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The Efficiency of Scrum Model for Developing Research and Publication Management Systems in Indonesia

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Abstract: Research, community service, and publication management systems are critical components of a higher education institution's governance in Indonesia. Sistem Informasi Penelitian, Pengabdian, dan Publikasi (SIP3) or Information System of Research, Community Service, and Publication is the name of the developed system in this study, which is a web application-based system. SIP3 was built utilizing the scrum methodology and the Laravel framework. Scrum is an easy-to-implement Agile approach that facilitates the rapid creation of systems or applications. This system includes four features: a researcher profile, research, community service, and publication. Development takes a short time with this scrum approach, roughly two months for these four features. SIP3 is evaluated for its effectiveness and practicality based on four criteria: system quality, information quality, user satisfaction, and benefits. The "benefit" component receives the highest score, with the assertion that SIP3 enables more effective and efficient archiving of research data, services, and publications, as well as the ability to lower data error rates.

Keywords: agile, laravel, research management system, scrum

1. Introduction

The Research and Community Service Center is an organization unit dedicated to doing research, performing community service, and publishing scientific articles for lecturers, students, and the academic community in every university in Indonesia. As a result of increasing interest, material pertaining to institutions' research, service, and scientific publications must be freely and rapidly accessible to lecturers, students, the academic community, and the public. Additionally, the institution works to manage resource allocation and to promote and improve the quality of research and community service. Additionally, the academic community is expected to provide feedback on the information supplied [1].

Currently, a rudimentary website is used, with functions limited to posting news and incomplete information. As a result, it is important to design a more interactive information system that can efficiently convey information from the institution while also receiving answers from users, particularly diverse information connected to research, service, and scientific publications. The data for these three items have not yet been combined. For example, information regarding scientific publications is still stored in the library using an independent system. The information on research is managed also in the different application and database, which contains reports, information on the utilization of research budgets, and information on research outcomes. If this system is compromised, it is probable that academic research material, particularly that in the form of files, will become difficult to follow.

Until now, the research, service, and publication systems have not offered complete information, based on observations. As previously stated, the three components' archive data must be organized in a manner that is specifically documented. This effort is expected to provide comprehensive information that is accessible to the public at any time via an online information system, as well as to streamline the process of tracking data for research products, services, and publications used in accreditation activities ranging from Departments to Universities. It is required to connect the many existing systems into a single container in order to facilitate monitoring and evaluation of academic community research activities, services, and publications. The existing system is still being integrated through the use of a REST web API [2].

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The brief explanation above emphasizes the critical importance of building an information system for research, service, and scientific publication called SIP3 (*Sistem Informasi Penelitian, Pengabdian, dan Publikasi* or Information System of Research, Community Service, and Publication). To create the system, a model that facilitates researcher development is required, particularly the Scrum model. This paradigm is an evolution of the Agile framework, with the primary objective of expediting the implementation and delivery of management information systems [3]. Agile approaches have had a significant impact on software engineering management in firms worldwide that produce software [4]. Due to the adaptive nature of agile software development (i.e., a flexible, nanostructured, and dynamic approach), it becomes difficult to conduct Software Requirement Engineering that uses a structured strategy for managing software requirements across the software development life cycle [5].

Scrum is a methodology or framework for agile software development that is generally utilized in software development projects with the goal of providing new software capabilities every 2-4 weeks. It is one of the techniques that impacted the agile, which articulates a set of ideals and principles for making decisions about how to produce higher-quality software more quickly [6]. Scrum is a well-known agile methodology that is commonly utilized by software development teams. To fulfill the market's fast-paced and dynamic requirements, businesses are adopting Scrum as their software development methodology [7]. The implementation of the Scrum Framework does not promise that the organization will be risk-free, as numerous risks will emerge during the framework's implementation [8]. While numerous studies have been conducted on agile Scrum, no research has been conducted on the direct integration of Scrum into a concurrent product development model in a comparable manner [9].

