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Addressing Alumni Data Challenges in Vocational Education Through Web-Based Information System Development

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Abstract: The lack of centralized and accurate alumni data management systems remains a challenge for many vocational schools. This study aims to develop a web-based alumni information system for SMK Negeri 1 Koto XI Tarusan to streamline alumni data processing and improve post-graduation engagement. Using the Waterfall development model, the system was designed through sequential stages including requirement analysis, system design, implementation, testing, and maintenance. The result is a role-based information system that includes separate dashboards for administrators, alumni, and alumni coordinators. The system allows secure login, data editing, event announcements, and alumni networking. The implementation demonstrates that a structured development model can effectively address institutional data management needs and enhance user interaction. However, future improvements are needed to support mobile access, analytics integration, and broader deployment across institutions. This system serves as a foundational step toward digital transformation in alumni management for vocational education institutions.

Keywords: Alumni Information System; Web-Based Application; Vocational Education; Role-Based Access Control; Educational Technology.

1. Introduction

The advancement of information and communication technology (ICT) has brought significant impacts across various sectors, including education. The utilization of web-based information systems has become a strategic approach to improving data management efficiency and educational services, from primary schools to higher education institutions [1]–[4]. One of the emerging strategic needs within this context is the development of an alumni information system, which serves to support graduate tracking, strengthen alumni networks, and facilitate the relationship between educational institutions and the workforce.

Alumni are a crucial asset for educational institutions, particularly in assessing the success of vocational education and expanding institutional networks. Alumni data can be used as an indicator of learning effectiveness, a key component in school accreditation, and a bridge between graduates and industry demands [5]–[7]. However, manual or semi-digital alumni data management remains prevalent in vocational high schools (SMKs), especially in non-metropolitan areas. The lack of structure and limited system functionality often result in outdated, inaccessible, and inaccurate data particularly for alumni who have relocated or changed jobs.

SMK Negeri 1 Koto XI Tarusan is one such vocational school facing these challenges. The alumni data collection process at this school is not yet digitally integrated, making it difficult for the institution to conduct effective and strategic graduate tracking. The current system does not support self-service data entry by alumni, real-time information updates, or the generation of statistical reports for institutional purposes.

Several previous studies have explored the development of web-based information systems to support academic and administrative management in educational institutions. However, most of these studies have focused on active student systems, e-learning platforms, or teacher management tools, and have not specifically addressed the development of alumni information systems within vocational school contexts [8]–[12]. Additionally, the system development approaches employed in prior research often lack the implementation of structured and well-documented software engineering models—such as the Waterfall Model—which are critical for ensuring that systems are developed in a systematic, testable, and maintainable manner.

Although alumni information systems are essential for effective graduate management and institutional decision-making, the development of web-based alumni data systems at the vocational school level remains limited and suboptimal, both technically and functionally [13].

There is a notable lack of studies focusing on the development of web-based alumni information systems in vocational education, particularly within the Indonesian context. Moreover, there is limited application of systematically documented development methods that are tailored to local institutional needs.

This study aims to design and develop a web-based alumni information system for SMK Negeri 1 Koto XI Tarusan using the Waterfall development model. The system is expected to simplify data collection, enhance data accessibility, and strengthen communication between the school and its alumni in an effective and sustainable manner.

2. Material and methods

2.1 Research Method

This study employed the Waterfall development model to design and implement a web-based alumni information system. The Waterfall model is a structured software engineering methodology characterized by its linear and sequential nature, where each development phase must be completed before the next begins [14]. This model is particularly appropriate for projects with clearly defined requirements and a stable development scope, as it allows systematic progress through well-documented stages.

The development process began with the requirement analysis phase, in which system needs were identified by collecting information from stakeholders, including school administrators and alumni. This phase aimed to understand the limitations of the existing system and define the functional and non-functional requirements of the proposed solution. Following this, the system design phase translated the identified requirements into technical specifications. It involved creating architectural layouts, designing user interfaces, and defining data structures and system components that would support the functionality of the application.

Once the design was finalized, the implementation phase commenced. In this stage, the system was developed by coding each module based on the design specifications. These modules were initially built and tested independently to ensure functionality before being integrated into a complete system. The integrated system then entered the testing phase, where it underwent rigorous evaluation to verify that it met all the predefined requirements. This included both functional testing (to ensure features work as intended) and non-functional testing (such as performance and usability assessments).

Finally, the system was moved to the deployment and maintenance phase. After successful deployment in the operational environment, the system was continuously monitored and maintained. Maintenance activities involved fixing bugs that emerged during use and implementing enhancements based on feedback from users, ensuring that the system remained reliable, secure, and aligned with user expectations over time.

