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(Research/Review) Article

Enhancing Data Management Efficiency in Higher Education: A Case Study on the Development of P2M Applications

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Abstract: Developing research and community service (P2M) applications is crucial in enhancing efficiency and accuracy in managing related data at higher education institutions. This research aims to design a web-based application that simplifies the data management process for research, community service, and associated activities at Universitas Informatika dan Bisnis Indonesia (UNIBI). The research engaged the Rapid Application Development (RAD) methodology to actively incorporate stakeholders throughout the application development lifecycle, thereby guaranteeing alignment with their requirements. The results showed that the developed Application effectively resolved inaccurate data displays, manual data collection, and inefficient validation processes. Key features include a more accurate dashboard, an automated article validation tool integrated with Google Scholar, and streamlined submission community service activities. The activity submission process enhances operational efficiency and improves transparency and accountability in managing academic data. This research contributes to the broader adoption of digital solutions in educational administration, offering significant improvements in data accuracy and management at UNIBI.

Keywords: 2M Application, Research Management, Community Service, Data Management, Web-Based Application

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1. Introduction

Research and community service are fundamental in the context of higher education in Indonesia (Welch & Aziz, 2021). Research produces new knowledge and serves as the basis for service activities that benefit the community (Cress et al., 2023). In this case, community service (PKM) should be seen as downstream from the results of the research conducted so that it can provide real solutions to the problems faced by the community (Darni et al., 2023; Novita & Ismail, 2022). According to one study, 'community service should be downstream of research,' and research results should be directly applicable to improve the community's welfare.

Furthermore, community service is an integral part of the Tri Dharma of Higher Education, which includes education, research, and service. This is regulated in Law No. 12/2012 on Higher Education, which emphasizes that PKM aims to advance the welfare of society and educate the nation's life (Abdillah et al., 2022; Ismawan et al., 2022). Consequently, this endeavor not only yields advantages for the community but also enhances the standing and caliber of the university itself. Hence, the partnership between faculty members and students in executing Community Service Programs (PKM) should be promoted to ensure that research outcomes can be implemented efficiently and sustainably within the community. (Ismail et al., 2022; Mulyadi et al., 2024).

Developing research and community service data management applications is urgent to improve efficiency and accuracy in information management (Dwivedi et al., 2020). In many institutions, research and community service data are still managed manually, which can result in recording errors and loss of important information (Saffady, 2021). Applications designed for this purpose can facilitate the digitization process, allowing data entry to be done online from anywhere and at any time and making it easier to monitor research activities (Amankwah-Amoah et al., 2021; Hamdy et al., 2024). Furthermore, computerized applications can speed up data processing and improve information integrity and security (Vegesna, 2022). With an integrated information system, the time needed to manage data can be minimized so researchers and community servants can focus more on implementing their activities (Collins et al., 2021). Moreover, this Application facilitates transparency in the processes of reporting and assessment, which is crucial for ensuring accountability within the academic sphere.(Ortega-Rodríguez et al., 2020). Therefore, investment in developing

this Application will improve the quality of research and community service and enhance the reputation of higher education institutions (Alenezi, 2021).

This study seeks to establish a web-based application designed to enhance efficiency, precision, and transparency in the administration of research and community service data. Utilizing technology for digitization, this Application aims to overcome problems arising from manual data management, often resulting in recording errors and the loss of essential data. The developed Application will allow data entry to be done online from several locations, increasing accuracy and reducing the time required to manage data. In addition, the application will facilitate the monitoring and reporting of research and community service activities, providing greater transparency and supporting accountability.

This research aims to develop a web-based application to improve efficiency, accuracy, and transparency in managing research and community service data. This Application aims to reduce errors in data recording, speed up information processing, and provide digital solutions for institutions managing data manually. This study additionally seeks to foster collaborative efforts between educators and learners in the implementation of research findings within community service initiatives, which are anticipated to yield a more substantial beneficial effect on the welfare of the community. In addition, this Application will improve the reputation and quality of higher education institutions through more efficient and organized data management.

2. Literature Review

The importance of accurate data management is emphasized in several studies. For instance, the Kalimasada application improves population data quality by facilitating the collection of unregistered marriage data enhancing data accuracy through automatic validation features (Fawaid & Hariyoko, 2024). Similarly, developing a Laravel-based information system aids in managing research and community service data, ensuring real-time access and improving data credibility (Farady Coastera & Risdianto, 2023).

The use of advanced technological platforms like OneNET for community service systems demonstrates the potential of IoT in enhancing service delivery and management effectiveness (Tan, 2023). Moreover, web-based systems, such as those developed for STMIK Dipanegara Makassar and Universitas Negeri Medan, utilize the waterfall method to ensure

comprehensive system development, addressing issues like poor documentation and manual data management (Susanto et al., 2021).

