time. There are three levels in the active learning environment. In the first level, as in the traditional system, it also contains context information and gathers feedback from the students by frequently asking questions. The second level is of more intense interaction used to build knowledge rather than simply exchange simple questions. There are various means to accomplish this goal such as discussion forums moderated by the instructor within the specified subject context and interaction within the student group. Well defined goals and assessment patterns are followed in both the levels. The third level goes further and emphasizes self-directed learning where each learner defines specific learning needs. Learners build their own knowledge through discussing and trying ideas by themselves or through participation in groups, constant and directed process of identifying learning goals and recording outcomes in their learning outputs. The learner can achieve the learning goals through the active components rather than instructions. These active components will set up personalized workspaces for students and provide contacts to individuals or groups for guidance or interaction [4].

According to Ellis [5] a strong LMS system has the ability to:

- Centralize and automate administration
- Use self-service and self-guided services
- Assemble and deliver learning content rapidly
- Consolidate training initiatives on a scalable web-based platform
- Support portability and standards
- Personalize content and enable knowledge re-use

Today the teaching-learning process is not strictly confined to the classroom atmosphere, but it goes far beyond the walls of

the classroom. According to the present system of education, it is not necessary that learners have to be physically present in the classrooms. They can also be students in some other institution or they will be in industry [6].

The present LMS systems provide various features to support the teaching-learning more interactive and student oriented. The main objective of LMS systems are online tutoring but it creates great impact in the classroom teaching too. The unique features identified from the present LMS systems can be summarized as follows:

- Interactive learning environment
- Administration capabilities
- Good authoring tools
- Communication facilities
- Media support
- Scalability
- Repository and Database
- Inclusiveness
- Security
- Cost effectiveness
- Self-paced and self-directed Learning
- Accommodates multiple learning styles
- Designed around the learner
- Eliminates geographical barriers
- 24/7 accessibility
- On-demand access

A. Limitations of Present LMS

LMS has become very popular and widely used in almost all the universities and higher education institutions all over the world. Analysis and studies shows that many of the LMS parameters are still in its primitive stage and various limitations and drawbacks are identified with the present LMS systems. The following are the major drawbacks identified in the present LMS systems:

- Curtail the academic freedom to design and conduct courses.
- Constraints to innovation in teaching and course design related to the creative capabilities in any LMS
- Accessibility issues for staff and students within and outside the campus.
- Many LMS systems do not collaborate with other systems and hence accessing content in other systems is a challenge.
- LMS transparency and portability issues across online courses
- Functionality that supports multiple learning styles, multimedia enrichment and the social construction of knowledge
- Integration with existing enrolment services including grading function as a faculty option
- Most of the LMS systems are not adaptable with the recent technological changes
- Cost of LMS tools is pretty high.
- It is very difficult for the staff to repetitively create the content each time.

Identify applicable sponsor/s here. *(sponsors)*

The primitive and essential features of ICT- based LMS were identified. The following are the six essential features of LMS systems.

- **Accessibility:** The ability to locate and access instructional components from multiple locations and deliver them to other locations.
- **Adaptability:** The ability to integrate new features to the existing system without changing the entire framework.
- **Affordability:** The ability to make the cost reduced which can be afforded by all the institutions
- **Durability:** The ability to withstand technology changes over time without costly redesign, reconfiguration or recoding.
- **Interoperability:** The ability to take instructional components developed in one system and uses them in another system.
- **Reusability:** The ability to use instructional components in multiple applications, courses and contexts.

III. OBJECTIVE OF THE STUDY

The major objectives of the study include the following:

- To identify the primitive parameters of ICT-based LMS to enhance performance
- To identify the current availability of these parameters in various ICT-based LMS systems

IV. METHODOLOGY

This research is descriptive in nature. The methodology comprises instrument development, validation, sampling, data collection and data analysis.

A research instrument was developed using five point Likert scale. There are five categories from each item ranging from strongly agree to strongly disagree. The following methodology was used in validating the instrument:

- Item generation
- Content validity
- Reliability test

A. Item Generation

Item generated for the various features of LMS are listed below:

- Accessibility
- Adaptability
- Durability
- Interoperability
- Reusability
- Affordability

The above mentioned items were generated through literature review, expert discussion and observation. Table 1 contains the items generated for each of the identified parameters.

