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# Optimizing the Waste Bank Mapping Management Information System in Batam City

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**Abstract**

Geographic Information Systems (GIS) have been widely applied in environmental health, including determining the locations of waste banks. Currently, in Batam City, there is no mapping-based system available to track the distribution of waste banks, posing challenges for residents to access information about nearby waste bank locations. Population growth is correlated with rising household demands, including the need for food, clothing, and housing. People need their basic necessities to survive. The industries of manufacturing, transportation, healthcare, and communication have all seen significant advancements since the Industrial Revolution. With the advent of information and technology (IT), all of those areas' development in the 19th and 20th centuries was larger and faster. Hence, this study introduces a management information system with mapping technology for waste banks in Batam City. Employing a descriptive analysis approach, the software development follows the waterfall method, and Unified Modeling Language (UML) serves as the design tool. The resulting system proves effective in providing information on Waste Bank locations and assisting administrators in managing Waste Bank location data.

**Keywords:** Geographic Information System,Waste Banks, Environment

## 1.Introduction

### 1.1 Sub Introduction

Waste is a serious problem in various cities and villages, requiring serious attention to handling. Unhealthy public behavior in waste management, such as burning, hoarding and throwing away carelessly, has a negative impact on the environment and health, causing natural disasters, the spread of disease, climate change and other impacts. To overcome this, society needs to show active concern for reducing and preventing environmental damage (Nursya'bana *et al.,* 2021).

With increasingly active community involvement, environmental improvement policies can better reflect the interests of society as a whole. However, if this awareness does not arise from the community or does not originate from community aspirations, then the community's sense of ownership of environmental cleanliness can decrease. So it is important to build public awareness and ensure that environmental policies reflect the needs and aspirations of society as a whole in order to achieve more effective and efficient results(Anjani and Adlin, 2020).

Every individual from various community groups has a responsibility to clean up the waste they produce, encouraging the need for waste management that focuses on environmental aspects. According to Latif *et al.,* (2019) one of the proposed solutions is to increase the number of waste banks, which function as places for sorting and collecting recyclable waste.

According to Erdiansyah *et al.,* (2016) In the waste bank there is potential waste that can be utilized, involving the categories of plastic, paper, glass and metal waste. Types of paper waste involve paper, newspapers, duplex paper, and cardboard, while plastic waste includes plastic cups, non-bottle plastic, and plastic bottles. The aim of this waste bank concept is to increase the reuse of waste with economic value, in line with the principles of reduce, reuse and recycle.

Selomo *et al.,* (2016) explained that waste bank activities are a social engineering effort that teaches people to sort waste and increases collective awareness in smart waste management, with the impact of reducing the amount of waste thrown into final disposal sites (TPA). The establishment of a

waste bank is considered as the first step to develop public awareness in sorting, recycling and utilizing waste, considering the economic value it has. Therefore, it is hoped that environmentally oriented waste management will become an integral part of the new culture in Indonesia.

Based on 2019 Batam City DLH data, the waste bank plays a role in reducing the amount of waste in Batam. Data shows that the amount of waste in Batam reaches 900 tons per day. Through waste bank activities, the amount of waste in Batam is reduced by around 31 tons per month. The types of waste that are successfully processed by waste banks include paper, plastic, aluminum and cardboard.

With the enormous benefits of waste banks, good management is needed for waste bank data collection in Batam City, so there is a need for a mapping-based waste bank management information system to make it easier for the Batam city government to collect data and inventory waste banks in Batam City.

## 2. Literature Studies

Previous research was conducted by Erdiansyah et al., (2016). Monitoring waste bank activities and searching for waste bank locations and their potential are two important problems in waste bank management. This problem can be solved by data visualization using a geographic information system. Data visualization using a geographic information system can provide clearer and easier to understand information regarding waste bank activities and their potential. This information can be used to monitor waste bank activities more effectively and efficiently, as well as to find waste bank locations that have high potential.

