



Integration Waterfall and Scrum Methodology in The Development of SIMARGA Web Application

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Abstract

This research explores the integration of Waterfall and Scrum methodologies in the development of the SIMARGA web application. The integration aims to maximize the strengths of each methodology, with Waterfall contributing to planning, analysis, and initial system structure, while Scrum supports the creation of Product Backlog and implementation of Scrum events. The combination results in a structured and methodical product management process, simplifying task lists and enhancing efficiency. The achievement of good efficiency and effectiveness in task execution is facilitated by leveraging both methodologies, reducing wastage. Progress in product development and team productivity is measured through daily meetings, evaluations, and sprint reviews. Emphasis is placed on fostering strong relationships among the Scrum team, customers, and stakeholders, promoting effective communication and collaboration. However, challenges are identified in team commitment to daily meetings, potentially influenced by their involvement in additional business activities. Future efforts should focus on technological resource enhancement and software maintenance to achieve the initially outlined product goals. The effectiveness of this product development initiative can be measured using metrics such as views and user data, particularly in Kabupaten Pegunungan Bintang.

Keywords: waterfall; scrum; web application; methodologies integration; software development

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1. Introduction

The significant growth in information technology in Indonesia has had a profound positive impact, particularly in the cultural domain [1]. Culture plays a crucial role in introducing a region, especially in Indonesia, which boasts over 1728 officially recognized cultural heritages by the Republic of Indonesia's Ministry of Culture [2]. Family names, or "Marga" in Indonesia, particularly in Kabupaten Pegunungan Bintang, Provinsi Papua, are an integral part of cultural richness [3]. Marga reflects the values, norms, degrees, and rules that govern the lives of the local community, encompassing rights to natural resources, residence, and various other entitlements [4].

In this context, information technology becomes a crucial element that needs to be efficiently integrated into the recording and preservation of culture [5]. SIMARGA application is initiated as a strategic step to provide structured information about traditional family names derived from paternal lineages. The development

of such an application requires an appropriate methodological approach, and hence, this research combines the strengths of both Waterfall and Agile Methodologies [6].

Although the use and integration of these two methodologies are not common, literature, such as the research by Shamsulhuda Khan and Shubhangi Mahadik, indicates that the Agile methodology excels in adapting to dynamic changes in the software development environment, while the Waterfall model remains relevant in certain sectors. Agile stands out in project management, schedule management, and customer satisfaction, offering rapid development with low defect rates [7].

Research by Fagarasan, C Popa, O Pisla, A., and Cristea, C explores the effectiveness of Agile methodologies in software projects as an alternative to the Waterfall model. The study focuses on predictability, feasibility, and complexity, highlighting strengths and weaknesses. Among Agile methods,

Scrum is identified as the simplest and most reliable, enabling periodic software delivery to address complex issues and adapt to market changes swiftly [8].

The latest research by Ramadhan, Jadid Alif Haniva, Diandara Tresya, Suharso, and Aries emphasizes the importance of choosing a development methodology for information systems before constructing a system. While the Waterfall method remains a popular choice, this study aims to compare the use of development methodologies, including systematic Waterfall, Agile, and Hybrid method that combines both. The results indicate that Waterfall is suitable for small-sized projects, Agile is appropriate for projects with short timeframes, and the Hybrid method can be employed when benefits from both methodologies are needed [9].

Previous research [10] on the development of traditional family-name web applications still utilized the Extreme Programming framework. Subsequently, in the prior studies regarding the implementation of the Waterfall and Scrum frameworks [11], [12], there was a lack of proper document usage. Therefore, in this research, we provide a novel contribution by constructing a traditional family name web application using the integration of the Waterfall and Scrum frameworks.

Combining the findings from the literature, this research evaluates that the integration of both Waterfall and Agile methodologies can enhance the efficiency of application development [13]. The Waterfall approach provides a strong foundation for initial planning and design [14], while the integration of Scrum as a representation of the Agile methodology brings the adaptability and team collaboration necessary to address changing requirements during development [15]. Titled "Integration Waterfall and Scrum Methodology in The Development of SIMARGA Web Application," this research aims to optimize the efficiency and quality of SIMARGA application development [16]. It not only focuses on technological aspects but also considers the relevance of the traditional family name structure system in Kabupaten Pegunungan Bintang amidst the dynamics of societal changes. The hope is that the integration of Waterfall and Scrum methodologies will result in a SIMARGA application that not only meets initial specifications but also adapts to changes during development, while still paying attention to and preserving the integrity of cultural values and traditions in Kabupaten Pegunungan Bintang.

2. Research Methods

In this study, the development of our application, SIMARGA, employs a unique approach by integrating both Waterfall and Scrum methodologies. The integration aims to leverage the strengths of each methodology to create a more efficient and adaptive development process. While Scrum provides a lightweight and flexible framework, Waterfall

contributes structured planning and initial design phases [6] [9].

The decision to combine both methodologies arises from a thorough literature review and in-depth research [7], [9], leading to the formation of a system development method that integrates both Waterfall and Scrum.

2.1 Integration of Waterfall and Scrum Methodology

The Implementation of the Waterfall in developing the SIMARGA Application involves an initial analysis stage that encompasses planning, analysis, and initial design [14]. In the planning phase, the SIMARGA application development team conducts a comprehensive analysis of the project's objectives, schedule, resources, and budget. This aims to create a robust project planning document. In the analysis phase, the SIMARGA application development team identifies functional and non-functional requirements of the SIMARGA application. This is done through collaboration with relevant parties, including the Dinas Kebudayaan Kabupaten Pegunungan Bintang, to obtain a document of system requirements to be fulfilled.

