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Developing Information System Prototype for Thesis Guidance using Waterfall Model

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Abstract

This paper presents the design and implementation of a web-based thesis supervision management system developed using the Waterfall model as the primary software development framework. The Waterfall model was adopted due to its sequential and systematic structure, which ensured that each development phase. We employed a process-oriented design methodology utilizing Context Diagrams and Data Flow Diagrams (DFDs) to model the interactions among three primary external actors, namely Academic Staff, Lecturers, and Students. An Entity-Relationship Diagram (ERD) was further constructed to establish a logically organized database structure aligned with the identified system requirements. We implemented the proposed system using PHP and MySQL within an XAMPP server environment, incorporating several core functional modules including user authentication, lecturer data management, thesis configuration, student dashboard, manuscript upload guidance, and supervision reporting. The disciplined phase-by-phase structure of the Waterfall model contributed significantly to the clarity, consistency, and completeness of the overall development process. Our proposed system clearly delineates actor roles and integrates all stakeholder interactions within a centralized digital platform, enabling real-time monitoring of thesis progress. The results confirm that our proposed system significantly improves transparency, reduces manual administrative workload, and enhances the efficiency and accuracy of thesis supervision management. This study affirms that the proposed method constitutes a viable and scalable solution for academic institutions seeking to modernize and streamline their thesis supervision processes.

Keywords:
Thesis guidance, Waterfall, DFD, ERD, Academic Information System

1. Introduction

The rapid advancement of information technology continuously transforms academic administration in higher education institutions. Universities increasingly adopt digital systems to improve service quality, operational efficiency, and academic monitoring. Despite these developments, many thesis guidance activities still rely on conventional procedures involving face-to-face meetings, printed documents, and manual progress tracking. These practices often create inefficiencies, particularly when students and supervisors have conflicting schedules or limited availability. As thesis completion represents a critical requirement for graduation, ineffective supervision processes can delay academic progress and reduce overall educational quality. Therefore, universities require integrated digital solutions that support communication, documentation, and monitoring throughout the thesis lifecycle. Previous studies emphasize that structured information systems can improve transparency, accountability, and coordination among students, supervisors, and academic administrators. [1], [3], [6], [7]

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The thesis guidance process presents numerous challenges that directly affect students' ability to complete their final projects on time. Traditional supervision methods require students to repeatedly print thesis drafts for review and revision, generating additional costs, excessive paper consumption, and administrative burdens. Furthermore, revision histories often become difficult to track because feedback is exchanged through separate documents, emails, or informal communication channels. Supervisors may also experience difficulties monitoring student progress consistently, especially when managing multiple supervisees simultaneously. Research demonstrates that web-based thesis guidance applications can significantly reduce these limitations by enabling digital document submission, online consultation, and centralized storage of revision records. Such systems create a more efficient and environmentally sustainable supervision process while improving accessibility for both students and lecturers. [2], [5], [18], [20]

Another significant issue involves the lack of effective monitoring mechanisms during thesis development. Many institutions struggle to evaluate student progress systematically because supervision records remain fragmented and difficult to access. Consequently, academic departments often face challenges in identifying delayed students, measuring supervisory performance, and ensuring compliance with institutional regulations. Previous studies on thesis monitoring systems reveal that digital platforms provide substantial benefits by offering progress tracking features, supervision logs, notification mechanisms, and performance monitoring dashboards. These capabilities help academic stakeholders identify problems early and implement corrective actions before delays become critical. Therefore, monitoring functionality becomes an essential component in modern thesis guidance systems. [4], [5], [24]

In addition to monitoring challenges, communication barriers frequently hinder the effectiveness of thesis supervision. Scheduling conflicts between students and supervisors often result in postponed consultations and slower revision cycles. These difficulties become more evident when supervisors handle large numbers of students or when students engage in internships and employment while completing their theses. Several researchers propose online supervision systems that facilitate asynchronous communication through messaging modules, digital feedback, and online consultation features. These systems allow students and lecturers to communicate regardless of time and location constraints, thereby improving responsiveness and accelerating thesis completion. Enhanced communication capabilities also contribute to stronger academic engagement and more effective supervision outcomes. [6], [10], [17]

