

# Creating Android-based System Aiding Tebuireng Waste Bank Management using Looker Studio

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## Abstract

Due to the growing influx of visitors in the Tebuireng area, there has been a substantial rise in the accumulation of waste. Bank Sampah Tebuireng (BST) has been established as a concrete effort to address the negative consequences arising from the increasing accumulation of waste. However, the BST still relies on manual data management, which is prone to errors and lacks efficiency. Therefore, the development of an efficient and effective information system becomes crucial. This research aimed to develop an Android-based information system using Kodular and utilize Looker Studio for dashboard visualization for waste bank management in the Tebuireng area. The development methodology included requirement analysis, system design, implementation, and testing. The Android-based information system encompassed features such as transportation, sorting, waste sales, as well as data reporting and analysis. Users could access this system through a user-friendly Android application. Data visualization using Looker Studio displayed interactive graphs, diagrams, and tables for monitoring and analyzing waste bank management data in Tebuireng. The system testing involved evaluation through black box testing. This research has created a user-friendly Android system for Bank Sampah Tebuireng. The system streamlines waste transportation, sorting, and sales processes. Furthermore, this research utilizes Looker Studio for data visualization and interactive reporting, making it user-friendly for day-to-day use and an effective tool for waste management data analysis.

**Keywords:** Bank Sampah Tebuireng, Android, Kodular, Looker Studio, Black Box Testing

## 1. Introduction

Waste has been recognized as a significant byproduct of human activities [1]. The accumulation of waste is on the rise due to factors such as increased mobility, development, population growth, and consumption [2]. This trend has substantial implications for the environment and human health when waste is not managed effectively [3]. The link between consumer behavior and waste generation is crucial, as the more goods are purchased, used, and discarded, the greater the quantity of waste produced. Prior studies have highlighted that households are the primary contributors to waste, followed by businesses and markets [4]. Inadequate waste management practices have been associated with air, soil, and atmospheric pollution, which can have detrimental effects on human health [5]. Therefore, there has been a recognized need to implement robust waste management systems to address these environmental and health risks [6].

It is essential to recognize that waste possesses intrinsic value, as indicated by previous research [7]. Waste is not merely a discardable byproduct; instead, when effectively managed, it can be transformed into valuable resources. Sustainable waste management practices emphasize the principles of reducing, reusing, recycling, and minimizing technological and equipment waste. This perspective underscores the potential of waste to contribute positively to resource sustainability.

In response to the waste challenge, the development of Waste Banks has emerged as a viable solution. Waste Banks operate based on the 3-R principles (Reduce, Reuse, Recycle) [8]. Notably, Bank Sampah Tebuireng, owned by Tebuireng Islamic Boarding School, has adopted the waste bank model for waste management. However, the existing waste transaction management system at Tebuireng Waste Bank relies on manual methods involving books and calculators. In the contemporary technological era, there is a compelling case for implementing an Android-based

management system and a visualization dashboard utilizing Looker Studio to enhance the efficiency and effectiveness of waste management practices [9].

This study is driven by the goal of designing an Android-based information system and Looker Studio visualization dashboard tailored specifically for managing waste at the Tebuireng waste bank. The objectives of this research are twofold:

1. To facilitate efficient waste data processing through the implementation of an Android-based system, optimizing data collection and management processes.
2. To provide user-friendly data analysis reports and visual representations via a Looker Studio visualization dashboard, aiming to empower decision-makers with valuable insights to inform and refine waste management strategies.

In conclusion, this research aims to address the existing gap in waste management practices by developing an Android-based information system using Kodular and harnessing the capabilities of Looker Studio for dashboard visualization to oversee and enhance waste management operations at BST in Tebuireng.

## **2. Literature Review**

In recent years, the integration of technology, especially Android-based systems, has emerged as a promising solution to tackle the multifaceted challenges in waste management. Researchers [10] shed light on the manual transaction recording processes encountered by waste bank personnel, which posed significant risks of data loss. Their innovative study yielded a breakthrough by developing an Android application rooted in the Kanban method, effectively streamlining transaction recording and thereby enhancing operational efficiency within waste banks. Moreover, the discourse extended to the underutilization of technology in waste management, particularly evident in manual waste disposal and collection systems. By harnessing the potential of Android-based waste bank applications, remarkable strides were made in improving both the effectiveness and efficiency of waste management practices within residential communities[11].

