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Design of Android-based Waste Bank Management System to Improve Waste Management Efficiency

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ABSTRACT
Waste management is a serious concern, and traditional approaches have struggled to change public attitudes towards waste. The adoption of a more modern waste disposal method is evident in the emergence of waste banks. These institutions operate on a buy-and-sell waste system. To enhance the convenience for both customers and waste bank administrators, an Android-based application is being developed to augment the waste bank ecosystem. Employing prototype development techniques in the application design allows users to easily tailor the functionality to their specific needs. This study proposes a waste delivery system that eliminates the necessity for individuals to personally transport their waste to landfill management sites, thus enhancing the efficiency of waste disposal systems. The application also incorporates a waste collection function, where waste bank administrators schedule and transport waste from households according to predetermined schedules. Additionally, the app facilitates the recording of waste collection transactions. The design of the application involves the use of usage and activity diagrams, along with a depiction of the relationships within the database. The envisioned application aims to significantly contribute to improving the efficiency and effectiveness of waste bank systems.

Keywords
Waste Bank Management, Android, prototype.

1. INTRODUCTION
The amount of waste generated is increasing day by day, along with the growing number of products and consumer behaviors. As a result, the local community finds it challenging to control waste management, and waste-related issues are being overlooked [1]. Waste is relevant to public health because it shapes the ecosystem of disease-causing microorganisms. Waste management must be conducted carefully to minimize the spread of diseases. One solution to address the waste issue is by establishing waste banks. This is a social activity that educates the community on how to sort waste and enhances public awareness [2]. Effective waste management follows the 3R pattern (Reduce, Reuse, Recycle), enhances environmental awareness, strengthens environmental thinking, and evaluates the economic and aesthetic value of waste to improve waste management. Introducing a pattern of proper waste management will elevate public awareness [3]. In the present era, the development of information technology has become a necessity for society. The advancement of technology increasingly facilitates individuals in making decisions and formulating policies in their daily lives. These facilities can also be utilized for waste management. Effective waste management is crucial to control the increasing generation of waste. Waste Banks are a government program designed to educate the public about household waste sorting and to raise awareness about waste reduction [4].By leveraging information technology to enhance the efficiency of the waste banking system, an Android-based waste banking application has been developed. We employed the prototype method for application development to create a user-centric application. This application is anticipated to assist city governments and landfill managers in waste management, thereby improving the efficiency of landfill systems.

2. REASEARCH METHOD

2.1 Data Collection Techniques:
In this research, a comprehensive approach is undertaken to gather data through interviews and literature review methods, aiming to delve into the intricacies of the waste bank system. Through interviews with key informants intimately involved in the system's workflow, qualitative insights are extracted to provide a nuanced understanding of operational nuances and challenges. Concurrently, an extensive literature review is conducted to synthesize information from prior research, establishing a broader context and identifying features that can be further developed. The integration of these two sources of data allows for a holistic perspective on the waste bank system, facilitating the identification of specific opportunities for improvement. By validating and iteratively refining these opportunities, researchers ensure that proposed enhancements align with practical considerations, thereby contributing to a more informed and effective waste management approach.

2.2 Architectural Model
The design structure of the web service API will be created using Laravel as a bridge for communication between the user and the database. The backend language used is PHP with the Laravel framework. This framework functions to create an API for retrieving and sending data to the database. MySQL is the database used, employing relationship tables to ensure that data is not empty and remains valid in each inter-table relationship. Users involved in the waste bank application consist of administrators and subscribers. Each user has a distinct UI as administrators and subscribers engage in different activities. Android Studio is utilized as the tool for mobile application development. The backend language used in Android Studio is Kotlin, while XML is used for the frontend.