The growing complexity of thesis administration further highlights the need for integrated management systems. Modern thesis processes involve multiple stages, including topic submission, supervisor assignment, proposal approval, consultation activities, seminar registration, examination scheduling, and final thesis submission. Managing these activities manually often leads to inconsistencies, data duplication, and administrative delays. Several studies report successful implementation of web-based thesis management platforms that integrate these processes within a single environment. By centralizing academic workflows, institutions can improve data consistency, streamline administrative operations, and provide real-time information to all stakeholders. Such integration also supports institutional governance and enhances decision-making through accurate academic data management. [3], [7], [23], [25]

The adoption of information systems in thesis supervision also depends on user acceptance and usability. Even when institutions implement digital platforms, students and lecturers may hesitate to use them if the systems are difficult to navigate or fail to address their practical needs. Research on thesis guidance information systems indicates that usability, perceived usefulness, and ease of use significantly influence system adoption. Studies utilizing usability evaluation methods and technology acceptance frameworks demonstrate that well-designed interfaces and user-centered functionalities contribute to

higher satisfaction and successful implementation. Consequently, prototype development should prioritize user requirements to ensure that the resulting system supports actual supervision practices effectively. [9], [8], [13]

To address these challenges systematically, many researchers adopt the Software Development Life Cycle (SDLC) using the Waterfall model. The Waterfall approach remains widely utilized in academic information system development because it provides a structured and sequential framework consisting of requirements analysis, system design, implementation, testing, deployment, and maintenance. This methodology facilitates comprehensive documentation, clear project planning, and controlled development activities. Several studies on thesis guidance systems, thesis management systems, and academic consultation platforms successfully apply the Waterfall model to produce reliable and maintainable software solutions. The model is particularly suitable when system requirements are clearly defined and stable throughout development. [1], [2], [6], [7], [19]

Based on the identified problems and research gaps, this study develops a prototype of a Thesis Guidance System using the Waterfall model to support digital supervision activities in higher education institutions. The proposed prototype aims to facilitate communication between students and supervisors, manage thesis documents electronically, record revision histories, monitor supervision progress, and provide centralized academic information. By implementing a structured development methodology, this study seeks to produce a prototype that addresses the limitations of conventional supervision practices while improving efficiency, transparency, and accessibility. The resulting system is expected to contribute to more effective thesis management and support timely completion of student research projects. [1], [2], [6], [7], [24]

2. Related Works

Christanto and Singgalen developed the Student Guidance Information System (SIBIMA) using the Software Development Life Cycle (SDLC) and Waterfall model. Their study focused on supporting thesis registration, supervisor assignment, and consultation activities through an integrated academic platform. The system improved administrative control and supported digital transformation within higher education institutions. However, the study primarily emphasized system analysis and design rather than prototype implementation and usability evaluation. Therefore, further development was needed to demonstrate practical functionality and user interaction within the guidance process [1].

Hermawan et al. designed a web-based online thesis guidance application for the Computer Science Study Program at Bina Bangsa University. Their system addressed common problems associated with paper-based supervision, including printing costs, document management difficulties, and communication delays. The researchers implemented the application using PHP, CodeIgniter, MySQL, and the Waterfall development approach. The study successfully demonstrated the benefits of digital supervision. However, it focused mainly on document exchange and online consultation, while progress monitoring and comprehensive supervision analytics received limited attention [2].

Utariani and Herkules developed a web-based thesis monitoring application for STMIK Palangka Raya using the Waterfall model and CodeIgniter framework. Their system enabled lecturers and students to conduct supervision activities online and provided monitoring capabilities for academic staff. The researchers validated the application through Black Box Testing and reported successful implementation. Although the system improved accessibility and supervision management, the study did not discuss integration with broader thesis administration activities such as scheduling, progress reporting, and performance evaluation [3].