Furthermore, attention was drawn to the persistent inefficiencies stemming from outdated waste data management systems, prompting proposals for web-based solutions aimed at bolstering efficiency across waste management processes[12]. Noteworthy efforts were directed towards addressing data integration challenges, advocating for the adoption of data warehousing to augment decision-making processes in waste management[13]. Not stopping there, initiatives were introduced to foster better communication between residents and waste collection officials, thereby fostering greater coordination and efficiency in waste collection endeavors[14]. Additionally, endeavors were undertaken to alleviate the burdens associated with manual recording and documentation of waste management activities, with the proposition of Android-based Waste Bank Information Systems to streamline transaction data reporting and enhance transparency, ultimately leading to significant improvements in both efficiency and usability[9].

Moreover, there were proposals aimed at addressing localized issues of inadequate waste management, with a strong emphasis on the pivotal role of socialization in ensuring successful implementation[15]. Suggestions for the development of Android-based waste bank applications were put forth, with a focus on enhancing efficiency and effectiveness in waste management systems, resulting in tangible improvements in transaction streamlining[16]. Simultaneously, endeavors to design Android applications tailored for Sharia-based waste bank systems aimed at contributing to the broader goal of waste management improvement and micro-enterprise empowerment[17]. Lastly, concerted efforts were made to address the pressing issue of a dearth of waste transport volunteers, with proposals aimed at facilitating efficient waste collection and fostering a cleaner environment, all while generating income in local communities[18]. Collectively, these studies underscore the transformative potential of Android-based systems in bolstering various facets of waste management, paving the way for more sustainable and efficient practices.

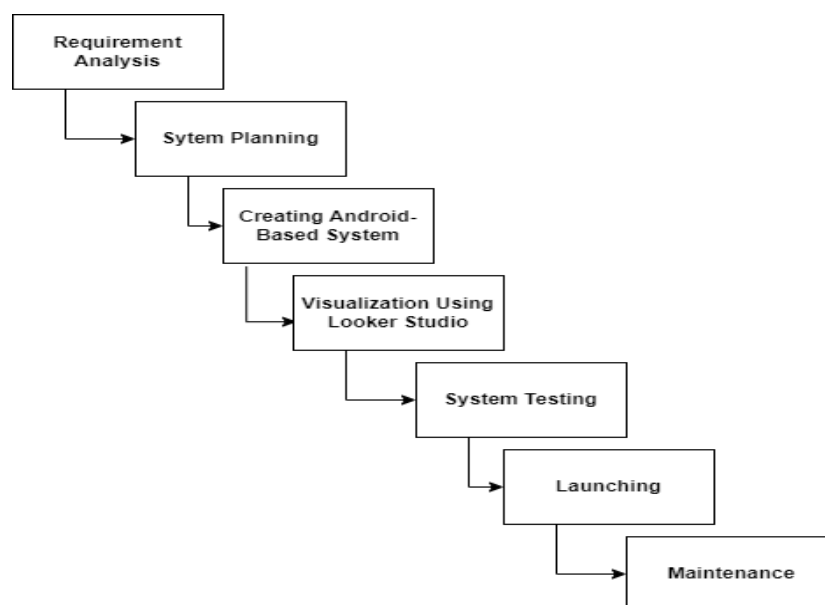
## **3. Research Method**

This research employs the waterfall methodology, a classical and systematic approach to software development characterized by its sequential nature. Referred to as the "Classic Life Cycle,"

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the waterfall model progresses through distinct phases in a structured manner[19]. The method was employed in the research titled "Creating Android-Based System Aiding Tebuireng Waste Bank Management Using Looker Studio" incorporating the following steps:

1. Requirement Analysis: Understand user needs, data processing requirements, waste scale, and system goals.
2. System Design: Design the Android-based system and Looker Studio dashboard, covering UI, database, and system architecture.
3. Android System Implementation: Develop the Android app based on design requirements, including transportation, sorting, and sales features.
4. Looker Studio Dashboard Implementation: Implement waste data visualization with visually appealing displays and interactive elements.
5. System Testing: Conduct functionality, integration, and performance testing to ensure proper functionality.
6. Launch: Communicate effectively with users for a smooth transition and full system implementation.
7. Maintenance: Regularly monitor and maintain the system for optimal performance, handling issues, updates, and repairs.