Furthermore, in the Initial Design phase, the SIMARGA Application development team will design the system structure and system architecture. This includes interface concepts, usage, database structure, and the system model of the SIMARGA Application. These steps are taken to ensure that the initial stages of the SIMARGA Application development proceed smoothly and meet the previously identified system requirements.

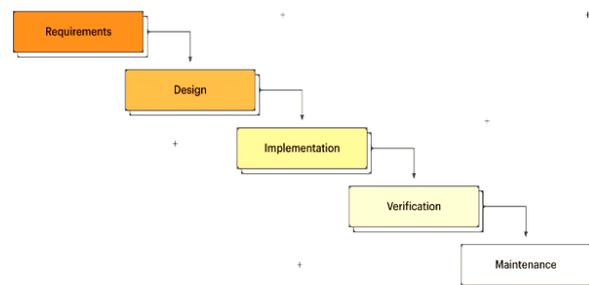


Figure 1. Waterfall Methodology [17]

Incorporating Scrum during the iterative development phase of the SIMARGA Application enables adaptability to evolving requirements and enhances collaborative teamwork efficiency. This approach is informed by the initial analysis undertaken through the Waterfall Method (Figure 1). According to the Scrum Guide, Scrum Events are structured to coordinate a sequence of tasks with the goal of establishing coherence and minimizing the necessity for redundant meetings within the Scrum framework [18]. For optimal simplicity, it is recommended that all events occur simultaneously and in the same location. The visual representation in Figure 2 showcases the five Scrum events, namely sprint, sprint planning, daily scrum, sprint review, and sprint retrospective.

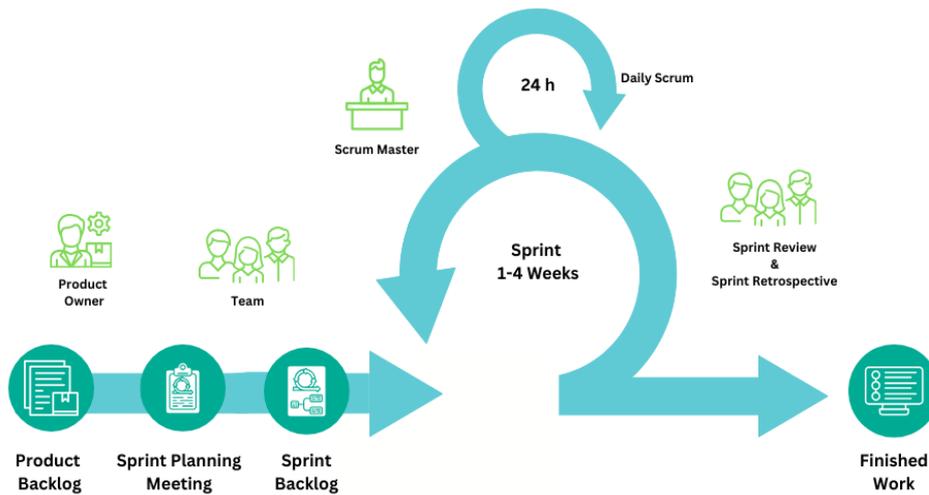


Figure 2. Scrum Event [19]

During this phase, ideas are translated into valuable outcomes. Sprints typically span one month or less, encompassing all essential tasks for reaching product milestones. This encompasses tasks like sprint planning, daily scrum, sprint reviews, and retrospectives. It is imperative during the sprint to steer clear of significant deviations from the sprint goal, uphold product quality, and fine-tune the product backlog as required [18].

Sprint Planning is dedicated to carrying out all tasks within its scope. The outcome of this process is the collective effort of the Scrum team. Additionally, individuals external to the Scrum team are welcome to contribute suggestions during sprint planning [18]. The daily scrum serves the objective of showcasing advancements toward the sprint goal and fine-tuning the subsequent work plan. This 15-minute event is exclusively designed for the Scrum development team. To streamline operations, the daily scrum typically occurs at a consistent time and location, fostering enhanced communication among members of the Scrum team [18].

The outcomes of the Scrum team's efforts and the product goal's advancement are showcased to stakeholders during the sprint review. This event is aimed at examining the sprint's results and deciding on subsequent actions. The Scrum team and stakeholders evaluate the achievements of the sprint and any changes in their environment during this gathering [18]. The Sprint Retrospective aims to enhance quality by evaluating the Scrum team's performance in areas like individuals, interactions, processes, tools, and the definition of done from the previous sprint. This time-boxed event, concluding the sprint, lasts up to three hours for a one-month sprint, with shorter sprints requiring less time. [18].

Based on the functions and applications of the Waterfall and Scrum methods, a system development model is formed as a result of integrating the Waterfall and Scrum Methods in the SIMARGA application development process. This aims to optimize, streamline, and provide structured documentation. The system development model can be seen in Figure 3.

