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IMPLEMENTATION OF WASTE BANK INFORMATION SYSTEM TO MANAGE WASTE TRANSACTION DATA FROM THE COMMUNITY

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Abstract

Considering that a significant amount of waste can be recycled and recognizing the need for more service providers to handle community waste, employing information technology becomes crucial for more efficient data management. This study aims to create an information system that can manage waste transaction data from the community. The current problem is that the process of calculating customer transaction data is not accurate and still relies on the use of a calculator. This often leads to typing errors which resulted in discrepancies between the amount of funds withdrawn and the total transaction data. This requires repeated checks, which can be time-consuming. The method used in this study is the Design Science Research Methodology for Information System, which involves a prototype and the Object-Oriented development method. The system design is assisted by the Unified Modelling Language tool. The application is a desktop-based Java program with a one-tier architecture. The program aims to calculate community waste transaction data more accurately by automatically accumulating transactions from start to finish. With this waste bank management information system in place, waste data management would potentially be more efficient because the data is stored in a database and can be accessed when needed. Therefore, customers receive funds according to their transactions without the need to check the archive, as all transaction data are be stored in the database thus reducing wasted time.

Keywords: Community waste management, Design Science Research Methodology (DSRM), Waste bank information system.

1. Introduction

Waste poses a ubiquitous challenge for every nation, as each individual contributes to the accumulation of substantial amounts of garbage. Based on a report from the World Economic Forum in 2020, the world generates around 300 million tons of waste each year [1]. Waste management has been a persistent challenge in Indonesia's urban centres, including Bandung City. According to Open Data of West Java, the Housing and Settlement Office has reported that the city's daily waste production in 2021 ranged between 1,529 to 1,600 tons, comprising 63% organic waste, 23% inorganic waste, and 14% residual waste [2]. Bandung City, the capital of West Java Province, is among the cities with the largest populations. The city spans an area of 167.31 km2, encompassing 30 sub-districts and 151 villages [3].

The population of the community has shown a gradual increase over the period of 2021 to mid-July of 2023. In 2021, the population was recorded at 2,452,943 individuals, followed by a slight rise to 2,461,553 individuals in 2022. As of 2023, the population had further increased to 2,469,589 individuals [4]. This upward trend reflects a consistent growth in the community's population over the specified time frame. It can be seen that the increase in population growth rate from 2021 to 2023 certainly have an impact on the increasing number of consumptions by the people of Bandung City, which can directly increase the amount of waste generated from this consumption. The increasing volume of waste but limited landfills is certainly a problem if not handled carefully [5]. This research contributes to providing a solution for a waste management system in South Sekeloa village, Bandung city. The system developed here can also be used in other waste management communities in different.

The Indonesian government has established laws to manage waste, namely the Law of the Republic of Indonesia Number 18 of 2008 concerning Waste Management and Government Regulation Number 81 of 2012 concerning Management of Household Waste and Waste Similar to Household Waste. These laws mandate a fundamental shift in waste management from disposal to utilization. This shift can be achieved through the development of waste banks that provide economic value while promoting environmental protection. The development of waste banks aims to instil a new culture among the Indonesian people in handling waste and educate them on how to manage waste wisely by implementing a waste sorting system [6, 7]. Waste banks are a collective dry waste management system that encourages the community to take an active role in waste management [7].

One way to minimize the accumulation of too much waste is to recycle waste that can still be reused into useful items, recyclable waste is grouped into 4 main categories: paper, plastic, metal, and glass [8]. A suitable concept so that waste can be collected faster is the community-based recycling program or the Waste Bank as an innovative technique to encourage the motivation of residents to sort waste at home by exchanging it for an amount of money according to the waste price determined by the recycler or waste collector [9]. The waste bank system involves collecting, sorting, and distributing waste with economic value in the market, which benefits the community by providing economic rewards for waste reduction. Therefore, to make community transaction data more accurate, it is necessary to manage waste transaction data in a structured manner with the application of information system technology.

The design of this application refers to research that has been published but has different problems. As research entitled A Social Innovation Model for Reducing Food Waste: The Case Study of an Italian Non-Profit Organization [10], other research such as Waste Bank: Waste Management Model in Improving Local Economy [11], while for other research discusses the Design of Inventory Management Information Systems at Suhuf Kertaseni Nusantara Bandung [12], as for research that discusses Participation in community-based solid waste management in Nkulumane suburb, Bulawayo, Zimbabwe [13], and also research on Blockchain for Waste Management in Smart Cities: A Survey [14]. These five studies have the same thing in common, namely using technology for community-based waste processing using a waste bank, while the difference is in the type of waste used, namely food that can be reprocessed. As the previous studies recycle solid waste, this study describes the creation of an information system to process transaction data to be more accurate when people withdraw funds to waste bank officers. This research is based on a desktop and is intended for areas that want to apply this waste bank information system to become a smart city.