User training and engagement are crucial for the successful implementation of these applications. The Kalimasada application, for example, includes community training to increase public participation in data reporting (Fawaid & Hariyoko, 2024). The Prisma Information System also supports user engagement by providing a responsive design and assistance documentation, facilitating more straightforward access to research and service information (Farady Coastera & Risdianto, 2023).

Innovative frameworks and system designs address challenges such as limited budgets and coordination difficulties. The OneNET platform, for instance, offers a cost-effective solution by dividing the system into functional modules (Tan, 2023). The transition from manual to digital systems, as seen in the P4M unit at STMIK Dipanegara Makassar, highlights the need for applications that can efficiently manage administrative data and disseminate information (Susanto et al., 2021).

3. Methodology

The methodology delineated in Figure 1 exemplifies the procedural framework for application development through the implementation of the Rapid Application Development (RAD) paradigm. This RAD approach accelerates application development by involving intensive collaboration between developers and stakeholders.

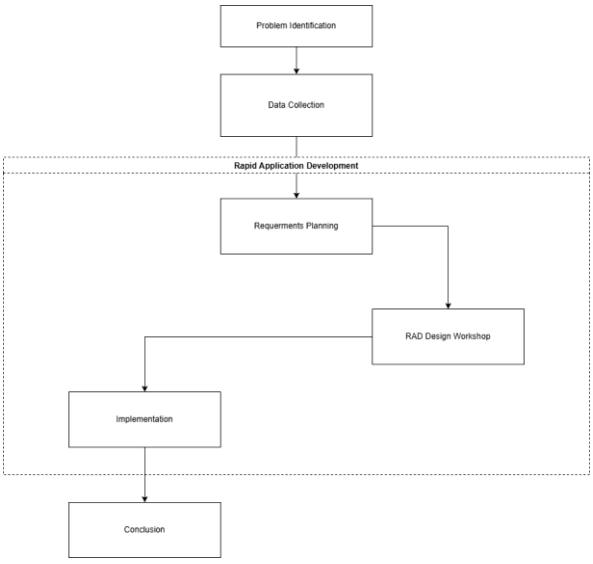

Figure 1. Proposed Method

The process begins with the Problem Identification stage, where the problem or need to be solved with this Application is identified. At this

juncture, it is imperative to thoroughly comprehend the matter under consideration to ensure that the devised solution is precisely aligned with the objective.

Upon the identification of the issue, the subsequent phase entails the gathering of data. At this stage, relevant information regarding the existing situation is collected. This data can be user data, technical data, or data from other sources that can help design a better solution. Accurate and comprehensive data collection is essential to ensure the developed Application can fulfil user needs effectively.

The next stage is Requirements Planning. Here, the development team and stakeholders formulate the Application's needs. The purpose of requirements planning is to ensure that all essential requirements are identified and will be implemented in the app development. At this juncture, the various attributes and operational capabilities of the application are meticulously devised to align with the anticipations of the end-users and to effectively address the issues that have been recognized.

Once the requirements are planned, the RAD process moves to the RAD Design Workshop stage. At this stage, the development team works closely with stakeholders to design the application solution. The design is rapid and iterative to produce a prototype that can be immediately tested and implemented. This workshop allows developers and stakeholders to collaborate directly in designing the app's features and interfaces.

Next, once the design is complete, the Implementation stage begins. At this stage, the Application begins to be developed based on the previously agreed-upon design. Developers start writing code, building user interfaces, and integrating the several systems needed. The implementation process is done iteratively, with constant feedback from stakeholders to ensure that the developed Application remains in line with the predefined needs.

At the implementation stage, testing is generally done to ensure that the Application functions properly and fulfils the predefined requirements. This testing can involve user trials to ensure that the Application is easy to use and can satisfy the needs set at the beginning.

The concluding phase represents the stage in which the ultimate outcome of the comprehensive process is assessed. Here, the development team evaluates whether the Application that has been developed successfully solves the problems identified initially and fulfils all the planned needs. If

needed, further improvements or iterations are made to enhance the app so that it can be ready to be used effectively by its users.

4. Research Result

Requirement Planning

At this stage, an in-depth analysis of the needs of existing problems is carried out to develop the correct Application. This analysis aims to identify the issues faced and provide solutions to these problems. This process is critical to ensure that the application developed will offer maximum benefits to user needs. It can overcome several issues that exist in the current system.