Numerous research have incorporated the scrum model, including [10]–[19]. Srivastava et al. [20] reports that approximately 82% of respondents out of 5000 participants use Scrum. 95% of them intend to continue using it, while other new fields find Scrum valuable for execution or task management in order to get quite successful results. Thus, scrum transforms into an easy to-implement agile methodology that enables the effective, practical, and rapid development of systems or applications [20]. As a result of this research, SIP3 was established, which is more comprehensive and capable of providing a summary of all academic community activities within the institution by integrating previously existing systems. This project will assess the efficacy of developing and implementing SIP3 in managing research files, services, and publications using a scrum strategy. Where the system can provide real-time statistical data.

2. Literature Review

Previously conducted research resulted in the development of a prototype project in the form of a research publication system and community service based on MVC (Model-View-Controller) using Laravel PHP framework [1]. Initial projects have been carried out to develop prototypes for storing data relating to research, services, and publications in a single repository [21]. The use of a BOT was designed with the Telegram mobile application to gain access to research data and intellectual property rights [22].

A. Agile

Agile methodology in software development is iterative and incremental in nature. The requirements and solutions were developed collaboratively by self-organizing and cross-functional teams. It is a 1990s-era lightweight software development methodology. This paradigm was created in response to the heavyweight models, which were infamous for being highly regulated, regimented, and micromanaged [23].

Agile modeling is an approach for modeling and documenting software-based systems that makes use of practice. Agile approaches are considered to increase software development performance and responsiveness by enabling adaption to changing needs and environments, as well as the ability to learn from development experiences [24]. Traditional modeling techniques have been phased out of software development projects in favor of modern practices, which are more adaptable. It is intended to complement the many agile approaches such as extreme programming, agile unified process, and scrum models.

B. Scrum

The scrum model is well-suited for projects that undergo frequent changes and have tight deadlines. This technique is designed for teams of three to nine individuals that work in sprints to finish a single scope of work within a set timeframe. Teams convene daily for a meeting dubbed the daily scrum to review progress [25].

Among the benefits of this scrum approach is its adaptability, which makes it simple to update and change on a frequent basis. Assist managers in determining individual productivity by speeding up the development process and resuming slow initiatives. The development team makes the majority of decisions. This enables the individual to focus and increase his or her motivation. Additionally, this method enhances communication and productivity among the team.

Scrum be used on a small scale project with a small team, allowing it to anticipate changes that occur during in the development process [26]. While this method is excellent for small-scale applications that change frequently, it is not recommended for large-scale projects. Product development should be broken down into smaller sprints with care. This method requires experienced personnel who have worked on projects comparable to those now underway. Team members must possess a diverse set of

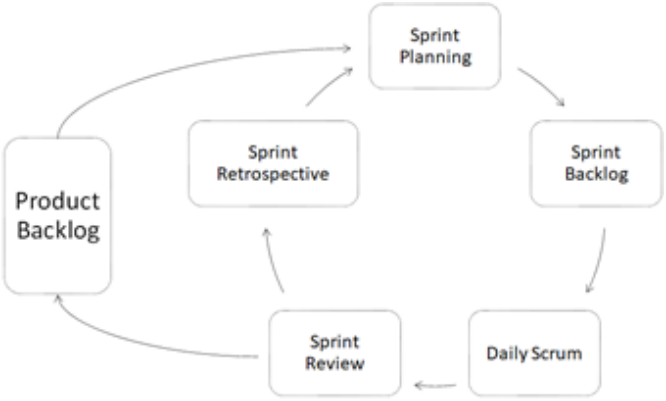


Figure 1. Stages of System Development using the Scrum Approach

talents to enable them to perform tasks outside their area of expertise [27].

3. Methods

The stages of system development using the scrum model are shown in Figure 1, which starts from the product backlog, sprint planning, sprint backlog, daily scrum, sprint review, and sprint retrospective stages.