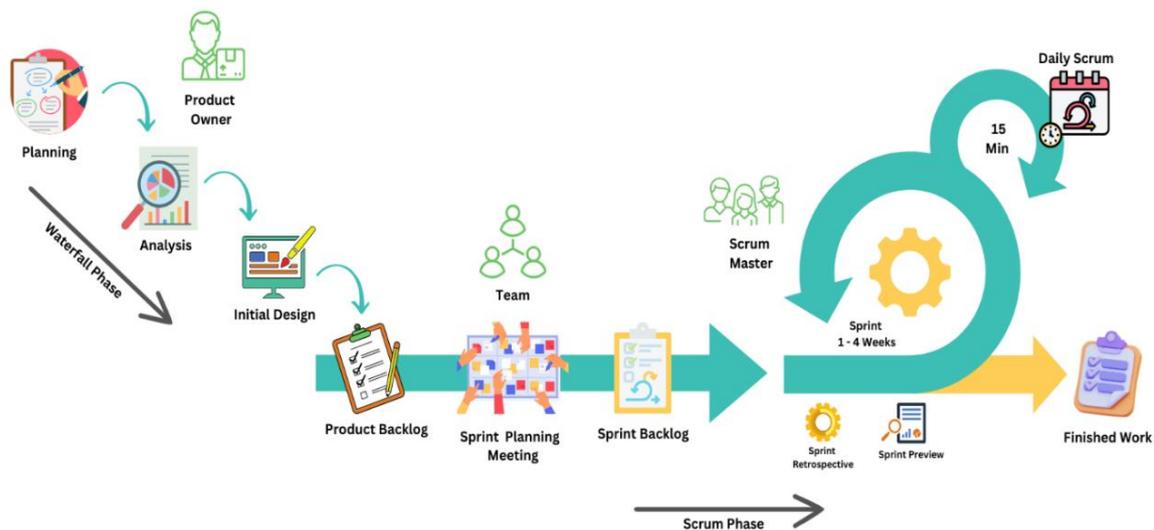


Figure 3. Integration Waterfall and Scrum Methodology

2.2 Tools

We utilize various tools to enhance the team's capabilities in accomplishing specific tasks, especially in managing assignments for each team member. These tools are accessible to every member through the feature of link sharing. Figma (figma.com) serves as an assistant in creating collaborative interface designs for the application. Google Docs (docs.google.com/docs) and Spreadsheet (docs.google.com/spreadsheets) function as tools for documenting notes and recording a series of tasks to be completed.

Google Meet (meet.google.com) and Zoom (zoom.us) are used as tools to facilitate online meetings and discussions regarding the application's development progress.

Miro Board, available at miro.com, asserts itself as a rapid, cost-free, and user-friendly digital whiteboard designed for collaborative tasks. It offers an expansive canvas suitable for diverse activities like research, design, planning, strategy development, classroom instruction, and agile workflow management [20].

The notion is accessible at the notion.so, emerges as an innovative workspace designed for collaborative teamwork. It employs customized markdowns and provides various templates, including Kanban boards, tasks, wikis, and databases. This versatility makes Notion well-suited for activities such as note-taking, organization of knowledge and data, as well as managing projects and tasks.

3. Results and Discussions

In this research undertaking, we adhered to the specified protocols, aligning our approach with the principles of both Waterfall and Scrum methodologies. Each methodology yielded outcomes that harmonized to produce a product of heightened developmental value. Comprehensive documentation and visuals were also produced to elucidate the integration and application of both methodologies in creating the SIMARGA application, ensuring a structured and effective development process.

3.1 Result

After assigning roles and functions to each method, the Waterfall method becomes the first approach utilized in the development of the SIMARGA application. The development team collaborates with stakeholders, specifically Dinas Kebudayaan Kabupaten Pegunungan Bintang, through direct interviews to gather project planning documents. The document encompasses various aspects, such as the purpose of building the SIMARGA application, aiming to serve as a platform for the community to access information regarding family structures and cultural heritage rights left by ancestors. Additionally, it serves as a digital inventory for cultural preservation in Kabupaten Pegunungan Bintang. The planned schedule is approximately 1-2 weeks for completion, along with the identification of

resources to be used in managing this application, including the Application Manager, System Specifications, and an agreed-upon work contract.

Moving forward in the same stage of SIMARGA application development, the development team will create an initial system structure or early design of the application. This will serve as the foundational basis for application development and as a guide to determine the priority of the Product Backlog in the Scrum method, which will be divided into several sprints and executed accordingly. Figure 4 illustrates activities that users can engage in within the SIMARGA application, portrayed through an Activity Diagram. The Activity Diagram is an illustration or representation of user, system, and database activities in using the application [21]. Users can perform various activities, such as searching for "Marga" or family names, creating a personal profile, entering family data, viewing family structures in a tree format, and obtaining data about the number of families registered in the SIMARGA application.

In Figure 5, there is an architectural system that will be utilized in the SIMARGA application. This system architecture consists of three major elements: Client, Server, and Data [22]. These three elements are interconnected to obtain input and feedback in line with the requests. The product goal obtained from previous activities is clear and accurate, with reinforcement from the Waterfall method's functions serving as a good starting point in the initial stages of Scrum Events. This efficiency in SIMARGA application development is evident in terms of time and execution, demonstrating high business value due to the strong initial product goals. [23], [24].

Table 1 illustrates the outcomes of stakeholder interviews, specifically those with Dinas Kebudayaan Kabupaten Pegunungan Bintang, transformed from the Activity Diagram into a tabular format. This facilitates the generation of simplified and summarized Product Backlog items derived from user requirements. Subsequently, the development team can focus on tasks or products aligned with each sprint based on this streamlined information.

Figure 6 displays the Sprint Backlog, incorporating interview outcomes structured as incrementally arranged Product Backlog items. Each sprint is distinctly defined with a specific goal. In the development of the SIMARGA application, each sprint spans one week and maintains a consistent number of items.