Analysis of the Running System

The system at the Faculty of Technology and Informatics, Universitas Informatika dan Bisnis Indonesia, has several issues that need improvement, including difficulties in data entry, incorrect display of Research, Intellectual Property Rights, Journal Articles, and Community Service data on the dashboard, and the display of inactive lecturer data. Book data collection is done manually, leading to inefficiencies, while the unsynchronization between active lecturer status and users causes data mismatches. Additionally, the manual article validation process is time-consuming and error-prone. These problems highlight the need to automate and improve the system for greater efficiency, accuracy, and user convenience.

Weaknesses of the Existing System

The analysis of the existing system reveals several weaknesses that need correction to enhance performance. These include inaccurate data on the dashboard, such as displaying inactive lecturer information, which undermines the system's reliability and decision-making accuracy. The absence of a dedicated menu for book data input hinders effective management, while unsynchronized lecturer and user tables cause data mismatches. Manual article validation through Google Scholar is time-consuming and prone to errors, and the lack of a Research and Community Service submission feature complicates the submission process. Addressing these issues will improve data accuracy, system efficiency, and user experience.

Problem Solving Solution

To overcome the existing problems, the author proposes the development of P2M (Research, Community Service) website-based applications. This Application will provide a more effective and efficient

solution to the weaknesses found in the existing system. Using the website as a platform will facilitate access for all parties involved, from lecturers to data managers. In addition, the development of this Application will include features that can improve data accuracy, speed up the data input process, and automate article validation and submission of research and community service. With a website-based application, the data management and submission process becomes more transparent, easily accessible, and more efficient.

RAD Design Workshop

Design modelling for research and community service applications uses the Unified Modeling Language (UML), a standardized method for visualizing system design. The Unified Modeling Language, commonly referred to as UML, consolidates a wide spectrum of diagram types, such as Use Case Diagrams that detail the main functions of a system in relation to the interactions; Class Diagrams that showcase a precise representation of the system's framework and associations; Activity Diagrams that portray the operational sequences and user duties; Sequence Diagrams that display the time-linked connections of object interactions; and State Machine Diagrams that delineate the specific states of an object and the changes that transpire between those states.

Use Case Diagram

Figure 2 is a Use Case Diagram illustrating the interaction between actors and the system in managing research and community service. This diagram involves several main actors, namely Lecturers, Secretaries, and Admins. Each actor has different functionality or access according to their role in the system. Lecturers can log in to the system, submit or view research proposals, update and validate research data, and manage data related to community service, including viewing and entering data on community service performed.

The Secretary plays a role in monitoring and managing data in the system, with access to view proposal submission data submitted by lecturers and update and add data related to community service activities. On the other hand, Admin has a more significant role in managing the system as a whole. Admins can log in to the system to manage and verify user data access reports and data related to research. Admins also have access to validate and verify all data entered into the system by lecturers or secretaries.

Overall, this Use Case Diagram clearly shows how each actor can access and carry out relevant functions in the research and community service management system. This diagram is handy for system developers to design and implement a system that can meet each user's needs and ensure that the system's data flow and user interaction run effectively.

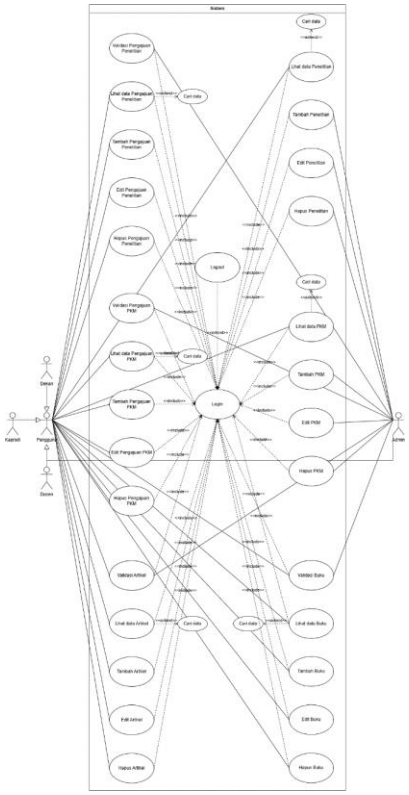

Figure 2. Use Case Diagram

Class Diagram

Figure 3 is a Class Diagram that illustrates the structure of the data management system related to research and community service. This Class Diagram shows the entities or classes in the system and the attributes and methods associated with each class. This diagram provides an overview of the relationship between classes and how data and functionality interact in the system.

The Users class is at the centre of this system and includes attributes such as ID, email, role, and created_at. This class also has methods to manage user data, such as create(), read(), update(), and delete(). These methods allow the system to create, read, update, and delete user data, including lecturers, students, or admins.

The PKM (Pengabdian Kepada Masyarakat) class is related to managing community service data with attributes such as id, created_at, updated_at, and title. PKM also has a relationship with Users, meaning each community

service can be associated with a user or responsible lecturer. This class includes methods such as validate(), create(), read(), update(), and delete(), which govern the management of community service-related data, including data validation and updates.

