

An Integrated Web-Based Waste Management Platform for Urban Collection Scheduling and Fee Payment Services Pekanbaru City

Ibnu Surya¹, Juni Nurma Sari², Satria Perdana Arifin³, Thesa Nabila Balqis Pardede¹

¹Program Study of Computer Engineering Technology, Department of Information Technology, Politeknik Caltex Riau, Pekanbaru, Indonesia
ibnu@pcr.ac.id, thesa@pcr.ac.id

²Program Study of Master of Applied Computer Engineering, Department of Information Technology, Politeknik Caltex Riau, Pekanbaru, Indonesia
juni@pcr.ac.id

³Program Study of Information System, Department of Information Technology, Politeknik Caltex Riau, Pekanbaru, Indonesia
satria@pcr.ac.id

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Abstract—Waste management has become a global issue, encompassing various challenges such as the separation of organic and inorganic waste, waste collection scheduling, fee collection, and the accumulation of waste at final disposal sites (TPA). In Pekanbaru City, the waste management mechanism involves empowering Waste Collection Agencies (LPS) across 83 sub-districts. LPS is responsible for collecting household waste and transporting it to the TPA, as well as managing the waste collection fees paid by residents. Since the fee management process is still carried out manually, an information system is needed to manage resident data and monitor fee payments effectively. This study developed the SilepasPKU Waste Management Information System using the prototype method, featuring waste collection management and fee management modules. The system was tested through three iterations with LPS UmbanSari users: the first iteration focused on design testing, while the second tested system functionality. Several improvements were made based on user feedback. In the third iteration, all system functionalities operated successfully. The testing method is Blackbox Testing, User Acceptance Test (UAT) and Usability Testing. The UAT result is user accept all the functional system. The usability test is held to take test for three role which is waste fee collector, waste collector and LPS administrator, and the processing results of the questionnaire data, it shows that the system has a good level of usability and is acceptable to users. Currently, SilepasPKU is being used by LPS UmbanSari in their waste management operations.

Index Terms—, Household waste; Waste collection agency; Waste collection fee; and Web-based management system.

I. INTRODUCTION

Waste is a global issue that affects many parts of the world. In developing countries, waste management systems remain poorly organized due to limited public knowledge on proper waste handling, inadequate

household-level management practices, and the lack of adequate infrastructure for final disposal sites (TPA). Many TPAs still rely on open dumping, while controlled landfill and sanitary landfill methods are rarely implemented. Other challenges include insufficient recycling facilities, excessive use of single-use plastics, and weak coordination between existing institutions and local governments, resulting in ineffective waste management systems [1].

According to the 2023 National Waste Management Information System (SIPSN) report [2], the largest portion of waste is disposed of in TPAs (60%–70%), followed by burning (15%–20%), recycling (10%–15%), composting (5%–10%), and uncontrolled dumping (10%). Waste burning is commonly practiced due to the absence of waste transportation facilities, inherited traditions, and limited awareness of the environmental risks associated with open burning.

Since July 2025, waste management in Pekanbaru has been carried out through Waste Collection Agencies (LPS), which operate at the sub-district level to collect household waste. Based on interviews with LPS officers in Umbansari, waste collection was previously managed by private companies. However, frequent delays in collection often resulted in waste accumulation in residential areas. Consequently, the establishment of LPS was initiated by the local sub-district leader and operated by community members. This system aims to regulate household waste collection and ensure its transport to the TPA, contributing to a cleaner and healthier environment. LPS has become one of the city's flagship programs. In addition to collecting waste, LPS is responsible for managing waste collection fees. To facilitate these responsibilities, the SilepasPKU Waste Management Information System was developed using the prototype

method, featuring modules for waste collection management and fee management.

Several previous studies have explored waste management information systems. Study [3], [4], [5], [6] developed a mobile-based system designed to simplify household waste collection, where waste had already been sorted into organic and inorganic categories, and pickup was requested directly by residents or coordinated and assembled in one place. Another study [7], [8] developed a web-based waste management system.