Putra et al. proposed a Thesis Monitoring Information System using the B-Model, an extension of the Waterfall methodology. Their research highlighted the importance of monitoring student progress and maintaining communication between students and supervisors. The system proved effective in supporting thesis completion, particularly for students with employment responsibilities. In addition, the researchers applied the Wilcoxon Signed-Rank Test to evaluate system effectiveness. Despite these strengths, the study concentrated primarily on monitoring functions and offered limited support for document management, revision tracking, and comprehensive supervision workflows [4].

Karubaba and Yuliawan developed a web-based online thesis information system for the Department of Informatics Engineering at the University of Papua. Their application provided functionalities such as proposal submission, thesis title management, messaging services, and supervision control cards. The researchers utilized PHP, CodeIgniter, MySQL, and the Waterfall model to develop the platform. The study successfully facilitated communication and administrative management within the department. Nevertheless, the system focused on operational activities and lacked advanced monitoring mechanisms to evaluate supervision effectiveness and student progress systematically [5].

Muslihah et al. designed and implemented a web-based thesis guidance system for students at ISI Surakarta using the Waterfall methodology. Their study addressed scheduling conflicts and communication barriers that frequently occurred in conventional face-to-face supervision. The developed system stored revision histories digitally, provided academic announcements, and supported monitoring of thesis milestones. The findings demonstrated improved administrative efficiency and better interaction between students and supervisors. However, the research concentrated on system implementation and did not explore prototype-based iterative validation involving diverse stakeholder feedback [6].

Doni et al. developed an online thesis management system to overcome limitations associated with manual supervision processes. Their system enhanced transparency, communication efficiency, and progress monitoring through an integrated academic platform. The researchers applied the Waterfall model and evaluated the system using usability testing involving multiple respondents. The results indicated high user satisfaction and improved management efficiency. Although the study presented a comprehensive management solution, it focused on a fully implemented system rather than a prototype development approach that could support early-stage requirement validation and refinement [7].

Several studies also investigated user acceptance and management aspects of thesis guidance systems. Priyanto and Ramadhan analyzed the use of a thesis guidance information system through the Technology Acceptance Model and reported that perceived usefulness and ease of use significantly influenced system adoption among students. Meanwhile, Septiawan et al. developed a thesis supervision monitoring system that enabled students to track examination status and supervision progress. These studies confirmed the importance of usability, transparency, and monitoring features in academic supervision platforms. However, they focused either on acceptance evaluation or monitoring functionality individually. They did not integrate these aspects into a prototype-oriented thesis guidance system developed through a structured Waterfall process. Therefore, the present study addressed this gap by developing a prototype that combined supervision management, communication support, document handling, and progress monitoring within a unified framework [8], [9].

3. Proposed Method

In this study, we develop a web-based Thesis Guidance System prototype using the SDLC with the Waterfall model. The system supports thesis supervision activities such as consultation management, document submission, revision tracking, progress monitoring, and communication between students and supervisors. The Waterfall model is selected because it provides a structured sequential development process consisting of requirements analysis, design, implementation, testing, deployment, and maintenance.

A. Waterfall Development Process

The Waterfall development structure is defined as a finite set of sequential phases:

$$W = \{R, D, C, T, M\}$$

where each element represents Requirements Analysis, System Design, Coding and Implementation, Testing, and Maintenance respectively. Each phase produces outputs that become inputs for the next phase, ensuring traceability and structured progression.

B. Requirement Coverage

Requirement Coverage is used to measure how many identified requirements are successfully implemented:

$$RC = \frac{N_i}{N_r} \times 100\% \quad (1)$$

where N_i is the number of implemented requirements and N_r is the total number of identified requirements. Higher values indicate better completeness of system implementation.

C. Thesis Progress Measurement

Student thesis progress is quantified as the proportion of completed supervision stages:

$$P_t = \frac{S_c}{S_t} \times 100\% \quad (2)$$

where S_c is the number of completed stages and S_t is the total required supervision stages. This metric provides an objective measure of academic progress.

D. Revision Fulfillment Rate

The responsiveness to supervisor feedback is evaluated using:

$$RFR = \frac{N_c}{N_f} \times 100\% \quad (3)$$

where N_c represents completed revisions and N_f represents total revision requests. This reflects how effectively students address supervisor comments.