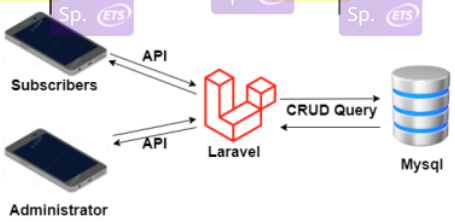

Figure 1: Architectural Model

2.3 System Development Model:
The Software Development Life Cycle (SDLC) is the process

of creating a system, and various models are used for software development within SDLC. This study adopts the prototype model for developing the waste bank application. This method is chosen because it allows interaction between the system developer and the system user, addressing any discrepancies between them. The prototype model used by the system enables users to understand the stages of the system, ensuring smooth operation [5]. The prototype method offers several advantages, such as engaging users in the analysis and design process, providing tangible rather than abstract solutions, and clarifying the SDLC [5]. The prototype created will be periodically confirmed with potential system users to enhance work effectiveness and avoid unnecessary tasks [6]. The prototype process involves the following stages [7]:

1. Needs Identification Stage:

During this crucial phase, developers engage in a comprehensive collaboration with clients to thoroughly understand and articulate the specific requirements and expectations for the desired software. This involves in-depth discussions, interviews, and analysis to identify the essential features, functionalities, and overall format that the software must encompass. The primary objective is to establish a clear understanding of the client's needs and goals, laying a solid foundation for the subsequent stages of the software development life cycle.

2. Prototype Design Stage:

With the identified needs in mind, the focus shifts to crafting a preliminary design or prototype that serves as a visual representation of the anticipated software. This stage involves the creation of a temporary model that incorporates the desired inputs and outputs as specified by the client. Developers work closely with clients to capture their preferences, ensuring that the prototype aligns with the envisioned product. Feedback from clients plays a pivotal role in refining the design before proceeding to the next phase.

3. Prototype Evaluation Stage:

In this phase, the client meticulously examines the prototype to assess its alignment with the initially outlined goals and requirements. The client's feedback is critical in determining whether the prototype accurately reflects their vision for the software. If any discrepancies or deviations are identified, the development team returns to the previous stage to incorporate necessary corrections and refinements based on client input.

4. System Code Generation Stage:

Building upon the approved prototype, developers embark on the process of transforming the design into actual software code. This involves translating the conceptualized model into a programming language, effectively converting the visual representation into a functional and executable program. Rigorous coding standards and best practices are adhered to during this stage to ensure the creation of a robust and efficient software foundation.

5. System Testing Stage:

The coded software undergoes a comprehensive testing phase to evaluate its usability and functionality. Various testing methodologies, including Black Box, White Box, architecture testing, and Basis path testing, are employed to identify and rectify potential bugs, errors, or discrepancies. The goal is to ensure that the software performs as intended and meets the specified requirements, providing a reliable and stable user experience.

6. System Evaluation Stage:

After successful testing, the built program undergoes evaluation by the client to confirm that it aligns seamlessly with their expectations and requirements. If the system meets the client's criteria, it is deemed ready for implementation. However, if any issues or discrepancies arise during the evaluation, developers must revisit the relevant stages to address and rectify concerns before progressing further.

7. System Implementation Stage:

Upon passing the client evaluation stage, the software is officially deployed and becomes actively operational. This marks the culmination of the software development life cycle, transitioning from the conceptualization and design phases to a fully functional and utilized system. Ongoing support and maintenance may follow as needed to ensure the continued effectiveness and relevance of the implemented system.

3. RESULT AND DISCUSSION

Based on the research method described above, this study proceeds to the results and discussion phase by implementing several stages of the prototype in accordance with the development of the waste bank application.

3.1 Identification App Requirements

The Waste Bank Application has two user categories: subscriber and waste bank administrators. Collaboration between the public and waste bank administrators is essential to create a system that meets the feature needs of both parties.

a. Subscriber feature: Submitting waste collection requests, Viewing the transaction history of waste collection, Accessing the waste collection schedule, Checking account balances through an Android smartphone.
b. Administrator feature: Managing waste collection requests, adding accepted types of waste, Managing waste collection schedules.

Software and hardware requirements for build Waste Bank App:

a. The software used for developing the waste bank application is Android Studio. This choice is made because the application is Android-based.

The hardware used for application development is Acer Nitro 5 AN515-58, equipped with the following basic specifications: Processor: Intel Core i5 12500H, RAM: 16GB DDR4 3200MHz, Graphics Card: VRAM RTX 3050 4GB.

3.2 System Flow Design

The system flow design in this research utilizes the Unified Modeling Language (UML) method. UML serves as a tool/model for designing object-oriented software development. It provides standards for creating a system blueprint containing business process concepts, class creation in a specific programming language, database schema, and components required for software systems [8]. UML encompasses several diagrams to explain the system flow in detail.