**Figure 1. Waterfall Method**

Figure 1 is the Waterfall method which is a linear approach that guides the stages in this research, with each stage being conducted sequentially and the next stage starting after the completion of the previous stage [20].

The study aims to create an advanced waste management system using modern technology. It utilizes Kodular and Android for system development and testing, while Looker Studio handles data visualization and spreadsheets for data storage. The synergy between the waste management system and the visualization dashboard significantly shapes the design, providing stakeholders with valuable insights for informed decisions. This research aims to produce an Android-based waste management system and user-friendly dashboard, promising improvements in environmental stewardship.

#### 4. Results and Discussion

The study's results and discussion encompass the design phase, Android UI design outcomes, Looker Studio dashboard development, and black box testing. It evaluates the effectiveness, usability, and performance of the system, addressing challenges and proposing future optimization directions.

#### 4.1. Business Use case

The Business Use Case section examines both the current and proposed scenarios for utilizing the developed system. It outlines the existing practices and challenges faced by Tebuireng Waste Bank Management, highlighting the inefficiencies and limitations. Subsequently, it presents the envisioned use case facilitated by the Android-based system integrated with Looker Studio, outlining the expected improvements in waste management efficiency, transparency, and data-driven decision-making processes. This section serves to bridge the gap between existing practices and the transformative potential of the proposed solution, setting the stage for a comprehensive analysis of its implementation and impact.

##### 4.1.1. Current Use Case

Prior to the creation of the waste bank management application system, the process of recording waste data relied on manual methods involving markers and whiteboards. Subsequently, the data had to be manually transferred to Excel format. This recording approach was deemed inefficient and susceptible to errors during data input.

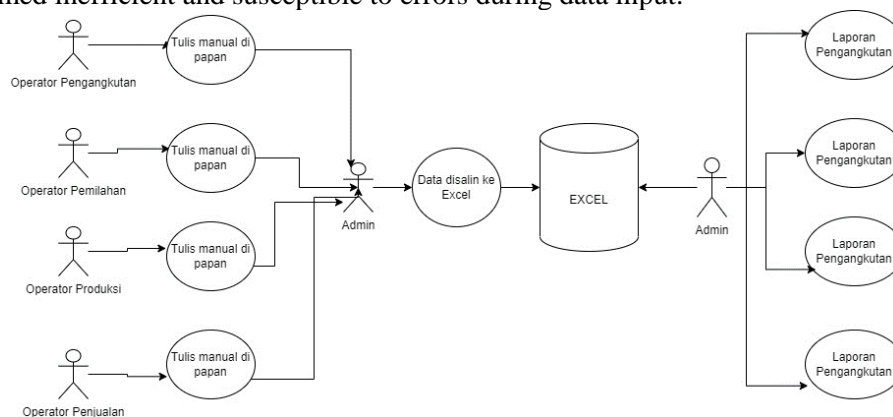
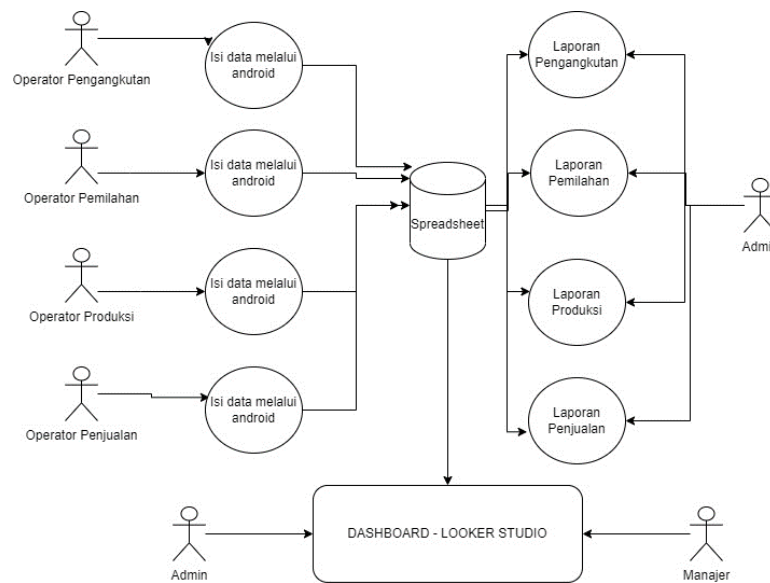