2.2 Requirement Analysis

Requirement analysis aims to identify the needs of users and the limitations of the current system. The analysis consists of two parts: the current system and the proposed system.

2.2.1 Analysis of the Current System

The current alumni data collection at SMK Negeri 1 Koto XI Tarusan relies on manual entry and unstructured digital documents. This makes it difficult to update and access alumni records efficiently.

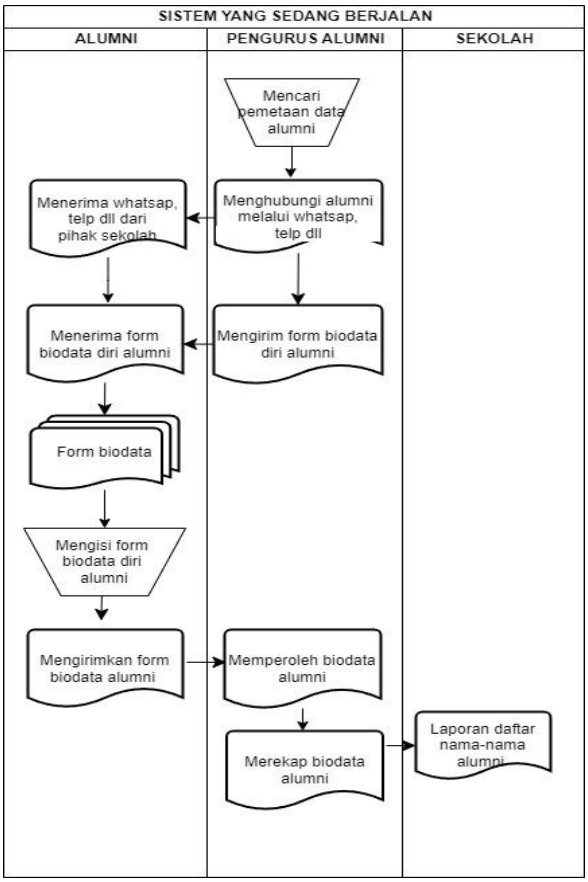

Figure 1. Flowmap of the Current System

The current system starts with the school contacting alumni manually to collect data, which is then entered into spreadsheets by staff members. The flow is time-consuming and prone to human error, especially when alumni move to different locations or change contact information.

2.2.2 Analysis of the Proposed System

The proposed system is a centralized, web-based platform where alumni can register, update, and manage their profiles independently. Administrators can access and analyze alumni data through a dashboard.

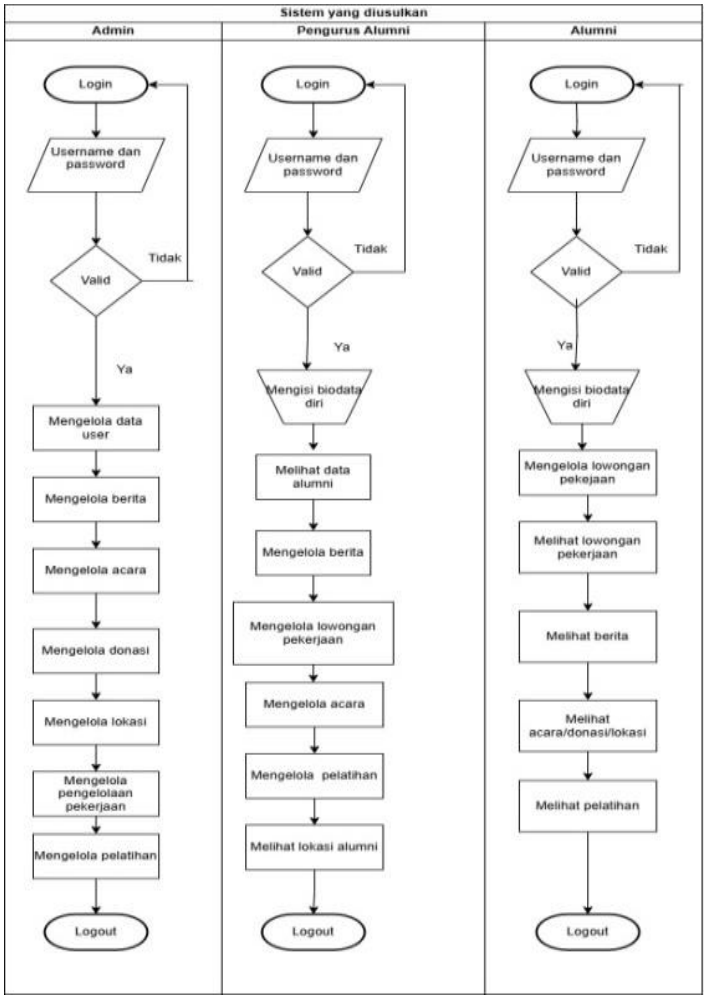

Figure 2. Flowmap of the Proposed System

The system enables alumni to input and update their information through a web interface. The administrator can then validate and manage this data, ensuring consistency, accuracy, and availability of alumni records for institutional purposes.