This study employs various UML diagrams to illustrate the system flow. This can be articulated as follows:

3.2.1 . Use case Diagram

A Use Case Diagram is utilized to visualize and document the operational requirements of a system [9]. Use cases enable readers to easily comprehend the system flow, making it more accessible for understanding.

Figure 2: Usecase Diagram

3.2.2 Activity Diagram

The activity diagram illustrates the specific flow of a use case diagram [9]. The activity diagram provides a more detailed explanation of the use case diagram, depicting the step-by-step flow of an activity from initiation to completion.

1) Submitting waste collection requests activity diagram.
This activity diagram provides a detailed flow of the waste submission feature from both perspectives of the subscriber and the administrator.

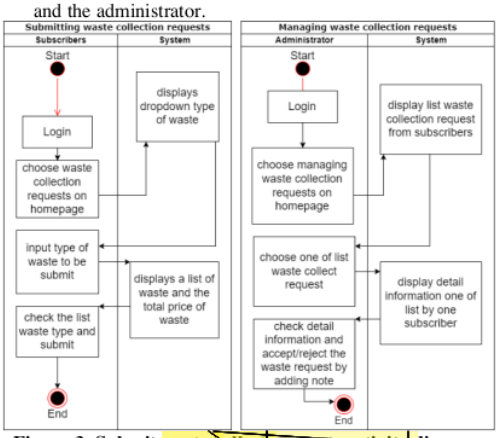

Figure 3: Submit waste collect requests activity diagram

2) Waste collection schedule activity diagram
This activity diagram illustrates the detailed flow of the waste collection schedule feature from both the community and administrator perspectives.

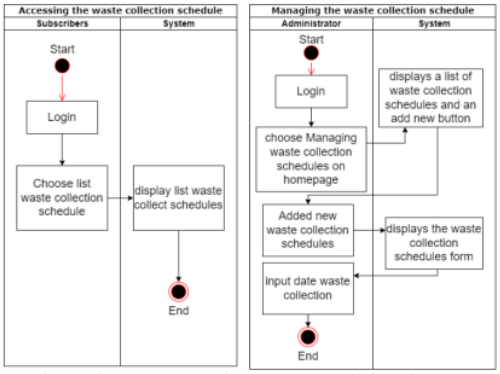

Figure 4: Waste collection schedule activity diagram

3) Transaction history of waste collection
This activity diagram provides a detailed flow of the waste collection transaction feature from both the community and administrator perspectives.

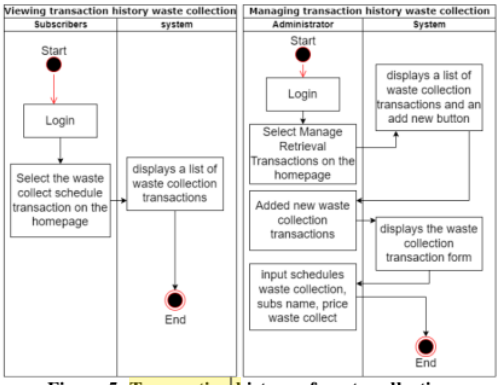

Figure 5: Transaction history of waste collection

4) Adding accepted types of waste activity diagram
This activity diagram illustrates the detailed flow of the waste addition feature for administrators.

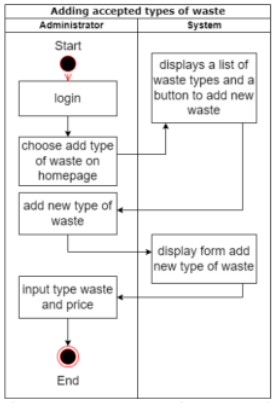

Figure 6: Adding accepted types of waste activity diagram

3.2.3 Entity Relationship Diagram

An Entity Relationship Diagram (ERD) is a diagram that illustrates the relationships between entities in the constructed

system [10]. ERD is employed to facilitate the design of database relationships, which are then implemented in the database system according to the ERD flow.