E. Functional Testing Accuracy

System correctness under Black Box Testing is measured using:

$$FTA = \frac{T_p}{T_t} \times 100\% \quad (4)$$

where T_p is the number of passed test cases and T_t is the total executed test cases. Higher values indicate better conformance to functional requirements.

F. System Usability Scale (SUS)
User usability evaluation is computed using:

$$SUS = 2.5 \sum_{i=1}^{10} X_i \quad (5)$$

Where X_i represents the adjusted score for each questionnaire item. The final score ranges from 0 to 100, where values above 68 indicate acceptable usability.

G. User Satisfaction Index
Overall user satisfaction is measured using the Mean Opinion Score:

$$MOS = \frac{\sum_{i=1}^{n} r_i}{n} \quad (6)$$

where r_i is the rating from respondent i, and n is the total number of respondents. The score ranges from 1 to 5, with higher values indicating greater satisfaction.

H. Prototype Performance Model
The overall system performance is evaluated using a weighted aggregation model:

$$SP = w_1 RC + w_2 FTA + w_3 SUS \quad (7)$$

subject to:

$$w_1 + w_2 + w_3 = 1$$

where SP represents system performance score, and w_1, w_2, w_3 are weighting coefficients for requirement coverage, functional accuracy, and usability respectively. This methodology integrates structured Waterfall development with quantitative evaluation metrics to assess system completeness, correctness, usability, and overall effectiveness of the proposed Thesis Guidance System.

4. Result and Analysis

In this study, the design phase comprises both process design and data design. The process design adopts a process-oriented methodology using Context Diagram and Data Flow Diagrams (DFDs). This begins with the identification of key external entities, namely program staff, supervising lecturers, and students, followed by the development of a context diagram. At the highest level, the context diagram represents the system as a single process that interacts with external entities through well-defined data flows. Fig. 1 depicts the Context Diagram of the prototype.

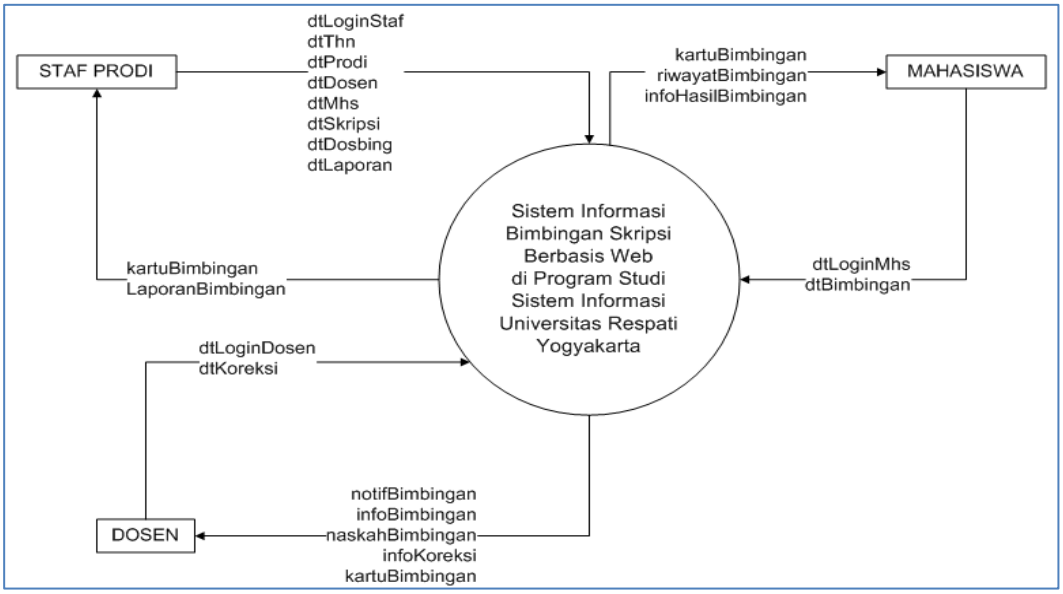

Fig. 1 Context diagram

We also present the DFD as a decomposition of the context-level model to provide a more detailed representation of the system's internal processes. The DFD represents the system as a centralized platform that manages all thesis supervision activities and interactions among three main external actors**:** Academic Staff (STAFF PRODI)**,** Lecturers (DOSEN)**,** and Students (MAHASISWA). The system serves as the core interface that integrates all data flows and ensures that supervision activities are recorded, monitored, and managed efficiently in a unified environment.