Studies [9], [10], [11], [12] developed web-based waste bank applications using the 3R (Reduce, Recycle, Safe Disposal) approach, aiming to educate communities on reducing household waste generation. These systems include roles for administrators, officers, and residents, enabling convenient waste exchange transactions.

Another study [13] introduced an application featuring route search for disposal sites, real-time updates on waste collector arrival times, and reporting capabilities for local planning agencies (Bappeda) to monitor collected waste volumes. The application, named E-waste, serves as a solution to optimize waste management in Gorontalo City.

From the analysis of previous research, it can be concluded that most of the systems that have been developed focus on aspects of waste collection, waste banks, disposal routes, reporting waste quantities, or community education. Although these features are important in supporting waste management, there are still limitations in the integration between waste collection schedule management and resident waste fee management, especially in waste services at the sub-district level.

The research being conducted currently is the development of waste management system that integrates waste collection scheduling and waste fee management for residents in UmbanSari sub-district. The waste collection module manages scheduling and daily collection recording, while the fee management module records and organizes resident fee payments. The primary contribution of this study is the integration of waste collection operational management and waste fee administration functionalities within a unified web-based platform.

The waste management application that developed in this research integrates specialized functionalities for waste collection operations and household waste fee administration in UmbanSari Village. The system was commissioned by the management of LPS UmbanSari to streamline and enhance local waste management activities. The System, named SilepasPKU, was developed using the Prototype methodology, which emphasizes continuous user involvement throughout the development process to ensure conformity with organizational business processes and stakeholder

requirements. The Prototype methodology, consisting of the following phases: identifying existing business processes and roles, proposing improved workflows, designing the system and user interfaces, conducting user evaluations, implementing the system using the Laravel framework with MySQL database, and performing black box testing to ensure all functionalities work as expected. Testing was conducted with LPS administrators. Results indicate that SilepasPKU effectively supports waste collection and fee management activities, helping LPS monitor waste collection, disposal, and resident fee contributions more efficiently.

II. RESEARCH METHODOLOGY

The development of SilepasPKU employed the Prototype software development method, which consists of the following phases: identification, design, prototyping, evaluation, implementation, and testing. The methodology used in this study is described below.

A. Identification

The identification phase focused on gathering user requirements for SilepasPKU. The users in question were the waste management administrators (LPS) of Umbansari Sub-district. Observations were carried out through interviews and evaluations of the existing LPS operational processes. The observation process was conducted through interviews with LPS managers using a predefined set of questions to gather user requirements. During these interviews, an evaluation of the current operational processes of the LPS was also carried out. A gap analysis of the current system provided the foundation for developing the new information system. A comparison between the current (As-Is) business processes and the proposed (To-Be) processes is presented in Table 1.

TABLE I COMPARISON OF THE EXISTING AND PROPOSED BUSINESS PROCESSES

No	As-Is	To-Be
1.	Viewing contribution data and waste collection progress is done manually.	Displays statistical data on contributions and progress of automatic waste collection in the system.
2.	Management of sub-district, village, and family card data is still done manually.	Management of sub-district, village and family card data is carried out directly in the system, such as adding, changing and deleting.
3.	Manual recording and monitoring of the status of annual citizen contribution payments.	Recording and monitoring of payment status is done on the system.
4.	Manual recording of daily waste collection status per house.	Recording daily waste collection status is neater and easier in the system.

During this stage, the business value of the proposed waste management information system was identified, namely improving efficiency in data

management and waste fee recording within LPS. The resulting business requirements are:

- The system must be able to record and store resident waste fee data.
- The system must allow monitoring and recording of daily waste collection progress.
- The system must be able to record resident data registered under LPS.
- The system must support the management of sub-district and village data used in SilepasPKU

Based on the identification process, the users of SilepasPKU consist of the super admin, LPS admin, waste collection officers, and fee collection officers, each with the following access rights:

- The LPS super admin is a user with full access rights, responsible for managing master data (sub-districts and villages) and user accounts.
- The LPS admin is an officer or staff member at the sub-district level who manages family card data, waste fee data, and waste collection activities within their designated area.
- The waste collection officer is a user assigned to the Waste Collection feature, responsible for marking the waste collection status in the designated zones within their assigned village.
- The fee collection officer uses the Waste Fee Payment feature to record payments received from residents in the village where they are assigned.

