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## Development Of Open-Source Elements Of Learning Management System For Sustained Online Learning In Tertiary Education

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Abstract - Learning Management System (LMS) is a web-based software used to facilitate the delivery of online learning, blended approach or even an assistance to face to face settings, whether in an academic setting or in the world of business. The LMS has proven its value especially in the COVID-19 pandemic. The purpose of this study is to develop and utilize Learning Management System using the open-source technology for tertiary education. The researcher describes the strategies as development learning management system for sustained online learning to cater the need of the University to have its own controlled LMS. With this system they have full control on the information, learning materials and other LMS functionality that can be enjoyed in a commercialized LMS. The system used the Moodle Open-Source framework which is the most used LMS platform in the Philippines. The management of the opensource LMS is primarily assigned to MIS office. Moreover, the created system can be an avenue of hands-on training for Information Technology Education (ITE) students, especially in managing a system. The researcher will identify its problem by the respondents and will be used to create an improved LMS service. Moreover, the researcher recommended ISO 25010 as the base standard for quality software. The researcher recommended considering the utilization of an open LMS as one of the available technological options in managing own LMS.

**Keywords** – LMS, Open Source LMS, Learning Management System, ISO25010

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### Introduction

LMS or Learning Management System is an aid for the distribution of instructional materials via online learning (Rottmann et al., 2020). This technology management of online learning becomes seamless and efficient. With this web-based tool called a Learning Management System (LMS) makes it easier to deliver blended, in-person, and online courses in both academic and professional contexts. LMS has proven its value and worth more on present in the online education, it has made its impact more especially in the COVID-19 Pandemic. Universities and academic institutions need to have backup plans in place to handle large operational disruptions like pandemics, as the arrival of COVID-19 has made clear. (Rodrigues et al., 2020). Moreover, the COVID-19 Pandemic has transformed teaching-learning and has affected the interactions between students and teachers. Therefore, universities were forced to do all their student teaching and learning online because of the epidemic. (Sobaih et al., 2020).

Besides the technology it offers, it also provides a remedy to cover classroom needs since it provides an online classroom environment where blended learning transpires with remote accessibility (Al-Hunaiyyan et al., 2020). Needless to say, LMS has played a disruptive role in the academic process.

LMS also comes in a different variety; an institution can have the pre-created, pre-formatted systems that usually a third party is managing. The LMS systems are already in place and the user will just have to adapt the process of the LMS platform. The maintenance of the platform is supervised by the third party. On the other hand, there is also an existing option that a tertiary education can take and that is the Open-source LMS without even buying a paid LMS that is very expensive. Under Open-source LMS, the opensource proponent can maximize the free usage of LMS and cater-fit the needs of its stakeholders that is tailored-fit to the school beneficiary. Comparing the paid LMS on the Open-source LMS, the latter is more important since it has greater advantage since schools can maximize the people that the school has and utilize their existing skills for the process.

For educators and administrators, LMS platforms offer unparalleled efficiency in course management. They streamline the process of creating, delivering, and managing courses, automating tasks like grading, assessments, and progress tracking. This automation saves valuable time and effort, allowing instructors to focus more on designing effective learning content and supporting their students (Seo et al, 2021).

