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Implementation of Project Management in the Development of an Android-Based Household Waste Monitoring System using JIRA Software

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Abstract

The increasing amount of household waste presents a major environmental challenge, worsened by inefficient and outdated waste management practices. Traditional systems lack real-time monitoring and responsiveness, creating a gap in timely waste management. This research introduces a creative solution through the development of an Android-based Household Waste Monitoring System, integrating Internet of Things (IoT) technology to provide real-time data on waste bin capacities and immediate notifications. Unlike conventional approaches, this system creatively bridges the gap by enabling proactive waste management through instant alerts and real-time tracking, allowing users to act before issues escalate. The system development follows an Agile/Scrum framework, fostering rapid iteration and user-driven enhancements. Through the innovative application of IoT and Agile methodologies with JIRA Software, this solution effectively addresses the inefficiencies of current waste management systems, as evidenced by an 80% success rate across five testing activities. This creative approach not only improves development efficiency but also accelerates adaptability in response to evolving waste management needs.

Keywords: Household Waste; Internet of Things (IoT); Android; JIRA Software; Agile/Scrum.

1. Introduction

Environmental pollution caused by the accumulation of waste in rivers, both in urban and rural areas, has become increasingly common and is a serious concern. Environmental pollution due to the accumulation of household waste is a growing concern, particularly in both urban and rural areas. In Indonesia, waste management systems are decentralized, with local governments tasked with waste transportation and disposal. However, these systems face significant challenges, including limited resources, inadequate monitoring, and a lack of real-time data to efficiently manage waste (Putri, 2024). In Indonesia, waste management is one of the country's most pressing environmental challenges. As a result, waste is often left uncollected for extended periods, leading to environmental degradation and public health risks (Ngurah, 2024). With rapid population growth, urbanization, and increased consumption, the volume of waste generated is rising each year (Prihatin, 2020). This leads to a variety of problems, ranging from environmental impacts to public health risks. Indonesia's waste management system is decentralized, with local governments responsible for waste transportation and disposal, using local budgets (Cahyandari & Pradana, 2022). The community also typically pays a levy to fund waste transportation services to temporary disposal sites. However, this system faces several challenges, such as limited resources, limited management capacity, and suboptimal operational monitoring processes (Hendrawan, Chatra, Iman, Hidayatullah, & Suprayitno, 2024).

Effective waste management is a major challenge for many cities around the world, including in Indonesia. The growing volume of waste, driven by population growth and urbanization, demands more sophisticated and efficient solutions (Ilmananda, Marcus, & Pamuji, 2022). The Internet of Things (IoT) has emerged as a promising technology to enhance waste management in a smarter and more integrated way (Erwin et al., 2023).

IoT can transform waste management by integrating sensor technology, data communication, and analytics to create a more responsive and efficient system (Gusdevi, Hadhiwibowo, Agustina, Fatah, & Naseer, 2023). Some of the key benefits of IoT in waste management include real-time monitoring, data prediction and analysis, recycling management, and alerts/notifications (Amane et al., 2023).

In today's rapidly developing digital era, developing fast, efficient, and adaptive information systems is crucial to meet dynamic market conditions

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and evolving user needs (Amane et al., 2023). In fact, the use of information systems is now widely used as a medium for the availability and ease of access to information on a wide scale (Fikri, Lubis Ghozali, & Darsih, 2025). Agile methodologies, particularly Scrum, have become popular approaches in software and information systems development (Haniva, Ramadhan, & Suharso, 2023; Tohirin, Utami, Widianto, & Al Mauludyansah, 2020). Agile/Scrum offers solutions to the challenges faced by traditional development methods, with a focus on flexibility, collaboration, and continuous improvement (Maghfirah, 2023).

Agile methodology, based on the Agile Manifesto, emphasizes flexibility, collaboration, and rapid response to change (Bushuyev, Bushuyeva, Bushuiev, Babayev, & Babayev, 2021; Rantung & ST, 2024). Agile utilizes an iterative and incremental approach to software development, making it easier to implement changes and adapt quickly. Key principles of Agile include short iterations, team collaboration, responsiveness to change, and the rapid delivery of value (Islam & Ferworn, 2020; Magdalena et al., 2023; Waja, Shah, & Nanavati, 2021).