The Research class manages research-related data with attributes similar to PKM, such as id, created_at, updated_at, and title_research. Like the PKM class, this class is also connected to Users to associate research with a particular user. In addition, there are methods such as create(), read(), update(), and delete() that manage research data.

The Articles class manages published article data with attributes such as id, title, author, and status_document. These articles also have methods that allow the management of article data through actions such as validation, reading, updating, and deleting.

Finally, the Book class is used to manage data related to published books, with attributes such as id, title_book, author, and year_academic. Like other classes, Book also has create(), read(), update(), and delete() methods, which allow the manipulation of book data in the system.

Overall, this diagram illustrates the relationships between classes in the system, which are interrelated to manage several aspects of research and community service. Each class represents essential data that needs to be handled with methods that enable efficient and structured data management. Relationships between classes, such as between Users and PKM, Research, Articles, and Books, show how data in the system relate and complement each other for better information management.

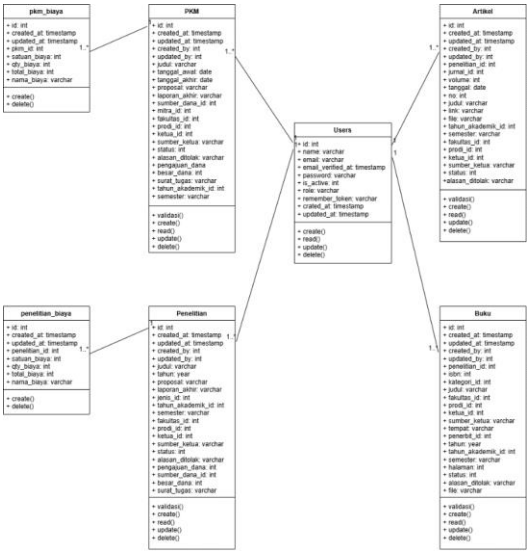

Figure 3. Class Diagram

Activity Diagram

Figure 4 is an Activity Diagram that describes the flow of activities in the research submission system, involving several actors such as Admin, Deans, Heads of Study Programmes, and Lecturers, and their interactions with the system. This diagram illustrates the process from start to finish in submitting research, from menu selection to data storage in the database.

The process begins when the Admin, Dean, Head of Department, or Lecturer selects the research submission menu on the system. After that, the system will display the research submission page to provide an interface to the user. Then, the user selects the 'add research submission' option to start a new research submission. The system will then display a form for the research submission, which allows users to fill in several data related to the proposed research.

Next, the user fills in the required research submission data, such as the research title, team members, or other details. After all data has been inputted, the next step is to save the research submission data. The system will then perform input validation to ensure all data entered is correct and eligible. If the validation is successful, the system will save the data in the database, indicating that the research submission has been officially recorded.

If the input validation fails, the process will return to the user to correct incorrect or incomplete data. This diagram shows a clear and systematic flow of the user's interaction with the system to apply for research, from menu selection to data saving, with a critical validation step to ensure the quality of the data entered.

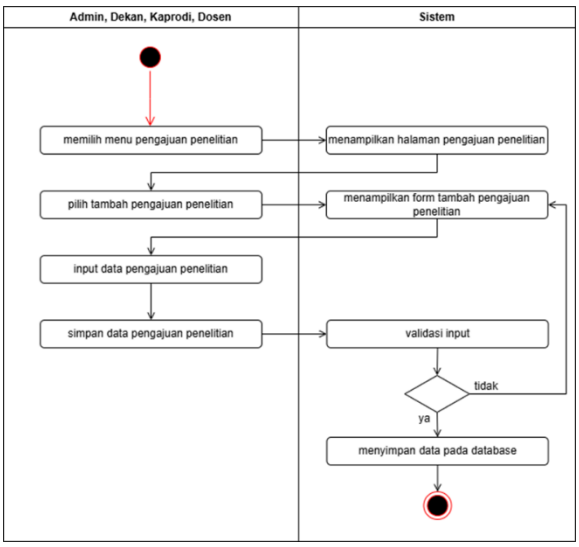

Figure 4. Activity Diagram

Sequence Diagram

Figure 5 is a Sequence Diagram that illustrates the interaction between objects in the research submission system, from data input to saving research data into the system. This diagram involves several entities or objects that interact with each other: User, Research Submission, Interface, Validation, Process_save, and Research.

The process begins when the user selects the option to add a research submission, which triggers the Research Submission object to call the add() method. The next step is for the user to input the required research submission data. This data is sent to the Validation object to verify the correctness and completeness of the data through the validation() method. If the data is invalid, the process will again ask for corrections from the user, but if the data is valid, the system proceeds to the next step.