Figure 7 illustrates the conversion of interviews and activity diagrams into a Notion-based "To-Do" list, facilitating the effortless monitoring of product development progress and ensuring transparent task allocation to team members.

Figure 7 displays Sprint 1's Sprint Backlog, categorized into "to do," "doing," and "done." The ongoing development tasks encompass sign-in, sign-up,

authentication, profile, and log-out. Each item entails the current emphasis on authentication, while the multiple tasks assigned to the development team. profile and log-out are the remaining items in progress. Notably, sign-in and sign-up have been completed, with

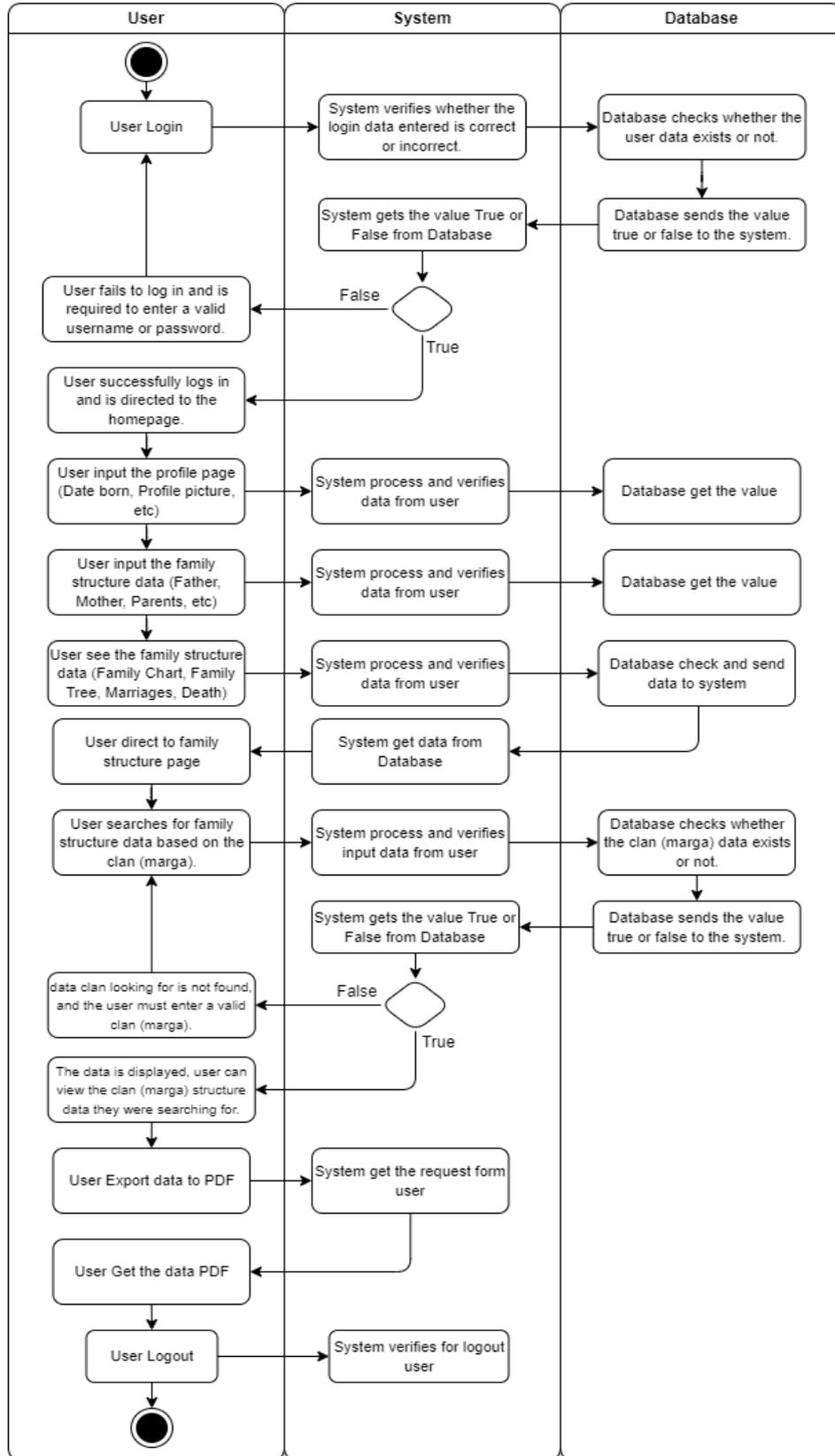


Figure 4. SIMARGA Activity Diagram

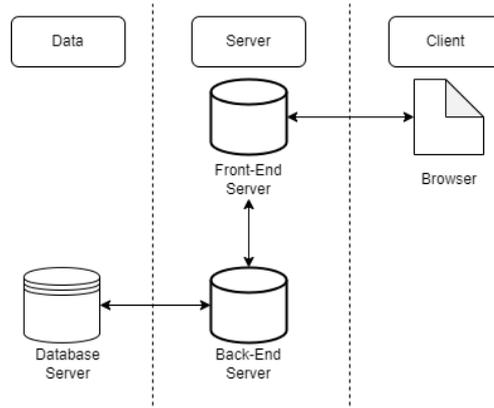


Figure 5. SIMARGA System Architecture

Table 1. Interview Result for Product Backlog

Items	Description
User Registration Mechanism	Implement a registration system using email, enabling users to create accounts and join the application.
User Login Mechanism	Establish a login mechanism using email to facilitate users in accessing their previously created accounts.
Database Integration	Create a system that seamlessly integrates with the database at Dinas Kebudayaan Kabupaten Pegunungan Bintang.
Homepage Creation	Develop a homepage allowing users to search for "Marga" or family names.
Family Tree Structure	Implement a family tree structure to enable users to easily trace their lineage.
