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Design and Contruction of a Website for Garbage Sales in Sirau Village Using the Extreme Programming Method (Case Study of KSM Kudu Bisa)

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ABSTRACT

Waste management remains a critical issue in Indonesia, including in Banyumas Regency, where increasing volumes are driven by population growth, urbanization, and low public awareness in waste sorting. In Sirau Village, the KSM KuduBisa waste management group faces various operational challenges, including the absence of real-time waste data, manual transaction records, and high operational costs. This study aims to design and develop a digital waste sales platform using the Extreme Programming (XP) method, chosen for its adaptability and emphasis on continuous testing. The system was built using the full-stack Next.js framework, allowing integrated front-end and back-end development, and was evaluated through Blackbox Testing and the User Experience Questionnaire (UEQ). The results showed a functional success rate of 98.96% and excellent usability scores across all UEQ dimensions. The novelty of this research lies in the integration of digital waste transaction features with educational content within a role-based, modern web architecture—an approach that not only enhances operational efficiency but also promotes public awareness and engagement in sustainable waste practices.

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1. INTRODUCTION

Waste management is a significant global challenge, especially in developing countries, including Indonesia. Population growth, urbanization, and lifestyle changes have drastically increased the volume of waste [1]. In Indonesia, the waste management system still faces various obstacles, such as inadequate infrastructure, lack of public awareness, and limited technology [2].

At the local level, Sirau Village, Kemranjen District, Banyumas Regency, faces specific problems in waste management. The KuduBisa Community Empowerment Group (KSM) experiences operational difficulties, including high costs for waste collection and sorting, manual transaction recording, and lack of real-time data on waste collection points. This results in low operational efficiency and the risk of data loss [3].

To overcome these problems, digital solutions are needed that can increase efficiency and transparency in waste management [4]. The application of technologies such as the Internet of Things (IoT) and Artificial Intelligence (AI) have proven effective in optimizing waste collection and

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processing systems in various countries [5]. In Indonesia, studies on the circular economy show that digitalization plays an important role in increasing management efficiency and strengthening community involvement [6]. In addition, the digital approach is also able to encourage changes in community behavior towards more responsible waste management [7].

The Extreme Programming (XP) methodology was chosen in the development of this system because of its ability to adapt to changing user needs and focus on continuous testing [8]. XP has been widely used in web application development because of its emphasis on continuous interaction between developers and users [9].

Based on this background, this study aims to design and develop a web-based waste management and sales system that is tailored to the needs of KSM KuduBisa in Sirau Village. This system will be built using the Next.js full-stack framework and evaluated through Blackbox Testing and User Experience Questionnaire (UEQ) to assess efficiency, effectiveness, and user satisfaction. It is hoped that the implementation of this system can optimize waste management and increase public awareness of sustainable waste management practices.

2. RESEARCH METHOD

The development process of the waste sales website in Sirau Village follows the Extreme Programming (XP) methodology, which emphasizes continuous feedback, iterative development, and direct user involvement. The research framework consists of several interconnected stages, as illustrated in Figure 1. Each stage is designed to systematically address the research objectives while ensuring that the system is developed effectively and efficiently.