This paper presents a Level 1 DFD to break down the main system process into a set of interrelated sub-processes, thereby enabling a clearer understanding of how data is transformed, stored, and distributed within the system. At this level, each process is explicitly defined to represent the specific activities performed by the system in response to interactions from external entities. The diagram illustrates the flow of data between processes, data stores (tables), and external actors, allowing for systematic tracing of information movement throughout the system. By mapping these interactions, the Level 1 DFD supports functional analysis, identifies dependencies among components. It ensures that all required data inputs and outputs are properly accounted for within the system architecture. Fig. 2 depicts Level 1 DFD of the prototype.

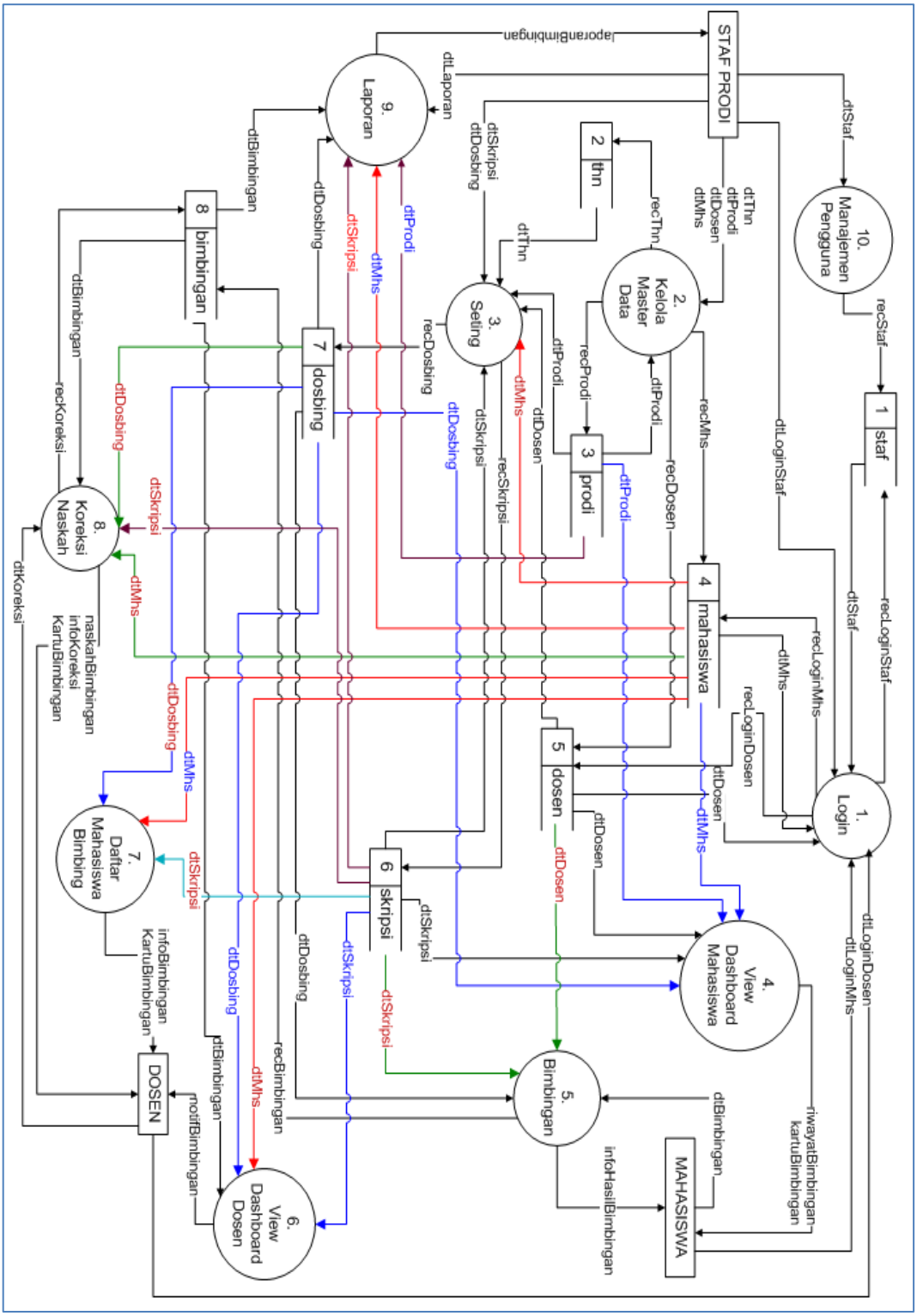

Fig. 2 Level 1 DFD

After the process design phase is completed, the next stage is data design. This phase is implemented using an ERD as the primary modeling tool to represent the system's data structure. The activities in this stage include constructing the ERD based on the identified entities and