After the data is validated, the Process_save object will handle the data-saving process by calling the process_save() method. This method will process the data and send the valid data to the Research object to be stored in the database. This saving process is done through the insert() method. After the data is inserted, the system sends a saved data message to the user, indicating that the research submission was saved.

If an error or problem occurs in data storage, the Research object will be called the destroy() method, indicating that the object has been destroyed or removed from the process. Thus, this Sequence Diagram illustrates the detailed steps in the research submission system, from data input validation to saving into the database, with feedback provided to the user at each step.

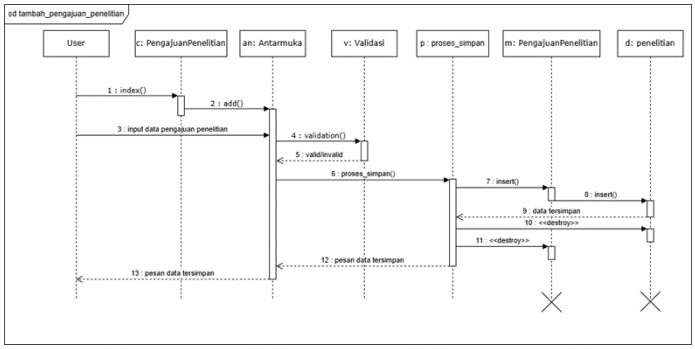

Figure 5. Sequence Diagram

State Machine Diagram

Figure 6 is a State Machine Diagram that illustrates the states or conditions of the research submission system and the transitions between states during the submission process. This diagram illustrates the user's flow, which involves several different states, starting from Start to Finish.

The process starts with the Start state, which then goes to the Dashboard Page state, where the user will see the initial view of the system. From this page, the user can select Add Research Submission. After selecting, the system will display the Add Research Submission Form, where users can fill in the required research submission data. The system will proceed to the Save state if the login is successful.

In the Save state, the system tries to save the research submission data entered by the user. If the data is successfully saved, the system will proceed to the Message Data Saved state, which notifies the user that the research submission data has been saved. Next, the system enters the Research Submission Data Saved state, which signifies that the submission has been successfully entered into the database. This process ends by reaching the Completed state.

However, if a failure occurs while saving the data, the system will send a Data Failed to Save Message, which informs the user that the data was not saved successfully and starts the process from the beginning. Thus, this State Machine Diagram illustrates the flow of states that the system experiences during the research submission process, from start to finish, by containing possible transitions between successful and failed states that occur during the process.

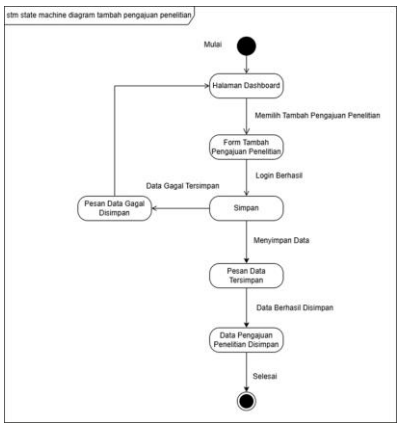

Figure 6. State Machine Diagram

Implementation

Figure 7 shows the login page of the research and community service (PKM) application of Universitas Informatika dan Bisnis Indonesia (UNIBI). This login page is designed with a simple yet modern look, using a fresh turquoise background colour to create a clean and professional impression.

The user must fill in two input fields on this page to log into the Application. The first column asks users to enter their email, which serves

as the user's identification in the system. The second column asks the user to enter their password to verify that the logged-in user is the legitimate account owner. Below both input fields is a Log button that will process the data entered and grant access to the Application if the information entered is valid.

At the top of the login page, there is a UNIBI application logo with the words' Research and PKM Application FTI UNIBI,' which shows the identity of this Application as a platform for managing research and community service at the Faculty of Technology and Informatics, Universitas Informatika dan Bisnis Indonesia. This logo provides a corporate feel that identifies the Application directly with the university. Overall, this login page has a simple yet straightforward design, allowing users to easily access the UNIBI research and community service application after entering a valid email and password.

Figure 7. Login Page

Figure 8 shows the dashboard page of the research and community service (PKM) application of Universitas Informatika dan Bisnis Indonesia (UNIBI). This dashboard presents statistical information concisely and visually, which makes it easy for users to understand data related to research and PKM at the institution.

At the top of the dashboard, several key statistics are presented in coloured boxes that provide essential information related to academic activities. These statistics include 2 Total Research, which shows the number of researches registered in the system; 3 Total PKM, which illustrates the number of community services that have been recorded; 187 Total Journal Publications, which displays the number of journal publications that relevant parties have published; and 2 Total IPR, which shows the number of Intellectual Property Rights that have been registered. These figures provide a glimpse of the achievements in each of these areas and help users monitor the progress of academic activities effectively.