This study aims to develop a more computerized waste data processing in the community by using a computer as a data storage medium that is stored in a database so that it is more effective for data retrieval in one center and can only be accessed by bank officers. The application of this information technology uses a one-tier architecture which is only centred on a single machine with a concept where computers can access databases from the computer itself. Data that is processed through information technology are more accurate, and the creation of customer data and other data goes through big data analytics because officers have access to more accurate data with big data they can find the value of hidden data connections and patterns [15]. By implementing this information system, the data provided to customers are more accurate so that by the initial transaction when exchanging waste, the public can participate more without having to wait too long to withdraw funds. The information system in this study is desktop-based with the development method using the Object-Oriented method and UML assistance, the stored data can be located anywhere because it is stored in one database on the computer.

2. Method

This research using Design Science Research Methodology (DSRM) for Information System [16] which has been adapted to develop an information system as in Fig. 1 [17].

2.1. Analysis

Literature studies are carried out to provide an overview of the problems uncovered and determine solutions to resolve these problems based on existing literature. At this stage, a literature study is carried out to determine the modelling tools and application models that will be created (see Fig. 1).

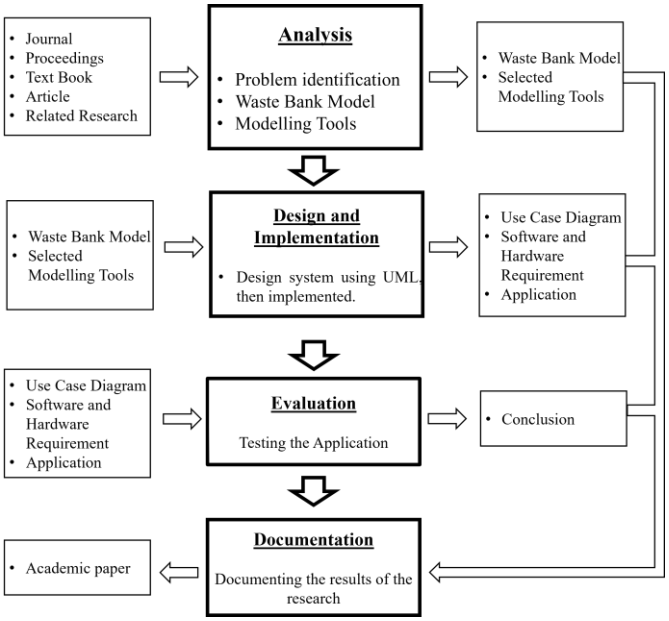

Fig. 1. Research methodology.

2.2. Design and implementation

The system development method employed in this research is Object-oriented method, while the approach method uses prototype method, thus enabling officers to use a system that is simpler and can be understood by ordinary people. The tool used for representation in system design employs the Unified Modeling Language (UML). This choice is particularly apt given the nature of the activities involved, which encompass the storage of data in a database and subsequent retrieval for utilization. The utilization of UML is deemed appropriate in this context. This information system program uses a desktop-based Java program with a one-tier (standalone) architecture where the data are centralized in one database and one machine. In a one-tier system, the presentation layer is located entirely within the server [18, 19]. It governs all aspects of the interaction between the server and the client, determining the appearance and display of information, as well as how to respond to user input. One-tier has some clear advantages, so that users can find various data in one location or one storage [19].

2.3. Evaluation

When developing an information system, the evaluation process is a very important thing to do. In this evaluation process, it is assessed whether the information system that has been designed and implemented can be used properly.

2.4. Documentation

At this stage, documentation is carried out in the form of scientific article documents based on all the processes that have been carried out in this research, then the scientific article is published.

3. Results and Discussion

3.1. Results

The results obtained in this study are an information system application program that can be used by the community to form waste processing using a more computerized community transaction data management application so that the data calculation process is carried out in one computer connected to the database. With the application of this information system, officers can find the data needed for reporting so that the printing process of the community waste passbook be faster.

In the results of other studies discussing the government that supports and facilitates waste transactions for community-based recycling activities called *Bank Sampah* (Waste Bank) in Indonesia [9], this research develops a waste bank application program that is expected to help the process of managing waste transaction data and support government programs.