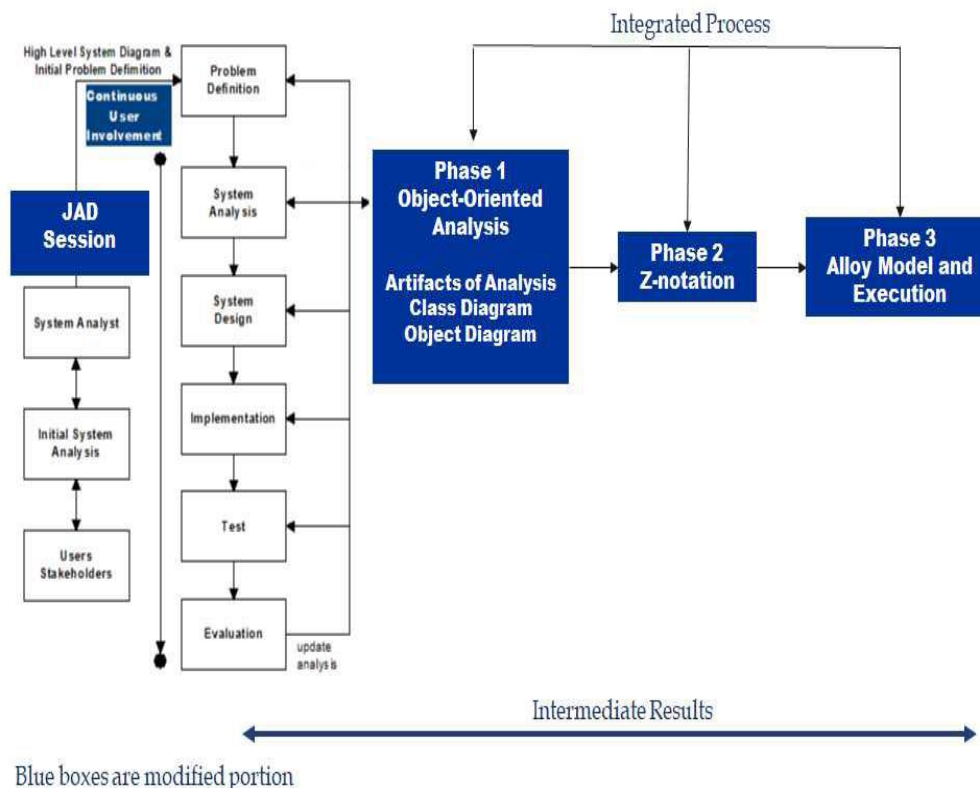
### Materials and Methods

This study is anchored with the Modified System Development Life Cycle (MSDLC) model developed by Harris (2019). Computing was not sophisticated enough before the 1950s to require a comprehensive method like the SDLC (Harris, 2019). The idea of organized programming arose as programming became more intricate and expansive. An enhanced SDLC was initially sparked by the need for more tactical development models over time, which was brought about by structured programming.

The stages of a system development project, from an initial feasibility assessment to maintenance of the finished application, are described by a conceptual model used in project management that software and system engineers refer to as the SDLC (Rouse, 2018). Using SDLC also has disadvantages; among the encountered common disadvantages are requirements are not clear/high risks and uncertainty, idealized, problems remain uncovered until testing, inappropriate for long term projects and difficult to make changes (Tarika, 2019). Though SDLC is considered to be robust and economically profitable products (Restrepo et al., 2021).

An improved version of SDLC which is the Modified System Development Life Cycle became applicable as technology progresses. Among the highlights of MSDLC is the Joint Application Development (JAD). According to www.study.com the JAD approach brings essential stakeholders to be involved in the process to define the requirements from the perspective of business ideas and technology implementation.