Based on these roles, the proposed business processes for the SilepasPKU system include monitoring waste management and fee collection (Figure 1), waste collection activities (Figure 2), and waste fee collection processes (Figure 3).

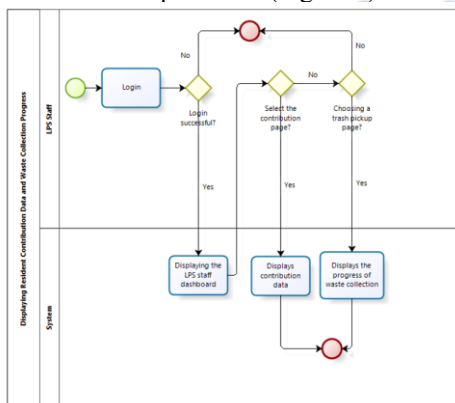


Fig. 1 Business Process for Monitoring Waste Management and Waste Fee Collection

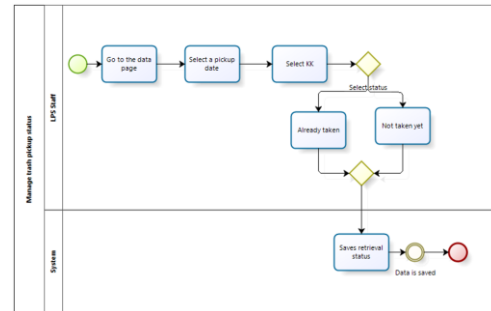


Fig. 2 Business Process for Waste Collection

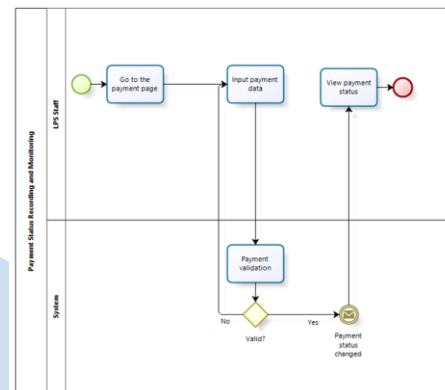


Fig. 3 Business Process for Waste Fee Collection

B. Design

In this stage, the SilepasPKU system was designed according to the proposed business processes. The design includes system architecture, use case modeling, database design, and user interface design:

1. System Architecture,

The SilepasPKU system architecture adopts a Client-Server model in which users interact with the system through their respective devices. The system architecture is presented in Figure 4.

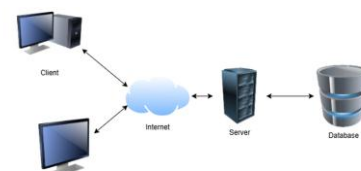


Fig. 4 System Architecture

2. Use case Diagram

The use case diagram in this study illustrates that the Super Admin is able to manage master data, including sub-districts and villages, as well as AdminLPS user accounts. Meanwhile, the AdminLPS user can manage zone data, resident data, waste fee data, payment validation, and the waste collection schedule within their designated area. The use case diagram is presented in Figure 5.