Research result Putranto *et al.,* (2019) also explained that implementing a Geographic Information System could help facilitate waste management. Latif *et al.,* (2019) revealed that the use of GIS in web-based waste management can make it easier for waste bank administrators and the public to manage waste banks and find out the location of waste banks. Siswanto *et al.,* (2022) revealed that. The Web-Based Waste Bank Management Information System makes transactions easier, more efficient, increases accuracy and helps facilitate user transactions.

Based on previous research studies as explained above, there are several similarities between previous research and the current research topic. Where GIS technology can be used to help manage waste banks to provide services to waste banks.

### 2.1. Geographical Information Systems (GIS)

According to Apata *et al.,* (2019) Geographic Information Systems (GIS) are the result of the evolution of information technology which is used to manage, perceive, store, display and analyze geographically based data. Whereas Saputra *et al.,* (2018) explains that GIS is a system that operates and displays data that has spatial or coordinated dimensions

GIS can be interpreted as a representation of the real world displayed on a computer device, similar to conventional maps, with four main components, namely: 1) Hardware; 2) Software; 3) Geographic Data and Information; 4) Human Resources/Management (Mooniarsih and Imansyah, 2020).

### 2.2. Google Maps

Google Maps is part of a series of services offered by Google to display digital maps. In its presentation, Google Maps adopts digital image technology to directly display objects on the earth's surface (Rahayu, 2018). Utilization of Google Maps can be done via a browser application for web-based applications, or alternatively, via a mobile device for mobile-based applications. As open source software, Google Maps provides the opportunity for users to participate in the development process*(Saputra et al.,* 2018)

### 2.3. Database

Hidayat and Safarudin (2018) explains that a database can be thought of as a secret warehouse where a group of interconnected data is stored on hardware, and managed using a magic manager called a database management system (DBMS). According to Reksoatmojo, DBMS helps users manipulate data in databases, including creating, reading, changing and storing data easily (Hidayat, 2021).

### 2.4. Unified Modeling Language (UML)

Unified Modeling Language (UML) is a tool used to model object-based systems. UML is useful in describing the information system that will be developed (Hidayat, 2020). According to Fowler, UML is a family of graphical notations that help explain the design of the system to be developed in detail (Hidayat, 2018). According to Haviluddin, UML is needed to explain in detail everything that is required by the system(Hidayat, 2021).

## 3. Method

This research uses descriptive methods with the aim of explaining phenomena or events that occur through scientific methods(Wijaya, 2017). The system development method used is the waterfall method, and the system design model adopts UML.

### 3.1. Research sites

This research was conducted in Batam City, which is the largest city in the Riau Islands province of Indonesia. In the city of Batam, the volume of waste transported to the Telagapunggur. Final Disposal Site (TPA) reaches 900-1000 tons per day. The Waste Bank in Batam, which has been operating since 2014, has succeeded in reducing waste at its source. Currently, Batam produces 900 tons of waste per day, and the main Waste Bank managed by the Environmental Service has succeeded in reducing total monthly waste by 31 tons, including paper waste, plastic waste, aluminum waste and cardboard waste.

The number of Waste Banks currently operating in Batam City can be found in the following data released by the Batam City Environmental Service:

**Table 1.** Number of Active Waste Banks in Batam City

| No | Year | Number of Waste Banks |
|---|---|---|
| 1 | 2019 | 198 |
| 2 | 2020 | 156 |
| 3 | 2021 | 121 |

*(Source: Batam City Environmental Service, 2022)*

### 3.2. Research Stages

This research process follows the Software Development Life Cycle principles and is detailed as depicted in Figure 1. The initial step in this research involves literature analysis, which aims to collect information, data or related research. The data required in this research includes:

1. Data on the Number of Waste Banks in Batam City;
2. Waste Bank location information;
3. Information about GIS;
4. Utilization of Google Maps.