Product Backlog: At this stage, a requirements analysis is conducted in order to offer thorough information on the development of SIP3. **Sprint Planning:** Following that, plan the work required to develop the system, beginning with the feature description, database design, and user interface design. **Sprint Backlog:** At this stage, work on the developed system components is distributed among the team members. **Daily Scrum:** At this stage, each team member converts the system design into coding activities. **Sprint Review:** At this stage, the constructed information system is evaluated to determine whether it functions well and within the constraints stated or if it still needs improvement. This procedure is repeated weekly. **Sprint Retrospective:** During this stage, the process of developing and enhancing the final system product is carried out based on evaluation and user feedback.

Scrum involves three actors, the product owner, the scrum master, and the scrum team [28]. **The product owner** is the one who is responsible for defining the application's requirements or business processes. The product owner will compile a list of all initial requirements that the team must fulfill (Product Backlog). **The Scrum master** is the individual who manages the scrum process throughout the duration of the project. The scrum master will introduce and implement Scrum's principles to the team, as well as guarantee that everyone on the project follows Scrum's procedures. **The Scrum team** consists of business analysts, systems analysts, developers, and testers, among others. The Scrum team is responsible for completing the Product Backlog that the product owner has compiled.

The data for this study were obtained by interviews, observation and a literature review. Interviews with numerous leaders of the institution were performed to elicit information on the institution's needs and required rules. Direct observation of the business processes of doing research, providing community service, and publication in research and community service center is used to conduct observations. The purpose of the literature review is to add information about the development of information systems.

4. Result and Discussion

A. System Requirements and Analysis

To ensure completeness, a needs study for the development of SIP3 is conducted. Interviews with users/stakeholders such as institutional leaders, researchers, and the academic community yield system requirements. Additionally, recommendations from other universities that have built such a system were solicited initially.

B. System Design

Naturally, prior to developing the SIP3 system, the design was completed in advance to ensure that development was focused. The design process encompasses the creation of use case diagrams, activity diagrams, and class diagrams, as well as the creation of databases and system interfaces as seen in Figure **??**. This step results in the design or prototype of the SIP3 system as shown in Figure 5.

C. Implementation

SIP3 is implemented using a scrum model method, in which projects are completed in teams and daily scrum activities are used to complete the work. Kanban board tools kanbantool.com has been used to scheduling and monitoring the scrum process. The example of Kanbad board shown in Figure 6. The created system is a website-based application that can be accessed using an internet-connected browser. This system was built on the Laravel framework, one of the most extensively used PHP frameworks available today. MySQL is the database management system that is used. The home page, login and registration, research page, community service, and publications are only a few of the existing features.

1) Product Backlog

The system requirements study was conducted through interviews with institutional officials, including the Director of the Research Center, the Director of the Community Service Center, and the Secretary. Additionally, feedback from numerous system users within the existing institution were gathered. Additionally, examinations of comparable systems in other government organizations were done. Finally, this initial step provided a list of features implemented in the system known as Product Backlog, specifically four major features, each of which is described in detail in the Table I.

2) Sprint Planning

The planning process for this system's development is separated into four phases: the development of features for researchers, the development of research features, the