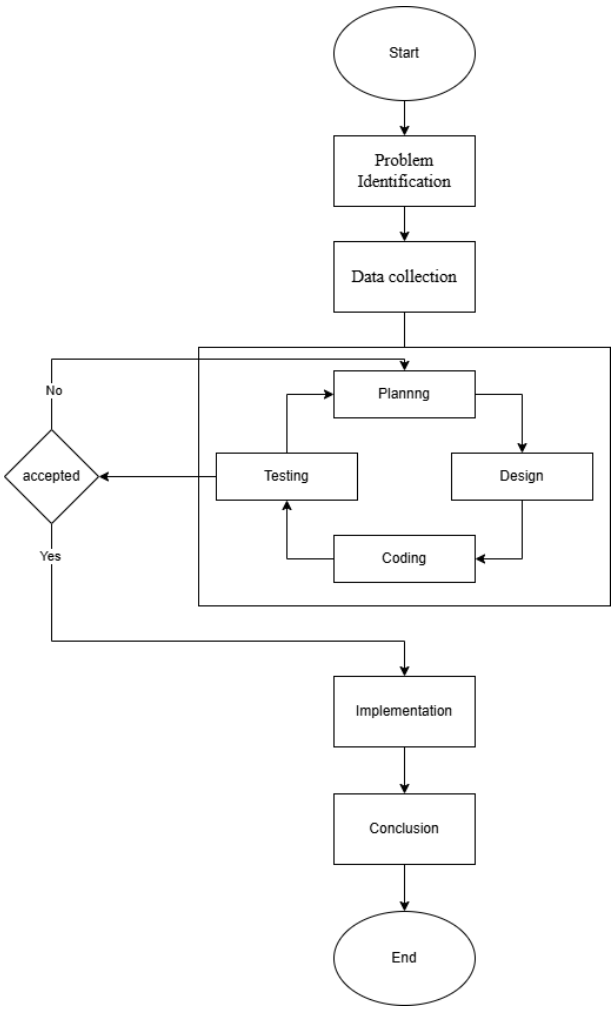

Figure 1. Research flow chart

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The following is an explanation of Figure 1, regarding the stages of the research method used, which are explained in each of the following sub-chapters:

2.1. Problem Identification

This initial stage focuses on identifying the core problems faced by KSM KuduBisa in managing waste transactions. Through preliminary observations and stakeholder analysis, the research highlights issues such as manual transaction records, high operational costs, and a lack of access to timely waste collection information.

2.2. Data collection

Data were collected through field surveys, in-depth interviews with KSM KuduBisa staff, and a review of relevant literature. The survey aimed to understand current operational workflows and technological limitations, while interviews captured specific user needs and pain points. Literature reviews helped identify best practices in digital waste management and previous implementations of XP in similar domains.

2.3. Planning

In this phase, user requirements were translated into system goals. Functional and non-functional specifications were defined. Planning also involved setting project milestones, identifying potential risks, and preparing use case scenarios for the next phases. User stories were drafted to align development with actual stakeholder needs.

2.4. Design

System design was carried out using UML (Unified Modeling Language), which includes use case diagrams, activity diagrams, and system architecture design. The aim was to visualize how users (public, agents, collectors, and admins) would interact with the system and how system components would communicate internally.

2.5. Coding

The development stage implemented the previously designed system using Next.js as a full-stack JavaScript framework, integrating both frontend and backend components. Server-side rendering (SSR) and static site generation (SSG) were used to optimize performance. MySQL was chosen as the database for its robustness and compatibility with Next.js. Features developed included: homepage, educational content, services, about page, login, and registration modules.

2.6. Testing

The testing phase aims to evaluate both the functionality and usability of the developed system to ensure it meets the requirements of each user role. Functional testing was conducted using the Blackbox Testing method, which focuses on validating system outputs based on specific inputs without examining the internal structure of the code. This approach allows each feature and module—ranging from community transactions to admin dashboards—to be tested independently and thoroughly. In addition to functional validation, usability testing was carried out using the User Experience Questionnaire (UEQ), which measures various dimensions such as attractiveness, efficiency, dependability, and novelty. Feedback was collected from users representing the community, agents, collectors, and administrators to assess the overall user experience. Only after all evaluation results met the predefined acceptance criteria did the system proceed to the implementation phase.

2.7. Implementation

After successful testing, the system was deployed and implemented at KSM KuduBisa. This involved user training and monitoring to ensure proper system adoption. Feedback was gathered to evaluate real-world usability and suggest future improvements.

2.8. Conslusion

This final phase summarizes findings across all research stages and draws conclusions based on system performance and user feedback. It evaluates whether the proposed solution met the original objectives and discusses its potential for future scaling or enhancement.