Family Count Display	Create a display showcasing the number of families for users to obtain accurate information.
Profile View for "Marga"	Design a profile view for the searched "Marga" encompassing personal and familial aspects.
Wealth Rights Information	Display information regarding the wealth rights of each "Marga" for user understanding.
Notification Feature:	Implement a notification feature to inform family members when a family with the same "Marga" inputs data.
Map Feature	Create a map feature indicating the birth and death places of an individual.
Backup History and Data Upload	Establish a page for backup history and data upload, facilitating administrators in storing the latest information.
User Profile Page	Develop a Profile page for users to view and edit their profiles.
Integrated Profile Page	Integrate the Profile page with other families, allowing users to easily input data.
Log Out Button	Implement a LogOut button for users to exit the SIMARGA application effortlessly.

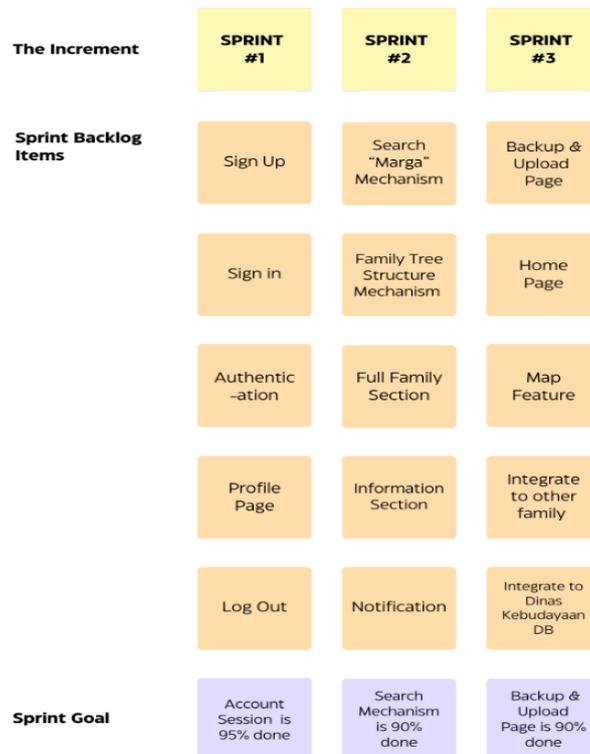


Figure 6. SIMARGA Web Application Product Backlog and Sprint Goals

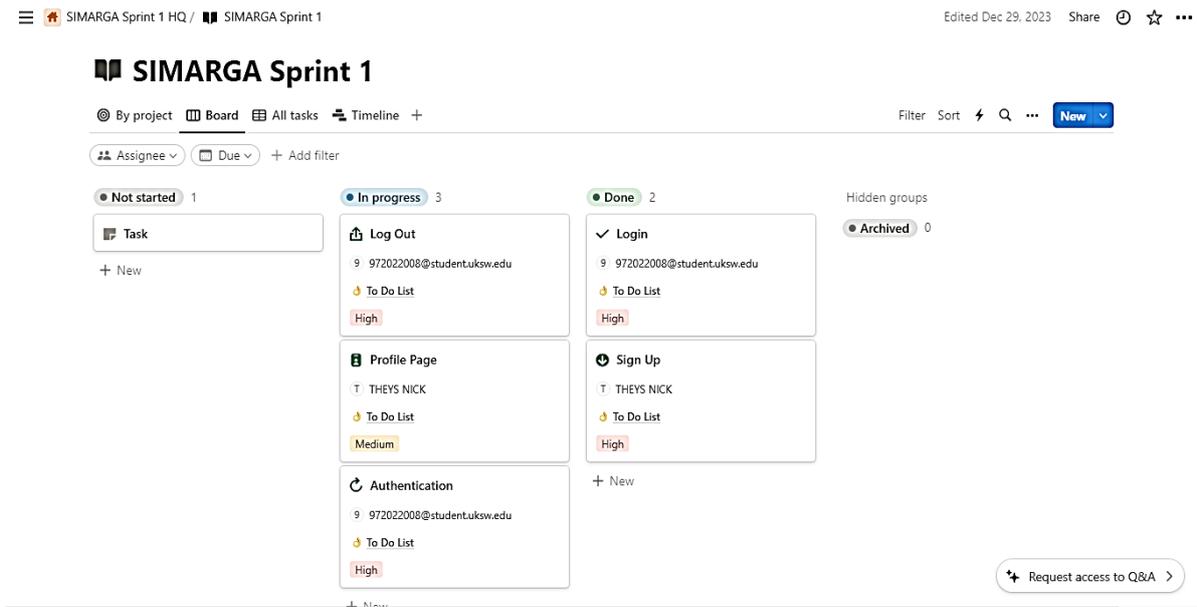


Figure 7. Product Backlog using Nation.os

In Figure 8, Scrum's Definition of Done is depicted, offering the development team a clear comprehension of the criteria necessary for considering Product Improvements as releasable. When an increment is labelled as "done," it implies that all members of the development team must have a shared understanding of what 'Done' signifies.