**Figure 1.**  
**Modified System Development Life Cycle (MSDLC)**

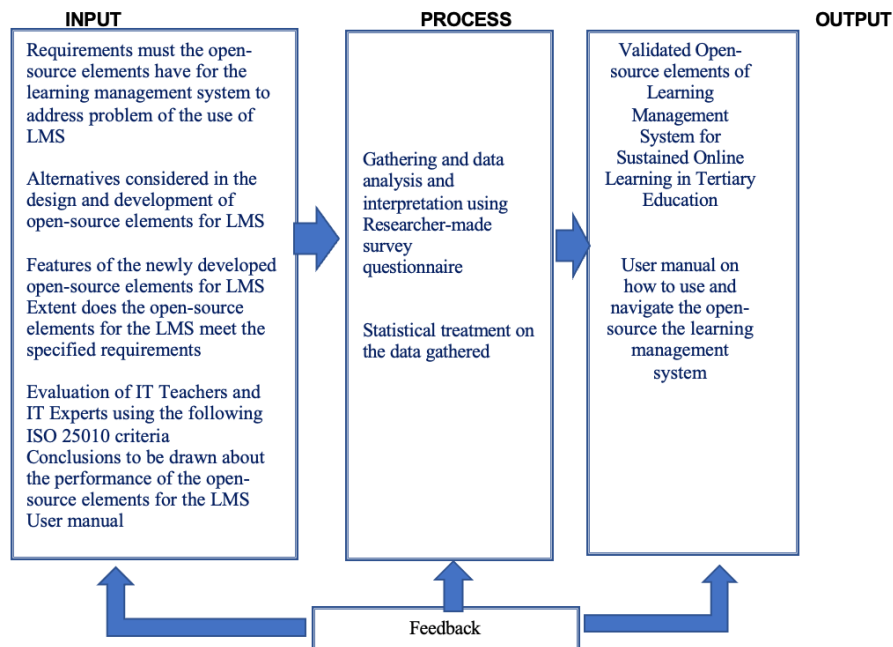


The project manager, managers, users, system analysts, and recorders (scribes) are typical attendees at the JAD session. The facilitator for the project will be the project leader, who will oversee the discussion's direction and flow. Managers take part to give permission and support for the project. Operational-level input from the user results in project requirements. The analysts are taking part to help out technically. The recorder records the discussion, the JAD session's outcomes, and the actions that need to be taken. (Harris, 2019). With the active participation in the process of the stakeholders, the produced system will become error proof and acceptable for everyone.

The presence of LMS in tertiary education has provided a variety of services and options in the delivery of education. As the LMS technology progresses various options are becomingly available which previously not available that can be utilized for its purpose. This study provided the options of utilizing an open-source LMS as an effective tool of sustaining its LMS operations.

Figure 2 contemplates the Input Process Output of the study. For input, various frameworks are taken into consideration on the cited theoretical framework which include the System Development Life Cycle. This helped the researcher to establish the based foundation of the LMS framework.

**Figure 2**  
**Input Process Output (IPO) Model**



To gauge the software quality of the Learning Management System ISO 25010 an international standard is to be used. The ISO 25010 covers Functional Suitability, Performance Efficiency, Compatibility, Usability, Reliability, Security, Maintainability and Portability. Another part of the input is the responses coming from the stakeholders which are generated through interview and survey questionnaire.

The process stage as shown in Box 3, focuses on the gathering and data analysis using a Researcher-made survey questionnaire, and statistical treatment on the data gathered. Various statistical processes are applied to generate the essential information that forms the output, which is the Validated Open-source elements of Learning Management System for Sustained Online Learning in Tertiary Education and the creation of a user manual on how to use and navigate the open-source learning management system. The Researcher utilized survey design which is a mode of research design where the crucial method of data collection is through survey. According to Preston (2021), surveys are utilized to have a deeper understanding of a certain topic or individuals or a group depending on their perception and perspective on the topic.

On the other hand, quasi-experimental study is a research design resembling an experimental study but lacking certain crucial features of a true experiment, such as the random assignment of participants to different groups. In addition, quasi-experimental study does not have full control over the assignment of respondents, which occurs naturally or due to practical constraints.

A quasi-experimental study typically compares two or more groups that already exist or were formed based on pre-existing characteristics, interventions, or exposures. The primary goal is to assess the impact of an independent variable (e.g., an intervention or treatment) on a dependent variable (e.g., an outcome) while accounting for potential confounding factors. One common type of quasi-experimental design is the "pretest-posttest non-equivalent groups design." However, the groups were not randomly assigned, which makes it challenging to establish a cause-and-effect relationship definitively. Instead, Researchers use statistical techniques such as matching or statistical controls to minimize potential biases and draw causal inferences.

Quasi-experimental designs are frequently used in fields where true experimental designs are difficult or unethical to implement, such as in educational research, social sciences, and public health. These designs allow Researchers to examine the effects of real-world interventions, policy changes, or other naturally occurring events on study outcomes.