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3. RESULTS AND DISCUSSION

3.1. Planning

In the planning stage, the system is analyzed to identify needs, problems, and determine goals, limitations, and alternative solutions. This analysis is done to understand the system workflow and the activities that will be involved.

In this study, the research variables are defined to guide the development and evaluation of the system. The first variable is **Functional Suitability**, which refers to the system's ability to perform its intended operations accurately and reliably. This variable is assessed using the Blackbox Testing method. The second variable is **User Experience**, which reflects user perceptions of the system in terms of attractiveness, efficiency, perspicuity, dependability, stimulation, and novelty. This variable is measured through the User Experience Questionnaire (UEQ).

These variables were selected because they align with the study's goal to develop a functional, efficient, and user-friendly web-based waste sales system for community use.

Furthermore, User Requirements are determined in Table 1 and Software Requirements in Table 2 according to research needs.

Table 1. User requirement

User Categories	System Requirements
Public	1. Access the homepage, information, educational materials, and waste price list without logging in. 2. Register and log in. 3. Sell waste by filling out the transaction form. 4. View sales transaction history.
Agent	1. Login to access agent features. 2. Manage Community sales transactions (view, add, update, and delete). 3. View Community transaction history.
Collector	1. Login to access Collcetor features. 2. Manage Agent sales transactions (view, add, update, and delete). 3. View Agent transaction history.
Admin	1. Login to access admin features. 2. Manage sales transactions for all users. 3. Add, update, and delete educational content, product data, types of waste, and prices. 4. Manage user data (community, agents, collectors). 5. View transaction history for all users.

Table 1 is a breakdown of system requirements from the perspective of users or stakeholders who will interact with the system. Each user category has different access and features according to their role in the system.

Table 2. Software requirement

Category	Technical Specifications
Functional	1. The system must provide authentication and authorization for various types of users (agents, community, collectors, admins). 2. Use a relational database to store user data, transactions, and reports. 3. The interface must be user-friendly and support access across multiple devices. 4. The system must record and manage waste sales transactions.
Non-Functional	1. The system must be able to handle the growth of users and data efficiently. 2. Responsive in processing user requests. 3. Have security mechanisms to protect data and transactions. 4. Must be reliable with minimal downtime. 5. The source code must be easy to maintain and further develop.

Table 2 defines the technical specifications that must be met, to build a system according to User requirements, so that the system can run properly.

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3.2. Design

At the design stage, the system workflow design is carried out using UML, the structure and component design through the Design System, and the visualization of the interface layout through wireframes. This process is carried out based on the analysis of system requirements to ensure that the design of the Website system for selling waste in Surau Village can function optimally according to its purpose.

a. Unified Modelling Language (UML)

In this study, UML is used to describe the system workflow, structure, and component interactions in the design of the waste sales website in Sirau Village.

1. Used case

A used case diagram illustrates the actions that actors or users can perform within a system. It is developed based on system requirement analysis during the requirement-gathering phase. The application is designed for four types of users: the public (customers), agents, collectors, and the waste bank administrator. Each user has different access rights, as depicted in Figure 2.