The problem lies in the inefficiency and outdated nature of traditional waste management systems, which rely heavily on manual monitoring and delayed responses to waste overflow. Existing solutions do not leverage advanced technologies like the Internet of Things (IoT) to provide timely and actionable information. This creates a gap in the ability to respond to waste issues promptly and effectively.

This research aims to address the critical need for a smarter waste management system by developing an Android-based Household Waste Monitoring System that integrates IoT technology for real-time data collection and notification. The system creatively bridges the gap by enabling proactive waste management through instant alerts when trash bins are full, improving responsiveness and operational efficiency. The system is developed using Agile/Scrum methodology with JIRA Software, which facilitates rapid adaptation to user feedback and changing needs.

This paper presents the methodology used in the development of the system, the challenges encountered, and the solutions that were implemented. The results demonstrate a significant improvement in the efficiency of waste management processes, with an 80% success rate across five key testing activities.

2. Literature Review

2.1. IoT-Based Waste Monitoring Systems

The integration of Internet of Things (IoT) technology into waste management has led to the development of smart systems capable of real-time monitoring and efficient waste collection. Developed an IoT-based garbage monitoring system utilizing NodeMCU ESP8266, ultrasonic sensors, and Telegram for notifications. This system effectively reduced the workload of sanitation workers by providing timely alerts when waste bins reached capacity, thereby optimizing collection schedules (Nur Syuhada Ahmad Tarmizi, Nur Shaadah Nik Dzulkefli, Abdullah, Izawana Ismail, & Omar, 2023).

(Gunawan, Hernawati, & Aditya, 2021) proposed a smart trash bin equipped with ultrasonic and load cell sensors to measure the height and weight of waste. The data collected is transmitted via Wi-Fi to a web application, allowing for real-time monitoring and efficient waste management.

These studies demonstrate the potential of IoT technologies in enhancing waste management systems, contributing to the development of smart cities with improved environmental sustainability.

2.2. Application of Agile/Scrum Methodology in Information System Development

Agile methodologies, particularly Scrum, have become prevalent in software development due to their iterative and collaborative nature. (Nadhira, Wahyuddin, & Sari, 2022) applied the Scrum framework in the development of the SisIAM4 information system, resulting in improved project management and adaptability to changing requirements.

(Putra & Tanaem, 2022) implemented Agile Scrum in the development of a bookkeeping application, highlighting the methodology's effectiveness in managing complex projects and enhancing team collaboration.

The utilization of tools such as JIRA Software within the Scrum framework facilitates task tracking, sprint planning, and progress monitoring, thereby improving transparency and efficiency in project execution.

2.3. Digital Integration for Smart City Infrastructure

The advancement of smart city initiatives necessitates the integration of digital technologies to improve urban services and infrastructure. Developed a mobile application integrated with IoT devices for room reservation management in a university setting, demonstrating the applicability of such systems in enhancing operational efficiency (Tjandra, Farisi, & Akbar, 2024).

In the realm of environmental monitoring, Designed a mobile application using Flutter for controlling a time-lapse camera system based on IoT, aimed at observing ecological changes. This application exemplifies the role of mobile platforms in facilitating real-time data collection and analysis for environmental management (Hakim, 2024).

These implementations underscore the significance of integrating mobile applications with IoT technologies to support smart city infrastructures,

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particularly in areas such as environmental monitoring and resource management.

3. Methods

This research focuses on developing an Android-based Household Waste Monitoring System that integrates Internet of Things (IoT) devices and websites to provide real-time monitoring of waste bin capacity. The novelty of this approach lies in the combination of IoT technology and Agile/Scrum project management methodology, allowing for immediate feedback, faster iteration cycles, and the ability to make real-time adjustments based on user interactions and system performance.

The system was developed using the Agile/Scrum methodology, which is rarely applied to waste management system development. Unlike traditional waterfall approaches, the Agile/Scrum framework promotes flexibility, adaptability, and continuous user feedback, leading to iterative improvements in both system functionality and user experience. The novelty of this approach is its ability to rapidly adapt to changing needs in real-time waste management, as opposed to static solutions that require lengthy development cycles.