TABLE 1: ITEM CATEGORY GENERATED FOR LMS PARAMETERS

Item	Item Categories
Accessibility	The extent of usage of a tool-based LMS (Learning Management System) in the institution/organization
	Ease of access to the LMS for the faculty within the institution/organisation
	Ease of access to the LMS for the students/learners within the institution/organization
	The LMS has good security features while providing online access / online testing
Adaptability	The LMS has compatibility with mobile devices (e.g. audio or video content can be downloaded to mobile devices)
	Course content in LMS can be accessed from hand-held devices (e.g. iPhones, Blackberry, mobile phones, smart phones)
	The LMS has good compatibility with all major browsers
	The LMS facilitates easy adoption through self-learning / online help options regarding its usage
	The LMS is adaptable to meet the requirements of different grading styles
Durability	The LMS is easily scalable in terms of users, courses etc.
	The LMS provides a quick and easy process to faculty in setting up courses
	The LMS provides flexibility in course management
	The LMS has consistent interface and options throughout
Interoperability	The LMS facilitates integration with other LMS systems
	The LMS has integration with the academic calendar / examination schedule
	The LMS is integrated with the existing authentication mechanisms and can be accessed using single sign-on
	The LMS provides integration with social media
	Integration with web conferencing tools is available
	The LMS has the ability to integrate RSS feeds, blogs, wikis, and other new technologies from external sources
	Web 2.0 tools (blogs, wikis, RSS feeds, etc.) are included in the LMS itself
	The LMS server is extensible with regard to different file types it can recognize
Reusability	Effective Backup / restore options are available in the LMS
	The LMS provides visual alerts / notifications when new information is submitted (e.g. submission of assignments / quiz, postings in discussion boards, etc.)
	The LMS has flexibility and provides customizable communication options for faculty and students (e.g. flexibility to communicate and send documents to large groups, customization of notifications from the system such as email, popup etc.)
Affordability	The LMS provides various additional tools (course calendar, shared whiteboard, plagiarism detection tools, etc.)

B. Content Validity

Content validity is qualitative in nature and is performed to confirm whether a specific element enhances or detracts from a test or research program. Content validity addresses the adequacy in representativeness of the items to the domain of testing purposes. It is performed mainly through the expert opinion.

C. Reliability Test

Reliability is the degree to which a set of latent construct indicators are consistent in their measurements. It has high reliability if the measure produces similar results under consistent conditions. A research tool should undergo a detailed reliability test before being administered to the respondents. Cronbach's alpha is the most commonly used measure of internal consistency or reliability.

The alpha value ranges from 0 - 1. The standard alpha values are explained in Table 2. The Cronbach Alpha value and the corrected item total correlation (CITC) are measured to improve the reliability of the constructs.

TABLE 2: STANDARD ALPHA VALUES

Cronbach's alpha	Internal consistency
$\alpha \geq 0.9$	Excellent

$0.8 \leq \alpha < 0.9$	Good
$0.7 \leq \alpha < 0.8$	Acceptable
$0.6 \leq \alpha < 0.7$	Questionable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

Alpha value above 0.7 is acceptable and anything less than 0.5 is discarded. The questionnaire consists of 25 questions and has undergone a reliability test using the SPSS statistical package. Table 3 gives the result of reliability test performed.

TABLE 3: RELIABILITY ANALYSIS-VALUE FOR CRONBACH'S ALPHA

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
.783	.821	25

It is quite clear from the analysis results that the items generated have a high alpha value (0.783) and hence it indicates good level of internal consistency. Commonly used threshold value of acceptable reliability is 0.70 [7]. Since the alpha value is 0.783 for the overall instrument it can be concluded that the research instrument exhibits high reliability.

The results prove that each of the elements has high internal consistency and CITC, thus in defining that the reliability test is successful. Through the process of item generation, content validity and reliability test 25 relevant questions were finalized in the research tool.

V. RESEARCH POPULATION

The stakeholders LMS systems were identified as the research population in this study. The most important stakeholders of any LMS package are:

- Students
- Teachers
- Parents
- Administrators or the management
- Technical experts and others.

This research gives high priority to the technological aspects than the management aspect. Therefore, the feedback and suggestions of technological experts, students and teachers were considered for the study. Various techniques like personal interview, interaction with technological experts and survey questionnaire were used for data collection.

A. Sampling Procedure

Snowball sampling technique is used for data colleciton in this study. Snowball sampling also known as chain sampling or chain-referral sampling is a non-probabilistic sampling technique where existing study subjects recruit future subjects from among their acquaintances. Thus the sample group appears to grow like a rolling snowball (similar to breadth-first search). As the sample builds up enough data is gathered to be useful for research. Snowball sampling uses recommendations to find people with the specific range of skill that has been determined as being useful [9]. The snowball method enables the investigator to locate hidden population which was not possible otherwise.