Despite their advantages in certain situations, quasi-experimental designs have inherent limitations. The lack of random assignment can introduce selection biases and reduce internal validity, making it more challenging to confidently attribute observed effects to the independent variable. Researchers must carefully consider potential confounding variables and adopt appropriate statistical methods to strengthen the validity of their findings.

## Results and Discussions

The research aims to develop a Learning Management System using the open-source technology for tertiary education using the survey design. The Researcher described the strategies as development learning management system for sustained online learning to cater the need of the University to have its own controlled LMS. With this system they have control on the information, learning materials and other LMS functionality that can be enjoyed in a commercialized LMS.

The Researcher used descriptive method and quasi experimental with respondents of 100 students, 20 faculties, 3 technical staff each from Taguig City University, Rizal Technological University & University of Makati. Taguig City University used paid account in Brightspace LMS while the other two, both used the paid account under Moodle. The period of study was from August 2023 to October 2023. The survey instrument is created under google form which was provided online for the respondents. To measure the acceptability of the created LMS, the Researchers used technical expertise of a third party using the User Account Testing (UAT). Weighted means were used to measure the acceptance of the LMS with reference to ISO 25010.

## Summary of the Findings

### 1. Requirements that the Open-source Elements of the Learning Management System Must Address Problem in the Use Of LMS In Teaching

The key requirements for the open-source elements of the learning management system meet to address the problem for the use of LMS in teaching includes Ease of Use Customizability and Flexibility, Scalability, Interoperability, Multimedia Support, accessibility, responsive Design, Security, Community Support, Analytics and Reporting, Multilingual Support, diverse global audience, and Regular Updates and Maintenance.

### 2. Alternatives Considered for the Design and Development of the Open-Source Elements in the Learning Management System

A number of alternatives were considered in the development of open-source elements for learning management system which includes Programming Languages and Frameworks Content Management Systems (CMS), Authentication and Authorization, Learning Tools Interoperability (LTI), Video Conferencing Integration, Load Balancing. Technologies and Accessibility Tools.

### 3. Features of the Newly Developed Open-source Elements for the Learning Management System

The common features often found in modern LMS open-source elements include user Management, Course Creation and Management, Multimedia Support, Assessment and Grading, Discussion Forums and Communication, Progress Tracking and Analytics, Gamification, Mobile Compatibility, Integration with Third-Party Tools, Accessibility, Security and Privacy, Content Repositories, Notifications and Alerts, Learning Analytics, Open Standards and API Support, Localization and Multilingual Support, and Support and Documentation.

### 4. Evaluation of IT Teachers and IT Experts using the following ISO 25010 criteria

- 4.1 **Functional Suitability.** It was found out that the IT experts assessed that LMS support different types of learning activities, such as self-paced courses, instructor-led training, and blended learning was acceptable with a mean score of 3.44, and that the IT teachers assessed that the LMS is acceptable since it integrates well with other existing systems or software as indicated from the mean score of 3.45.
- 4.2 **Efficiency.** Data reveal that the IT experts assessed that the implementation of the LMS is acceptable as it positively impacted the overall efficiency of the organization's training and learning processes as described from the mean score of 3.48, and that the teachers assessed that the LMS was acceptable as it provides comprehensive course management tools as indicated from the mean score of 3.48.
- 4.3 **Compatibility.** Findings show that the IT experts assessed that the LMS was acceptable as it protects user data and maintain confidentiality and integrity as seen from the mean of 3.25, and that the IT teachers assessed that the LMS was acceptable as it ensure consistent quality in delivering learning materials and services with a mean score of 3.45.
- 4.4 **Usability.** It was found out that the IT experts assessed that the LMS was acceptable as it integrates well with other existing systems or software, such as HR systems or e-commerce platforms with a mean score of 3.48, but IT teachers assessed that the LMS was acceptable since the LMS support different types of learning activities, such as self-paced courses, instructor-led training, and blended learning with a mean score of 3.17.