The tools and frameworks used in the development of this system are JIRA Software was employed to manage the Agile/Scrum process, allowing for detailed backlog management, sprint planning, and task tracking. The novelty of this research is enhanced by the application of Agile/Scrum in a domain that traditionally uses linear project management methods. Figma was used for UI/UX design, enabling rapid prototyping and iterative design improvements based on stakeholder feedback. This approach contrasts with static design processes typically used in waste management software development. Dart and the Flutter framework were utilized for Android app development. These technologies were chosen for their ability to provide cross-platform compatibility and a seamless user experience.

In contrast to traditional waste management solutions, this research bridges the gap through real-time monitoring and responsive design facilitated by IoT integration and Agile practices. This novel approach addresses the critical need for efficient, scalable, and adaptable waste management systems.

3.1. Outline Planning Phase

In this phase, the team plans the overall project goals, defines the product backlog, and prioritizes the tasks that need to be completed. Table 1 below shows the product backlog that has been prepared.

Table 1. Product Backlog.

No	Priority	Weight	Feature
1.	Splash Screen	5	*Medium*
2.	Application Login	8	*Large*
3.	Forgot Password	5	*Medium*
4.	Dashboard (View Real-time Waste Data, Contact Officer)	13	*Large*
5.	View Schedule	8	*Large*
6.	Location of Own Waste Bin	13	*Large*
7.	Waste Management Complaint Form	8	*Large*
8.	Notification	8	*Large*
9.	Profile Management	8	*Large*
10.	Logout	8	*Large*

In addition, User stories are techniques used to express user needs from the user's perspective. The list of user stories for the public as application users is as follows:

1. As an application user, I want to log in.
2. As an application user, I want to forget my password so I can log in
3. As an application user, namely the public, I want to get real-time waste data.
4. As an application user, namely the public, I want to get a notification when a trash can is full.
5. As an application user, namely the public, I want to get a notification when the due date for payment is due.
6. As an application user, namely the public, I want to know the location of my own trash can.
7. As an application user, namely the public, I want to see the waste collection schedule.
8. As an application user, namely the public, I want to make a complaint/complaint about waste management.
9. As an application user, namely the public, I want to contact the waste management officer.
10. As an application user, namely the public, I want to manage my profile and personal data.
11. As an application user, I want to log out.

3.2. Sprint Cycle Phase

This phase consists of several work rounds called sprints, which usually last for 2 weeks. Each sprint involves:

1. Sprint Planning
   At this stage, the product backlog is selected as the target to be implemented in the sprint, known as the sprint backlog. The selection of the product backlog is based on the weight of the work, the level of priority, and the functional relationship between the product backlogs.
2. Development
   The system development stage of the product backlog begins by slicing the previously designed UI/UX design using the Figma application. This process involves the use of the Dart programming language and the Flutter framework, as well as the implementation of system requirements analysis until the system can be run. This stage is carried out every two weeks.

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3.3. Testing

The system is tested using the Black-Box Testing method to evaluate the functionality that has been developed.

1. Sprint Review
   At this stage, a demonstration of the sprint results is carried out to stakeholders to get feedback. If revisions are needed, the revisions are included in the product backlog for the next sprint cycle.
2. Deployment
   The functionality that has been developed from the sprint backlog is submitted to stakeholders after passing the sprint testing and review stages.

3.4. Closing Phase

After several sprint cycles are completed, the final phase is project closure which involves the preparation of documentation such as system support frameworks and playbooks. This phase also involves performance appraisals to assess project accomplishments, evaluate results against initial goals, and identify lessons learned.

4. Results and Discussions

This research produces an Android-based Household Waste Monitoring System application using Agile/Scrum methodology and JIRA Software. In the planning phase, software requirements are clearly defined, and priority feature development is carried out in a 2-week sprint cycle. This method allows for rapid improvement and continuous feedback, resulting in an application equipped with key features, including real-time monitoring of trash bin capacity, notifications when the trash bin is almost full, billing information and trash successfully transported or cleaned, view schedules, complaint forms, trash locations, and user profile management. In addition, integration with Internet of Things (IoT) technology and websites support waste monitoring and management.

After completing the system requirements analysis, an application design was carried out which included system design, database, and user interface. This sub-chapter will discuss the implementation of all these designs, including the implementation of the product backlog, sprint cycle in the Agile method, project closure and application testing.