the requirements derived from the thesis. The ERD is developed to illustrate the relationships among entities, ensuring that the database structure is logically organized and aligned with the system requirements. Fig. 3 depicts ERD of the developing prototype.

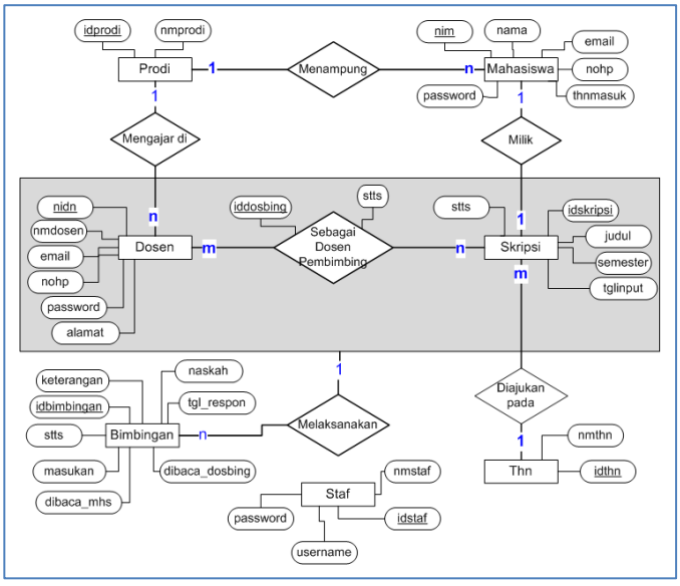

Fig. 3 ERD

We implement the system using PHP as the primary programming language with a MySQL database running on an XAMPP server environment. This configuration enables us to develop, test, and deploy the web-based application efficiently within a controlled local server setup. This paper develops several core features, including a login page for user authentication, lecturer data management, thesis configuration settings, a student dashboard, a guidance module for manuscript upload, and a guidance reporting module. These features are designed to support and streamline the thesis supervision process in an integrated manner. In the supervisor interface, we provide a dedicated button to display the guidance card. This feature allows supervisors to access and review detailed student guidance records. The visualization of the Thesis guidance system is presented in Fig. 4.