3.1.1. Use case diagram

Use case diagrams are UML diagrams to define functionality and graphically of a system in terms of actor, use cases, and relations [20]. The depiction of this information system is illustrated in the use case diagram as shown in Fig. 2.

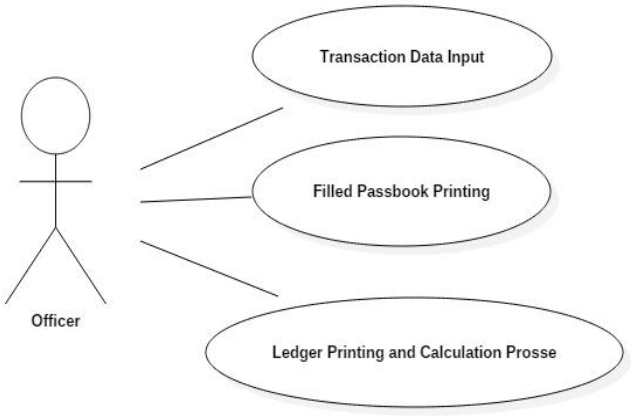

Fig. 2. Use case diagram.

Figure 2 shows that officers need to input data first for customers, collectors have new waste to proceed to the next process, but officers can also directly print the required transaction data if the required data is already stored in the database. In the last case, the system carries out a ready calculation process to be printed by the clerk.

3.1.2. Software requirements

The software that is required for the information systems, including:

(i) Using at least Windows 7,
(ii) XAMPP Control Panel, and Web Browser.
(iii) Software Editor NetBeans IDE 8.0, JDK 8.0.

3.1.3. Hardware requirements

There is hardware that also needs to be used by developers for the implementation of information systems such as:

(i) Minimum processor using Intel i3,

(ii) With 4GB Memory capacity and 100GB Hard Disk,

(iii) In addition to the main equipment such as input and output devices such as mouse, keyboard, monitor, and printer.

3.1.4. System architecture

Figure 3 shows the one-tier systems. The entire presentation layer resides within the server. The data is stored in the local system.

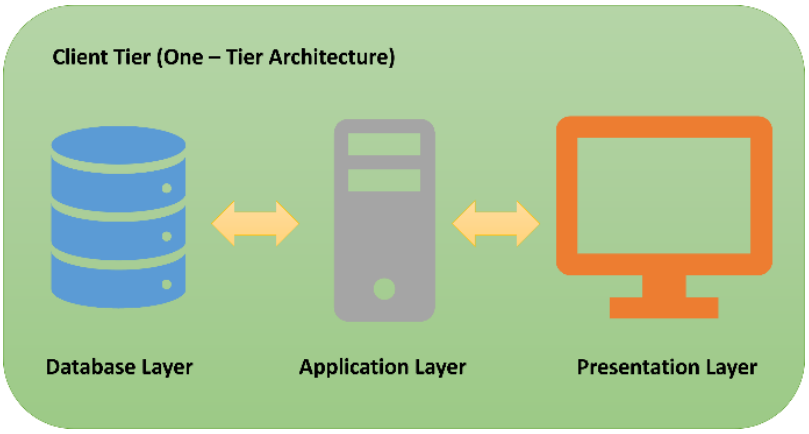

Fig. 3. System architecture.

3.1.5. Interface

This system is designed to help develop the agenda of activities that should be carried out, so that they can benefit while avoiding the risk of misinformation [21]. The data process that has been described according to the use case diagram was realized in the form of a program application that is in accordance with the needs of the officer as shown in Fig. 4.

In the menu bar display in Fig. 4, there is a file menu that contains master data such as customers, waste, and collectors, while in the report menu there are reports that can be directly printed. This form shows the calculation of price based on waste weight sent by the customer. Because faulty computation leads in collectors receiving lesser results than they should, the program has set a price so that collectors can receive the money calculation fairly. Users also learn about the flow of funds and other societal and individual benefits. This page describes crucial functions in the waste bank system, as well as critical success elements for implementation.

The display for the initial menu functions for inputting new transactions by retrieving data that has already been entered, as shown in Fig. 5. The Homepage mainly displays the function menu, calendar, time, weather information, and temperature [22], but this program only displays the required features, namely calendar and time.

Fig. 4. Transaction input data.

Fig. 5. Input customer data.

As in Fig. 5, the data that needs to be entered are name and address, each data has its ID by pressing the "Add ID" button, and customer data are stored in the database and displayed in a table. Next, the officer needs to fill in the data collector as shown in Fig. 6. To have the desired final target, it is necessary to collect labelled data so that it has the desired input and output [23]. Starting from this process to Figs. 4 and 5, the final reporting system produces the expected output for the customer.