Figure 2. Current Use Case

Figure 2 illustrates the use case where the manual process of recording waste data using markers and whiteboards was time-consuming and prone to errors. Transcribing the data into Excel format increased the risk of inaccuracies. This manual method lacked efficiency and was susceptible to human errors, including data omission or duplication. The use of a waste bank management application system can overcome these challenges. It allows direct data input through an interface, eliminating the need for manual transcription. The system automatically stores the data, minimizing errors. Additionally, the application system provides detailed reports and data analysis, empowering waste bank managers to make informed decisions based on accurate data.

##### 4.1.2. Proposed Use Case

The manual waste management system has transitioned into a mobile platform, greatly improving data entry efficiency and accessibility via mobile devices for administrators and managers who can share accounts. This shift eliminates the need for manual data transfer to Excel and minimizes errors. Additionally, a user-friendly dashboard created with Looker Studio enhances data visualization and analysis, simplifying decision-making with relevant reports, charts, and metrics.

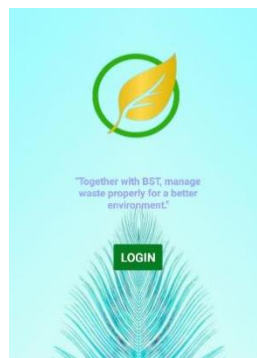


**Figure 3. Future Use Case Diagram**

Figure 3 illustrates the transformation of the system into a mobile platform and the integration of Looker Studio dashboard. It is anticipated that the efficiency of data entry and reporting will be greatly enhanced. Administrators and managers can swiftly review and verify data using their mobile devices, eliminating the need for reliance on physical office equipment. This system also provides better flexibility and accessibility, allowing users to connect and manage waste bank data more efficiently and effectively in various locations.

## 4.2. Design Results for Android

### 1. Login Menu



**Figure 4. Login Menu**

Figure 4 represents the login menu, which incorporates a password-less login button, aims to simplify the user login process for accessing an account or system without the need to remember a password. In this design, users only need to click the login button as the primary step to access their account. Users are relieved from the hassle of searching or remembering their passwords, providing significant ease of access.

### 2. User Data Input Menu

The user interface design in the Android application includes a menu that offers users effortless and intuitive access to various features and relevant information.



**Figure 5. User Data Input Menu**

Figure 5 presents essential menus, including "Transportation Data Input," "Sorting Data Input," "Production Data Input," "Sales Data Input," "View Dashboard Data," and "View Waste Types Data." These menus facilitate various data inputs and provide visualizations for efficient waste bank management.

### 3. Daily Reporting Menu

The design of the daily reporting menu interface is the result of a design process aimed at facilitating users in accessing and managing daily reports related to waste transportation, sorting, production, and sales activities.