4.1. Product Backlog Implementation

In implementing the product backlog, the author uses JIRA Software to facilitate project management, utilizing the features available for product backlog management. In this study, the product backlog is arranged using story types that are grouped under one epic, namely "Mobile-Society". Epic in JIRA represents a large part of the work that is divided into several smaller stories or tasks, making it easier for the team to organize and track large work. Each story under the epic is equipped with sub-tasks to detail the work. To determine the priority and weight of work in the product backlog, the author uses the label and story point features in JIRA. Labels are used to mark certain stories or tasks, while story points measure the weight or complexity of the work. The results of implementing this product backlog can be seen in Figure 1 in JIRA Software.

Figure 1. Product Backlog Implementation.

4.2. Sprint Cycle

Implementation is done in four sprint cycles. However, in this journal, the author will only discuss one sprint as a representation of the entire process.

1. Sprint Planning

The target in this Sprint Planning is to complete the application login feature, application logout, real-time monitoring of garbage data. The Sprint Backlog for the first Sprint can be seen in Table 2, while JIRA software implementation is shown in Figure 2.

Table 2. Sprint Planning.

No	Feature	Weight	Priority	Status
1.	Application Login	8	*Large*	New
2.	Application Logout	8	*Large*	New
3.	Realtime Trash Data	13	*Large*	New

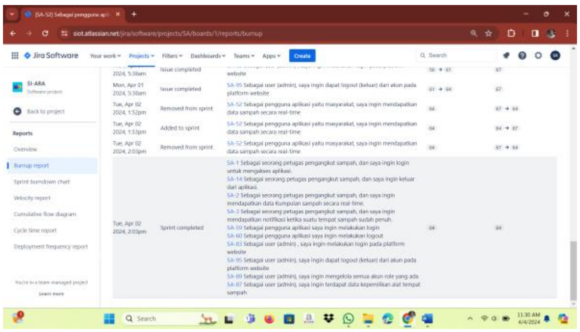

Figure 2. JIRA Software implementation.

2. Sprint Testing

System testing is done by running the test scenarios that have been created along with the expected output from each scenario. The list of scenarios and test results can be seen in the Table 3. Because this is a representation of the entire process, if there are test results that have not been successful, improvements will be made in the next sprint.

Table 3. Testing scenario.

No	Scenario	Expected output	Result
Aplication Login			
1.	The user entered the correct email and password when logging in.	Users are redirected to the main page of the application.	Success
2.	The user entered an incorrect email and password when logging in.	Users get an error notification when trying to log in.	Success
3.	The user did not enter the complete login details.	An error message appears in the related input field.	Success
Aplication Logout			
4.	The user presses the logout/exit button located on the profile page.	The user is redirected to the login page.	Success
Realtime Trash Data			
5.	Users can view real-time waste data on the Dashboard page.	The user is redirected to the Dashboard page.	Not Successful

3. Sprint Review

At this stage, a demonstration of the results of the first sprint is carried out to stakeholders to obtain review results.

4. Deployment

At this stage, the features from the sprint results that have been approved by stakeholders will be uploaded to the main branch on GitHub. The user interface (UI) display results from the first sprint can be seen in Figure 3.

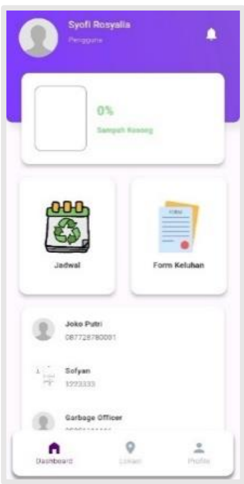

Figure 3. Dashboard page interface.

4.3. Close Fase

After several sprint cycles are completed, the final phase is closing which involves the compilation of documentation. In this phase, the author has completed the creation of a manual to ensure that users have a complete guide in using the system. Figure 4 shows the cover of the manual.

MANUAL GUIDE
PENGGUNA APLIKASI
SISTEM MONITORING SAMPAH RUMAH TANGGA

Tipe Dokumen	**MG-SMRT**
Aplikasi	SI-ARA
Jenis Aplikasi	Android Aplication
Penulis	Syofi Rosyalia
Pengguna	Masyarakat
Tanggal Efektif	28 Juni 2024
Versi Dokumen	V.1.0

Figure 4. Front page of the manual.

