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Waste management accounting information system design at the Solusi Hijau Waste Bank

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ABSTRACT

The phenomena of establishing a circular economy is aggressively advocated both in Indonesia and globally as a step towards a new, greener model of economic transformation to lessen the impact on the environment and support long-term and sustainable economic growth. By 2025, the administration of JAKSTRANAS wants all waste to be controlled, a goal that will be aidsd by digitizing waste banks. The Solusi Hijau Waste Bank has not digitized its business processes, making it challenging for customers and collectors to obtain crucial information quickly, accurately, and in real time. This is why the research is urgent. This research object was to design a waste management accounting information system at the Solusi Hijau Waste Bank. The two stages of the research method are requirement analysis and system design, where the latter uses the Unified Modeling Language to model the process design. The conclusion of this research is that a waste management accounting information system for the Solusi Hijau Waste Bank has been successfully created. Process design, database design, and user interface design are all components of the system's design. The Solusi Hijau Waste Bank will hopefully be able to handle and obtain information about waste management, customer data, collector data, and transaction data conveniently, quickly, precisely, and in real time with the help of this system design. The Solusi Hijau Waste Bank is not the only waste bank that can use this system design; another waste bank that has roughly the same business procedures can as well.

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1. INTRODUCTION

The pace of urbanization and the increase in the worldwide population have made the trash issue a global concern rather than just a domestic one. Many factors, such as population expansion and changes in people's consumption habits, contribute to the rise in trash production, including its volume, varieties, and increasingly diverse

characteristics and brands (Undang-Undang Republik Indonesia Nomor 18 Tahun 2008 Tentang Pengelolaan Sampah, 2008).

In order to transform the economy into a new, greener model and support long-term, sustainable economic growth in line with the 2030 Sustainable Development Goals (SDGs), the phenomenon of implementing a circular economy is actively promoted both in Indonesia and globally. This review can be done at the micro, meso, and macro levels. It goes without saying that this strives to increase social fairness, economic welfare, and environmental quality while also achieving a sustainable economy. Through changing human behavior, this idea can also generate a more environmentally friendly company model (Kirchherr et al., 2017; Solovida & Latan, 2017; Tjoa & Tjoa, 2016).

Indonesia's waste management is subpar. He claims that out of Indonesia's 514 regencies or cities, the average capacity for garbage management is still less than 50%. Meanwhile, 70 to 80 percent of waste is being managed in large cities. The pattern, however, is still following the previous pattern and has not changed. Even though other developed nations have adopted a circular economy pattern, which recycles waste by maximizing the economic value of waste, including plastic waste, by implementing reduce, reuse, recycle, or 3R, the old pattern still uses a collect-transport-waste linear pattern. Various issues relating to health, environmental carrying capacity, and economic competitiveness are raised by this (Setiawan, 2023).

Without the strong commitment of local governments in trash management, Indonesia's Clean trash 2025 aim, which calls for a 30% reduction in waste generation and a 70% increase in garbage treatment, cannot be achieved. The Ministry of Environment and Forestry (KLHK) continues to urge local governments to have plans in place for managing garbage from its origin through its disposal. The regional government is required to create the JAKSTRADA Document (Regional Strategy Policy), which details the achievement goals and quantitative waste management efforts made by the regional government as part of an integrated waste management program that is carried out by all regional apparatus organizations from the source to the final processing site (TPA) (Hadi, 2018).

Human-made technology is becoming more sophisticated with time. The Japanese government started one of them, called Society 5.0. With the use of current Artificial Intelligence (AI), Robotics, and the Internet of Things (IoT), this notion enables us to apply science to human needs so that people can live comfortably. A resolve for the industrial revolution 4.0, society 5.0 was just officially launched on January 21, 2019, exactly two years ago. In actuality, there are few differences between the ideas behind the Industrial Revolution 4.0 and those behind Society 5.0, but the latter is more attentive to the human condition. If artificial intelligence (AI) and artificial intelligence serve as the foundation of the fourth industrial revolution (Fukuyama, 2018; Zebua et al., 2023).

One of the reasons why the government, environmentalists, and waste care volunteers invite the public to care about the waste that households produce every day is because of the low level of public awareness in sorting their own household waste. By considering the impact of waste that is not managed properly for the environment, people are required to be able to sort their own household waste (Latan et al., 2018; Tim Publikasi Katadata, 2020; Zheng et al., 2020).