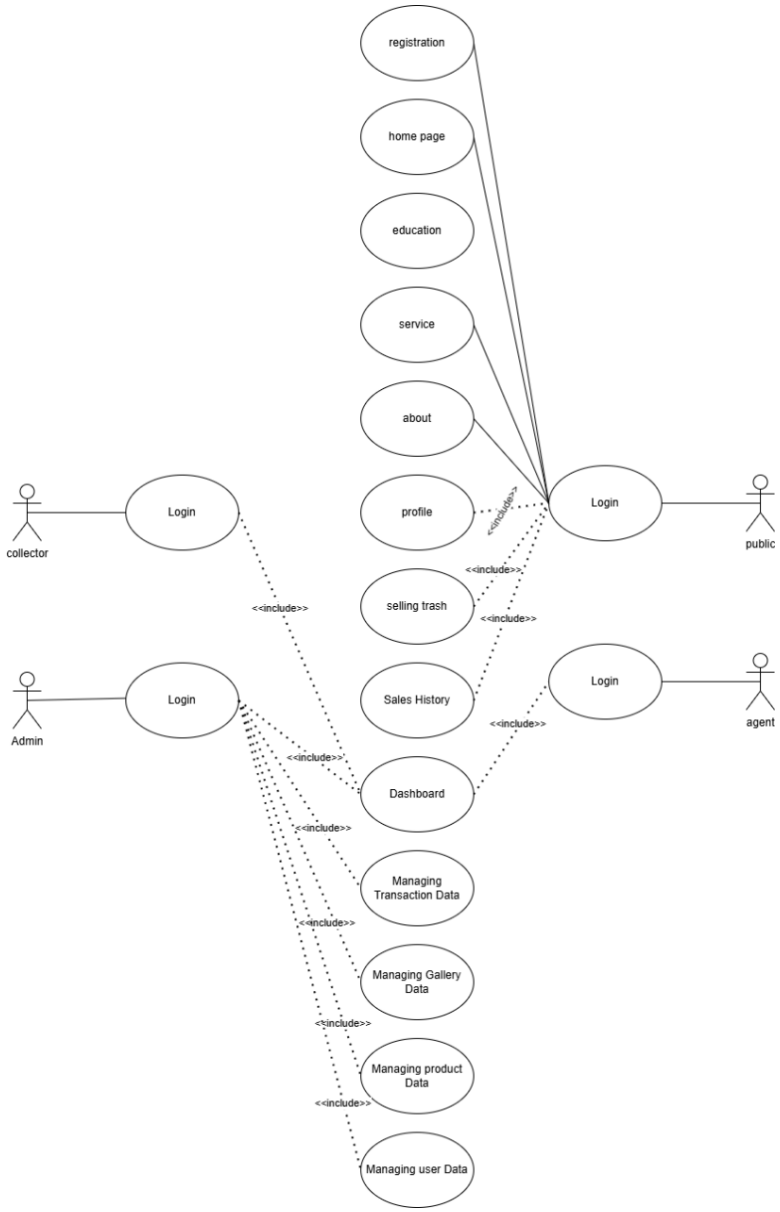

Figure 2. Used case diagram website Garbage Sales

2. Activity Diagram

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This diagram visualizes the interaction between three main actors: Community, Agent, Collector and admin. Each actor plays an important role in ensuring the system functions properly.

a) The following is a picture of the Community Activity diagram when they want to open the service page and want to make a waste sales transaction.