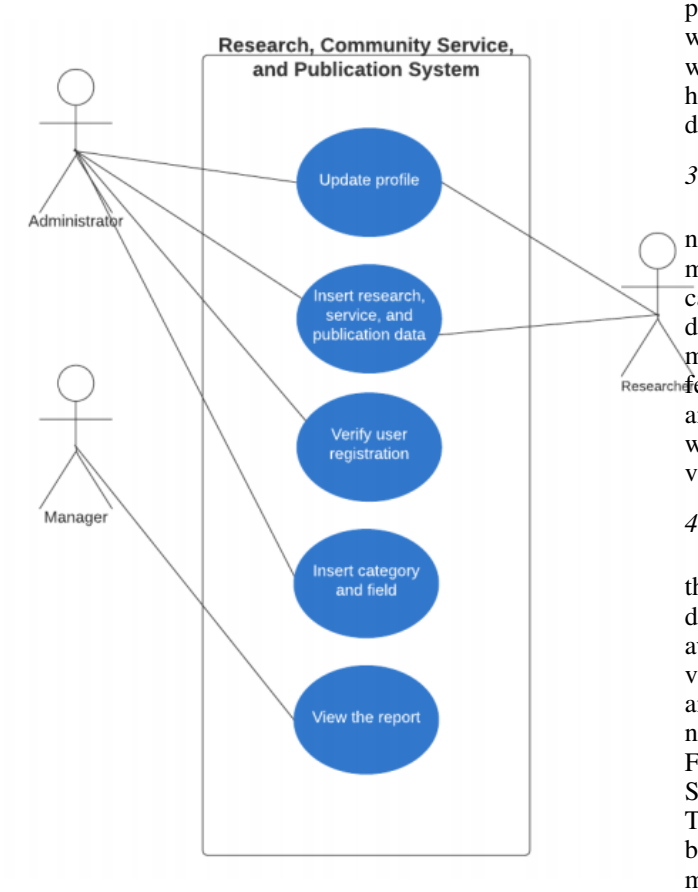


Figure 2. SIP3 application use case diagram

TABLE I. List of Features in Product Backlog

No	Features	Detail of features
1	User Profile	Registration Log in and log out Detail information
2	Research	Create research Filter and search data Research report
3	Community service	Create community service Filter and search data Community service report
4	Publication	Create publication Integration with research and community service Publication report

development of service features, and the development of publication features. On average, each feature takes two weeks to complete, which means that the four features will take around two months to finish. A sprint review is held every two weeks. Prior to constructing the system, the database and user interface are designed.

3) Sprint Backlog

Throughout the system design process, from the business process to the database to the user interface, all team members collaborate. Each person's division of labor is carried out in parallel. After the design is complete, module development begins, which is also done concurrently in one module. For example, in the research module, there is a feature for adding research data, viewing research details, and editing research that is completed by each individual with a single feature starting with the model, controller, and view.

4) Daily Scrum

The Laravel framework version 8 was used to construct this information system, which makes use of the MySQL database management system to handle the database. Laravel's architecture is split into three components: models, views, and controllers. The model is a representation of an item in the database that controls all database connections, and in this system, ten models are generated: Field, Researcher, Type of Publication, Category, Research, Service, Author, Publication, Source of Funds, and User. The Eloquent Model is used to implement the relationship between the model's entities. The controller is a script that manages the system's business activities, such as access privileges, page redirection, and the creation of functions in each module. The view is a script that allows you to display a specific page in your browser. The route/web.php file defines the URLs used to access each page or module, as well as the permissions associated with each URL.

5) Sprint Review

Every two weeks, development progress checks are conducted to ensure that each feature is being implemented as planned. Regular meetings, both offline and online, are held to ensure that the system is operating in accordance with business processes. This assessment is also intended to identify system flaws and bugs. The Scrum Maturity Model is used to evaluate the scrum implementation, which is the extent to which the scrum is implemented, including the implementation of roles, events, and artifacts [29].

6) Sprint Retrospective

Sprint retrospectives are conducted when there is a revision linked to the examination of system development results and, more specifically, when stakeholders have finished an evaluation of the entire system.

D. System Development Result

The SIP3 system's development resulted in the addition of various features/modules, including those for researchers,