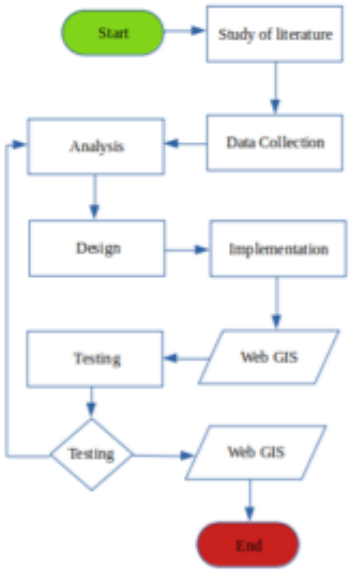


**Figure 1.** Stages of Research

This literature survey forms the main basis for this research. Data collection was carried out using various available media tools. Waste Bank location data is obtained through information that can be accessed on the Google Maps platform.

After completing the literature survey, the next step is to collect existing data and detail the requirements for the system to be built first. After determining system requirements, the next step is to analyze and design the system to be built. This process involves sketching the system design in UML as well as designing the user interface (UI) and user experience (UX).

After completing the design, the next step is to implement or build a computerized mapping system. The development of this web-based Waste Bank mapping information system uses map images from Google Maps, so that every Waste Bank in Batam City requires Google Maps data which includes longitude and latitude.

After building the system, testing is carried out. If there are errors, a system analysis evaluation is carried out, followed by redesign and improvement of the system. However, if the built system shows no errors during testing and is considered ready for use, the process is considered complete and the system is released. Each step is carried out continuously, forming a complete unity in this research.

To support research, several tools or software are used, including laptops/PCs, Ms. Word, M.S. Visio, Visual Studio Code, XAMPP, Google Maps, and Google Chrome.

## 4. Results and Discussion

### 4.1. System Design

System design is an advanced stage in the system development life cycle. In this phase, you will use various tools to design a system model that describes the current system or the new system being developed logically. Functional processing and data requests are carried out by the system using use case diagrams, activity diagrams, sequence diagrams and class diagrams.

### 4.2. Use Cases

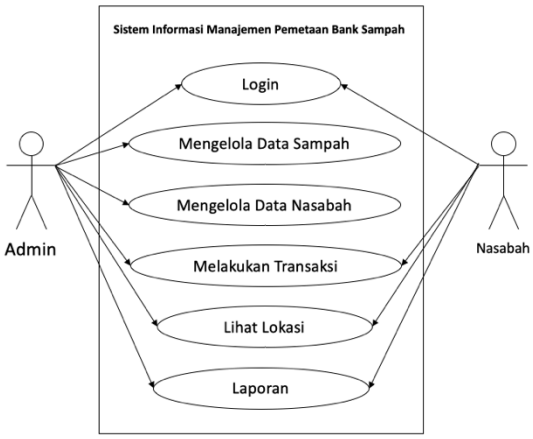


**Figure 2.** Use Case Diagram

Based on the illustration in Figure 2 which shows the usage scenario, it can be recognized that there are two categories of users, namely admins and customers. Admin acts as data manager, while customers carry out transaction processes. Customers can access three types of services, namely making transactions, searching for locations, and viewing Waste Bank data reports. The hope is that customers can get detailed information about the Waste Bank and the nearest location.

The data accessed by customers comes from input that has been entered by the admin previously. For admins to be able to manage data, they need to go through the login validation process by entering their username and password. The system will validate the data, and if it fails, the admin will receive an error message. However, if validation is successful, the system opens a dashboard that displays the Waste Bank data processing menu.

The menus in Waste Bank data management involve creating, displaying, modifying and deleting data related to the Waste Bank, the location of the Waste Bank, as well as information required by the Waste Bank. Only logged in users can access the data management page; Users who have not logged in will not be able to access it. After completing data management, the admin can exit the system by logging out, this action is important to maintain

system security and prevent misuse by parties who do not have authorized access.

### 4.3. Activity Diagrams

The following image will show an Activity Diagram that focuses on the Waste Bank Location Search Process. In this activity diagram, each step taken by the user in carrying out a search for a Waste Bank location will be explained in detail. From initiating a search to evaluating the results, the entire process will be clearly depicted in this visual representation.