Students, teachers and LMS technology experts were identified as the primary stakeholders of the study. A list of contacts was created using snowball method and fifty people from each of the stakeholder group were identified using random sampling technique.

The research instrument was sent to 150 people out of which ninety two people responded. After verifying all the responses received, a few were found to be incomplete and finally 28 responses from each of the stakeholder groups were selected for the final analysis. Table 4 gives the details of the sample set selected for final analysis.

TABLE 4: SELECTED SAMPLE SET

Sl. No.	**Stakeholders**	**No. of respondents**
1	Students	28
2	Staff	28
3	LMS technical experts	28
	TOTAL	**84**

VI. ANALYSIS AND INFERENCES

The responses received from each stakeholder reveal the drawbacks of the present LMS models and the features that need to be enhanced. The following graphs very well explain how each of the stakeholders responded to various LMS features.

A. Analysis on Applications of LMS Parameters Rated by Students

The responses collected from twenty eight students were analyzed. The figure 1 gives the details of the analysis result.

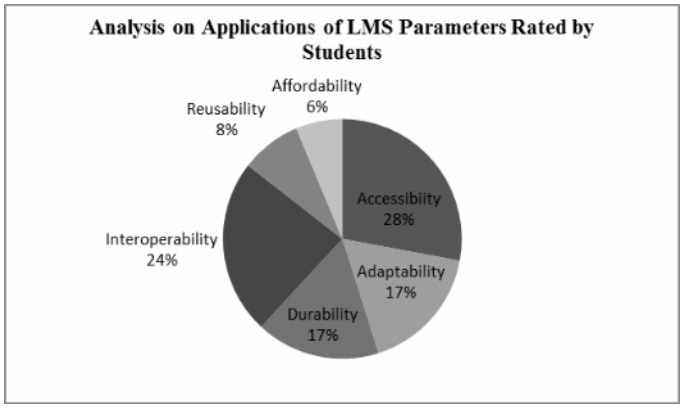

Figure 1. Analysis on Applications of LMS Parameters Rated by Students

According to Figure 1, it is quite clear that the students demanded improvement of the accessibility feature of present LMS systems. Interoperability feature of the LMS was the next concern. Adaptability and durability were also found as unaddressed to a great extent. As per students' evaluation, reusability and affordability were the least discussed features because those two factors were not directly a matter of their concern.

B. Analysis on Applications of LMS Parameters Rated by Teachers

The responses collected from twenty eight staff members working in different education institutions were analyzed. Figure 2 gives the details of the analysis result.

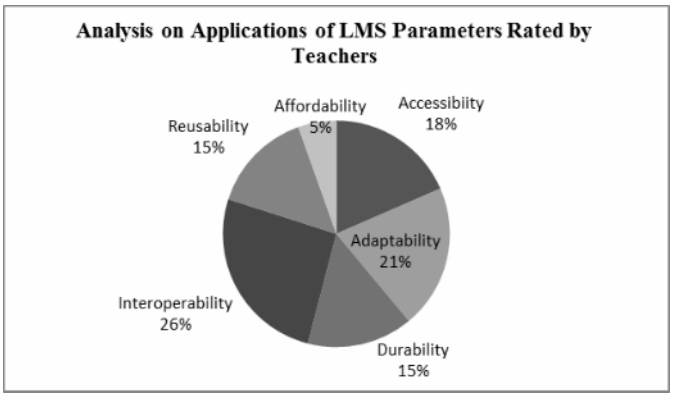

Figure 2. Analysis on Applications of LMS Parameters Rated by Teachers

According to the analysis results interoperability was found as the highest challenging feature. Other features like adaptability, accessibility, reusability and durability were also found lacking. Improvisation of features like interoperability, adaptability, accessibility, reusability and durability are very much required. Even teachers were also less concerned with the affordability feature because it was a matter of management concern.

C. Analysis on Applications of LMS Parameters Rated by LMS Technical Experts

The responses collected from twenty eight LMS technical experts working in different education institutions as well as industry were analyzed. Figure 3 gives the details of the analysis results.

