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Flutter Based Android Application for Smart Waste Management System

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Abstract: *This abstract introduces a Flutter-based Android application designed for efficient waste management through QR-based dustbin location tracking and alerting. The application aims to revolutionize waste disposal by leveraging QR codes to identify and monitor dustbin locations. Users can scan QR codes placed on designated bins, enabling real-time tracking and status updates. The system generates alerts when bins reach capacity, notifying authorities for timely cleaning interventions. Additionally, the application integrates a unique feature for waste material sales, connecting users with recyclers. This Recycler Management System promotes sustainability by streamlining the recycling process and fostering collaboration between waste producers and recyclers. Overall, the Flutter Android application provides a comprehensive solution for smart waste management, incorporating tracking, alerts, and a marketplace for waste material transactions. In summary, the proposed Flutter-based application addresses key challenges in waste management through an innovative approach. By combining QR technology, real-time tracking, and a marketplace for waste material, the system not only facilitates efficient cleaning operations but also contributes to sustainable practices by promoting recycling. This holistic approach aligns with contemporary environmental priorities, offering a user-friendly and integrated solution for optimizing waste disposal processes*

Keywords: Hair fall reduction, Herbal hair oil, Combing assay, Hair growth, clinical study

I. INTRODUCTION

1.1 OVERVIEW

Many times, in our city we seen that trash was present in out of dustbin. It creates unhygienic conditions for people as well as ugliness to that place leaving bad smell and also Realizing the need of the Internet in everyday life, we decided to give free Wi-Fi to people in exchange of a cleaner surrounding with an unique initiative. Now days a very fast growth of urban population in recent time. Due to increasing population of cities or states the city or states can faces many problems like environmental problem in which increasing garbage waste, increasing various type of diseases and create health problem. In recent time Garbage waste collection and its management is very critical issue. For that In India 2 October 2014 Indian Prime Minister Mr. Narendra Modi announced Clean India Mission launched by Government of India. In this mission covering 4,041 cities and infrastructure of country.

In the rapidly advancing landscape of mobile application development, innovative solutions are constantly emerging to address diverse challenges. This report delves into the creation and functionality of a Flutter-based Android application designed for efficient waste management – specifically focusing on QR-based dustbin location tracking, timely alerting for cleaning schedules, and facilitating the sale of waste materials to recyclers. The integration of Flutter, a versatile and user-friendly UI toolkit, ensures a seamless cross-platform experience, enabling users to access the application on various devices. This solution not only addresses the crucial need for effective waste disposal but also introduces a comprehensive system for managing and recycling waste materials, contributing to a sustainable and environmentally conscious approach.

The Flutter Android application outlined in this report leverages QR code technology to pinpoint dustbin locations, streamlining the waste collection process. Through a user-friendly interface, the app provides timely alerts for cleaning schedules, ensuring a systematic and well-maintained waste disposal infrastructure. Moreover, the inclusion of a feature that facilitates the sale of waste materials to recyclers adds an innovative dimension to the system, promoting a circular

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economy and contributing to waste reduction efforts. This report comprehensively explores the architecture, functionality, and potential impact of this Flutter-based Android application, shedding light on its role in revolutionizing waste management and promoting sustainable practices in modern urban environments.

While conventional waste management systems exist, they often lack real-time tracking and efficient communication mechanisms. The absence of a unified platform for both users and waste management services leads to inefficiencies and delays in addressing cleanliness issues. Furthermore, the lack of an integrated system for selling waste material to recyclers adds another layer of complexity. Existing solutions also tend to be platform-dependent, limiting their accessibility and usability. This report seeks to address these shortcomings by proposing a comprehensive Flutter-based Android application that not only tracks dustbin locations through QR codes but also provides a seamless interface for alerting cleaning services and managing the sale of waste material to recyclers, thus contributing to a more sustainable and technologically advanced waste management ecosystem.

In the ever-evolving landscape of waste management, the integration of technology has become imperative for enhancing efficiency and sustainability. This report delves into the development and implementation of a Flutter-based Android application designed for QR-based dustbin location tracking, alerting for cleaning, and facilitating the sale of waste material for a comprehensive Recycler Management System. The Flutter framework, known for its cross-platform capabilities and rich user interfaces, offers an ideal platform for creating an intuitive and user-friendly application. By harnessing the power of QR codes, this system aims to streamline the waste management process, from monitoring dustbin locations to alerting cleaning services and managing the recycling chain effectively.

1.2 MOTIVATION

Imagine a world where technology converges with environmental consciousness, creating a powerful synergy that propels us towards a cleaner, more sustainable future. Our Flutter Android application, designed for QR-based dustbin location tracking, stands as a beacon of innovation in waste management. With a seamless user interface, it empowers individuals to easily locate and deposit waste in designated bins, marked with QR codes. The application not only facilitates efficient tracking but also triggers alerts for timely cleaning, ensuring that our surroundings stay pristine. Going beyond mere waste disposal, our system introduces a revolutionary concept—connecting recyclers with those who generate waste. By incorporating a marketplace feature, users can sell their recyclable materials directly to recyclers, fostering a circular economy. This initiative not only contributes to environmental preservation but also creates economic opportunities. Embrace the future of waste management with our Flutter Android application, where technology meets responsibility, and every small action leads to a cleaner, greener world.