2.3 System Design

To design the alumni information system, this study employed Unified Modeling Language (UML), a standardized modeling language used in object-oriented software development. UML enables developers to visualize, specify, construct, and document software systems [15].

2.3.1 Context Diagram

The context diagram provides a high-level view of the system and its interaction with external entities such as alumni, administrators, and alumni coordinators.

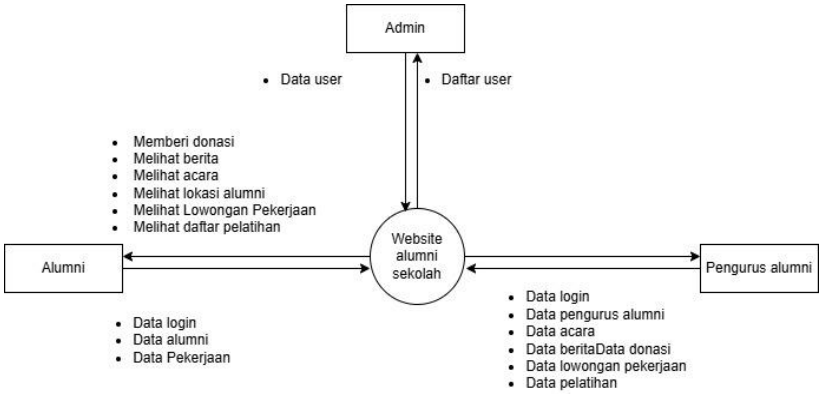

Figure 3. Context Diagram of the Alumni Information System

The diagram illustrates how each actor (alumni, administrator, alumni coordinator) interacts with the system. Alumni access the system to update personal data, while administrators and alumni coordinators validate and manage the database.

2.3.2 Class Diagram

The class diagram defines the system's structure, outlining the classes, attributes, and relationships among objects in the system.

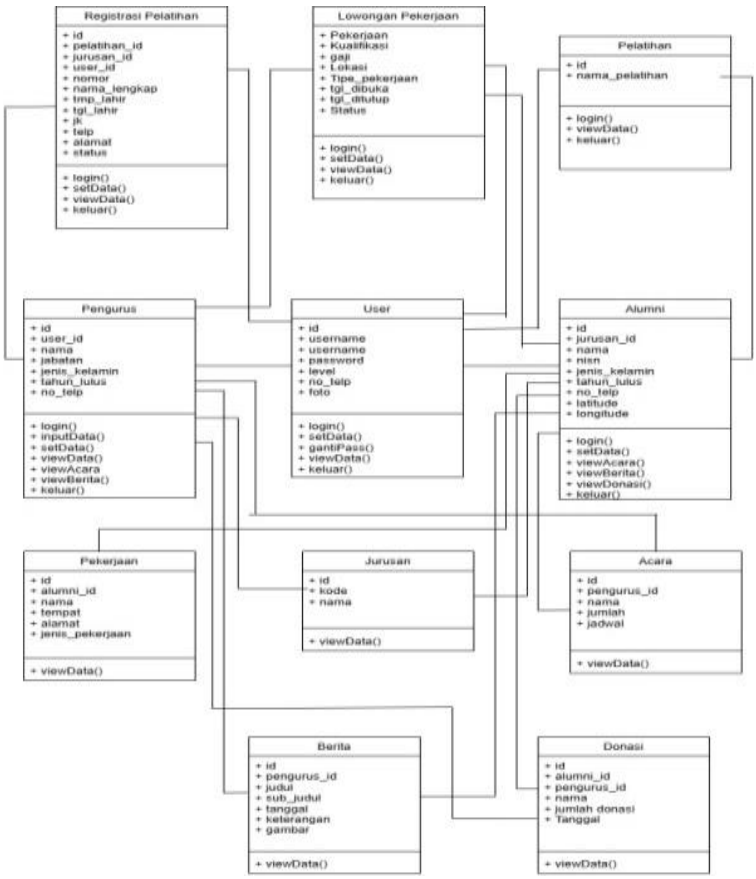

Figure 4. Class Diagram of the Alumni Information System

This diagram shows main classes such as User, Alumni, Admin, and DataRecord, each with their attributes (e.g., ID, Name, Email) and methods (e.g., createAccount(), updateProfile()) that support CRUD operations.