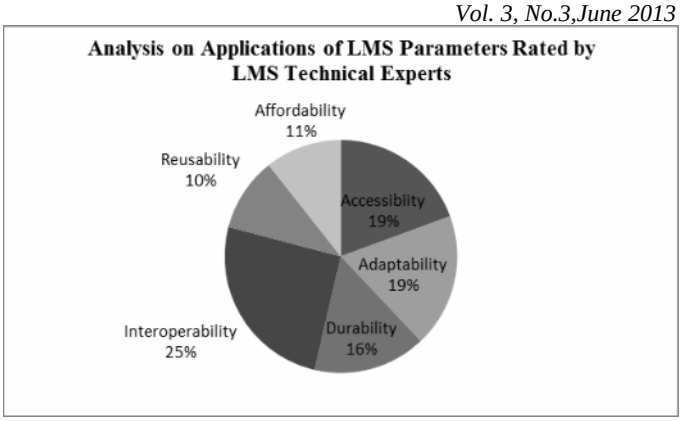

Figure 3. Analysis on Applications of LMS Parameters Rated by LMS Technical Experts

According to the analysis results, interoperability was found as the highest challenging feature. Other features like adaptability, accessibility and durability were also found lacking. Affordability and reusability were also suggested for improvement.

D. Regression Analysis on LMS Parameters

Regression analysis is a statistical technique for estimating the relationships among variables. Regression analysis helps to understand how the typical value of the dependent variable changes when any one of the independent variables is varied, while the other independent variables are held fixed [10]. If the R^2 value is 0.25 or above then it has significance in regression analysis and proportions of variance above 25% are considered substantial [11].

TABLE 5: REGRESSION ANALYSIS ON LMS PARAMETERS

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.595	.354	.303	.686

Dependent Variable: stakeholders

The resultant R^2 value of the analysis is 0.354 which is above the threshold value of 0.25 and hence it is evident from the regression analysis that each of the identified features contribute to the total system and a significant change in any of the variables would definitely affect the entire LMS system.

E. Comparative Analysis of LMS

A comparative analysis was conducted among the leading LMS systems available today which includes both proprietary and open source. Four widely used LMS were used in the comparative analysis such as Moodle, BlackBoard, Sakai, and ATutor. Among these LMS, three are open source systems and BlackBoard is a proprietary system. Major features of each of the LMS were analyzed and Table 6 provides the results of the analysis.

TABLE 6: LMS COMPARATIVE STUDY

LMS Features	Moodle	BlackBoard	Sakai	ATutor
Business Type	Open source	proprietary	Open source	Open source
Application Type	Web based	Web based	Web based	Web based
Deployment Model	SaaS	On Premise / SaaS	SaaS	SaaS
Business Size	Any	Any	Small	Medium
Accessibility	Good	Good	Fair	Good
Interoperability	Bad	Bad	Bad	Good
Adaptability	poor	Poor	Fair	Good
Durability	Fair	Fair	Good	Fair
Reusability	Poor	Poor	Poor	Fair
Affordability	Excellent	Poor	Good	Good
SCORM Enabled	Average	Average	Poor	Poor
Course development features	Fair	Fair	Good	Fair
Communicative features	Good	Poor	Fair	Good
Administrative features	Good	Average	Poor	Poor
Extensibility	Good	Good	Poor	Average
Offline mode	Bad	Partial	Bad	Bad
Integration of social networking sites	Bad	Bad	Bad	Bad

This comparative analysis gave a clear picture of the pros and cons of the existing LMS systems. When it is taken individually, each of the systems has its own advantages and disadvantages. Moodle is good in collaborative learning but not recommended for blended learning. Blackboard is good in blended learning but no provision for collaborative learning. Most of the parameters required are not properly incorporated in these LMS systems.

F. Analysis on Applications of LMS Parameters Consolidated Data

It is quite evident from the above discussions, how each stakeholder responded to different LMS features and in which areas improvement is required. A consolidated analysis of all the three stakeholders; students, staff and LMS technical experts were conducted and Table 7 gives an overview of the result.

TABLE 7: ANALYSIS ON APPLICATIONS OF LMS PARAMETERS

LMS Parameters	Students	Teachers	Technical Experts	Average
Accessibility	28%	18%	19%	22%
Interoperability	24%	26%	25%	25%
Adaptability	17%	21%	19%	19%
Durability	17%	15%	16%	16%
Reusability	8%	15%	10%	11%
Affordability	6%	5%	11%	7%

VII. CONCLUSION

A detailed analysis on applicability of the identified features was done from the perspective of three major stakeholders namely students, teachers and technical experts. The essential features of ICT based LMS systems were identified. The inferences of this analysis revealed that current LMS systems addresses only 25% of interoperability issues, followed by 21% accessibility and 19% of adaptability. This analysis further revealed that durability accounts for 16%, reusability is of 11% and affordability is of 8% only. Hence it is very evident that none of these parameters are completely addressed in the present LMS system. Enhancement of each parameter improves the total performance of the LMS system. A comparative study of various LMS systems pertaining to these parameters also shows the implementation gap of the essential LMS parameters such as interoperability, accessibility, adaptability, durability, reusability and affordability.

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