During the Industrial Revolution, waste was managed in many ways. A waste management institution is one of the community institutions that will be created as part of the implementation of the disruptive technology known as 4.0. The community's perceived need (basic need), which will give rise to institutions, is the driving force behind their development. These fundamental requirements cover social, environmental, and economic concerns, as well as those for cleanliness and sanity (Budiharsono, 2019; Jack, 2017).

In the research object, there are several urgent problems related to waste banks, namely (1) Population expansion, wealth growth, and changes in consumption habits in

contemporary society have led to rising volumes, types, and brands of waste that are more and more diverse. (2) Low public awareness of sorting their own garbage, low public knowledge of the circular economy, continued usage of the collect, transport, and dispose of paradigm, and lack of implementation of the circular economy idea with the principles of Reduce, Reuse, and Recycling. (3) The Solusi Hijau Garbage Bank's waste management procedures, operations, and transactions are still conducted manually using paper that has not been digitalized, making data vulnerable to loss, damage, ineffectiveness, and inefficiency and not meeting the needs of society 5.0.

The Solusi Hijau Bank, one of the garbage banks in Bogor Regency, is the answer developed to address the urgency of the research. It is situated at Puri Husada Agung, Rt 002/Rw 012, Cibinong Village, Gunung Sindur District, Bogor Regency, West Java Province. The manager of the Solusi Hijau Garbage Bank acknowledges that the data recording is still done manually and has not been digitized based on the findings of the interviews that have been performed. Customers and collectors struggle to swiftly, precisely, and instantly receive information because they lack access privileges to the system. The Solusi Hijau Garbage Bank still manages waste data, customer data, and collector data using paper and books, which puts that data at risk of loss, damage, wastefulness, requires a higher cost, takes a long time, and is not effective or efficient enough to meet society's demands. 5.0. The manager of the Solusi Hijau Garbage Bank, clients, and collectors are unable to view statistics on the classification of residential waste for each accounting period. Customers and collectors are unable to obtain financial statistics to evaluate the Solusi Hijau Garbage Bank's performance as a decision-making factor.

According to some supporting studies, including that by (Zeinora & Septariani, 2020) and (Rahardja et al., 2018), managing financial administration using a manual approach is thought to increase the likelihood of errors significantly(Gebo et al., 2022; Rifani & Sadikin, 2020; Solovida & Latan, 2017; Turner et al., 2022). Therefore, a website-based home garbage classification program must be created in order to solve this issue. The process of classifying waste based on its type when depositing waste, purchasing and selling waste, viewing transaction history, and downloading the necessary reports can be recorded using a household waste classification application that is connected to the internet, allowing for later, speedy, accurate recording. (Sansprayada & Mariskhana, 2020) research took the form of developing an Android-based trash bank transaction and service application that is simple to use by waste bank officers, clients, and collectors at the Villa Dago Residential waste bank in South Tangerang. By leveraging wireless sensor networks, research by (Tambekar et al., 2018) aims to reduce waste collection by developing a smart trash can. According to the research, this system will aid in reducing current waste collection issues through the effective operation of GSM sensors and modules. In their particular locations, proper and timely waste collection will contribute to a safer and cleaner environment. The goal of the research by (Sakshi et al., 2019) is to design a smart trash can that can distinguish between dry and moist waste. According to the findings of his investigation, the "Smart Dustbin" technology, as its name implies, successfully separates dry waste from wet waste. Designing a Smart Trash Management System for Smart Cities utilizing a mobile application is the sort of research done by (Kalpana & Jayachitra, 2017). The study's findings show that this planned system includes numerous trash cans positioned in towns or on campuses. The server stores information regarding bins and areas. A waste management application using IoT-based sensors and a microzonation survey initiative for cleaning and concentration of waste in regions and trash cans are two examples of research done by (Dutta, 2019).

The implications of the research for the field of science is that the design of a waste management accounting information system at the Solusi Hijau Waste Bank can be used as an accounting system that can help the Solusi Hijau Waste Bank and other

waste banks carry out the process of recording waste deposits, customer data, collector data, waste data, and financial reports effectively and efficiently so that the management of the Solusi Hijau Waste Bank no longer does the recording process manually. The design of a waste management accounting information system can be an alternative to the problems regarding information management faced by several waste banks that do not yet have an information system. The information collected in a system will make it easier for customers and collectors to track information, especially waste deposits and the latest waste data, in real time so that people become accustomed to using a computerized system when recording data and searching for the information needed in order to adapt to the era of society 5.0. The design of this waste management accounting information system can be a reference for developing other similar products to promote the scientific development of libraries and information.