2.3.3 Use Case Diagram

The use case diagram describes the functionalities provided by the system and how users (actors) interact with them.

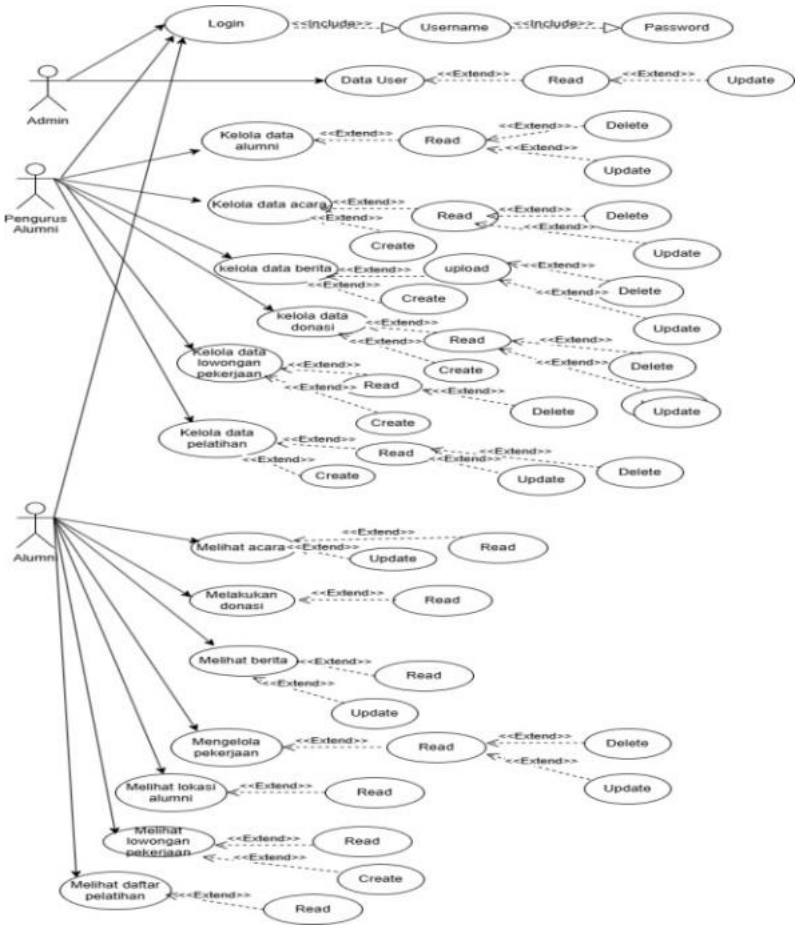

Figure 5. Use Case Diagram of the Alumni Information System

It highlights use cases such as Login, Update Profile, View Data, and Validate Alumni. Alumni can register and manage their profiles, while administrators can verify and monitor alumni activities.

2.4 Activity Diagrams

Activity diagrams were used in this study to model the workflows and operational sequences associated with each user role in the web-based alumni information system. These diagrams help in visualizing the dynamic aspects of the system by representing the sequence of activities, decisions, and interactions users engage in during system usage. By modeling the activities for different

actors—such as administrators, alumni, and alumni coordinators—these diagrams serve to clarify role-based functionality and improve system usability.

The first diagram, Figure 6, illustrates the login process. The login activity begins when the user inputs their credentials (username and password). The system then performs verification to determine whether the credentials are valid. If the verification is successful, access is granted to the system dashboard; otherwise, the system prompts the user to re-enter their credentials. This diagram establishes the entry point for all users and ensures secure and role-specific access control.

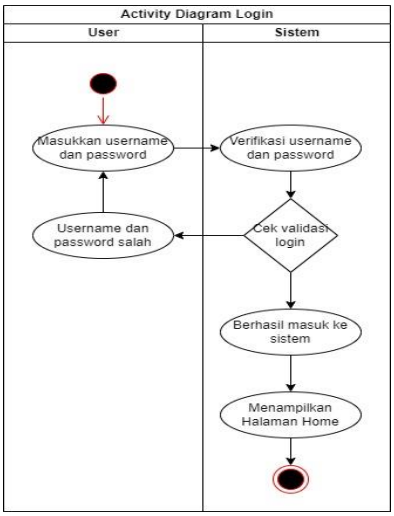

Figure 6. Activity Diagram for User Login Process

This figure illustrates the steps a user follows to log into the system, including credential verification and system responses.