It is important to note that this Activity Diagram is designed to provide an in-depth understanding of the steps involved in the process of locating a Waste Bank. Details such as the types of searches that can be carried out, interactions between the user and the system, and the responses produced by the system will be described in a structured manner. After the user carries out the search process, the system will respond and send data according to the user's needs, showing effective interaction between the user and the system in the context of searching for information on the location of the Waste Bank.

Thus, this Activity Diagram is not only a visual representation, but also an analytical tool that helps to thoroughly understand how the process of searching for a Waste Bank location takes place, as well as ensuring that the responses and data provided by the system are in accordance with the user's expectations and needs.

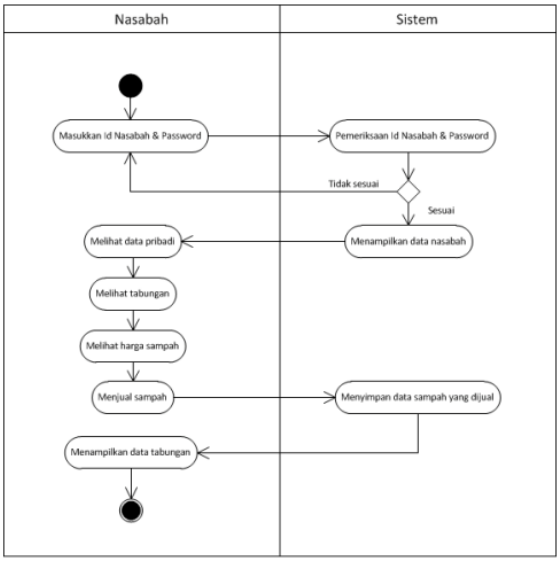


**Figure 3.** Search Activity Diagram

### 4.4. Implementation

The implementation step refers to the phase in which the system is realized through the coding process. This stage aims to implement the design that was created previously.

**1. Login Page**

To manage Waste Bank data, the first step that must be taken is through the login process. This login process is designed to ensure that individuals wishing to manage data are authorized admins and have full authority to perform data management tasks. In the context of this research, admin is identified as a user who has specific access rights to manage data in the system.

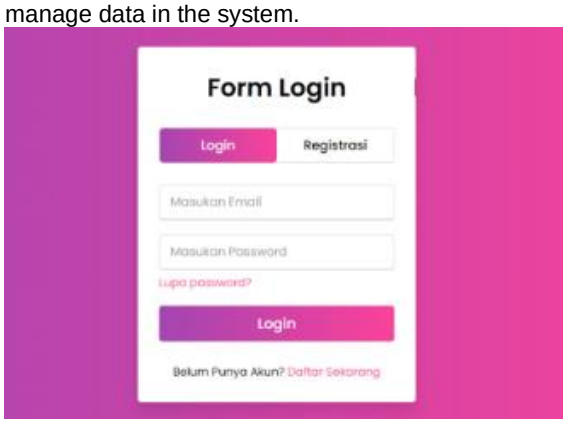


**Figure 4.** Login page

Figure 4 shows the Login Page which is the user interface. At the login stage, the admin will be asked to enter two credential information, namely username and password, which have been previously set. After the user inputs data, the system will carry out a verification process by comparing the information entered with the data stored in the database. If the login is successfully verified, the admin will be directed to the dashboard page.

The dashboard page is a control center that gives admins full access to manage Waste Bank data. Here, admins can view, change, add, or delete data related to the Waste Bank. Successful login is the key to unlocking access to these functions, ensuring that only admins with permission can run them. This not only validates the user's identity, but also secures the system from unauthorized access. Thus, the login process is a crucial stage in ensuring the integrity and security of Waste Bank data management

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**2. Dashboard Page**

After the admin has successfully gone through the login process and achieved success in login validation, the next step takes the admin to the dashboard page. This page is the central point that presents a number of menu options that can be accessed by admins to carry out various tasks related to waste bank data management.