2. RESEARCH METHOD

This research was carried out in two stages: a needs analysis stage and a system design stage. Figure 1 shows the stages of the research:

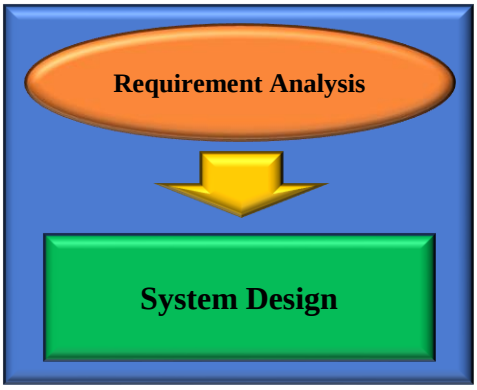

Figure 1. Steps in the Research Process

According to Figure 1, interviewing and observation are the data collection techniques employed during the needs analysis stage. On February 17, 2023, a full day of interviews with the Solusi Hijau Garbage Bank administration took place. On February 18, 2023, one day of observations of the Solusi Hijau Garbage Bank's operational procedures was conducted. At the system design stage, the process design was represented using use case diagrams and activity diagrams using tools from StarUML Version 5.0, the database design was represented using class diagrams and database tables using tools from Microsoft Visio 2019 and Microsoft Word 2019, and the user interface design was represented using tools from Balsamiq Wireframes(Rachmad et al., 2023; Sudipa et al., 2023).

3. RESULTS AND DISCUSSIONS

3.1 Comparative System Analysis

A comparison between the existing system and the proposed system is done based on the findings of the needs analysis conducted through observations made at the Solusi Hijau Garbage Bank. The following is a comparison of the system analysis shown in Table 1.

Table 1. Comparative System Analysis

Existing System	Proposed System
The management of the Solusi Hijau Garbage Bank must manually enter data about customers, collectors, waste, and waste deposits into the ledger and refrain from producing financial reports every accounting period. This requires the manager to purchase numerous books and other stationery, which lengthens the recording process and adds time, effort, and costs that are wasteful, ineffective, and inefficient. Additionally, paper that is easily lost, damaged, torn, and soiled is used.	In order to make it simpler to record and search for the data needed in real time, safely, quickly, accurately, effectively, and efficiently, the administrator can manage, input, and store customer, collector, waste, waste deposits, and upload financial reports for each accounting period into the system. This will save time and money.
To view information on garbage deposits and the most recent waste data, customer must go directly to the Solusi Hijau Garbage Bank, which makes the process of collecting the necessary information more time-consuming, costly, and wasteful.	Customer can view waste deposit information, waste data, waste statistics, articles about the circular economy, financial reports for each accounting period, and customer profiles to make it simpler to find the information they need in real time and to keep it safe, quick, accurate, effective, and current so that they can save time and money.
To view the most recent waste data information, including the most recent waste prices and waste inventories, a collector must go directly to the Solusi Hijau Waste Bank. This requires extra time, effort, and money, which is wasteful, ineffective, and inefficient.	In order to find the information they need quickly, safely, quickly, accurately, effectively, efficiently, and up to date in order to save time and money, collectors can view waste data information, waste statistics, articles about the circular economy, financial reports for each accounting period, and collector profiles.

3.2 Use Case Diagram

Use case diagrams are used to give a general overview of how users or actors interact with the functionality of the system that is being created. Use case diagrams can be used to uncover possible situations for how a system might operate. The use case diagram for the system being created describes a number of actors, including customers, administrators, and collectors, who are linked to a number of system activities. The relationship and interaction between actors and the system are illustrated in the use case diagram that follows:

