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Online Learning Information System Design Using Zachman Framework (Case Study: LMS Gajayana University Malang)

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Abstract
The development of information technology has encouraged educational institutions to adopt online learning systems to enhance the effectiveness and efficiency of teaching and learning processes. Gajayana University Malang, as one of the private universities in Indonesia, has implemented a Moodle-based Learning Management System (LMS) to support digital learning. However, in order for the system to function optimally and be well integrated into the institution's environment, a structured and comprehensive information system design is required. This study aims to design an online learning information system using the Zachman Framework, which is chosen for its ability to represent complex systems from multiple stakeholder perspectives—planners, owners, designers, and implementers—across different architectural focuses. The research adopts a case study method, with data collected through observation, interviews, and documentation related to the LMS at Gajayana University Malang. The result of this study is a visual and structured system blueprint based on the six perspectives and six focuses of the Zachman Framework. This blueprint is expected to serve as a reference for developing and evaluating more effective, efficient, and stakeholder-aligned online learning systems.

Keyword: Information System, Online Learning, LMS, Zachman Framework, Gajayana University Malang.

1. Introduction

The rapid advancement of information and communication technology has brought significant changes to the education sector, particularly in the delivery of teaching and learning processes. One key transformation is the adoption of online learning systems, commonly known as Learning Management Systems (LMS). This system provides a flexible, easily accessible, and measurable environment for academic activities. In higher education institutions, LMS platforms have become strategic tools that support the delivery of digital learning, particularly in response to the increasing demand for modern, technology-driven education. In general, an e-learning system is a system that utilizes information and communication technology, particularly the internet, to support the teaching and learning process (Bradley, 2021). An LMS itself is a software application designed to manage administration, documentation, reporting, automation, and the delivery of the entire learning process (Alia, 2022). Al-Sharhan et al. (2019) also defines an LMS as software that provides essential features in the learning process, enabling instructors or teachers to effectively manage classes, interact with students, and provide access to learning materials within a specified timeframe using the internet.

Gajayana University Malang, as one of Indonesia's private universities, has implemented a Moodle-based LMS as part of its digital learning strategy. This LMS enables lecturers and students to interact, manage course materials, submit assignments, and conduct assessments through a digital platform. However, as user demands become increasingly complex and technology evolves rapidly, there is a growing need for a more structured, integrated, and adaptive system design (Pakaja et al., 2024); (HM Amir et al, 2024). The existing LMS must not only function effectively but also align with the institution's objectives and meet the diverse expectations of stakeholders—including administrators, faculty, students, and IT personnel (Veluvali & Surisetti, 2022).

To address these challenges, this study proposes the design of an online learning information system using the Zachman Framework. The Zachman Framework is a widely recognized enterprise architecture methodology (Jayanto et al., 2025); (Sardjono et al., 2020). This framework is a tool for documenting the architecture of an organization from various aspects and different perspectives, resulting in a complete and comprehensive picture of the organization (Ningtyas et al., 2025); (Pratama et al., 2025). This enterprise architecture framework has six perspectives (planner, owner, designer, builder, subcontractor, system in operation) and six aspects (what, how, where, who, when, why) that support comprehensive system mapping (Jayanto et al., 2025); . Previous studies have shown that the application of the Zachman Framework can improve the effectiveness of information system design. Silalahi et al. (2024) in his study on the application of the Zachman Framework in LMS systems states that the use of this framework helps in identifying user needs in detail and ensuring that system components are fully integrated. This supports the development of a more structured LMS that is tailored to online learning needs.

The systematic writing of this journal will be explained in several sections. The next section will present a literature review covering the basic concepts of online learning information systems, Learning Management Systems (LMS), and the Zachman Framework. Then, the research methodology section will explain the case study approach, data collection techniques (observation, interviews, and documentation), and data analysis techniques using the Zachman Framework. Furthermore, the research results will present the mapping of the LMS system architecture of Gajayana University Malang using the Zachman Framework and the resulting architectural artifacts. The discussion will analyze the suitability of the Zachman Framework perspective, system requirements, and integration potential, as well as the strategic implications for LMS development. Finally, the conclusion will summarize the main findings of the research, limitations, and practical implications for the development of online learning systems in educational institutions.