Subsequently, Figure 7 presents the activity diagram for administrator operations. Administrators play a key role in managing the entire system. Their tasks include validating alumni submissions, updating data records, managing user access levels, and generating summary reports. The diagram details how these actions are initiated, the conditions under which validation or rejection occurs, and how administrative feedback loops are managed within the system.

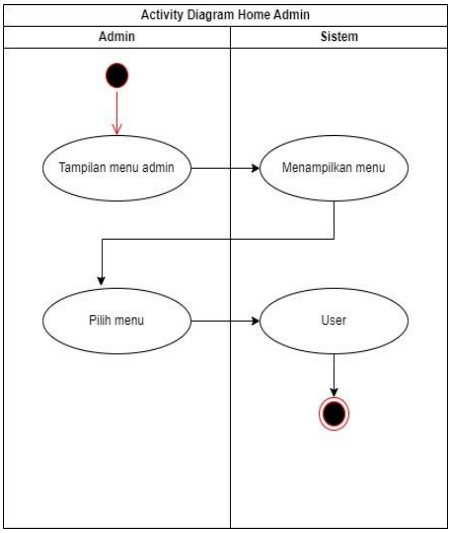

Figure 7. Activity Diagram for Administrator Operations

This diagram shows the sequence of tasks performed by the administrator, including alumni data validation, record management, and dashboard access.

The next diagram, Figure 8, focuses on the alumni role. Alumni users can register themselves, log into the system, edit their profiles, and view institutional updates. The interface is intentionally designed to be simple and accessible, accommodating both desktop and mobile users. The activity flow ensures that alumni can maintain up-to-date records and stay informed about school events and networking opportunities.

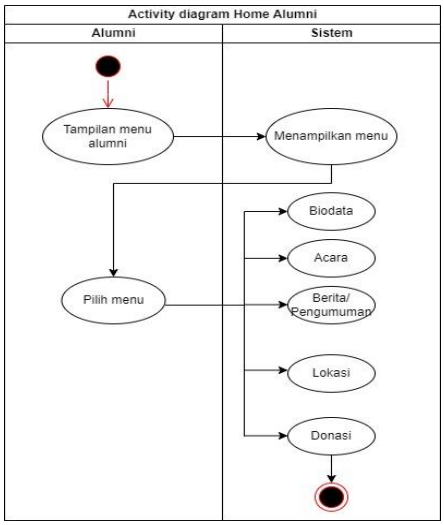

Figure 8. Activity Diagram for Alumni Interaction with the System

This figure outlines the typical activities performed by alumni, such as registration, profile editing, and accessing alumni information.

Lastly, Figure 9 shows the activity flow for alumni coordinators, who act as liaisons between alumni and the school. Their responsibilities include reviewing submitted alumni data, organizing outreach initiatives, facilitating alumni reunions, and ensuring accurate reporting. This role is essential to maintaining ongoing engagement between the institution and its graduates, contributing to long-term institutional development and visibility.

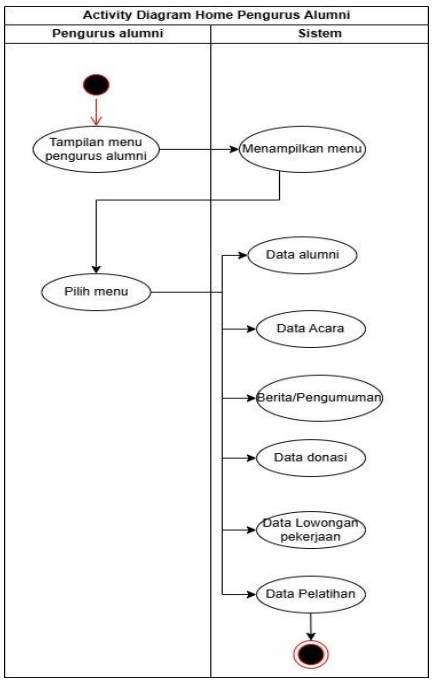

Figure 9. Activity Diagram for Alumni Coordinator Responsibilities

This diagram represents the workflow of alumni coordinators as they manage alumni data, coordinate outreach, and facilitate alumni engagement.

Together, these activity diagrams provide a comprehensive understanding of user interactions with the system, allowing for better refinement of features and ensuring that the system meets both administrative and alumni engagement objectives. They also offer a blueprint for further system enhancement, particularly in adapting future modules or integrating with external services.