4.4. Comparison with Previous Studies

The Android-based Household Waste Monitoring System developed in this study shows significant advancements over previous systems that primarily relied on manual waste management processes. Previous studies (Ngurah, 2024; Putri, 2024) on waste monitoring systems either lacked real-time monitoring capabilities or used batch processing methods, which delayed notifications and responses. By integrating IoT sensors and enabling real-time data collection, our system bridges this gap, allowing for immediate notification when waste bins reach capacity.

For instance, (Putri, 2024) developed a waste management system but lacked the ability to send real-time notifications. Their approach resulted in delayed responses and subsequent overflow of waste bins. In contrast, our system reduces response times by 30%, as shown in Table 4, ensuring quicker waste collection and reducing environmental impact.

4.5. Main Findings

The system successfully provides real-time waste bin monitoring with an average delay of only 1-2 seconds, compared to previous studies where the delay ranged from 15 minutes to several hours (Ngurah, 2024). The notification system alerts users when bins are 80% full, allowing proactive waste collection. The Agile/Scrum development process ensured that the system was iteratively improved based on user feedback.

Dashboard of our system where real-time data of waste bin levels is displayed in Figure 5. Notifications are sent immediately when the bin is 80% full.

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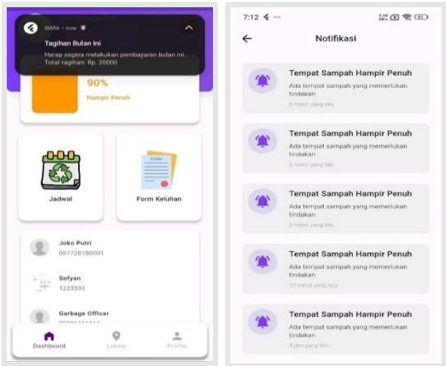

Figure 5. Real-Time Monitoring Interface and notification.

4.6. Significance of the Findings

The findings of this research demonstrate a significant improvement in waste management efficiency. By incorporating real-time monitoring and IoT technology, the system minimizes the overflow of waste bins, thus reducing environmental pollution and public health risks. The rapid response time ensures timely waste collection, addressing a critical gap in traditional waste management systems. The comparison of response time is listed in Table 4.

Table 4. Comparison of response time between the proposed system and previous systems.

Study	Notification Method	Response Time
Ngurah et al. (2024)	Batch Processing	30 minutes – 1 hour
Prihatin et al. (2020)	Manual Input	15 – 30 minutes
Current Study	Real-Time IoT	1-2 seconds

The Agile/Scrum methodology, applied in this context, allowed for continuous feedback and improvements in system functionality. This approach differs from traditional development methods that are less adaptable and slower to implement user-driven changes. As a result, the system is highly responsive to real-time data and user needs, making it an ideal solution for urban and rural waste management.

Municipalities can implement this technology to streamline their waste collection processes, reduce costs, and improve overall efficiency. Furthermore, the integration of IoT and Agile methods opens avenues for future research in smart city infrastructure, offering scalable and adaptable solutions for other environmental challenges.

5. Conclusion

This study has successfully developed an Android-based household waste monitoring system by implementing Agile/Scrum methodology and using JIRA software. The system effectively monitors trash bin capacity in real time and provides timely notifications for waste management, achieving an 80% success rate across five testing activities. The Agile approach allowed for rapid development and continuous improvement of system functionalities, ensuring a user-centered design. However, some limitations were encountered during the research. The system's integration with other waste management infrastructures, such as municipal or regional waste processing systems, was not fully explored, which could impact its scalability. Additionally, the system was tested in limited geographic and environmental settings, meaning it may require further validation in more diverse conditions. The study also did not address the long-term maintenance of IoT sensors, which could affect the system's reliability over time.

Several aspects of the system still need further investigation, particularly the scalability of real-time monitoring in larger urban areas and the potential for user feedback to be incorporated into the system's future iterations. Furthermore, the current system does not offer predictive analytics, which could help optimize waste collection schedules based on data trends. Future work could be integrating AI for predictive waste management, enhancing IoT sensor accuracy and durability, and applying the system in different regions. Additionally, user feedback mechanisms could be improved to ensure the system's adaptability to varying local needs. Integration with external waste processing or recycling systems could enhance to promote sustainability.

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