2. The Art of Research

a. Literature Review

1. Online Learning Information System

An online learning information system (e-Learning) is a system that utilizes information and communication technology, especially the internet, to support the teaching and learning process (Sutisnawati et al., 2021). This system supports the teaching and learning process through online media. LMS is the main tool in implementing e-learning in higher education. The online learning information system is designed to facilitate access to information, interaction between lecturers and students, as well as overall learning management (Oliveira et al., 2016). The benefits of online learning are:

- Flexibility: Students can study anytime and anywhere, according to their respective times and conditions.
- Accessibility: Learning materials can be easily accessed via various devices connected to the internet.
- Efficiency: This system can save time and transportation costs because learning does not have to be done face to face.
- Personalization: Learning can be tailored to each student's needs and learning style.

Among these various online learning platforms such as Google Classroom, Moodle, or other LMS (Learning Management Systems) are used to manage online learning.

2. Learning Management System (LMS)

Learning Management System (LMS) is a software application designed to manage administration, documentation, reporting, automation and delivery of the entire learning process. Apart from that, Kasim & Khalid (2016) believes that a Learning Management System (LMS) is software that provides important features in the learning process, enabling lecturers or teachers to effectively manage classes, interact with students, and provide access to learning materials within a predetermined time period using the internet. LMS comprehensively integrates these functions to facilitate efficiency and effectiveness in implementing the online learning process (Hu & Raman, 2024). In addition, LMS not only provides a platform for delivering learning materials electronically, but also supports various administrative aspects related to learning management. LMS such as Moodle allows interaction between lecturers and students, material management, assignment collection, quizzes, and discussion forums ((Alia, 2022).

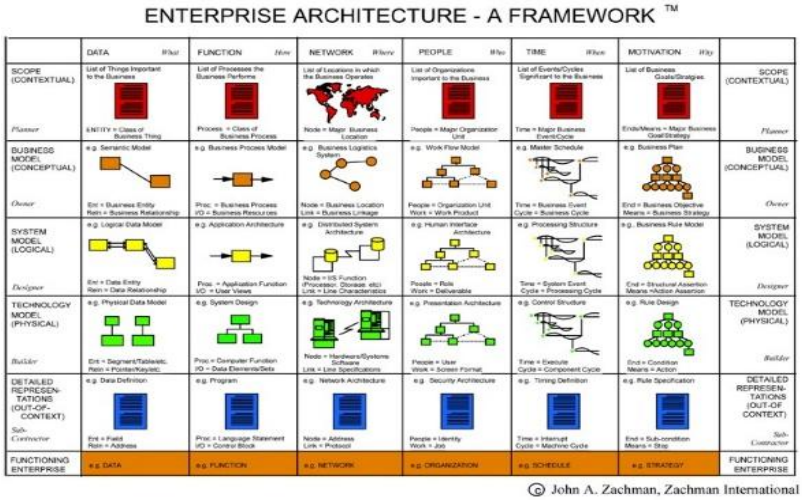

Figure 1. Zachman Framework

3. Zachman Framework

The Zachman framework or Zachman Framework is defined as one of the frameworks used to develop an enterprise architecture which was introduced by Zachman (1999). This framework is a tool for documenting organizational architecture

from various aspects and different points of view, so that a complete and comprehensive picture of the organization will be produced (Iyamu, 2019). This enterprise architecture framework has six perspectives (planner, owner, designer, builder, subcontractor, system in operation) and six aspects (what, how, where, who, when, why) which support comprehensive system mapping (Zachman, 2003). Zachman's framework is presented as the following figure 1.

Previous studies have shown that the application of the Zachman Framework can improve the effectiveness of information system design (Pratama et al., 2025). Silalahi et al. (2024) in his study on the application of the Zachman Framework in LMS systems stated that the use of this framework helps in identifying user needs in detail and ensuring that system components are fully integrated. This supports the development of a more structured LMS that is tailored to online learning needs.

3. Method

1. Type of Research

This research uses case study method with qualitative and descriptive approach to design online learning information system on LMS of Gajayana University Malang using Zachman Framework. The case study was chosen because the focus of this research is on the development and analysis of a specific information system, namely the LMS used at Gajayana University Malang.

2. Data collection techniques

The implementation of this research used several data collection techniques used in this research including:

- Interview: Conduct interviews with lecturers, students, and the LMS management team as LMS users to obtain information regarding system needs and obstacles faced.
- Observation: Carried out to see directly the use and workflow of the existing LMS system.
- Documentation: existing system documents and literature related to the Zachman Framework and LMS.