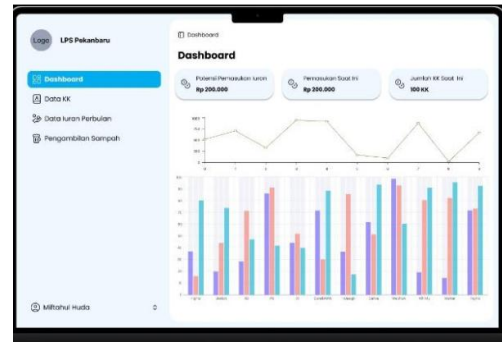


Fig. 5 Use Case Diagram of the SilepasPKU Application

LPS Pekanbaru

Dashboard

Data KK

Data Kurun Perbulan

Pengambilan Sampah

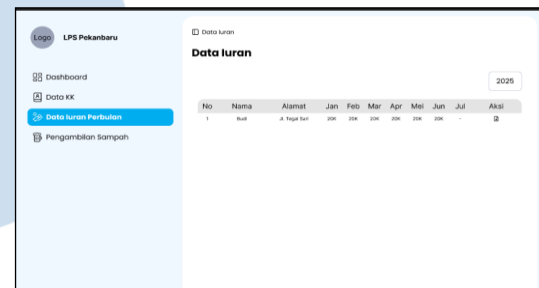
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The SilepasPKU system is designed to manage resident data, waste collection activities, and waste fee records; therefore, several database tables were created, including Sub-district, Village, Family Card, Schedule (Waste Collection Schedule), Collection (Waste Collection), Fee, Payment (Waste Fee Payment), and User for account management. The database design is shown in Figure 6.



C. Prototype Evaluation by Users

D. Implementation

E. Testing

III. RESULT AND DISCUSSION

After the user interface design was approved by the LPS Super Admin, the development of the SilepasPKU web-based system continued using the PHP

4. User Interface Design

The user interface design of SilepasPKU was developed based on the use case diagram. Several interface prototypes of the SILEPASPKU system are shown in the figures below. Figure 7 presents the dashboard prototype, Figure 8 illustrates the waste collection recording interface, and Figure 9 displays the waste fee data interface.

programming language with the Laravel framework and MySQL as the database management system.

A. Implementation of the SilepasPKU Web Application

Based on the proposed business processes, the SilepasPKU web application was developed with several key features, including a dashboard for displaying waste fee statistics and waste collection progress, data management modules, and interfaces for recording and monitoring both waste fee payments and waste collection activities.

The SilepasPKU system supports multiple user accounts according to the defined business roles. Users are required to log in through the login page, as shown in Figure 10, before accessing the system.

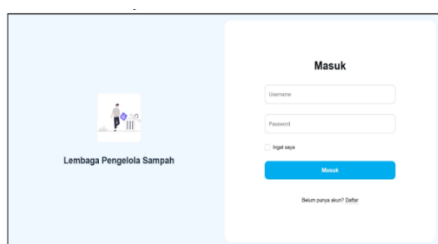


Fig. 10 Login Page

The SilepasPKU application is managed by the Super Admin account, which has full access rights to oversee all system master data, including sub-districts, villages, and AdminLPS user accounts. In addition, the Super Admin can monitor waste management and waste fee collection activities through the dashboard, as shown in Figure 11. The dashboard presents a summary of operational data in Pekanbaru, consisting of the following components:

1. Statistical Cards, displaying:
 - a. Annual Fee Potential: the total projected revenue for one year assuming full payment compliance by all registered households.
 - b. Fee Revenue (This Year): the actual accumulated revenue collected up to the current period of the year.
 - c. Total Family Card: the total number of households registered across the city.
2. Annual Fee Revenue Chart: which visualizes monthly waste fee revenue trends from January to December, helping to assess financial performance over time.
3. Weekly Waste Collection Progress Chart: which illustrates the number of households whose waste was successfully collected each day during the past week, providing an overview of operational performance.

The sub-district data management interface is shown in Figure 12, while Figure 13 presents an example of the account management interface.