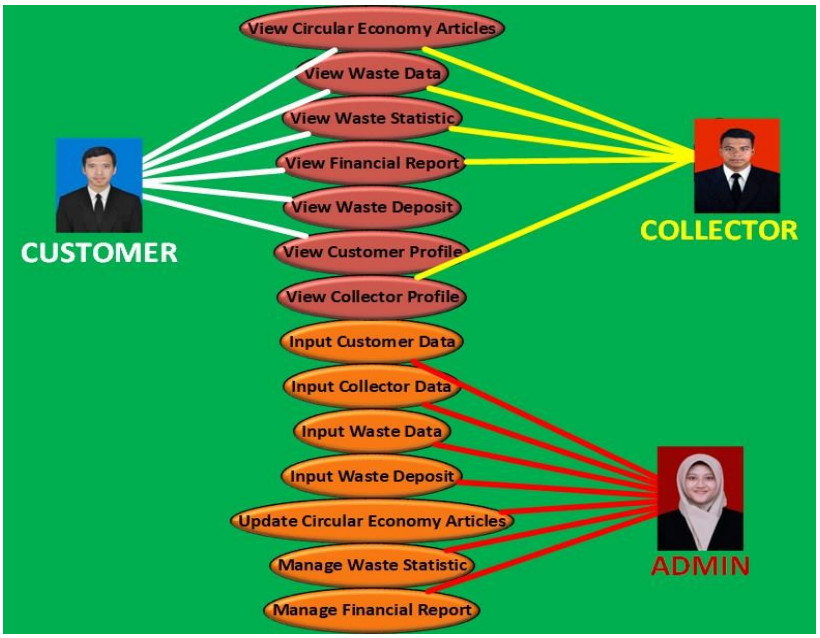

Figure 2. Use Case Diagram

According to Figure 2, the system that needs to be created comprises three actors: the admin, collector, and customer. Customers can interact with the system in six different ways, each of which is characterized by a different set of features. These interactions include seeing waste data, viewing circular economy, viewing waste statistics, viewing financial reports, viewing waste deposits, and viewing customer profiles. watching trash data, watching circular economy, viewing waste statistics, reading financial reports, and viewing collector profiles are the five interactions that collectors can have with the system, which are each described by five functions. The system's administrator can carry out seven interactions with it, or seven functionalities, namely entering customer data, collector data, waste data, waste deposits, updating articles about the circular economy, managing waste statistics, and managing financial reports.

3.3 Activity Diagram

An activity diagram is a visual representation of a system's processes, from the initial status procedure through the final status. A development of use cases with activities is an activity diagram. To describe the order of steps in a process, activity diagrams are employed. The following is an activity flow diagram for the admin's customer registration process:

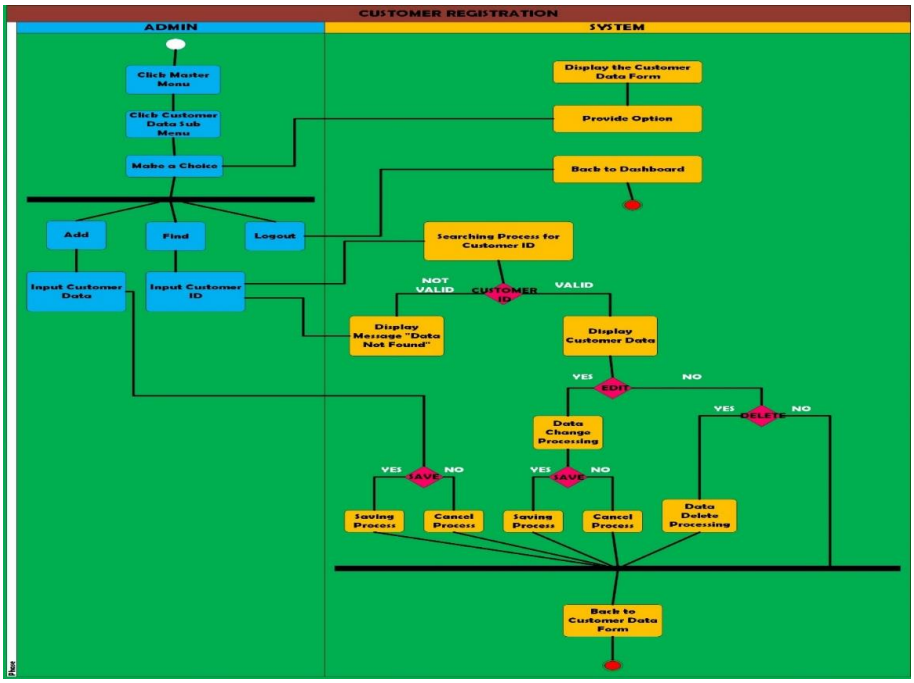

Figure 3. Activity Diagram for Customer Registration

According to Figure 3, the administrator must first select the Master menu, then select the Customer Data submenu, after which the system will display the button alternatives. Pressing the Add button and entering the necessary information, including the customer ID, name, phone number, address, email, account number, KTP number, and password, will add a new customer to the system. Once you've completed entering the customer's information, click Save. In the event that you choose Yes, the system will store the data and then return you to the Customer Data form's display. The system will stop the data storage procedure if you choose No. New customer registration has been completed. When an administrator clicks the Search button and enters the customer ID, the system processes the search for the customer ID. The system will show the requested