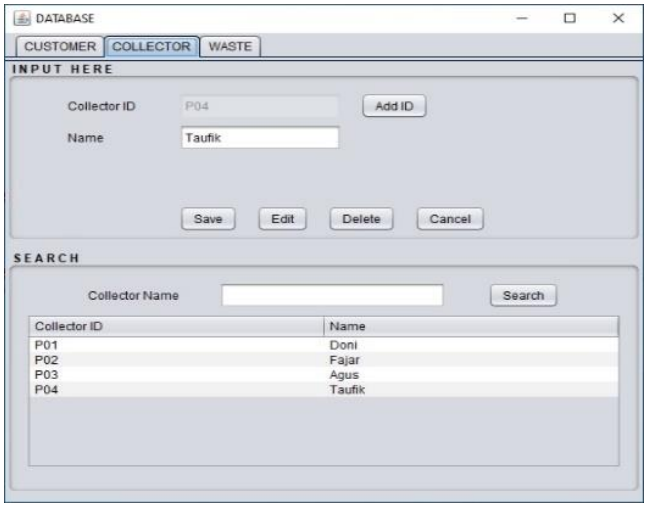

Fig. 6. Input collector data.

In Fig. 6, the officer needs to add a data collector if there is a new collector by pressing the "Add ID" button first and then entering the collector's name, then the data are stored in the database and displayed in the table. In a developing country, MSW recycling on household separation via scavengers and collectors who trade the recyclables for profits [8] next, the officer needs to enter waste data along with the price set as shown in Fig. 7.

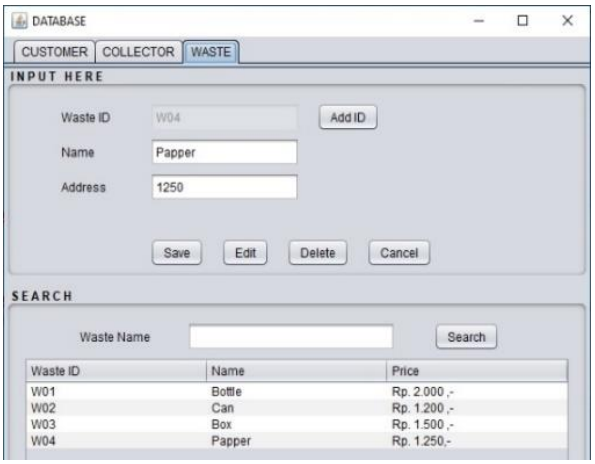

Fig. 7. Input waste data.

In Fig. 7, officers can add new types of waste, and the price is set per 1 kilogram, each waste data has an ID by pressing the "Add ID" button, and the data that has been stored in the database be displayed in the table. Furthermore, if customer data, collector data, and waste data are already stored in the database. When the data matched, the connection configured, and the service registration and reporting process is set, the system carries out the final accumulation which is displayed in the form of a ledger [23] as shown in Fig. 8.

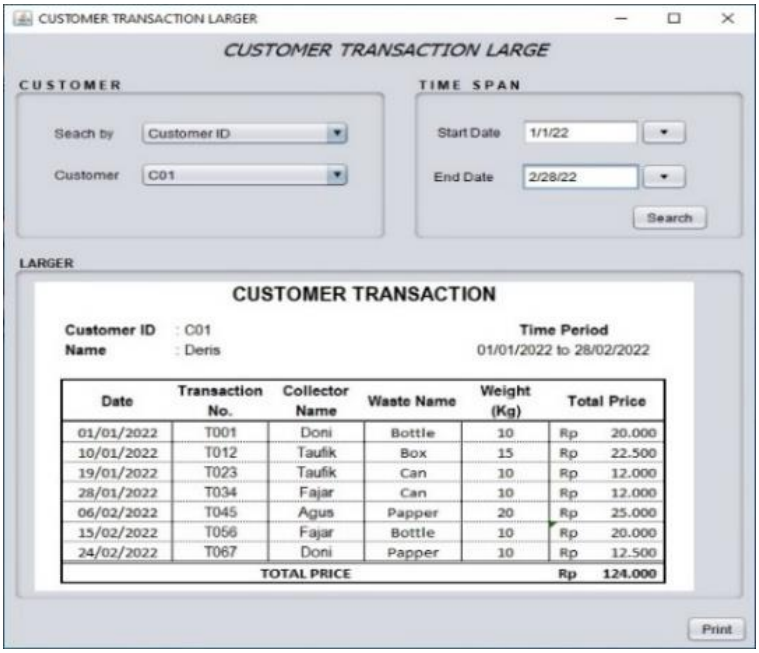

Fig. 8. Large printing and calculation process.