Below these statistics is a lecturer statistics chart, which depicts a more in-depth range of data related to lecturers' activities, such as the number of research, PKM, articles, and IPR they have conducted. The graph uses different colours for each category: Research (blue), PKM (red), Articles (green), IPR (yellow), and Books (orange). Each lecturer listed has a horizontal bar showing the amount of their contribution in each category, making it easy to monitor and analyze the lecturers' academic activities.

In addition, on the top right of the page, there are two filter dropdowns to select Academic Year and Cabinet Year, allowing users to customize the data display based on the relevant period. Users can also choose the All filter or customize the selection by selecting the Filter option. With this intuitive display, the dashboard provides an overall picture of research and community service performance at Universitas Informatika dan Bisnis Indonesia. It allows users to monitor more effectively and efficiently.

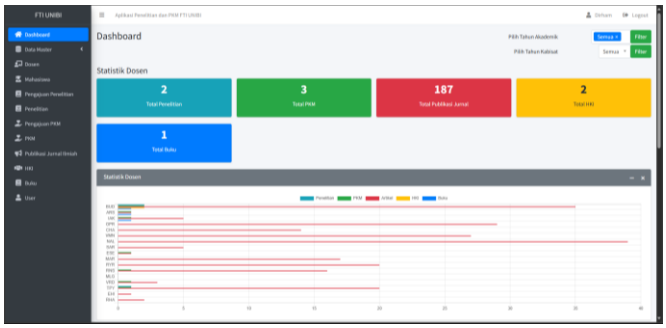

Figure 8. Dashboard Page

Figure 9 illustrates the Research Submission interface within the application for research and community service at the Universitas Informatika dan Bisnis Indonesia (UNIBI). This page is designed to display a list of research submissions entered into the system. At the top of the page are Limit and Search features, which allow users to filter the amount of data displayed (10 data per page) and search for research submission data based on specific keywords.

Under the search feature, there is a Research Submission List, which displays data related to research submissions that have been submitted. This table includes several columns of information, including No, Title, Members, Year, Research Scheme, Academic Year, Proposal, Final Report, Status, and Action. Each research submission entry includes complete information about the research title, members involved, year of implementation, research scheme, and academic year. At the end of each row, there is a button to view further details (View) regarding the proposal and final report of the research submission.

In addition, the Status column shows the current status of the research submission, such as whether the proposal has been approved or is still in progress. The Action column provides options for further actions, such as editing or deleting the submitted research submission. This page provides an intuitive interface for monitoring and managing research submissions, making it easy for users to access important information related to each research submission. On the top right, an Add button allows users to add new research submissions to the system. With a clear and organized design, this page serves to simplify the process of managing research submissions at UNIBI.

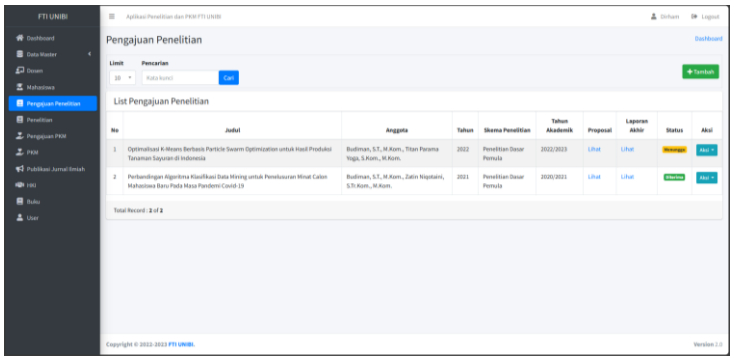

Figure 9. Research Submission Page

Figure 10 shows the display of the Research Data page on the research and community service application of Universitas Informatika dan Bisnis Indonesia (UNIBI). This page is designed to display a list of research recorded in the system. At the top of the page are Limit and Search features, which allow users to set the amount of data displayed (for example, 10 data per page) and search for research data based on specific keywords.

Below the search feature is the Research List, which contains a table with information about research that has been submitted and approved. This table includes several important columns: No, Title, Member, Year, Research Scheme, Academic Year, Proposal, Final Report, Status, and Action. Each row in the table displays information about a particular research, including the team members' names, the year of implementation, the chosen research scheme, and the relevant academic year.

In the Proposal and Final Report columns, there is a View button, which allows users to view more details about the research proposal and final report associated with that research. In addition, in the Status column, users can view the current status of the study, whether it is completed or ongoing, or other statuses indicate the progress of the research. In the Action column,

there are buttons to perform further actions, such as Edit and Delete, which allow users to change or delete existing research data.