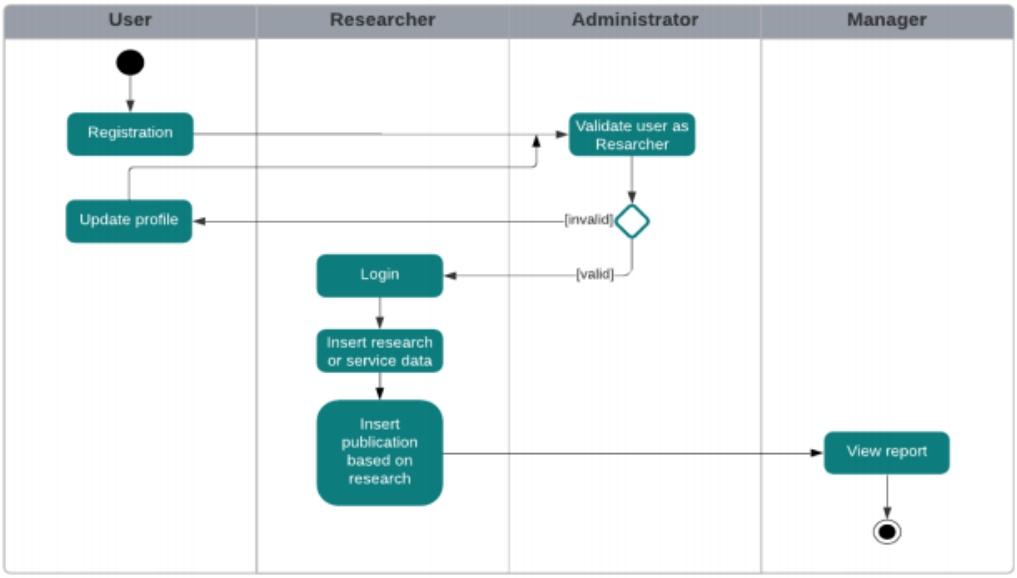


Figure 3. Activity diagram of the researcher registration process and input of research and publication data

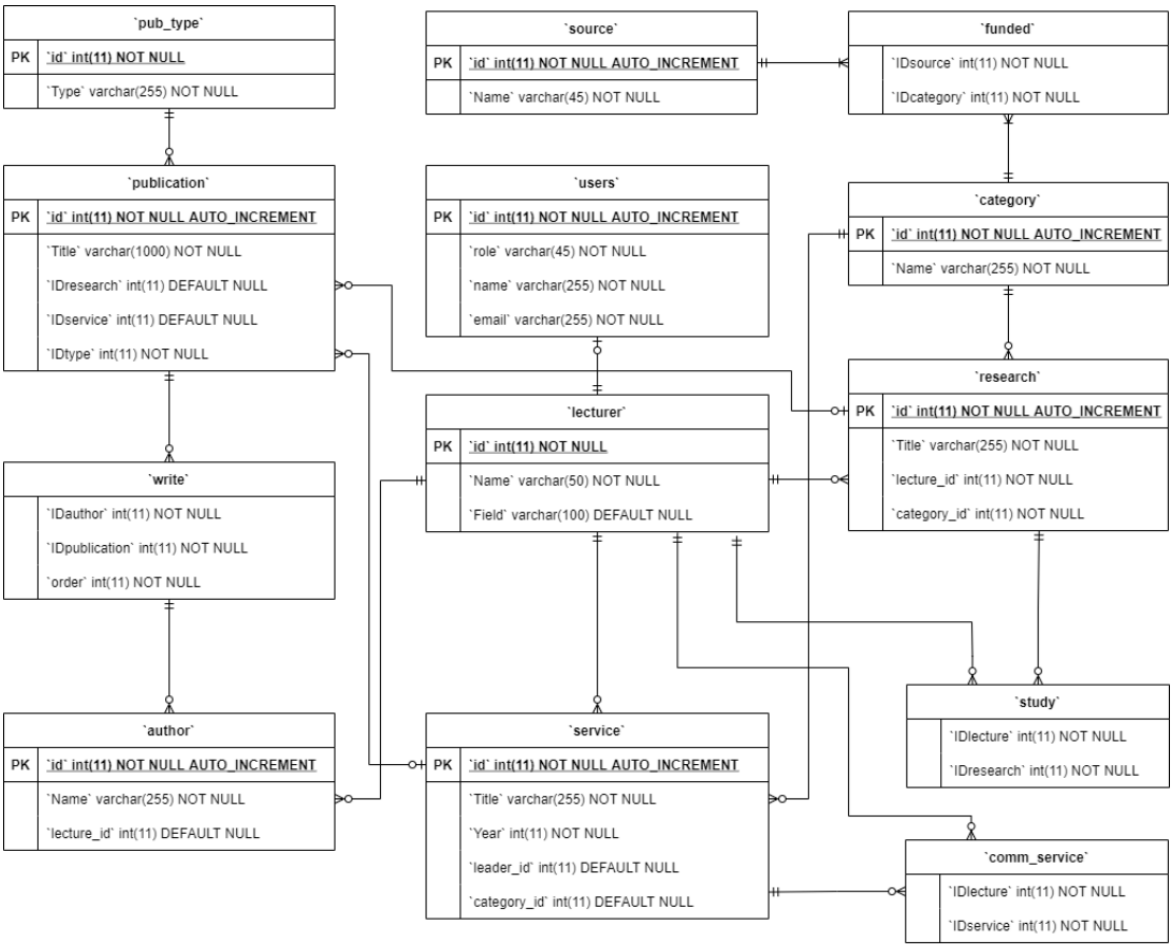
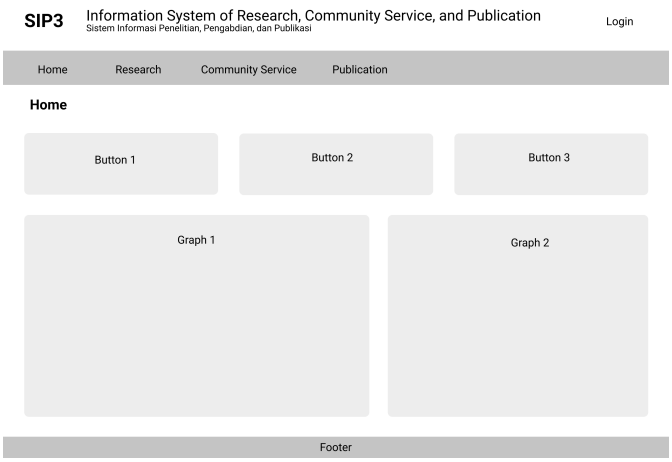