Figure 8 shows a report in the form of a ledger that can be printed based on customer ownership transaction data and also time. Officers need to arrange customer data to be printed by determining the data be sorted by Customer ID, Name, and Address, after resetting the waste transaction time range by specifying the start date to the end date, then press the "Search" button, then the data displays the customer transaction report form, the user can press “Print” to print the ledger. Many of the waste management systems are highly Internet of Things (IoT)-based and leverage centralized cloud-based resources to process waste-related data [14], therefore the officer can arrange the data to be selected and then the database provides the desired data.

3.2. Discussion

To provide a more concrete picture of the important benefits of this application, comparison was done between compare the time it takes to process waste data manually with the time it takes to process it using an application program. A sample of 30 transaction data was collected for each method and then the transaction processing time was calculated in minutes. The results of the comparison between manual processing and application processing are illustrated in Fig. 9.

From Fig. 9, it can be seen that processing waste data manually takes longer than using the application. Of the 30 transactions, for the manual requires an average processing time of about 19.6 minutes. Meanwhile, data processing using the application requires an average data processing time of about 5.8 minutes. Figure 10 also shows the error rate of processing waste data by officers manually and using the application, namely the type of error along the way [24].

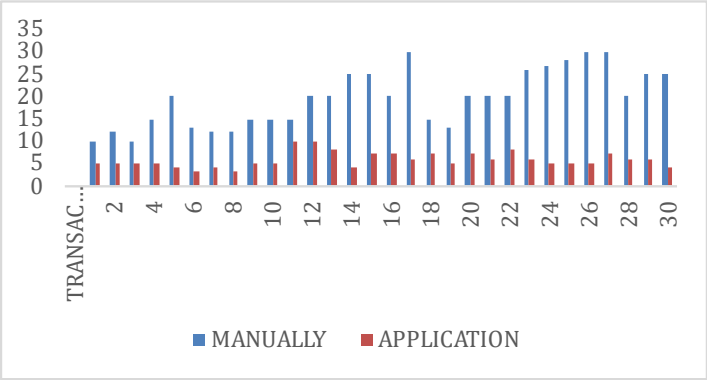

Fig. 9. Transaction time data manually and through the application.

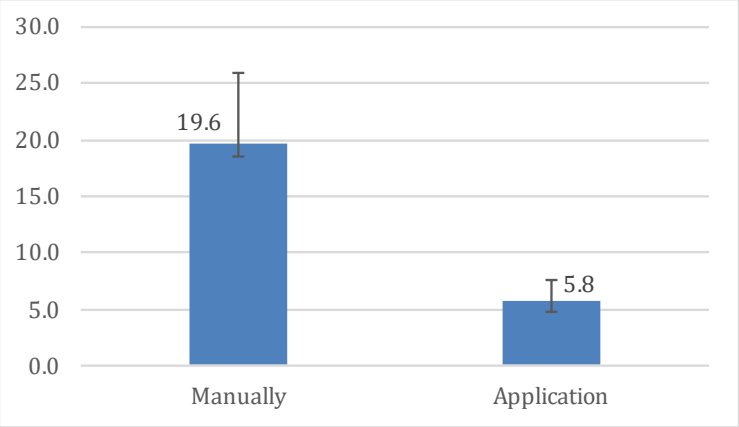

Fig. 10. Average processing time and error rate data.

The errors that occur are generally caused by difficulties in human resources collecting, confirming, and checking data from various existing archives. This data are used as a basis for calculating the amount of money the consumers received for the waste deposited. Varying amounts of waste, types of waste, consumer data, and others often cause calculation errors. This can ultimately be overcome with this proposed application, in accordance with researchers' statements regarding the use of applications that can increase the speed of transaction completion compared to manual processes [25, 26].

The presence of this application shows that this application makes it easier to input data, speeds up data processing, and provides information with more accurate results. This also provides an illustration of how important it is for this application to be implemented.

4. Conclusions

With the implementation of this waste bank information system, the community can implement waste processing, especially in managing waste transaction data which saves time. The required data also be input and stored in a database on one

machine that can only be accessed by officers. This system helps people to withdraw stored funds without having to wait for the officer to process the data for a long time. Further research can develop IoT-based applications to help sort waste and develop a mapping of waste collection points.

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