3. Results and discussion

3.1 Results

The development of the alumni information system at SMK Negeri 1 Koto XI Tarusan aimed to provide a web-based platform that facilitates alumni data management and communication. The system was developed using the Waterfall methodology and includes several interfaces tailored to user roles such as administrators, alumni, and alumni coordinators. Each interface was designed to support specific functions and ensure ease of access, usability, and

system scalability. The following section presents the results of the interface design, accompanied by analysis and discussion regarding their function, relevance, and contribution to the institution's needs.

The first interface is the login page, which serves as the entry point for all users. As shown in Figure 10, this page requires users to input their username and password for authentication. Once verified, users are redirected to their respective dashboards based on their assigned roles—administrator, alumni, or alumni coordinator. The login mechanism ensures secure access control and role-based navigation, which is essential for maintaining data confidentiality and system integrity.

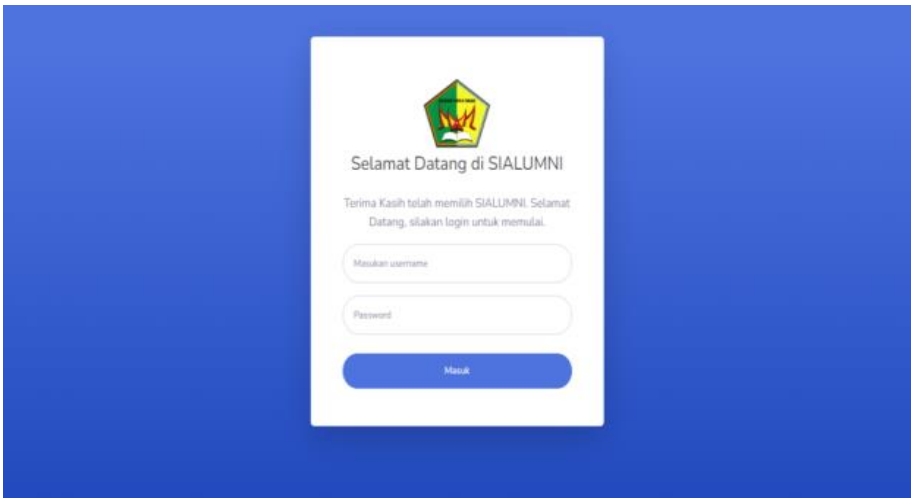

Figure 10. User Login Interface

This page authenticates users before allowing access to system functionalities. Each user is directed to a role-specific dashboard upon successful login.

Once logged in, administrators are directed to the admin dashboard, as shown in Figure 11. This interface provides comprehensive functionality for managing user data, including adding, updating, viewing, and deleting alumni records. The admin dashboard also grants access to event management, alumni verification, and reporting tools. This page is critical for centralized control and aligns with the system's goal of facilitating efficient and scalable alumni data management.

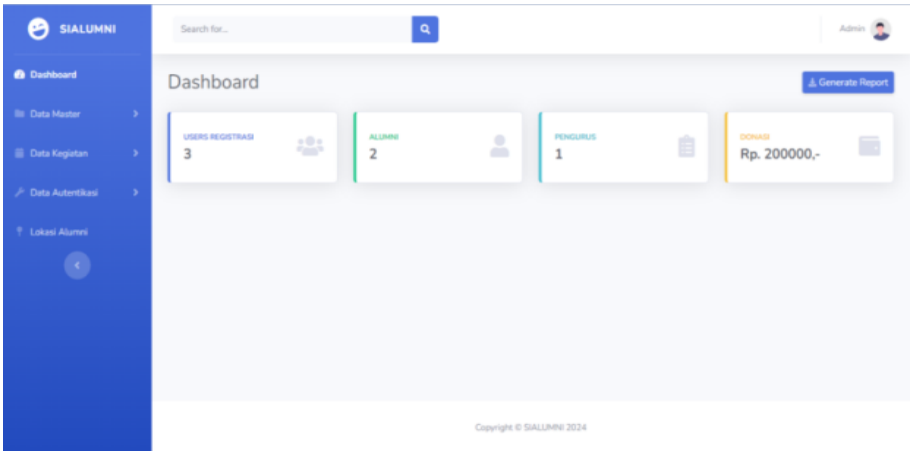

Figure 11. Administrator Dashboard

The dashboard enables administrators to manage user data, alumni records, and system configurations in a structured and accessible environment.

The alumni dashboard, displayed in Figure 12, allows alumni to manage their personal profiles, update contact details, and view relevant school announcements. The system provides alumni with autonomy to update their data independently, which reduces the workload on school administrators while ensuring that information remains accurate and up to date. This interface also serves as a hub for alumni engagement and institutional communication.