- 4.5 Reliability. Data show that the IT experts assessed that adhering in the user-friendly interface and navigation contribute the most in LMS was acceptable based from the mean score of 3.47, and that the IT teachers assessed that the LMS adheres with accessibility standards (e.g., WCAG) to ensure inclusivity for all users was acceptable as described from the mean score of 3.45.
- 4.6 Security. Findings indicate that the IT experts assessed that adhering in the LMS requires users to log in with unique credentials with a mean of 3.47, and that the IT teachers assessed that adhering in The LMS support multi-factor authentication (MFA) for user access was acceptable based from the mean score of 3.37.
- 4.7 Maintainability. It was found out that the IT experts assessed that adhering in clear guidelines and responsibilities assigned for LMS maintenance tasks was acceptable based from the mean score of 3.45, and that the IT teachers assessed that adhering in the process for end-users to report issues and feedback related to the LMS was acceptable based from the mean score of 3.47.
- 4.8 Portability. Findings show that the IT experts assessed that adhering in all features are available when using the LMS in any devices was acceptable based from the mean score of 3.36, and that the IT teachers assessed that adhering is important is LMS portability (accessibility across devices) for the learning needs as described from the mean score of 3.47.

### **5. Improvements Have to Be Made to the Open-source Elements for the LMS**

Some common improvements that might be considered include Refinement of the User Interface (UI) Enhancements, Identify Accessibility Improvements, Performance Optimization, Mobile Responsiveness, Enhance Course Content Management, Improvements to the Assessment and Grading Features, Identification of Collaboration Tools, Learning Analytics and Reporting, Integration with Third-Party Tools, Security Enhancements, Documentation and Help Resources, and Bug Fixes.

### **6. Conclusions Drawn About the Performance of the Open-Source Elements of the LMS After the Implementation of Enhancements**

The conclusions that drawn about the performance of the open-source elements of the LMS after the implementation of enhancements were improved functionality, enhanced user experience, performance and stability, scalability, security, compatibility, customization, community Contributions, feedback and user adoption, and ongoing maintenance and support.

### **7. User Manual Developed on How To Use and Navigate the Open-source the Learning Management System**

A user manual was developed to provide users a document that helps in using the LMS seamlessly. The manual serves as the guide in the overall processes of the users in the LMS.

Drawing upon the study's findings, the following recommendations were provided:

1. Prioritize development and integration based on the key features, especially focusing on ease of use, scalability, and security to significantly improve the LMS's effectiveness in educational settings.
2. Continue evaluating and integrating these alternatives to ensure the LMS is robust, versatile, and meets the varying needs of its users.
3. Focus on optimizing these features for user-friendliness and efficiency, ensuring they cater to the diverse needs of learners and educators.
4. Address areas with lower scores to enhance overall system quality and user satisfaction, paying special attention to aspects like usability and portability.
5. Implement these improvements methodically, focusing on user interface enhancements, accessibility, and integration capabilities to ensure a more efficient and user-friendly LMS.
6. Continuously monitor and evaluate the system to identify further improvement areas, ensuring the LMS remains effective and user-centric.
7. Regularly update the manual to reflect system changes and enhancements and ensure it is easily accessible and understandable to all users.

### **Conclusion**

Derived from the findings of the research, the subsequent conclusions were formulated:

1. Essential requirements for the open-source elements in a Learning Management System (LMS) are effectively identified, covering a comprehensive range of aspects vital for enhancing teaching experiences.
2. A diverse set of alternatives has been considered for the design and development of the LMS, indicating a thorough exploration of possible technologies and tools.

3. The new open-source element in the LMS encompasses a wide array of features, indicating a comprehensive approach to user management, course creation, and other essential functionalities.
4. The evaluations across various ISO 25010 criteria like security, efficiency, compatibility, usability, functional suitability, reliability, portability, and maintainability show that the LMS meets key performance standards.
5. Identified improvements are comprehensive, targeting key areas that could enhance the overall functionality and user experience of the LMS.
6. Post-implementation enhancements in the LMS have led to notable improvements in functionality, user experience, and system performance.
7. The development of a comprehensive user manual for navigating the open-source LMS is a crucial step towards enhancing user accessibility and ease of use.

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