With appropriate guidance and a well-structured schedule, the Sprint framework can prove to be an exceptionally efficient approach for fostering team collaboration [20], [25]. We use the sprint calendar to schedule our scrum events, encompassing sprint planning, daily meetings, sprint reviews, and sprint retrospectives. The aim is to maintain organizational efficiency, ensuring adherence to the timetable and keeping essential scrum activities in focus. This practice not only keeps us on track but also prevents unnecessary delays during sprint planning and development, thanks to the predefined outline.

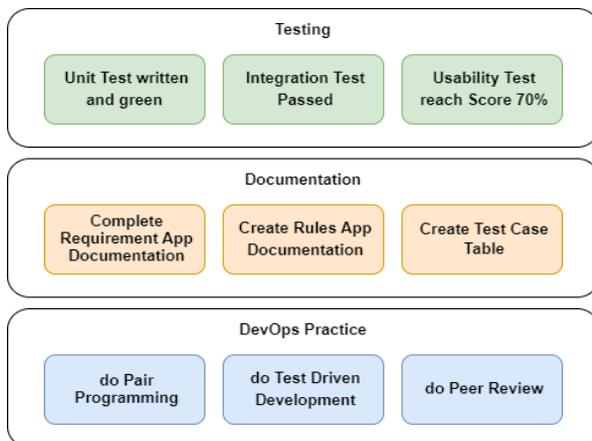


Figure 8. DoD of SIMARGA Web Application

In Figure 9, the development team adheres to the sprint calendar, ensuring prompt execution of all sprints. For example, on November 1, 2023, sprint planning occurred, followed by daily scrum meetings on the subsequent day. These daily meetings play a crucial role in monitoring SIMARGA's development progress and addressing team issues. On November 6, 2023, both a sprint review and retrospective were conducted, maintaining the outlined agenda for the first week.

Sprint planning is a vital session where the sprint goal, development timeline, and tasks for the team during the sprint are extensively deliberated. This scrum event requires the engagement of all members of the scrum team [26]. The scrum master bears the responsibility of ensuring that all team members participate in and comprehend their roles and responsibilities during sprint planning.

Figure 10 outlines the roles and responsibilities of each scrum role during sprint planning. The product owner is tasked with specifying stakeholder requirements, managing the product backlog, and prioritizing backlog items. Meanwhile, the scrum master leads team meetings, assists in prioritizing the backlog, and ensures the development team stays on track. The development team is tasked with reviewing or showcasing the product, updating team progress, and planning tasks for the upcoming sprint. In the SIMARGA application development, we integrate Waterfall and Scrum, employing Waterfall for initial Document Analysis in collaboration with stakeholders. This method involves modifying Scrum roles and engaging key participants such as the product owner, scrum master, development team, and stakeholders in the SIMARGA development process.

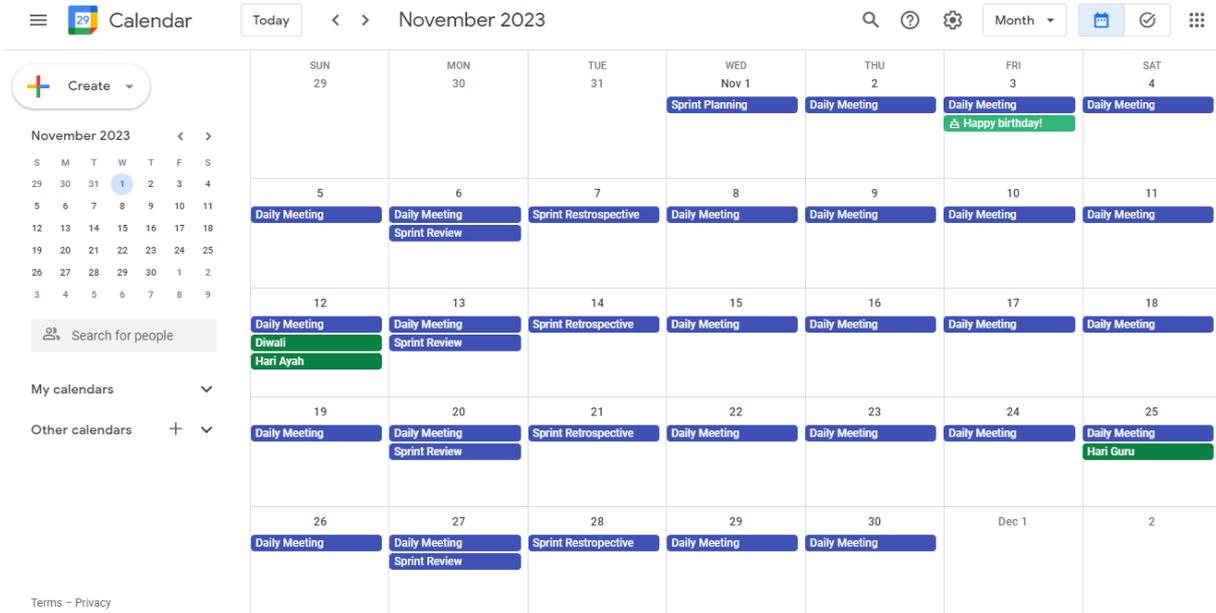


Figure 9. Sprint Calendar for SIMARGA Web Application



Figure 10. Roles Responsibility in Sprint

In Figure 11, the roles in the development of the SIMARGA application are outlined. Mr. Melkior N.N Sitokdana serves as the stakeholder representing the Dinas Kebudayaan Kabupaten Pegunungan Bintang. As a stakeholder, he collaborates with Marko, the product owner, who communicates with the team regarding development progress and manages the product backlog, incorporating stakeholders' desires. In the hierarchy, Nikson, as the Scrum Master, oversees the Scrum team's efficiency, ensuring the team navigates conflicts or obstacles without direct involvement in product development, the scrum master plays a crucial role. On the technical front, the development team, consisting of Bram (UI designer), Lody (DevOps specialist), Herfandy (Backend Developer), and Yandri (Web Master), adopts a cross-functional and autonomous approach to achieve the product goals. Additionally, the Daily Scrum, a concise 15-minute daily activity, is conducted by the development team. [27].