At the top right of the page, an Add button allows users to add new research data to the system. With a structured and user-friendly design, this page simplifies the management and monitoring of research data at UNIBI, allowing users to access the information needed and manage research efficiently and quickly.

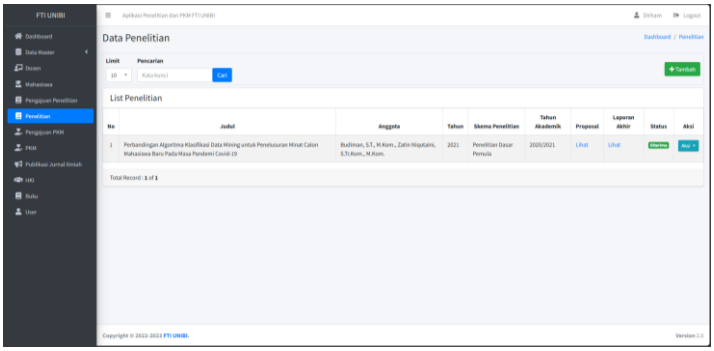

Figure 10. Research Page

Figure 11 shows the PKM Submission page on the research and community service application of Universitas Informatika dan Bisnis Indonesia (UNIBI). This page is designed to display a list of community service (PKM) submissions entered into the system. At the top of the page are Limit and Search features, which allow users to filter the amount of data displayed (for example, 10 data per page) and search for PKM submissions based on specific keywords.

Below the search feature, there is the PKM Submission List, which contains a table with information related to PKM submissions that have been submitted. This table includes several columns of information, including No, Title, Member, Implementation Date, Partner, Academic Year, Funding Source, Proposal, Status, and Action. Each row in the table displays the submitted PKM submission data, including the title, members involved, implementation date, partners involved in the activity, and the relevant academic year and funding source. In the Proposal and Status columns, there is a View button to access further details about the proposal and the status of the PKM submission. In addition, in the Action column, some buttons allow users to perform additional actions, such as Edit or Delete, to change or delete existing PKM submission data. At the top right of the page, an Add button allows users to add new PKM submissions to the system. With a structured and easy-to-use interface, this page will enable users to monitor and manage PKM submissions more efficiently at UNIBI.

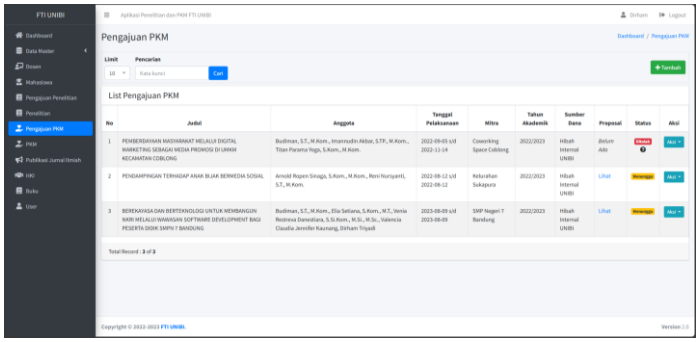

Figure 11. PKM Submission Page

Figure 12 displays the PKM Data page on the research and community service application of Universitas Informatika dan Bisnis Indonesia (UNIBI), designed to show a list of community service (PKM) records. The page features a Limit option to set the number of data displayed per page and a Search function to find PKM data by keywords. Below the search, the List PKM table presents columns for details such as activity title, members, implementation date, partners, academic year, funding source, and more. The Proposal and Final Report columns include buttons to view further details. The table shows no data, as indicated by the 'No data' message. An Add button at the top right lets users input new PKM data. The page's simple design helps users efficiently manage and monitor PKM data at UNIBI.

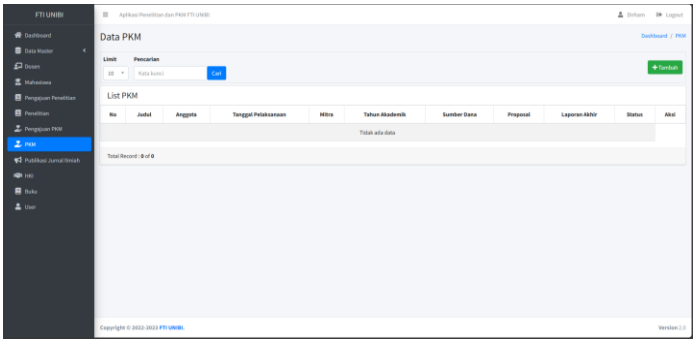

Figure 12. PKM Page

5. Discussion

This research endeavour was designed to respond to the significant need for better efficiency, accuracy, and transparency in managing research and community service data in higher education organizations. The developed web-based application successfully integrates features that automate data entry and streamline validation processes, thereby minimizing errors associated with manual systems. This transition from a traditional paper-

based or manual digital system to a fully computerized platform promises substantial operational efficiency and data quality improvements.