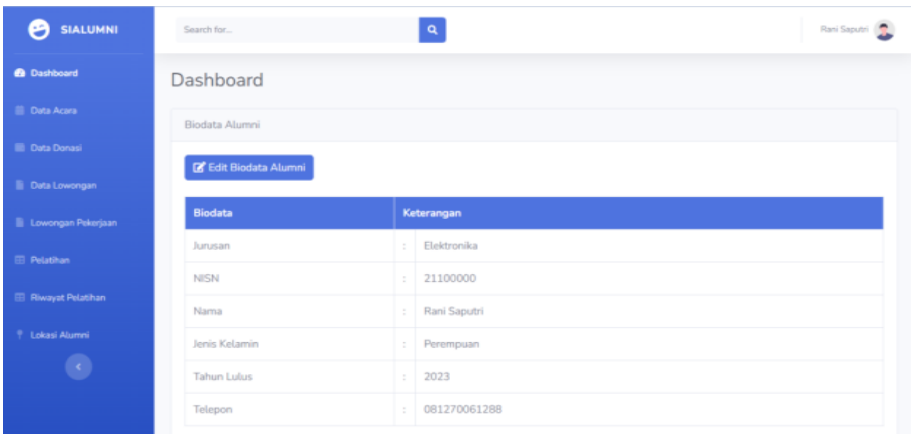

Figure 12. Alumni Dashboard Interface

This interface allows alumni to manage personal information and access updates from the institution, fostering continued engagement after graduation.

For alumni coordinators, the system provides a dedicated dashboard shown in Figure 13. This page is designed to support community management by displaying event schedules, donation activities, news updates, alumni networks, and geographical alumni mapping. These features allow coordinators to play a strategic role in maintaining long-term relationships

between the school and its graduates. It also opens opportunities for future collaboration in areas such as career development, mentorship, and institutional support.

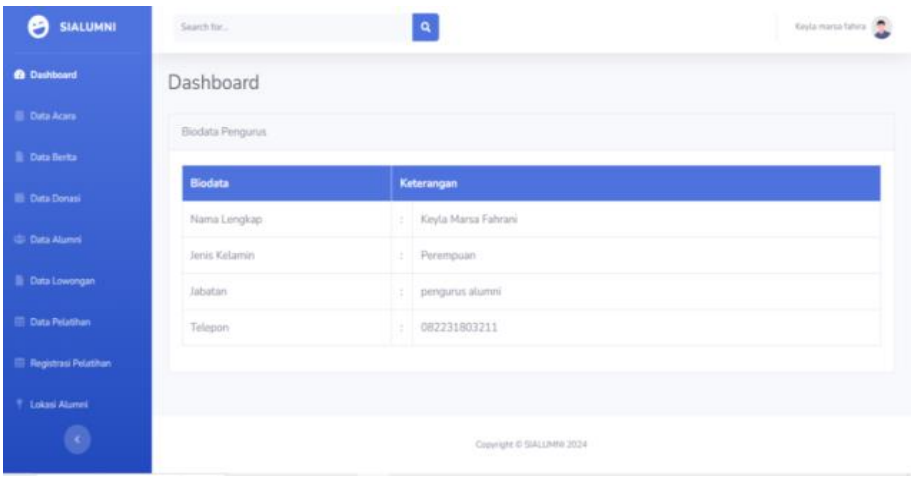

Figure 13. Alumni Coordinator Dashboard

This dashboard provides coordinators with tools to manage alumni engagement, events, and communication activities across the alumni network.

Overall, the development of these interfaces successfully addresses the research problem identified earlier: the lack of an integrated and easily accessible alumni information system. Each interface was designed with usability and user roles in mind, ensuring that both functionality and user experience were prioritized. The system not only enables efficient data management but also supports stronger alumni-school relationships, which are vital for institutional advancement and alumni network sustainability.

The implementation of this system illustrates how a role-based web application, grounded in well-defined development methodology, can solve operational challenges in educational institutions. In addition, it lays the foundation for future enhancements such as mobile application integration, analytics dashboards, or even integration with government employment databases for graduate tracking. This outcome underscores the importance of aligning software engineering principles with real institutional needs to produce impactful and sustainable digital solutions.

3.2 Discussion

The development of the web-based alumni information system for SMK Negeri 1 Koto XI Tarusan represents a significant improvement in how alumni data is managed, accessed, and utilized by the institution. This system addresses the core issue identified during the requirement analysis phase: the lack of centralized, accurate, and up-to-date alumni records. Previously, data collection relied heavily on manual processes and disconnected digital formats, which led

to inefficiencies and data loss, especially when alumni relocated or changed contact details.