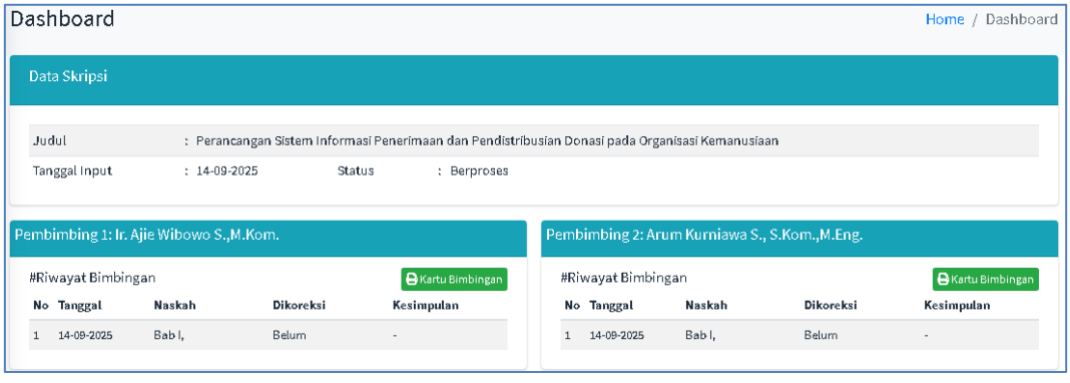

Fig. 4 Dashboard of thesis guidance system

The Academic Staff acts as the system administrator responsible for managing core academic data, including program data, lecturers, students, thesis records, assigned supervisors, and supervision reports. This actor performs administrative operations such as login authentication, data management, and report generation. Meanwhile, Students interact with the system to submit supervision requests, view supervision history, access feedback results, and generate supervision cards. Lecturers, on the other hand, are responsible for supervising students by providing feedback, submitting corrections, sending supervision notifications, and accessing student supervision information. To summarize the interaction structure, the roles and system functions can be organized as follows:

Table 1. Summary of Actor–System Interactions

Actor	Main System Functions
Academic Staff	Login, manage program data, lecturers, students, thesis records, supervision reports
Student	Login, submit supervision requests, view supervision history, access results, print supervision card
Lecturer	Login, provide feedback, send supervision notifications, review supervision data

Overall, the diagram shows a centralized and integrated information system architecture**,** where all actors interact through a single platform. Each interaction between users and the system is recorded systematically, enabling real-time monitoring of thesis progress. This design improves transparency, reduces manual administrative workload, and enhances the efficiency and accuracy of thesis supervision management

6. Conclusion

This study successfully designed and implemented a web-based thesis supervision management system through a structured software development methodology adopting the Waterfall model as the primary development framework. The Waterfall model was selected due to its sequential and systematic nature, which ensured that each development phase including requirements analysis, system design, implementation, testing, and maintenance. We employed Context Diagrams and Data Flow Diagrams (DFDs) in the process design phase to systematically model the interactions among three primary external actors including Academic Staff, Lecturers, and Students. Our Level 1 DFD effectively decomposed the system into interrelated sub-processes, enabling a clear and traceable representation of data transformation, storage, and distribution. Complementarily, our Entity-Relationship Diagram (ERD) established a logically organized database structure aligned with the identified system requirements, forming a solid foundation for the subsequent implementation phase.

We implemented the proposed system using PHP and MySQL within an XAMPP server environment, encompassing several core functional modules, including user authentication, lecturer data management, thesis configuration, student dashboard, manuscript upload guidance, and supervision reporting. The structured progression of the Waterfall model ensured that these features were systematically developed, tested, and validated at each phase, resulting in a reliable and well-documented system. These features collectively support a centralized platform through which all thesis supervision activities are recorded, monitored, and managed in an integrated manner. Our proposed system clearly delineates actor roles , wherein Academic Staff perform administrative operations, Students submit and track supervision requests, and Lecturers provide feedback and notifications. It is to ensure a well-structured workflow that minimizes redundancy and supports real-time monitoring of thesis progress.

In conclusion, our proposed thesis supervision management system demonstrates the effectiveness of combining the Waterfall development model with a process-oriented and data-driven design approach in developing academic information systems. The disciplined phase-by-phase structure of the Waterfall model contributed significantly to the clarity, consistency, and completeness of the system development process, from initial requirements through final deployment. By integrating all stakeholder interactions within a unified digital platform, this study confirms that our proposed system significantly improves transparency, reduces manual administrative workload, and enhances the overall efficiency and accuracy of thesis supervision management. These outcomes affirm that our proposed method is a viable and scalable solution for academic institutions seeking to modernize and streamline their thesis supervision processes. Future work may consider expanding the system's capabilities to include automated progress tracking, notification systems, and cross-institutional deployment to further broaden its applicability and impact.

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