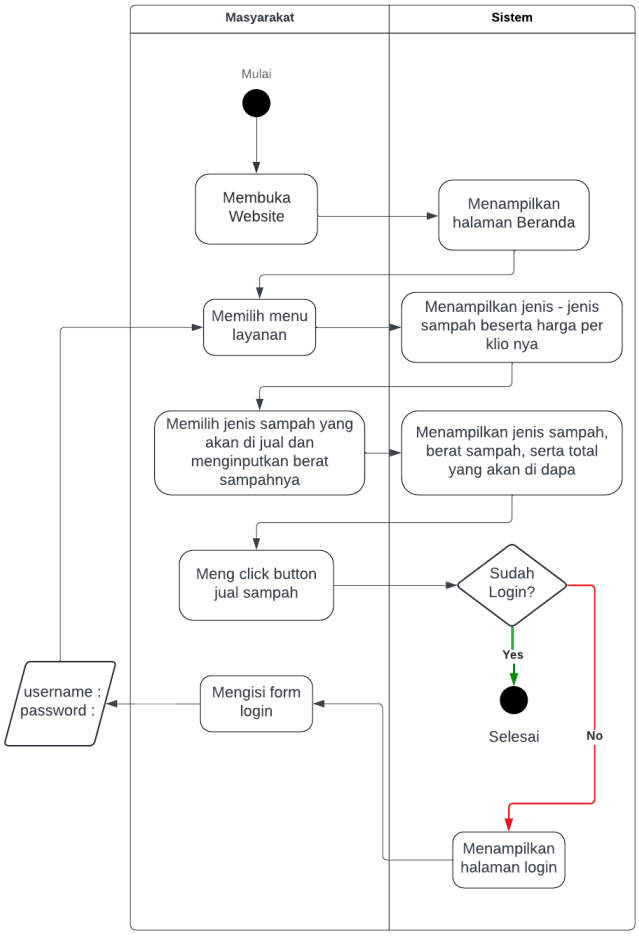

Figure 3. Activity Diagram Halaman Layanan

Figure 3 illustrates the user's activity flow when accessing the service page and selling waste. Upon reaching the website's homepage, users can navigate to the "Services" menu to view the types of waste that can be sold along with their respective prices. If a user wishes to sell waste but does not have an account, they must first register. However, registered users can simply log in. After logging in, users can select the waste type and input its weight to calculate the total earnings they will receive.

b) Activity diagram Viewing Agent, Collector and Admin Transaction Pages
The following is a picture of the Activity diagram of Agents, Collectors, and Admins when they want to open the transaction page.

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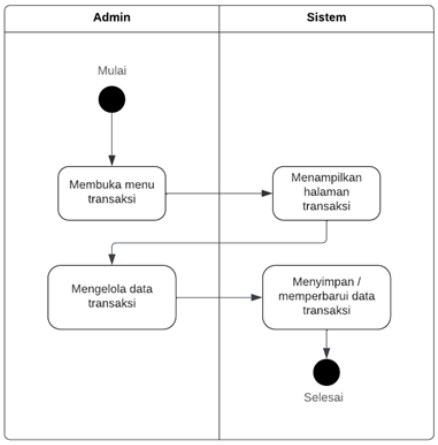

Figure 4. Activity Diagram Managing Agent, Collector, Admin Transactions

Figure 4 shows the process of agent, collector and admin activities when managing Transaction data according to each Role. This process occurs when you are on the home page, then select the Transaction menu to display Transaction data. There is a detail and delete menu, which is useful for managing Transaction data, an export button to export data to excel, filter data based on status and month, and there is also a search feature based on the name of the User who made the transaction.

B. Wireframe

Wireframe is an initial framework of interface design used to visualize the layout of elements on a website, such as navigation, buttons, and forms. Wireframe Design helps researchers design user interaction flows efficiently before the development stage. Figure 5 is a Low Fidelity Design of the User page.