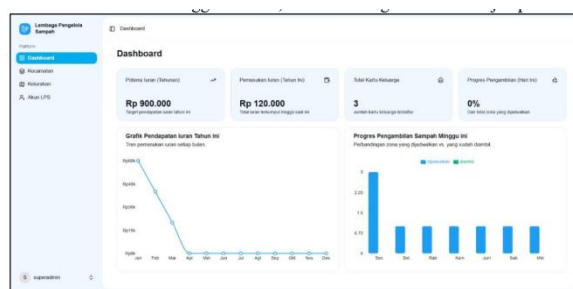


Fig. 11 Dashboard Page

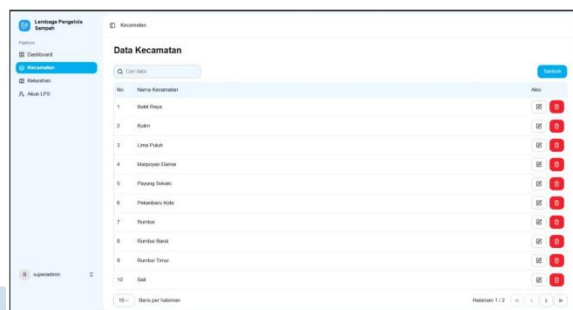


Fig. 12 Sub-District Data Management

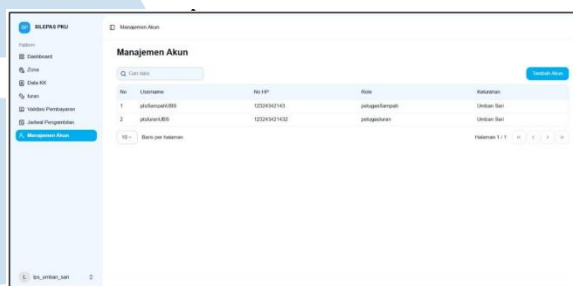


Fig. 13 Account Management

The next user role in the SilepasPKU system is the LPS Admin, who can view and manage data exclusively within the sub-district to which they are assigned. The LPS Admin can access the dashboard for their respective sub-district, perform create, read, update, and delete (CRUD) operations on Family Card data, manage the waste collection schedule (Figure 14), validate daily waste fee deposits (Figure 15), define collection zones for each area (Figure 16), and set monthly waste fee amounts in accordance with applicable regulations (Figure 17). In addition, the LPS Admin is responsible for managing the accounts of waste fee collectors and waste collection officers.