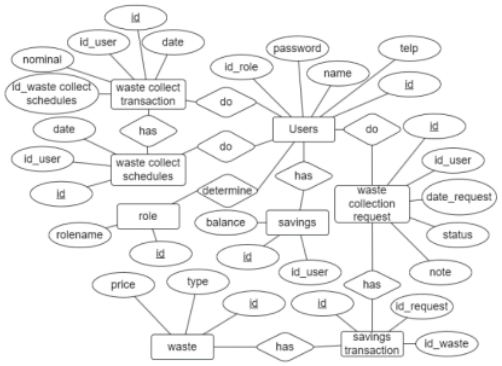

Figure 7: Entity Relationship Diagram

3.2.4 Database Design

The aim of the database design in this paper is to create a simple and efficient structure for the Android-based waste bank management system. The design focuses on keeping the stored information accurate and ensuring that the system operates smoothly. It's designed to easily adapt and grow over time, and it prioritizes data security. The goal is to make it straightforward to manage users, monitor waste submissions, and handle collection schedules. By achieving these goals, the database design becomes a strong foundation for an effective and user-friendly waste bank management system.

The following details about the database design that will be created:

Table 1: User

Attribute	Data type
id	Integer
name	String
telp	Integer
password	String
id_role	Integer

Table 2: Transaction waste collection

Attribute	Data type
id	Integer
nominal	Integer
date_transaction	Date Time
id_user	Integer
id_wastecollectschedule	Integer

Table 3 : Savings

Attribute	Data type
id	Integer
balance	Integer
id_user	Integer

Table 4 : Waste Collection Schedule

Attribute	Data type
id	Integer
date	Date Time
id_user	Integer

Table 5 : Role

Attribute	Data type
id	Integer
rolename	String

Table 6 : Submitting waste collection

Attribute	Data type
id	Integer
Id_user	Integer
date_submit	Date Time
status	Boolean
note	String

Table 7 : Savings transaction

Attribute	Data type
id	Integer
Id_waste	Integer
id_submit	Integer

Table 8 : type of waste

Attribute	Data type
id	Integer
type	String
price	Integer

3.3 User Interface Design

The implementation of the interface for the waste bank application serves as the intermediary for interactions between the system and users [11]. The interface details the visual design of the application for readers of this research.

1. Login Page

This page serves as the entry point for users, both community members and administrators, allowing them to log in using their phone number and password.

Figure 8: Login page

2. Homepage subscriber and administrator

This page serves as the landing page for administrators and subcriber members, offering access to their profiles and various features provided by the waste bank.

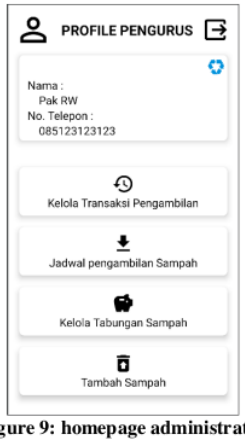

Figure 9: homepage administrator

Figure 10: homepage subscriber

3. Page list waste collection requests
This page is designed for viewing the list of waste submissions from both the community and administrators.

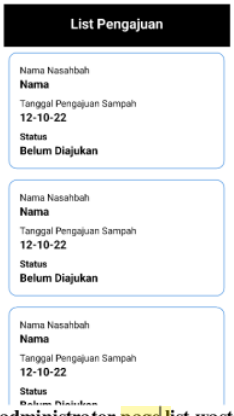

Figure 11: administrator page list waste collection

Figure 12: subscriber page list waste collection request

4. Page form waste collection
This page is dedicated to waste submission activities. From the community's perspective, it allows them to submit waste, while from the administrator's perspective, it enables them to approve or reject waste submissions from the community.

Figure 13: page form waste collection subscriber

Figure 14: page form waste collection administrator

4. CONCLUSION

This research has successfully achieved its objective of enhancing the efficiency and effectiveness of the waste bank system through the implementation of an Android-based waste bank application. The introduction of the waste submission system has significantly streamlined transactions for both subscriber members and waste bank administrators, allowing for the submission of waste in advance and simplifying processes at the waste bank. Moreover, the Android-based application has replaced conventional, more cumbersome methods, providing a more user-friendly and efficient means of recording transactions. Building on these achievements, a promising future scope for development is identified. For future iterations, the application could be further expanded to incorporate mapping features, facilitating the identification and navigation to the residences of subscribers. This enhancement would optimize waste collection routes for administrators, making the process more efficient and contributing to an even more streamlined and sustainable waste management operation.

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