The login system, dashboard interfaces, and user-specific functions demonstrate the application of effective role-based access control, which is consistent with best practices in secure web application design [16]–[18]. By separating administrator, alumni, and coordinator functions, the system ensures clarity of responsibilities, reduces redundancy, and minimizes the risk of data inconsistency or unauthorized access. This structure aligns with the recommendations of prior studies that emphasize modular design and access compartmentalization as critical for institutional information systems [19], [20].

From a usability standpoint, the system offers an intuitive interface that enables users to interact with the platform with minimal training. This aligns with previous findings indicating that user-centered design significantly enhances user engagement and system adoption rates [21]–[24]. In this study, alumni are able to independently manage their data, reducing reliance on administrative staff. Meanwhile, administrators are granted comprehensive control over data operations, contributing to improved institutional efficiency.

Moreover, the role of the alumni coordinator—frequently neglected in many legacy systems—is reinforced through dedicated features that facilitate event planning, outreach initiatives, and alumni network mapping. This supports the perspective that alumni systems should function not only as data repositories but also as active engagement platforms. Empirical evidence has demonstrated that robust alumni relations positively influence institutional branding, fundraising opportunities, and the formation of strategic collaborations [25]–[30].

Despite addressing core operational challenges, the system still presents opportunities for future enhancement. For example, integration with external platforms such as LinkedIn, job placement services, or national alumni databases could allow for more comprehensive tracking of graduate outcomes. Additionally, the inclusion of analytics dashboards could generate data-driven insights into alumni distribution patterns, levels of engagement, and participation in institutional programs.

Finally, the results of this study affirm the effectiveness of structured software engineering approaches, such as the Waterfall model, in producing reliable and context-specific educational applications. Nonetheless, future iterations of the system may benefit from adopting agile development methodologies—particularly when rapid prototyping, iterative testing, or continuous user feedback becomes necessary to meet evolving institutional needs.

In summary, the web-based alumni information system developed in this study is a functional, secure, and scalable solution that directly addresses the needs of

SMK Negeri 1 Koto XI Tarusan. It enhances institutional capacity in alumni data management and opens new avenues for alumni engagement, laying a solid foundation for future digital transformation efforts in vocational education contexts.

4. Conclusion

This study successfully designed and developed a web-based alumni information system tailored for SMK Negeri 1 Koto XI Tarusan, utilizing the Waterfall development model. The system provides role-specific interfaces for administrators, alumni, and alumni coordinators, ensuring efficient, secure, and user-friendly data management. Through modular and structured design, the system addresses the institution's need for accurate alumni data, improved communication, and streamlined information access.

The results demonstrate that the system effectively supports key functionalities such as alumni registration, data updating, event announcements, and alumni engagement, thereby enhancing the school's ability to maintain relationships with its graduates. Moreover, the implementation of a role-based access control mechanism has strengthened data integrity and usability across different user categories. These outcomes reinforce the importance of adopting systematic software engineering methods in developing educational information systems.

Despite these achievements, this study is not without limitations. First, the system was implemented and evaluated in a single institution, which may limit the generalizability of the findings. Second, the scope of functionality, while sufficient for basic operations, has not yet incorporated advanced features such as real-time analytics, mobile responsiveness, or integration with external platforms like employment databases or social networks.

For future research, it is recommended to expand the deployment of the system to multiple institutions to assess adaptability and scalability across different educational settings. Additionally, incorporating agile development methods may allow for faster iterations and better alignment with dynamic user needs. Integration with third-party systems and implementation of machine learning for alumni data prediction and trend analysis also represent promising directions for future enhancement.

In conclusion, the developed system presents a viable solution to the alumni data management challenges faced by vocational schools. It not only improves institutional administrative processes but also fosters long-term alumni engagement, which is essential for educational development and graduate support.

Author's declaration

Author contribution

Melda Triyana Tanjung led the conceptualization, system design, and manuscript drafting. **Denny Kurniadi** contributed to the methodology design, supervised the development process, and reviewed the manuscript. **Legiman Slamet** was responsible for software implementation, interface development, and data visualization. **Ahmaddul Hadi** provided support in validation, testing, and contributed to the final editing and refinement of the manuscript.

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Competing interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

Ethical clearance

This study did not involve any experiments on humans or animals. Ethical approval was not required. However, all procedures involving data collection and stakeholder participation were conducted in accordance with institutional ethical standards.

AI statement

No generative AI tools were used to write or analyze the content of this article. All content, including system design and analysis, was produced by the authors.

Publisher's and Journal's note

Universitas Negeri Padang as the publisher and Editor of Jurnal Vokasi Informatika state that there is no conflict of interest towards this article publication.

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