3. Data Analysis Techniques

Data analysis was carried out using the Zachman Framework approach (Zachman, 2003). This process includes:

- Identify the stakeholders involved and map them into Zachman lines.
- Classify system aspects based on Zachman columns (What, How, Where, Who, When, Why).
- Arrange architectural artifacts in the form of a Zachman matrix as a reference for LMS system design.

Table 1: Zachman Framework: Enterprise Architecture Perspectives and Aspects

Perspective / Aspect	**What (Data)**	**How (Function)**	**Where (Network)**	**Who (Person)**	**When (Time)**	**Why (Motivation)**
Planner (Scope)	List of main entities	Key business processes	Studio location	Stakeholders	General project schedule	Business objectives
Owner (Business Model)	Business Data model	Work process flow	Work distribution	Organizational structure	Work schedule	Rules and policies
Designer (System Model)	ERD Diagram	DFD Level 0/1	System architecture	User access rights	Scheduled process	Decision logic
Builders (Technology)	Database design	Architectur e diagram	Network topology	User role in the system	Cron jobs and notifications	Rule engine system
Implementor (Details)	SQL Script	Program code	Server configurati on	User account and login	System execution time	Validation message/log error
System Functioning (Function)	Active data table	Running function	Active location	Active users	Activity timestamp	Automated system logic

The research instrument is an interview guide and observation sheet which is prepared based on important aspects in the Zachman Framework (Zachman, 1987) to ensure all perspectives and system elements can be properly identified. With this method, it is hoped that the resulting system design can suit user needs and provide a comprehensive solution in developing the Gajayana University Malang LMS.

4. Result

a. Object of Research

The main object in this research is the Moodle-based Learning Management System (LMS) system used by Gajayana University Malang. This LMS is the backbone of online learning activities in the campus environment, involving various stakeholders such as lecturers, students, and IT management team.

b. System Architecture Mapping with Zachman Framework

To get a comprehensive and systematic picture of the LMS of Gajayana University Malang, a system architecture mapping was conducted using the Zachman Framework. This mapping includes six perspectives (Planner, Owner, Designer, Builder, Implementer, and Functioning System) and six aspects (What, How, Where, Who, When, Why) (Zachman, 1999). The results of the mapping are summarized in the following blueprint:

Tabel 2: Peta Arsitektur Sistem LMS Gajayana University Malang dengan Zachman Framework

Perspective / Aspect	What (Data)	How (Function)	Where (Jaringan)	Who (People)	When (time)	Why (Motivation)
Plan (Scope)	User data, materials	Online learning process	Campus server, online	Lecturer, Student	School year, semester	The purpose of digitization institutions
Owner (Business)	Learning content	Teaching flow	UNIGA LMS	Academic stakeholders	Academic calendar	Flexible education strategy
Designer (System)	ERD of LMS database	LMS system DFD	LMS system architecture	Admin, Lecturer	Registration process flow	Learning business rule
Builder (Tech)	MySQL Database	Backend, frontend PHP	Cloud Hosting, Moodle	Programmer, Sysadmin	Maintenance schedule	Academic process automation
Implementor (Details)	SQL scripting, configuration	UI/UX Design, chat features	External API integration	Dev Team	System log	Audit trail, system monitoring
System Function (Work)	Student live data	Access materials, active quizzes	Active online platform	Active online lecturer / studer	Login timestamp	The learning process is optimized

At this stage, the system requirements analysis has not been carried out formally or comprehensively for all stakeholders. However, initial information regarding system requirements is obtained through:

- The researcher's direct experience in using the Gajayana University Malang LMS during lectures.
- Informal interviews with several student LMS users that provide an initial overview of the system's advantages and disadvantages from the user's perspective.

From this interaction, several initial points were obtained as an indication of system needs, namely:

- Students want a more intuitive and responsive LMS interface, especially when accessed via mobile devices.
- It is felt that the notification and reminder features for assignments or exams are not optimal, so there are often delays in submitting assignments.
- Some students complained about long access times or system limitations during high traffic, especially during online exams.
- Information and structure of course material is sometimes inconsistent between courses, indicating the need for standardization.