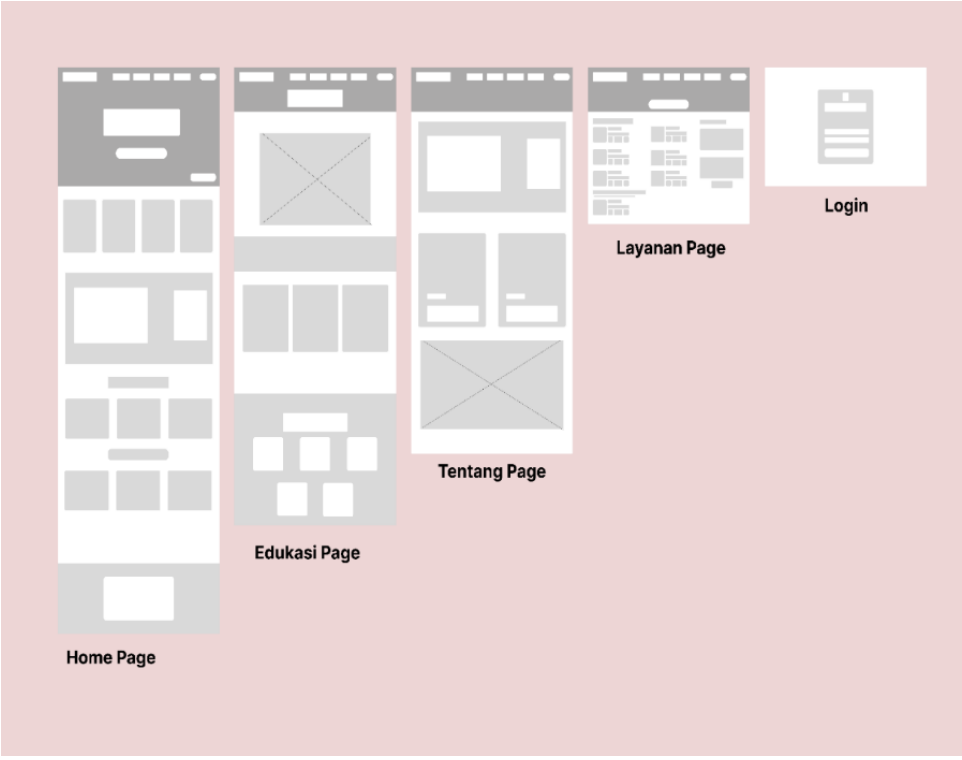

Figure 5. Wireframe User Page

There are 5 pages on the User page including the home page, education, about, services, and Login. Each page has a different size to suit the information needs that will be displayed on the page.

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Previous studies have demonstrated the practical benefits of incorporating UML modeling and wireframe design to facilitate clarity and stakeholder alignment in system development [10].

3.3. Coding

After completing the design stage, the research continues to the coding stage. At this stage, system development is carried out thoroughly, starting from the user interface to the backend process. Coding includes creating display designs, functionality, and integration with existing systems.

3.4. Testing

At the Testing stage, it is done to ensure that the Website functions as needed, has optimal performance, and provides a good user experience. Testing includes the Blackbox Testing method and the User Experience Questionnaire (UEQ).

1. Blackbox Testing

Table 3. Recapitulation of blackbox testing results

No	Pola Situasi	Hasil Pengujian Berhasil	Hasil Pengujian Tidak Berhasil
1	Halaman *User*	28	1
2	Halaman Admin	37	0
3	Halaman Agen	8	0
4	Halaman Pengepul	8	0
5	Halaman *Login*	6	0
6	Halaman *Register*	8	0
Total Hasil Pengujian		96	0

The recapitulation data is then calculated using descriptive analysis techniques, namely:

$$Testing\ Successful = \frac{95}{96}\ x\ 100\% = 98.96\%$$

$$Test\ Failed = \frac{1}{96}\ x\ 100\% = 1.04\%$$

Based on calculations using descriptive analysis, the results of Blackbox Testing show a success rate of 98.96% and a failure rate of 1.04%. With these results, the KSM KuduBisa Website is declared very feasible and can be used well.

The Blackbox Testing method is widely recognized for validating web application functionality from the user's perspective, as it verifies the behavior of the system without accessing internal code [11].

2. User Experience Questionnaire

Table 4. UEQ user questionnaire results

Scale	Mean	Comparisson to banchmark
Attractiveness	2,89	Excellent
Perspicuity	2,83	Excellent
Efficiency	2,89	Excellent
Dependability	2,83	Excellent
Stimulation	2,89	Excellent
Novelty	2,71	Excellent

Based on the results of the UEQ questionnaire, the system received an excellent category in every aspect of the assessment. Attractiveness received a score of 2.89, indicating an attractive and user-friendly system display. Perspicuity received a score of 2.83, indicating ease of understanding the system. Efficiency also received a score of 2.89, proving that the system is efficient in helping the waste sales process. Stimulation with a score of 2.89 indicates an attractive and beneficial system. Meanwhile, Novelty received a score of 2.71, indicating that the system has elements of novelty and creativity.

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The User Experience Questionnaire (UEQ) is a reliable and benchmarked tool for measuring UX in interactive systems, with metrics that include attractiveness, dependability, and novelty [12].