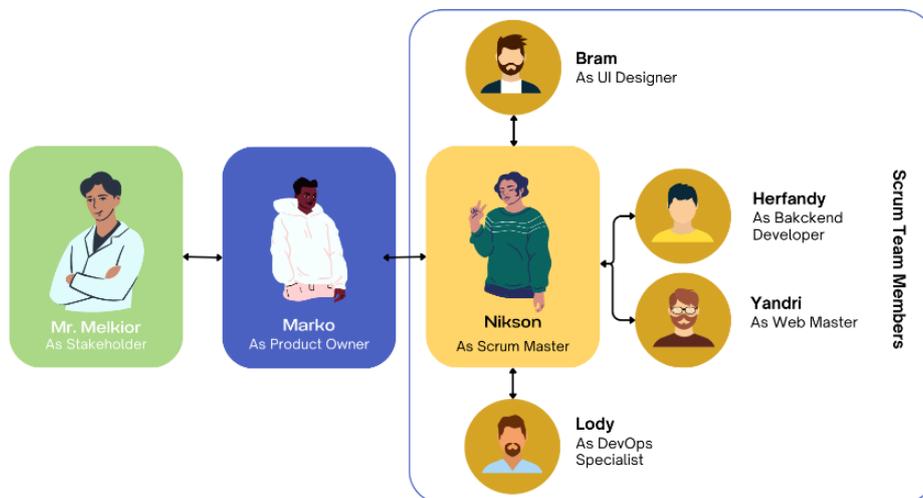


Figure 11. Scrum Roles in SIMARGA Web Application

During these daily meetings on November 4, 2023, documented in Figure 12, each team member answers three key questions: "What did you do yesterday?", "What obstacles are impeding your progress?", and "What are you working on today?". The "What did you do yesterday?" reports are related to the tasks completed the previous day, with each team member providing a unique update. Bram reports the completion of the registration page design, Lody has finished OTP via Email, Yandri has created a service for new users, and Herfandy has developed a database to store user data. In the "What obstacles are impeding your progress?" segment, none of the team members reported facing obstacles during this particular daily meeting. The final section, "What are you working on today?" outlines the tasks to be accomplished on that day. Bram will design the profile page, Lody will assist Yandri in integrating OTP into Email, and Herfandy will work on the registration page display. The daily scrum activities play a crucial role in monitoring the development team's performance and checking the sprint project's objectives.

In the Sprint Review, the Scrum team presents their achievements to stakeholders, participating in discussions and assessments of the progress toward the product goal [28]. Figure 13 illustrates the scrum team's activities, showcasing the ongoing progress of the SIMARGA application through Zoom Meetings.

The purpose of the sprint retrospective is to assess the efficacy of the preceding sprint and integrate the insights or achievements into the planning of the subsequent sprint [27]. The duration of the retrospective sprint aligns with the sprint duration; for instance, if the sprint extends over 1 month, the maximum timeframe is set at 3 hours. Illustrated in Figure 14 is the retrospective sprint in this study, where each member of the development team reviews the completed sprints. While Bram and Lody expressed satisfaction with the work accomplished during the sprint, Herfandy offered feedback to ensure tasks were executed effectively and systematically. On the other hand, Yandri recommended maintaining smooth and effective communication.

Daily Meeting (November 4, 2023)

	 Bram As UI Designer	 Lody As DevOps Specialist	 Herfandy As Backend Developer	 Yandri As Web Master
What did you do yesterday?	Complete a High Fidelity of Sign Up Design Page	Finished OTP Code by Email For Registration	Complete to Design and Create Database For SIMARGA APP	Finish to Create a Service For New User
What obstacles are impeding your progress?	Don't have issue blocking me to work	Don't have issue blocking me to work	Don't have issue blocking me to work	Don't have issue blocking me to work
What are you working on today?	Bram will create and design High Fidelity Profile page	Lody will Assist Yandri to make Integration OTP into Email	Herfandy will create and make a Registration Page	Yandri will make Integration OTP into Email