In this context, the admin is given full control to enter data related to the Waste Bank. Available menu options include the ability to add information, including Waste Bank location data, and other information related to Waste Bank operations.

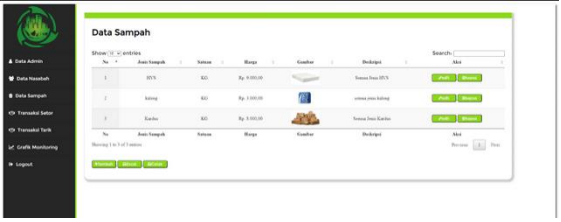


**Figure 5.** Dashboard page

The dashboard page creates a friendly and intuitive interface for admins, providing a visual overview that makes navigation easy. In the image listed below, admins can see a visual representation of the dashboard page that includes all menu elements and accessible functionality. Thus, through the dashboard page, admins can efficiently and

effectively carry out waste bank data management tasks, increasing the management capacity and accuracy of the information contained in the system.

### 3. Waste Bank Location Page

For general users, there is the ability to search for Waste Bank locations and obtain additional information through access to the system provided. In this context, the system is designed to provide a comprehensive overview of all Waste Banks operating in Batam City. Users will be able to search for relevant information regarding location, type of service, and possibly other information related to the Waste Bank.

At a general level, the system will display a summary of all Waste Banks in Batam City. Furthermore, users have the flexibility to select or search for Waste Banks that are located close to where they live or the desired location. This process can utilize the mapping features integrated in the system, making it easier to make choices based on geographic location.

As supporting information, a visual description of the location of the Waste Bank based on mapping is presented. This aims to provide users with a clear and intuitive overview of the available Waste Bank locations, helping them make informed and efficient decisions regarding the selection of the Waste Bank they want to visit or utilize its services.

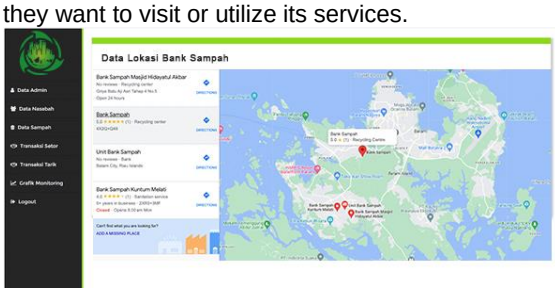


**Figure 6.** Mapping of Waste Banks

## 5. Conclusion

The results of this research illustrate that the use of Geographic Information System (GIS) technology in managing Waste Banks in Batam City has succeeded in providing information regarding the location of Waste Banks through a mapping approach. By combining GIS, this application is able to present data visually using geographic coordinates, enabling accurate mapping of the location of the Waste Bank. This approach proves that the application of GIS is not only effective in information management but also provides a visual dimension that helps users understand the geographical distribution of Waste Banks in the city.

The application of a web-based application in this research showed positive results, especially in providing easier access for the public to find the location of the nearest Waste Bank. Through a web interface, this information can be accessed quickly and efficiently, optimizing the use of mapping data for the benefit of society.

This system is designed using spatial maps from Google Maps as the main platform, with data integrated and stored in a MySQL database. The use of the PHP programming language supports system functionality, enabling responsive and interactive data display for users.

Although this application has had a positive impact, there is room for further development to enrich the features presented by the system. Such developments may include functionality improvements, such as the addition of more advanced search features or the integration of additional data that can provide more detailed information to users.

Apart from that, the emphasis on massive socialization is the key to the successful use of this application by the public. By providing an in-depth understanding of the benefits and how to use it, it is hoped that people can utilize this system optimally according to their needs. Outreach efforts can also involve training in the use of the application to ensure that people can utilize it easily and effectively. Thus, sustainable development and socialization can form a strong basis for the sustainability and success of this Geographic Information System application in the context of Waste Bank management in Batam City.

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