customer info if it is accurate. If an administrator wants to alter client information, they should first click the Change button and then carry on. In the event that you choose Yes, the system will store the data and then return you to the Customer Data form's display. The system will stop the data storage procedure if you choose No. Finding customer data has been successfully completed. If an admin wants to delete client data, they should first click the Delete button and then keep on. If you choose Yes, the system will delete the specified data and then return you to the Customer Data form's display. The system will stop deleting your data if you choose No. Customer data has been completely deleted. The system will indicate "Data Not Found" if the customer ID entered is incorrect. When the admin clicks the Exit button, the system will return to the main menu and the procedure will be finished.

3.4 Class Diagram

Class diagrams outline the system's structure in terms of the classes that will be created to construct the system. Attributes, methods, and operations are all part of classes. The variables that are a part of a class and provide a line of text in the class box to describe a property are called attributes. Functions that are part of a class are methods or operations. A class diagram that explains the system's classes and their connections to one another is provided below:

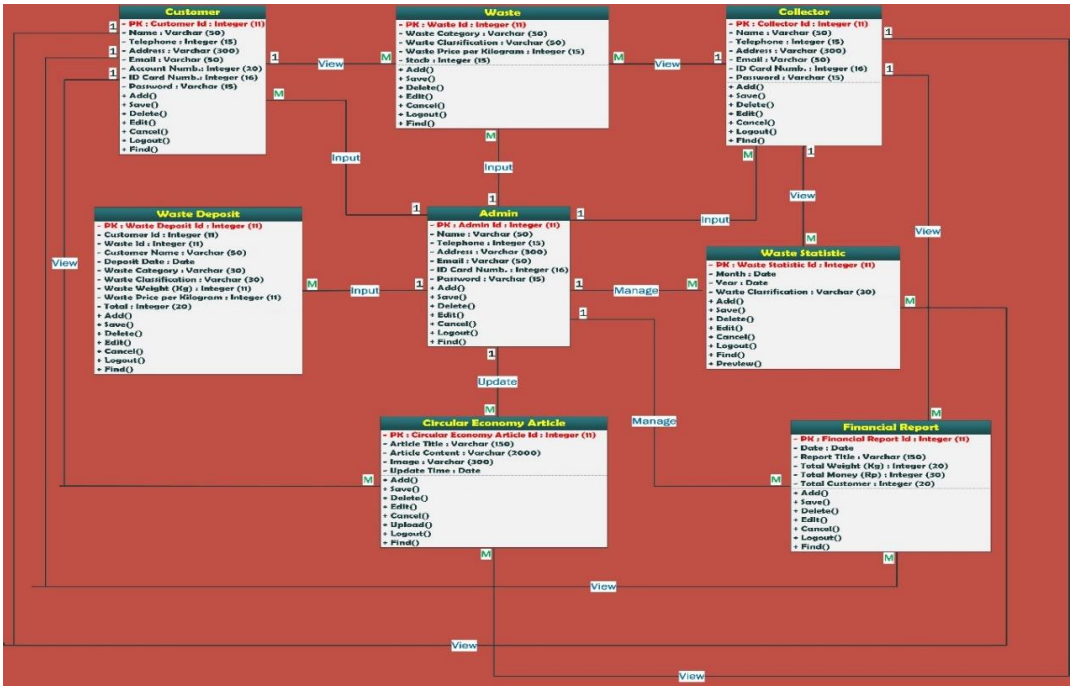

Figure 4. Class Diagram

According to Figure 4, there are eight classes in the system that need to be designed: the client class, the waste class, the collector class, the trash deposit class, the admin class, the waste statistics class, the circular economy class, and the financial report class. Each class has connections to the others. One administrator can enter a substantial amount of client, garbage, collection, and deposit data. One admin can handle a large number of useless statistics and financial reports. Numerous circular economy articles can be updated by a single administrator. One user can access a large amount of trash data, numerous circular economy articles, numerous financial reports, and numerous garbage statistics. One collector can view a ton of garbage information, statistics, financial reports, and circular economy-related articles.