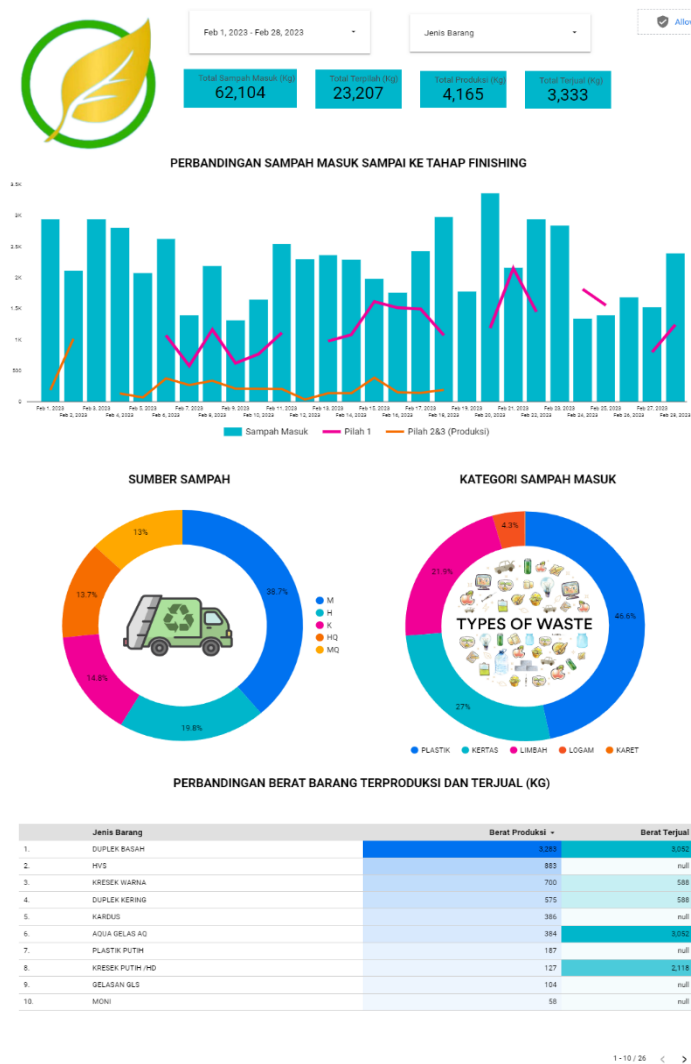


**Figure 6. Daily Reporting Menu**

Figure 6 exhibits the daily reporting menu interface, encompassing crucial elements. It includes menus like "Daily Transportation Report," "Daily Sorting Report," "Daily Production Report," and "Daily Sales Report." These menus provide access to daily reports on various waste-related activities, with details on transportation, sorting, production, and sales. Users can also download the reports in PDF format for convenient access and reference. This design ensures easy access to daily report data and facilitates monitoring and analysis.



### 4.3. The results of the dashboard implementation



**Figure 8. Dashboard Layout**

Figure 8 has been presented to provide various features for visualizing and analyzing waste data. The dashboard provides a comprehensive overview of waste-related statistics for the month of February 2023. It reveals that a substantial amount of waste, totaling 62,104 kilograms, entered the system during this period. However, efficient sorting processes successfully managed to separate 23,207 kilograms of waste, resulting in a total production of 4,165 kilograms. Among the produced waste, 3,333 kilograms were sold.

Analyzing the data from waste entry to the final processing stage, it's evident that waste entry exhibited fluctuations throughout February, with an initial increase followed by a decline. The initial sorting stage, depicted in pink, involves selecting marketable waste, while the orange graph represents the final processing stage, where waste is thoroughly cleaned and made ready for sale. Notably, the difference between these stages is halved, indicating the quantity of clean waste available for sale.

Further insights from the first donut chart reveal that the majority of waste originates from the pesantren (Islamic boarding school). Additionally, the second donut chart categorizes waste by type, with plastic waste constituting the largest percentage, followed by paper, general waste, rubber, and metal.

Lastly, the table at the bottom of the chart provides a comparison between the quantity of clean waste prepared for sale and the actual weight of waste sold. Wet paper emerges as the most frequently

sold type, amounting to 3,052 kilograms. This data offers valuable insights into the waste management process and highlights the efficiency of sorting and selling processes.

#### 4.4. Black-box Testing

Black Box testing for Android and Looker Dashboard was conducted without examining the technical implementation details. The focus was on ensuring that the application or dashboard functions properly and meets user requirements. The testing involved filling out forms, interacting with the interface, navigating, data processing, and interacting with dashboard elements. The Black Box approach aims to identify issues, ensure good performance, and meet user needs without needing to know the technical details of the application or dashboard.

1. Testing the Android interface for operators

**Table 1. Testing the Android interface for operators**

Actions	Carry	Sort	Prod	Sell
1. Open the application.	Passed	Passed	Passed	Passed
2. Fill in the form with valid data.	Passed	Passed	Passed	Passed
3. Press the "Save" button or similar option.	Passed	Passed	Passed	Passed
4. Ensure that the new entity is created and saved correctly.	Passed	Passed	Passed	Passed
5. Navigate to the "List" or "View" section of entities.	Passed	Passed	Passed	Passed
6. Verify that the entity data is displayed correctly.	Passed	Passed	Passed	Passed
7. Select the entity you want to modify from the list or search.	Passed	Passed	Passed	Passed
8. Click the "Edit" button or similar option.	Passed	Passed	Passed	Passed
9. Modify the entity data with valid information.	Passed	Passed	Passed	Passed
10. Press the "Save" button or similar option.	Passed	Passed	Passed	Passed
11. Verify that the changes to the entity are saved and displayed.	Passed	Passed	Passed	Passed

From table 1, the successful testing results indicate that the application functions well. All steps were performed successfully, starting from opening the application, filling out the forms with valid data, saving new entities, to displaying and editing entity data. The application can be considered successful in all tested functions.