Although these results cannot yet represent all stakeholders such as lecturers, LMS admins, or institutional management, they can be an initial basis for preparing a system blueprint based on the Zachman Framework approach. In the future, a more comprehensive analysis is still needed to produce a system design that is truly comprehensive and meets institutional needs.
The design of an online learning information system at the Gajayana University Malang LMS produced a number of architectural artifacts as a technical representation of the proposed system. This artifact is prepared based on the Designer's perspective in the Zachman framework, with the aim of documenting business and technical requirements into a system model that can be used as a reference for further development.
Some of the main artifacts produced are as follows:
1. Entity Relationship Diagram (ERD)
ERD is used to describe relationships between entities in the LMS system, such as users, materials, tasks and learning activities. Key entities include:

- User (Students, Lecturers, Admin)
- Course
- Materials (Modules, Videos, Documents)
- Assignment (Assignments, Quizzes, Exams)
- Submission and Grade (Gradebook)

The relationships between these entities describe how data is stored and used in a structured manner in the system.
2. Data Flow Diagram (DFD) Level 0 and Level 1
DFD models the flow of data to and from the system, as well as the main processes in the LMS system.

- DFD Level 0 describes the system in general, including the login process, material access, assignment submission, and assessment.
- DFD Level 1 details processes such as "Managing Materials," "Performing Assessments," and "Submitting Assignments," so developers can understand internal processes in more detail.

3. System Architecture (System Architecture Diagram)
This diagram explains how system components are connected to each other, both logically and physically.

- The LMS system is designed using a web-based client-server architecture.
- The backend uses PHP and a MySQL database, while the frontend uses a responsive web interface.
- The system is hosted on a cloud server, with external API integration (e.g. email notifications or WhatsApp).

4. Design Access Rights (Role-based Access Control)
The system is designed with a clear division of roles to ensure security and orderliness of the process:

- Administrator: manages users, courses, and systems.
- Lecturer: upload materials, give assignments, and assess.
- Students: access materials, submit assignments, and view grades.

5. Registration Process Flow and Learning Activities
The blueprint includes user activity flow diagrams, such as:

- Student and lecturer account registration process.
- Class entry flow, material access, assignment submission, and grade checking.
- Reporting and auditing activities by the system (activity log, login time, etc.).

6. Business Rules and System Logic
Several system rules are compiled as part of the business logic artifact, such as:

- Automatically lockable assignment due dates.
- Automatic quiz scoring mechanism based on answer keys.
- Activation or de-activation of classes based on the academic calendar.

These artifacts are an important part of system design because they document technical specifications that can be translated directly by the software development team. Apart from that, this artifact also facilitates evaluation and validation by institutions regarding the system's suitability to real needs in the field.
7. Field Findings
Some important findings from field observations are:

- The existing system is running but is not yet fully integrated between learning, administration and reporting processes.
- There are still several features that are less intuitive or difficult for lecturers and students to use.
- Not all learning processes have optimal time tracking or data validation.

It is hoped that the resulting blueprint can answer the various problems above with a systematic and holistic approach based on the Zachman framework.
8. Analysis of the Suitability of Perspectives and Aspects of the Zachman Framework
The application of the Zachman Framework in designing an online learning information system on the Gajayana University Malang LMS provides a comprehensive understanding of the structure, processes and system requirements.

Each perspective (from Planner to System Function) and aspect (What, How, Where, Who, When, and Why) is successfully mapped to describe the key elements of the system.

- The Planner's Perspective (Scope) has explained the main scope in the form of user data and materials, as well as institutional objectives in supporting the digitalization of learning.
- The Owner's Perspective (Business Model) highlights the learning workflow as well as the need for flexibility in supporting the academic calendar.
- The Designer's Perspective (System Model) successfully converts business requirements into technical models such as ERD, DFD, and system architecture.
- The Developer Perspective (Technology) translates the design into technical specifications including databases, API integration, and use of cloud hosting.
- The Implementor Perspective (Detail Representation) describes the system implementation through SQL scripts, access configuration, and time control and activity logs.
- The Functioning System perspective shows how the system is actually used by lecturers and students, with features such as active quizzes, online materials, and login tracking.

With this mapping, the resulting blueprint is able to represent the real needs of stakeholders.

9. System Requirements and Integration Potential

From informal observations and interviews, it was discovered that a number of important needs were not fully accommodated by the current LMS:

- The user interface (UI/UX) is still not optimal on mobile devices.
- Automatic notifications, especially assignment and exam reminders, have not been effective.
- System performance decreases when traffic loads are high, such as during online exams.
- Inconsistency in material structure between lecturers causes confusion for students.

The blueprint prepared using the Zachman Framework approach allows identifying these gaps and offering solutions in the form of system integration and academic process automation.