3.5 Design of User Interfaces

a. Design of the Customer Registration Page

A website called the Customer Registration website has a form for new customers to fill out. Customers' personal information, including their customer ID, name, phone number, address, email, account number, KTP number, and password, must be entered by the admin during registration. If the registration procedure is successful, the consumer can log in to the system using their name, email address, and password. In order to search for specific customer data, an administrator can enter the customer ID in the Customer Data search area. If the customer ID is provided correctly, the system will process and show the desired customer data. The customer registration page shown in Figure 5 has the following design.

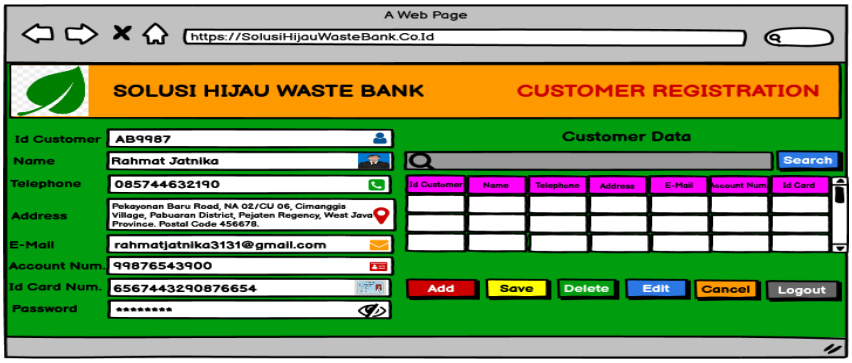

Figure 5. Design of the Customer Registration Page

b. Design of the Waste Deposit Page

A form for clients to make garbage deposits may be found on the page known as the garbage Deposit Page. When depositing trash, the administrator must enter client information as well as waste information, including customer ID, customer name, deposit date, deposit id, trash id, type of waste, waste classification, waste weight (Kg), waste price per kilogram, and quantity. In order to store the information put into the system after the garbage deposit process is successful, the admin can click the store button. If the trash Id or deposit Id entered is accurate, the system will process and show the particular waste data or specified deposit data that is requested. The administrator can use the Garbage Deposit search field to look up specific waste data or certain deposit data. The waste deposit page design shown in Figure 6 is as follows.

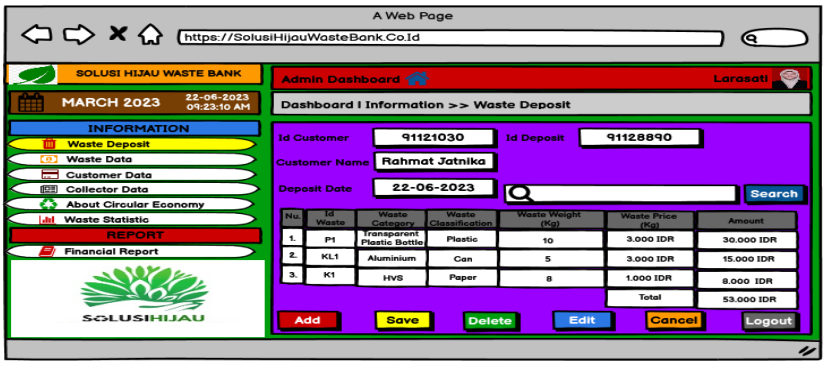

Figure 6. Design of the Waste Deposit Page

c. Design of the Waste Data Page

Waste Data Page refers to a page with a form for entering waste data that customers and collectors can subsequently view on their page. The admin must enter the Waste Id, Waste Type, Waste Classification, Waste Price per Kilogram, and Waste Inventory while filling out the waste data. Customers and collectors can view real-time updates on waste data on the customer and collector Garbage Data pages once the waste data storage process has been completed. If the trash Id entered is accurate, the system will process and show the specific garbage data that is being searched for. The administrator can enter the garbage Id in the garbage data search field to search for specific rubbish data. The Waste Data page design shown in Figure 7 is as follows.