Figure 4. Relational database design for research, service, and publication systems



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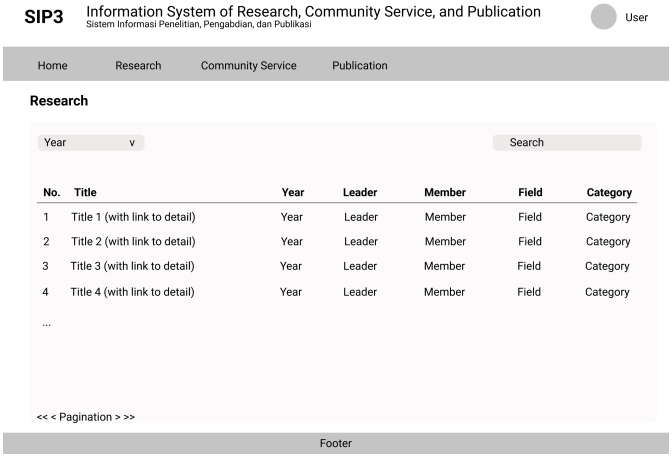

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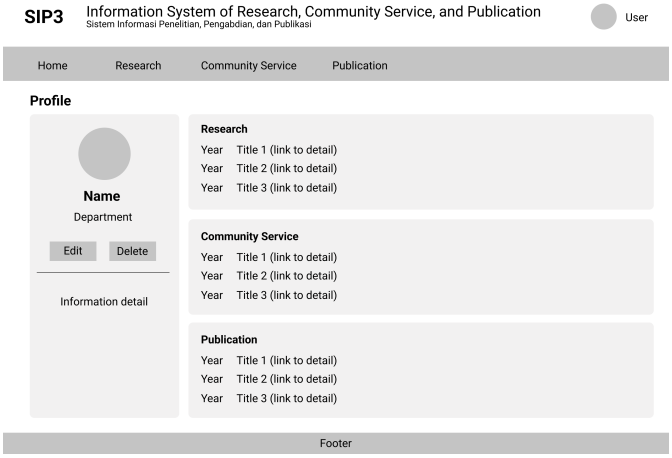


(c)

Figure 5. Wireframe design interface of SIP3 (a) home page, (b) research page, and (c) profile page