Figure 12. Daily Meeting Activity Result

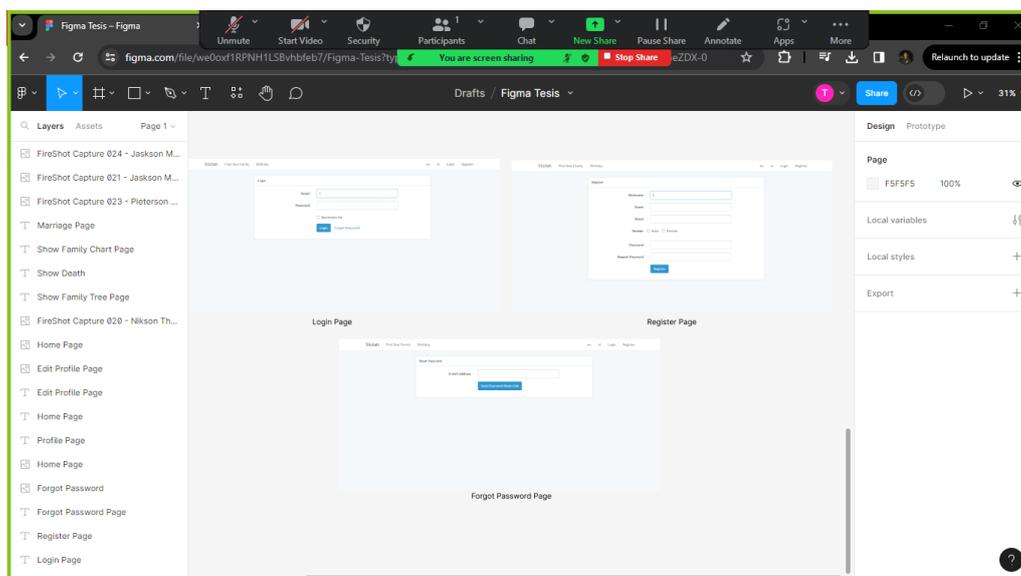


Figure 13. Sprint Review Activity Result using Zoom Meeting



Figure 14. Sample of Sprint Retrospective Activity Result by Team

3.2 Discussion

Drawing from the outcomes of the conversation, multiple benefits and advantages emerge from incorporating the integration of Waterfall and Scrum Methodology in the ongoing development of the SIMARGA Application, as detailed in the presented Table 2.

Table 2. The Advantages of Integration Waterfall and Scrum Methodology into the Development of the SIMARGA Web Application

Issue	Benefits
Application Work Design	Well-planned and analyzed processes in the early Waterfall stage can make Scrum highly powerful in the development process.
Clarity of Work Items	The Waterfall method is capable of fulfilling all requirements upfront, forming the basis for creating the Product Backlog in Scrum.
Time Efficiency	The detailed tasks shared in Scrum, typically over 1-2 weeks, are very clear for the development team.
Product Control	Creating a To-Do List using Nation.os significantly aids in controlling work effectively.
Business Process Changes	The development process is highly flexible, adapting to essential changes aligned with business requirements. In the final sprint, the team incorporates new tasks based on input, paving the way for the next sprint.
User Feedback	Users actively contribute to product development by testing and offering feedback. Alignment of user and stakeholder requirements is crucial during sprint discussions.
Project Transparency	During the sprint review, each team member presents their sprint work, providing a comprehensive overview of the product development progress.
Maximizing Team Performance	Communication and collaboration through sprint reviews and retrospectives within the development team can maximize work performance.
Ease of Use	Two user-friendly methods capable of complementing each other's shortcomings, resulting in the creation of a more efficient product.

Based on Table 2, The incorporation of the Waterfall and Scrum methodologies in the development of the SIMARGA application yields nine significant benefits. This integration is designed to address the challenges of an undocumented and time-consuming software development life cycle, aiming for enhanced efficiency and effectiveness. The complementary nature of these two development models is evident in the thorough analysis and detailed task estimation that Waterfall provides at the outset. Moreover, Scrum facilitates user

engagement in the product development process through feedback and reviews, promoting transparency within the development team to reduce the occurrence of communication errors. Moreover, the schedule and sprint planning in Scrum, rooted in Waterfall principles, support tracking and controlling productivity throughout software development, enabling precise determination of time costs. Throughout the development of the SIMARGA application, Daily Meetings serve as a pivotal activity, enhancing communication among development team members and ensuring everyone is informed about the progress of application development. After each sprint, a Sprint Retrospective is conducted to evaluate each developer's work, providing insights into the ongoing product development. The successful execution of the Waterfall and Scrum methodologies in the development of the software application is attributed to our adherence to the distinct characteristics and functions of each methodology. This commitment is evident in our real-world application of Waterfall and Scrum, ranging from interviews to intensive communication, and the formation of a team in alignment with established guidelines. The success of this integration is gauged by the extent to which we follow the guidelines, facilitated by well-documented Scrum practices, which streamline progress tracking, act as a reference during system development, serve as archival records, and assess the integration of Waterfall and Scrum across the entire development process are essential roles.

4. Conclusions

Based on the development of the SIMARGA web application through the integration of Waterfall and Scrum methodologies, several conclusions can be drawn as follows: (1) The integration of Waterfall and Agile methodologies maximizes the use of each methodology, where Waterfall aids in planning, analysis, and the creation of the initial system structure while supporting Scrum in creating the Product Backlog and implementing Scrum events. (2) The product management process can be structured and methodical in task completion, thanks to a framework that simplifies the creation of a to-do list. (3) Good efficiency and effectiveness in task execution are achieved by utilizing both methodologies, reducing wastage. (4) Progress in product development and team productivity can be measured through daily meetings, evaluations, and sprint reviews. (5) Building good relationships among the Scrum team, customers, and

stakeholders is emphasized. (6) Communication and teamwork among the team members can be significantly enhanced. The evaluation we obtained from integrating Waterfall and Scrum in the development of SIMARGA indicates that team members face challenges in committing to direct daily meetings, perhaps attributed to their engagement in additional business activities beyond application development, the participants may encounter challenges. For future endeavors, there is a need to augment technological resources and focus on software maintenance to attain the product goals initially outlined. The effectiveness of this product development initiative can be measured using metrics like view counts and usage data, particularly in the Kabupaten Pegunungan Bintang, Provinsi Papua.

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