2. Testing waste report generation for admin

**Table 2. Testing waste report generation for admin**

Actions	Expected Actions	Admin
1. Change Date	Change Date The daily report is displayed according to the selected date Valid	Passed
2. View Report Table	View Report Table The daily report table is displayed with all relevant attributes and data Valid	Passed
3. Download Report	The daily/monthly report is downloaded in the appropriate format and its content is accurate Valid	Passed

Based on this testing shown in table 2, it can be concluded that all steps performed by the admin were successfully accepted by the application. Access to transportation, sorting, production, and sales reports successfully displayed the reports according to the selected dates, and the reports showed all



relevant attributes and data. Additionally, the admin was able to successfully download the daily and monthly reports in the appropriate format, and the content of the reports was accurate. In conclusion, the application has successfully met the admin's needs in accessing, viewing, and downloading reports with satisfactory results.

### 3. Dashboard Testing for Manager and Admin

**Table 3. Dashboard Testing for Manager and Admin**

Actions	Admin	Manager
1. Login validation.	Passed	Passed
2. Functional testing of dashboard display and data visualization.	Passed	Passed
3. Functional testing of filtering and data processing functionality within the dashboard.	Passed	Passed
4. Functional testing of user interaction with dashboard elements.	Passed	Passed
5. Functional testing of integration with backend systems (database, APIs).	Passed	Passed
6. Testing of navigation and user interface in Looker Studio dashboard.	Passed	Passed
7. Testing of readability and comprehensibility of information displayed in the information system and dashboard.	Passed	Passed
8. Testing of ease of use of features within the information system and dashboard.	Passed	Passed

The results in table 3 indicate the success of admins and managers across various aspects. They were able to log in using Google accounts, and the dashboard effectively displayed Tebuireng Waste Bank management data through graphs and visualizations. The dashboard's filtering and data processing functions worked smoothly, allowing users to customize their data view. Integration with backend systems, like databases and APIs, was seamless, ensuring access to up-to-date data. Looker Studio's dashboard had a user-friendly interface for easy data exploration and interpretation. Both the information system and Looker Studio dashboard offered user-friendly features without complex instructions.

The result of this study is the development of an Android-based information system and visualization dashboard using Looker Studio for Tebuireng Waste Bank management. This system facilitates efficient waste data collection and management, providing user-friendly data analysis reports and visual representations to support better decision-making in waste management. The novelty of this research includes the implementation of an Android information system enabling efficient waste data processing, from collection to management, as well as the development of a visualization dashboard using Looker Studio, offering a clear and intuitive view of trends and patterns in waste management. Furthermore, this transformation of waste management from a manual process to a more efficient and mobile-accessible system minimizes human errors in data input. Additionally, the provision of easily accessible and downloadable daily and monthly reports aids decision-making based on accurate data. Thus, this research offers an effective solution for better and efficient waste management, assisting users in making informed decisions towards environmental preservation and sustainable waste management.

## 5. Conclusion

In conclusion, this research addresses the pressing issue of waste management in the Tebuireng area due to the rising number of visitors, leading to increased waste accumulation. The establishment of Bank Sampah Tebuireng (BST) is a commendable step to combat these challenges; however, its reliance on manual data management has proven inefficient and error-prone. Therefore, the development of an Android-based information system using Kodular and the integration of Looker Studio for dashboard visualization were undertaken. The research followed a comprehensive methodology encompassing requirement analysis, system design, implementation, and testing phases.

The resulting Android-based system offers features such as streamlined waste transportation, sorting, sales processes, and robust data reporting and analysis. The user-friendly Android application ensures easy access to the system, while Looker Studio's data visualization capabilities provide interactive representations like graphs, diagrams, and tables for effective monitoring and analysis of waste bank management data in Tebuireng. Through rigorous black box testing, the system's reliability was evaluated. This research ultimately delivers a user-friendly Android system for Bank Sampah Tebuireng, enhancing waste management processes and introducing Looker Studio for intuitive data visualization and interactive reporting, making it an invaluable tool for both day-to-day use and in-depth waste management data analysis.

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