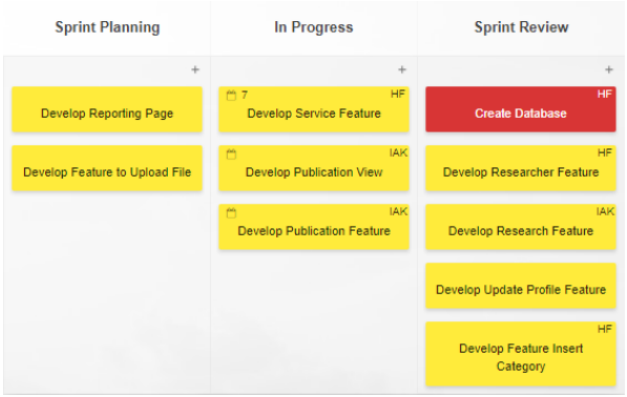


Figure 6. Scrum development using Kanban board

research, community service, and publication. Each feature is designed to be interconnected. The system has been deployed to the server and is now accessible through the Internet.

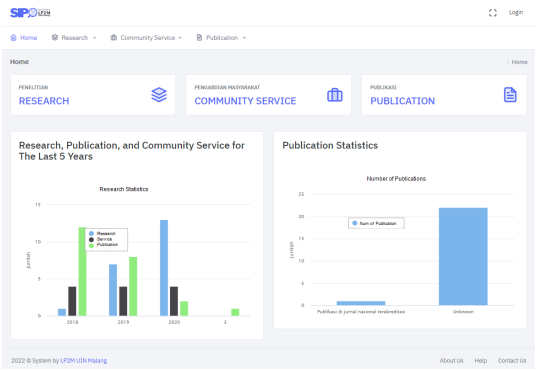
The main system page is divided into three sections: the header part, the body text portion, and the statistical graphs section. There are various buttons on the header section, including Home, Research, Publication, Service, and Login. While in the body area, visitors can navigate via sub menus such as Research, Service, or Publications, as illustrated in Figure 7(a). Both the header button and the body's sub menu direct readers to the currently selected website page.

SIP3 is intended to support three unique user types: visitors, researchers, and administrators. The difference between these three types of users is their varying levels of access. Additionally, admin users possess features for data processing, such as editing, adding, and even deleting data. If the user does not have an account or their email address is not registered, they can create one by clicking the Sign-Up menu at the bottom of the Login page, which will bring them to the registration form.

After logging in, registered users can view their research, community service, and publication data. The page displays a table containing the related data and year. The user can conduct a title search or filter by year. The example of research page shown in Figure 7(b). The advantage of this system is the integration of research data, community service, and publications on user profiles as shown in Figure 7(c).

E. Evaluation

The developed information system has been tested to discover whether it functions properly and within the established boundaries or whether it still requires improvement. Additionally, this step evaluates the effectiveness of the resultant system product through the use of questionnaires distributed to stakeholders and partner institutions. The evaluation considers four aspects of the system, namely the system quality, the information quality, the user satisfaction,



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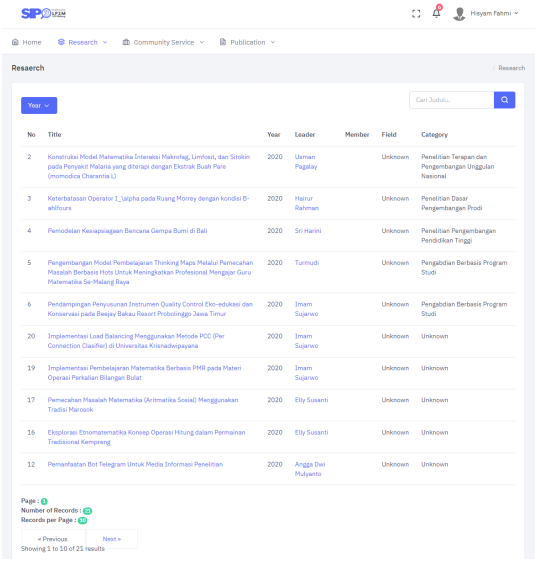