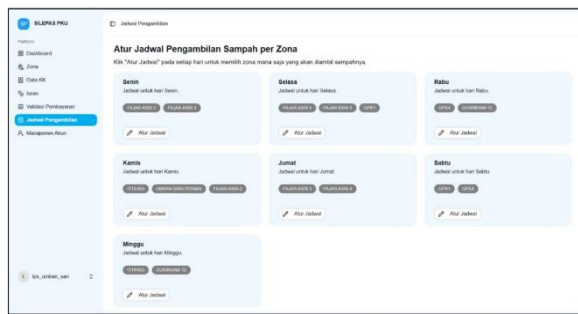


Fig. 14 Waste Collection Recording Page

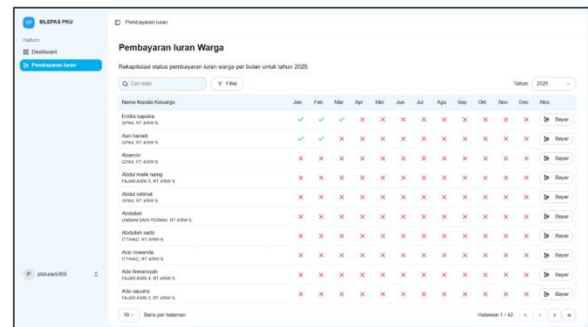


Fig. 18 Waste Fee Payment Recording Page

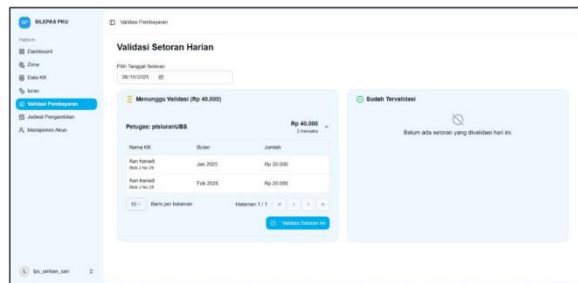


Fig. 15 Daily Deposit Validation

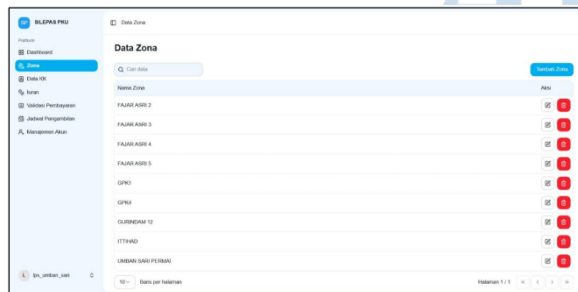


Fig. 16 Zone Assignment Page

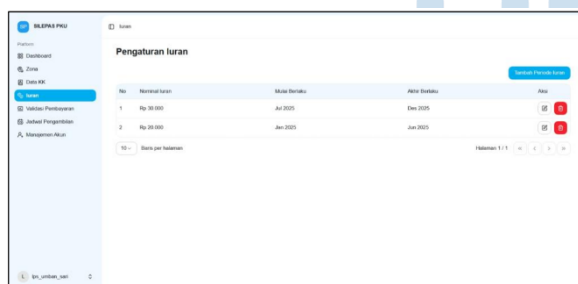


Fig. 17 Waste Fee Determination Page

The next user role in the SilepasPKU system is the fee collection officer, who is responsible for recording resident waste fee payments into the system, as illustrated in Figure 18.



Fig. 19 Waste Collection Checklist Page

Each user account performs its respective role according to the access rights assigned. After completing their tasks, users can log out of the system, as shown in Figure 20.



Fig. 20 Logout Menu

B. System Testing

The final phase of the Prototype methodology consists of system functionality testing and user interface (UI) evaluation using the System Usability Scale (SUS) to assess the system's usability.

1. User Acceptance Test

Comprehensive system testing was conducted to evaluate the functionality of the system from the users' perspective, specifically the LPS management acting in the role of Super Administrator. This testing phase, known as the **User Acceptance Test (UAT)**, involved the LPS Super Administrator, who has access to all functionalities available within the SilepasPKU system.

The results of the UAT are presented in Table II.

TABLE II UAT TESTING

Function	Scenario	Expected Result	Test Result	Conclusion
Displaying automatic waste fee statistics and waste collection progress in the system	The Super Admin selects the Dashboard menu and views the waste fee statistics and waste collection progress	The waste fee statistics and waste collection progress are displayed as expected	Successful	Valid
Managing sub-district, village, and family card data directly in the system, including adding, modifying, and deleting	The Super Admin selects the management menu for sub-districts, villages, and family cards, and performs add, edit, and delete operations	Sub-district, village, and family card data can be properly managed	Successful	Valid
Recording and monitoring payment status in the system	The Super Admin selects the payment recording and payment monitoring menus	Both the recording and monitoring menus function correctly	Successful	Valid
Recording daily waste collection status in a clearer and more organized manner	The Super Admin selects the daily waste collection status recording menu	The daily waste collection status menu functions correctly	Successful	Valid

During the UAT phase, the Super Admin user performed several test scenarios to evaluate the system's functionalities, including monitoring the progress of waste collection and waste fee collection, recording waste collection activities, recording waste fee payments, and managing various data within the SilepasPKU application. The results showed that all functions operated correctly and were validated successfully. These findings indicate that the SilepasPKU application meets the defined business requirements, namely: the ability to record and store resident waste fee data, monitor and document daily waste collection progress, record resident data registered under LPS, and manage sub-district, village, and user account data within the system. Therefore, SilepasPKU provides increased efficiency in data management and waste fee recording for LPS operations.