The primary challenge faced by institutions before implementing such a system was the inconsistency and inaccuracy of data, particularly in the display of research and community service activities. As noted in the analysis of existing systems, inaccuracies in data, such as the display of inactive lecturers or mismatched lecturer-user data, were significant issues. By systematically addressing these challenges, the application guarantees that accurate and current information is presented, augmenting the system's dependability for decision-making processes.

Additionally, the system incorporates automated validation mechanisms for research article submissions, replacing the labour-intensive manual checks prone to human error. This automation saves time and improves the overall workflow, enabling users to focus on more critical tasks, such as research and community service execution. The feature of having a centralized platform for all data management also promotes transparency, as users can easily access and track the status of research and community service submissions, ensuring higher levels of accountability.

Including features like real-time reporting and user-specific dashboards in the application is also noteworthy. These features provide stakeholders—lecturers, administrators, or students—valuable insights into ongoing research and community service efforts. The integration of graphical statistics allows for a quick understanding of academic activities, contributing to better monitoring and evaluation of institutional performance.

Additionally, utilizing Unified Modeling Language (UML) across the design phase, with elements like Use Case Diagrams, Class Diagrams, and Activity Diagrams, yielded a cohesive structure for interpreting system capabilities. These diagrams facilitated the elucidation of user interactions, data flows, and system behaviours, guaranteeing that the application effectively satisfied user requirements. In addition, incorporating agile design strategies, like the Rapid Application Development (RAD) method, which underscores persistent engagement from stakeholders, ensured that the system was both viable and user-focused.

However, the initiation of such systems is riddled with complications. A principal concern pertains to the imperative for user training and active participation, as the efficacy of the application is predominantly contingent

upon the capability of the end-users to engage with the system proficiently. As seen with other applications, such as the Kalimasada and Prisma Information Systems, user involvement through training and support is critical for ensuring that the transition to a new system is smooth and that the system is used to its full potential (Farady Coastera & Risdianto, 2023; Fawaid & Hariyoko, 2024). In this regard, ongoing user support, training programs, and user interface enhancements are crucial to the continued success of the application.

Furthermore, challenges such as budget constraints and the complexity of coordinating large-scale system deployments remain. Tan (Tan, 2023), cost-effective solutions, such as dividing systems into functional modules, can help mitigate these issues. This modular approach, adopted by the OneNET platform, provides a viable strategy for institutions that face limited resources. Nevertheless, ongoing investment in both technological upgrades and user training remains essential to keep pace with the evolving needs of research and community service activities.

In conclusion, the web-based application developed through this research represents a significant step toward improving data management in higher education institutions. By addressing the limitations of manual systems, promoting transparency, and ensuring accurate data handling, the application promises to enhance the quality and efficiency of research and community service activities. Future developments should focus on enhancing system integration with other institutional platforms, expanding its features to cater to a broader range of academic functions, and ensuring user engagement remains a priority for sustained success**.**

6. Conclusions And Recommendations

Based on the results of the analysis carried out related to the development of the P2M application of the Faculty of Technology and Informatics UNIBI, the objectives of this research have been achieved well. The application development has provided several conveniences in data management and processes within the faculty. This Application has several benefits, including: first, the Application allows admins to easily view accurate data on the dashboard page, which ensures more precise decisions and reports are generated. Secondly, the book menu feature and the application make it easier for admins and lecturers to collect and manage book data. Third, the Application facilitates the research and PKM

submission process, making it easier for lecturers and admins to manage these submissions in a more structured manner. Fourth, with the graphic feature on the dashboard, the Application allows admins to monitor the activities of lecturers involved in research and community service more clearly and effectively. Finally, integrating the article search feature directly connected to Google Scholar facilitates article validation, reducing time and potential errors in the validation process that was previously done manually. Developing this P2M application improves efficiency and convenience in managing research and community service data at UNIBI.

7. Advanced Research

Future investigations ought to prioritize the augmentation of the system's interoperability with various institutional platforms, the enhancement of scalability, and the assurance of adaptability to meet the increasing demands of data and user requirements. It is essential to explore mobile accessibility for on-the-go data management, as well as the incorporation of advanced data analytics and AI for predictive insights and task automation. Additionally, research could aim to refine user training and support systems, develop a more intuitive user interface, and explore cost-effective solutions to optimize the application's financial feasibility. These enhancements will guarantee that the system continues to operate efficiently, is accessible to users, and can adapt to the dynamic requirements of higher education institutions.

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