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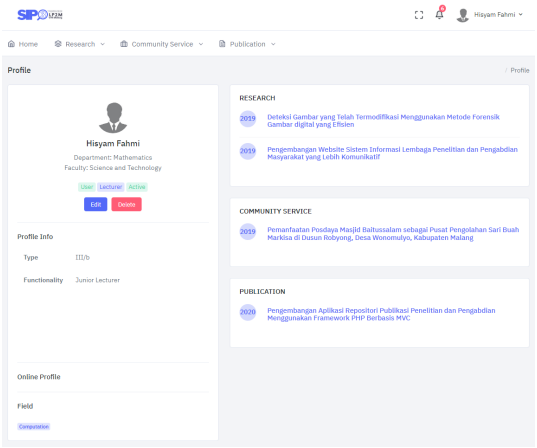

(c)

Figure 7. SIP3 interface (a) home page, (b) research page, and (c) profile page

and the system benefits. Table II summarizes the four aspects.

The assessment was conducted with 30 respondents who attempted to utilize SIP 3 using a Likert scale rating of 5 scales, with 1 indicating extremely improper and 5 indicating extremely acceptable. Table III summarizes the findings of the stakeholder assessment. The aspect with the highest score is the one about the system's benefits, which has an average score of 4.50. Two statements are evaluated in this context: first, SIP3 supports in the more effective and efficient preservation of research, service, and publication data; and second, SIP3 can help minimize data error rates. The highest average score on statement B1 is 4.73.

In terms of information quality and user satisfaction, stakeholders gave it a favorable rating of 3.80 and 3.68, respectively. This demonstrates that the availability of this SIP3 system enables the exchange of information that is both relevant and beneficial for user requirements. The SIP3 system's deficiency is seen in its lowest average score, namely 3.00 for appearance in the aspect of system quality. Thus, it can be claimed that the majority of stakeholders expect a more beautiful design for the system currently being created.

5. Conclusions and Future Work

The Research, Community Service, and Publication Information System (SIP3) was developed in response to an examination of the needs of users engaging in university research, service, and publication activities. The use case diagrams, activity diagrams, and ER diagrams serve as the starting point for system design. SIP3 was built utilizing the scrum methodology and the Laravel framework. This initial system generates four features: a researcher profile, research, community service, and publication. Development takes a short time with this scrum approach, roughly two months for these four features. SIP3 is evaluated for its effectiveness and practicality on the basis of four criteria: system quality, information quality, user happiness, and advantages. The "benefit" component has the highest average score of 4.5 out of the four. The statement evaluated on this point is that SIP3 enables more effective and efficient archiving of research data, services, and publications, and that SIP3 can assist eliminate data mistakes. In the next development it will be focused on integrating with research flow ranging from the submission of research proposals to, assessment by reviewers, to the collection of output and research output.

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TABLE II. System Assessment Aspect

Aspects	Code	Statement
System Quality	S1	SIP3 is easy to use
	S2	SIP3 has an attractive appearance
	S3	SIP3 is useful in the process of recapitulating research, service, and publication information
	S4	SIP3 already integrated
	S5	SIP3 has a user manual facility
	S6	SIP3 is reliable
	S7	SIP3 has fast access
Information Quality	I1	SIP3 produces complete information
	I2	SIP3 generates correct information
	I3	SIP3 produces easy-to-understand information
	I4	SIP3 produces timely information
	I5	SIP3 produces reliable information
	I6	SIP3 generates relevant information
User Satisfaction	U1	SIP3 can help in processing information
	U2	SIP3 is satisfying
Benefit	B1	SIP3 supports in the more effective and efficient preservation of research, service, and publication data
	B2	SIP3 can help minimize data error rates

TABLE III. System Assessment Aspect

Aspects	Variable	Score	Avg	Std. Dev.
System Quality	S1	3.64	3.38	0.237
	S2	3		
	S3	3.73		
	S4	3.45		
	S5	3.36		
	S6	3.18		
	S7	3.27		
Information Quality	I1	3.64	3.8	0.328
	I2	3.55		
	I3	3.45		
	I4	3.82		
	I5	3.91		
	I6	4.45		
User Satisfaction	U1	4.09	3.68	0.410
	U2	3.27		
Benefit	B1	4.73	4.5	0.230
	B2	4.27		

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