3.5. Implementation

The following are the results of the implementation that has been carried out

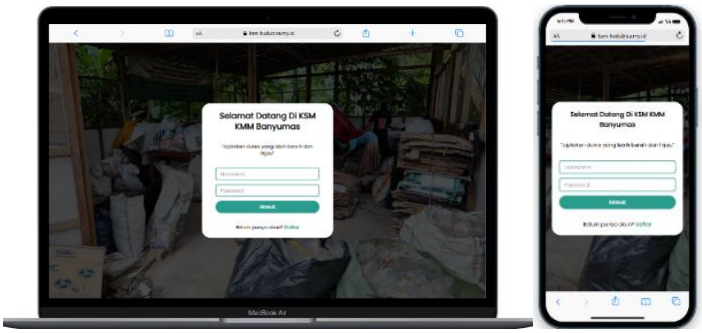

Figure 6. Login menu results

Figure 6 is the Login page containing the Username and password. This display is presented in 2 models for access using a PC or gadget. On this page there is also a registration feature for community actors who do not have an account.

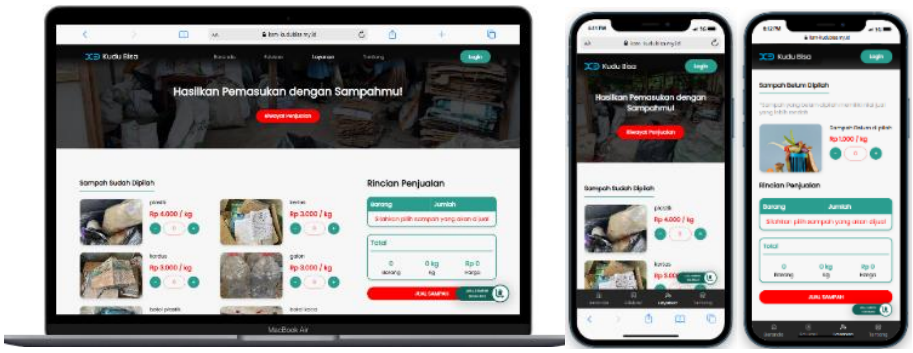

Figure 7. User service page

Figure 7 is a service page for users whose function is for the public to make waste sales transactions. This display is presented in 2 models for access using a PC or gadget.

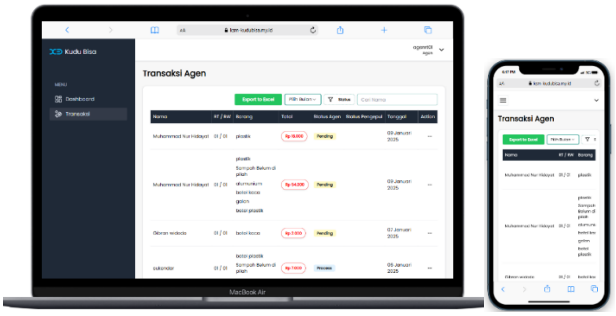

Figure 8. Agent, Collector, Admin transaction dashboard page

Figure 8 is the admin transaction dashboard page. The purpose of this page is to manage waste sales data. There are also export features to excel and data filtering to make it easier for admins to manage it. This display is presented in 2 models for access using a PC or gadget.

4. CONCLUSION

Based on the research conducted, the development of the KSM KuduBisa Website using the Extreme Programming method has been successfully implemented. The development process begins

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with the planning stage to determine user needs, then continues with the design stage to ensure the flow and appearance of the website are in accordance with needs. The resulting website is able to facilitate users in accessing educational information about waste management and conducting digital waste sales transactions. Testing using the Blackbox Testing method showed a system feasibility level of 98.96% with the category "Very Feasible". In addition, usability evaluation through the User Experience Questionnaire (UEQ) involving 32 respondents showed that this system had an average score above 2.50 in all aspects, so it is included in the "Excellent" category. Thus, the system developed can be well accepted by the community and functions optimally in supporting digital waste management and sales.

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