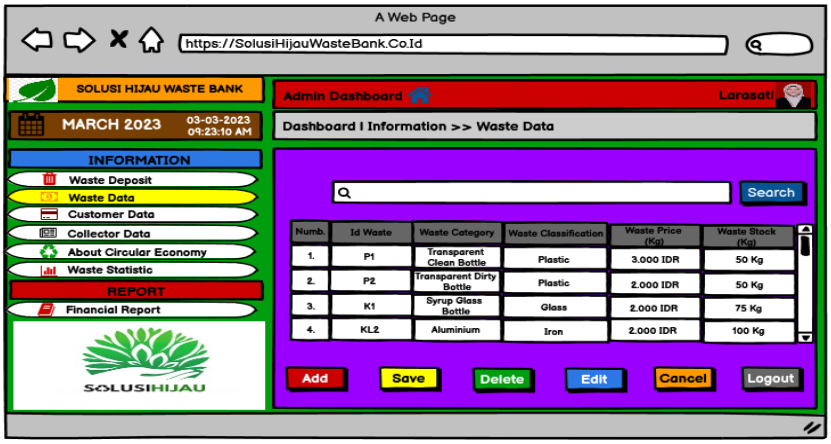

Figure 7. Design of the Waste Data Page

d. Design of the About Circular Economy Page

A collection of articles on circular economy themes may be found on the Circular Economy page, which can be viewed and read. When users or collectors want to read one of the articles that have been chosen, they must click the Continue Reading area, after which the system will display the article being read in its entirety. Presented in Figure 8 is the following page layout for the circular economy.

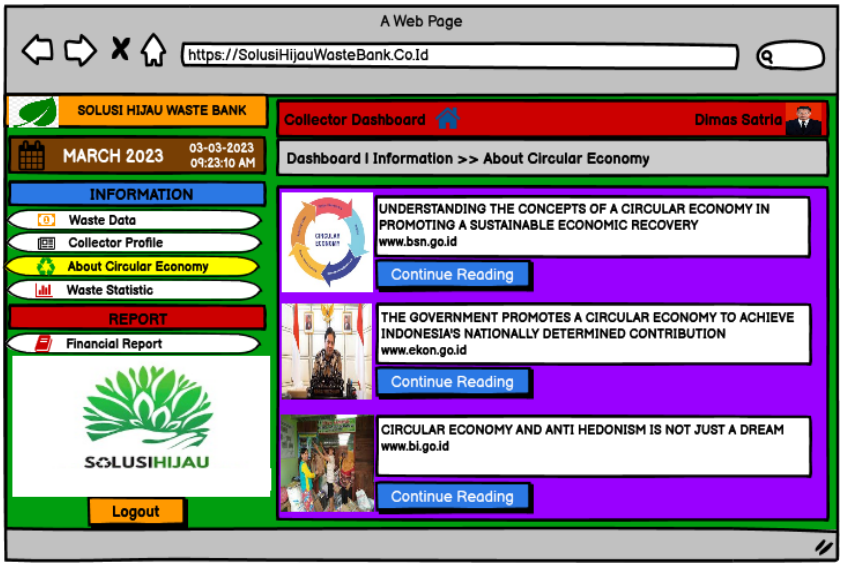

Figure 8. Design of the About Circular Economy Page

e. Design of the Waste Statistic Page

The Waste Statistic page allows users to view statistics on the volume and prevalence of each sort of garbage for a predetermined time they have chosen. The consumer must choose the Month, Year, and Type of Waste Classification when requesting waste statistics. The system will then display information on the amount and percentage of each sort of waste for the selected period if the consumer presses the Show button. The Garbage Statistics page shown in Figure 9 has the following layout.