2. Usability Testing

Usability testing was performed for all user roles within the SilepasPKU system, including the LPS Administrator, Waste Collector, and Fee Collector. The assessment employed the System Usability Scale (SUS) method, using the questionnaire items listed in Table III

Table III Usability Testing

No	Question	Score				
1	I think that I would like to use this system frequently	1	2	3	4	5
2	I found the system unnecessarily complex					
3	I thought the system was easy to use.					
4	I think that I would need the support of a technical person to be able to use this system.					
5	I found the various functions in this system were well integrated					
6	I thought there was too much inconsistency in this system.					
7	Saya merasa sebagian besar orang akan cepat mempelajari cara I would imagine that most people would learn to use this system very quickly					
8	I found the system very cumbersome to use					
9	I felt very confident using the system					
10	I needed to learn a lot of things before I could get going with this system					
Questionnaire for the LPS Administrator Role						
1	I was able to log in without difficulty					
2	The resident data menu is easy to find					
3	The fee recording process is easy to perform.					
4	The deposit validation process was easy to understand					
5	Proses validasi setoran mudah dipahami					
6	The deposit validation process was easy to understand					
Questions for the Fee Collection Officer						
1	I was able to log in without difficulty					
2	The resident list was easy to find					
3	Recording payments was easy to perform					
4	The deposit reporting process was easy to understand.					
Waste Collection Officer						
1	I was able to log in without difficulty.					
2	The collection schedule was easy to find					
3	The collection checklist was easy to complete					
4	The collection checklist was easy to complete					

The SilepasPKU system was tested for ease of use and usefulness using the System Usability Scale

(SUS) method. The testing involved all user roles present in the system, namely LPS Admin, Contribution Collection Officer, and Waste Collection Officer. Each role in the system filled out the SUS questionnaire with questions as shown in Table III using a 1–5 Likert scale, where :

- 1 indicates Strongly Disagree
- 2 indicates Disagree
- 3 indicates Neutral
- 4 indicates Agree
- 5 indicates Strongly Agree

Based on the processing results of the questionnaire data, it shows that the system has a good level of usability and is acceptable to users. This result indicates that users find the system easy to learn, easy to use, and able to support the implementation of operational tasks in waste management and contribution administration. Additionally, users also assessed that the available features are well integrated and align with the operational needs of LPS Umbansari.

Therefore, it can be concluded that the SilepasPKU system has a good level of usability and is suitable for use as a supporting tool.

IV. CONCLUSION

Waste is an everyday issue, particularly household waste, which includes food ingredients, leftovers, plants, and other organic materials. Proper waste management should be coordinated by local authorities to ensure that it does not negatively impact the environment. Several initiatives have been implemented by local governments, such as using applications for waste collection, organizing recyclable waste management (waste banks), and conducting regular household waste pickups. These efforts motivate the development of innovations that can simplify waste collection coordination and facilitate the collection of waste fees used to support waste management operations.

In this study, the innovation that build is the SilepasPKU web based application, which serves as a system for monitoring and recording waste collection activities and waste fee payments in Umbansari Village at Pekanbaru Indonesia. SilepasPKU, a web-based waste management information The main contribution of this research is the integration of waste collection management and waste fee administration into a single platform that can be accessed by multiple user roles, including LPS Super Admins, LPS Admins, waste collection officers, and fee collection officers. The system was developed using the Prototype methodology, which enabled continuous user involvement throughout the development process to ensure that the implemented features aligned with the operational requirements of LPS Umbansari. The evaluation results indicate that the system functions properly based on Black Box Testing, is accepted by users through User Acceptance Testing (UAT), and

demonstrates a satisfactory level of usability based on System Usability Scale (SUS) assessment. These results suggest that SilepasPKU can improve the efficiency of waste data management, waste collection monitoring, and waste fee recording processes.

Despite these positive results, the current system has several limitations. The application is only available as a web-based platform and does not yet support mobile devices. In addition, it does not provide automatic notification features for fee payments and the system hasn't integrate GPS-based location tracking to monitor waste collection activities in real time.

Future research may focus on developing a mobile application version, implementing notification services, integrating GPS and mapping technologies, and evaluating the system in a wider operational environment involving multiple villages or waste management organizations. These enhancements could further improve the effectiveness, scalability, and usability of the system.

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