10. Strategic Implications for LMS Development

This architectural design has strategic implications for LMS development at Gajayana University Malang, namely:

- Provide systematic and structured guidance in the development of efficient and integrated systems.
- Become a technical reference for system developers in building modules that suit academic workflows.
- Assist institutions in carrying out monitoring and evaluation through reporting systems and activity logs.
- Increase user satisfaction by simplifying system navigation and equalizing material standards.

11. Blueprint Evaluation and Initial Validation

Even though it has not yet gone through the implementation stage, the blueprint results have been initially validated through:

- Feedback from early users, such as students and lecturers, regarding feature requirements and common issues.
- Mapping technical models relevant to the technology that has been used (Moodle, MySQL, PHP).
- Suitability of system workflow with actual academic activities.

This evaluation provides confidence that the design is conceptually appropriate and can be developed into a real system.

5. Discussion

1. Research Process

This research was conducted through a case study approach to the implementation of the Moodle LMS at Gajayana University in Malang. Data was collected through direct observation of online learning activities, informal interviews with users (students and lecturers), and documentation of the existing system. The design process was carried out iteratively, starting from mapping user needs, developing architectural artifacts based on the Zachman Framework, to creating a system blueprint. This approach enabled researchers to understand real-world challenges and systematically identify opportunities for system improvement.

2. UNIGA's Support Needs in AE Implementation

For the implementation of the Enterprise Architecture (EA) design to be successful, Universitas Gajayana needs to prepare several important aspects. First, improving IT infrastructure capacity, such as servers and bandwidth, to ensure stable LMS performance. Second, intensive training and mentoring for faculty and educational staff on the use of the new system and the importance of standardizing teaching materials. Third, the formulation of institutional policies that support the integration of academic, administrative, and reporting data into a centralized platform based on the designed architecture.

3. Implementation of AE with Consideration of the Environment and Education Stakeholders

The concept of implementing Enterprise Architecture (AE) in the UNIGA LMS system takes into account internal campus environmental factors and the education stakeholders involved. The internal environment includes technological readiness, the digital culture of the academic community, and the availability of resources. Meanwhile, stakeholders such as faculty members, students, IT staff, and university management must be actively involved in every phase of development. This

participatory and needs-based approach will ensure that the developed system is not only structured but also adaptive and aligned with the institution's long-term educational development vision.

6. Conclusion

This study aimed to design an online learning information system for the Learning Management System (LMS) at Gajayana University Malang using the Zachman Framework as a methodological foundation. The research findings confirm that the Zachman Framework can be effectively applied to structure and organize LMS design by capturing various system components from multiple perspectives—planner, owner, designer, and implementer—across six architectural focuses. The resulting system blueprint presents a comprehensive and visual representation of the LMS architecture, encompassing critical elements such as user data structures, learning processes, network locations, actors and their roles, system timelines, and institutional goals. Several architectural artifacts including the Entity Relationship Diagram (ERD), Data Flow Diagram (DFD), system architecture overview, and user access rights schema were successfully developed and can serve as technical references for future LMS development. Furthermore, analysis of user needs indicated areas of improvement in the existing LMS, including interface design, consistency of learning materials, notification systems, and system responsiveness under high user traffic conditions.

Despite achieving its objectives, this study has several limitations. First, the research was limited to a single institutional context—Gajayana University Malang—thus the generalizability of the findings may be constrained when applied to other institutions with different technological infrastructures or user characteristics. Second, the research focused primarily on system design and architectural modeling rather than implementation and testing, which means that the effectiveness of the proposed blueprint in a real-world operational environment has not yet been empirically validated. Third, while the study collected data through observation, interviews, and documentation, it did not incorporate quantitative measurements or system performance metrics, which could provide deeper insights into user experience and system optimization needs.

The findings of this study offer meaningful practical implications for both academic institutions and system developers. The blueprint developed can serve as a strategic guide for implementing LMS systems that are more responsive, efficient, and aligned with institutional goals. Universities considering LMS development or enhancement can use this framework to ensure stakeholder needs are systematically addressed during the design phase. Moreover, staged implementation of the blueprint—beginning with key areas such as interface enhancement, content consistency, and automated notifications—can lead to more manageable and sustainable system development. Continuous user feedback, training, and periodic system evaluations are also recommended to ensure long-term adoption and adaptability of the LMS in response to evolving educational demands.

Acknowledgments

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