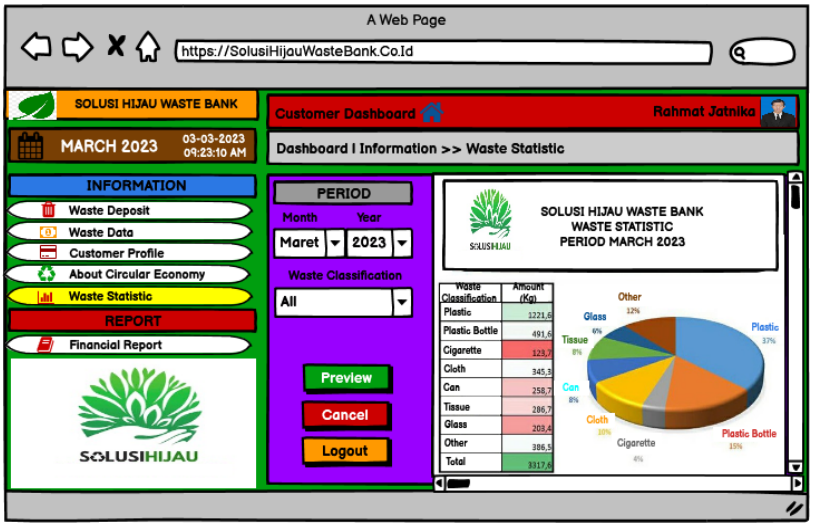

Figure 9. Design of the Waste Statistic Page

f. Design of the Financial Report Page

The Financial Report page is a page with a form that users may fill out to create a financial report that will later appear on their page. The admin must include the following information on financial reports: Report ID, Date, Report Title, Total Waste Weight (Kg), Total Money Collected (Rp), and Total Customers. The Financial Statements page for customers and collectors will display the financial reports for each period once the procedure of storing financial data has been accomplished. If the report ID entered is accurate, the system will process and display the specific financial reports being searched for. The admin can enter the report ID in the financial report search area to search for specific financial reports. The following is a design of the Financial Report page shown in Figure 10.

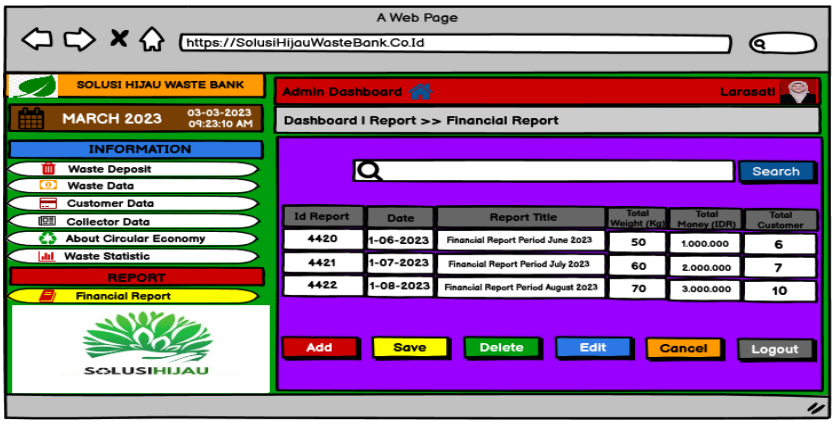

Figure 10. Design of the Financial Report Page

4. CONCLUSION

The design for the Solusi Hijau Waste Bank's waste management accounting information system has been created successfully. This system's design is carried out in two stages, namely the needs analysis stage and the system design stage. Process design, database design, and interface design are all components of the system's design. Use case diagrams, activity diagrams, and class diagrams from the Unified Modeling Language (UML) are used to model the design process that was produced. The Solusi Hijau Waste Bank will hopefully be able to handle and obtain information about waste management, customer data, collector data, and transaction data conveniently, quickly, precisely, and in real time with the help of this system design. The Green Solution Waste Bank is not the only garbage bank that can use this system design; other garbage banks that have roughly the same business procedures can as well. This investigation is still only in the planning stages. In order for the waste management accounting information system to be employed, design work on the system must continue through the implementation and testing phases. There are differences in the information system features that the authors will create from the five waste management information systems that have been developed by prior researchers, including the presence of a waste statistics feature, features related to the circular economy, and features of financial reports that should have an impact on the community in terms of a new way of life that involves sorting waste. In order to assist the study goal of creating a waste management accounting information system at the Solusi Hijau Waste Bank, it is important that individuals sort out their household garbage, comprehend the idea of a circular economy, and put it into perspective. The contribution of this research is in the form of a computerized waste management accounting information system design that can be applied to the Solusi Hijau Waste Bank and other waste banks with the same business processes so that it can provide convenience for admins, customers, and collectors in managing waste and finding information about waste deposits, data waste management, and financial reports in a fast, accurate, and real-time manner so that they can assist the circular economy implementation process at the community level. The limitations of the research is that it only reaches the design stage and not the user evaluation stage due to insufficient time. Interviews were conducted with only one administrator, one customer, and one collector at random, so the analysis of system requirements was not comprehensively detailed. The interview and observation times were short, namely only one day each. Suggestions for future research to improve the research are expected to be able to continue and develop information system design up to the stages of coding, testing, integration, implementation, operation, and maintenance. Adding new features, for example, the waste pick-up feature, where there is a list of recycled products and their prices, the payment process can be made directly through the system using the QR Code payment method, via ATM or mobile banking, or even adding new actors, namely visitors, to make it easier for visitors when they want to find information when they want to buy recycled products.

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