1.3 OBJECTIVES

The objective of this Flutter Android application is to create a robust and user-friendly system for QR-based dustbin location tracking, with a primary focus on efficient waste management. The application aims to empower users to easily locate designated dustbins using QR codes, fostering a cleaner environment. Additionally, the app will feature an alerting mechanism to notify designated cleaning personnel when a dustbin requires attention, ensuring timely and systematic waste removal. Furthermore, the system will incorporate a unique selling point by allowing users to sell their waste materials through the application, thereby promoting recycling and sustainable practices. This integrated waste management system seeks to bridge the gap between users, cleaning personnel, and recyclers, contributing to a cleaner, greener, and more environmentally conscious community

II. LITERATURE SURVEY

STUDY OF RESEARCH PAPERS

SR. NO.	TITLE	METHODOLOGY	FINDING
1	Location Based Garbage Management System with IoT for Smart City	IoT based technology used Hardware module or embedded based project	This article incorporates IOT solutions to implement a system that provides the municipal council with a system that better equips them to handle the garbage problem in a smart

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			city. Every party is interacting with this system, that is the citizens, the workforce, and the admins.
2	Smart Garbage Management System	IoT with android application	The system keeps track of the garbage levels in the bins and allocate cleaning staff accordingly. Shortest path algorithm is added which results in less time and fuel consumption for the garbage trucks.
3	Solid Waste Management in India: A Brief Review	Waste management system in municipal area	Waste management not only deals with its treatment and disposal; it is a whole system that incorporates reduction of waste generation, collection, segregation and proper transportation to its corresponding recycling hub.

Paper 1:
Title: Location Based Garbage Management System with IoT for Smart City
Author: Shashika Lokuliyana, Anuradha Jayakody, G.S.B.Dabarera, R.K.R.Ranaweera, P.G.D.M.Perera, P.A.D.V.R.Panangala
Description: This paper proposes a cost-effective IOT based system for the government to utilize available resources to efficiently manage the overwhelming amounts of garbage collected each day, while also providing a better solution for the inconvenience of garbage disposal for the citizens. This is done by a network of smart bins which integrates cloud-based techniques to monitor and analyze data collected to provide predictive routes generated through algorithms for garbage trucks.

Paper 2:
Title: SMART GARBAGE MANAGEMENT SYSTEM
Author: Ms. Akhila Joseph, Ms. Anjali, Ms. Suhaila B.M, Mr. Mahesh B.L
Description: The Smart Garbage Management System would give a solution for the increasing waste management problems in a city. The system keeps track of the garbage levels in the bins and allocate cleaning staff accordingly. Shortest path algorithm is added which results in less time and fuel consumption for the garbage trucks. The bin doors are automated which helps to make the surroundings hygienic. Additional features in the system include report generation which gives detailed information about the waste generation in each area. The waste management becomes a difficult task for a smart city authority.

Paper 3:
Title: Solid Waste Management in India: A Brief Review
Author: Priyabrata Banerjee, Abhijit Hazra, Pritam Ghosh, Amit Ganguly, Naresh Chandra Murmu and Pradip K. Chatterjee
Description: Waste management not only deals with its treatment and disposal; it is a whole system that incorporates reduction of waste generation, collection, segregation and proper transportation to its corresponding recycling hub. Disposal of solid waste with conventional way is not so effective in reducing its noxious effect. As a consequence, for biodegradable Solid Waste Management in India: A Brief Review 1047 waste, composting is a very useful method since here the residual part can be further used as fertilizer. Some disposal methods like gasification, pyrolysis, RDF can minimize the solid waste volume and its lethal effect. These methods are very efficient for generating fuel, for instance syn gas which can be a prominent source of energy in the recent future.

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Paper 4:
Title: LOCATION BASED GARBAGE MANAGEMENT SYSTEM
Author: Rushikesh Wanjare, Harshad Pawar, Sarthak Kadu, Pratik Nikam, Prof. Pradnya Narkhede
Description: The developed system provides an improved database for garbage pickup time and therefore the quantity of garbage pickup at each location. By implementing this project, we'll avoid overflowing garbage from the container in residential areas which was previously either loaded manually or with the assistance of loaders within the traditional trucks. All necessary hardware and software are available for implementing the project. The project is ideal for saving time and changing the regular way of dumping trash. Keep the world neat and clean and supply the residents with a waste-free environment.

Paper 5:
Title: GARBAGE MANAGEMENT
Author: Jaleshwari Dilip Ghatage, Sidhiee Jaiddep Mohitey, Shireen Shahanawaj Jamadar, J.M.Waykule
Description: This project work is the implementation of garbage management system using ultrasonic sensor, Arduino MEGA and Wi-Fi module. This system assures the cleaning of dustbins when the garbage level reaches its maximum level. This reduces the total number of trips of garbage collection vehicle and hence reduces the overall expenditure associated with the garbage collection. It helps to keep cleanliness in the public place. Therefore, the garbage management system makes the garbage collection more efficient. By using this method the collection of garbage in the city becomes more easier. It helps in reducing air pollution, traffic flow, man power, time and money. With the help of proper technology (GPS & SOFTWARE APPLICATIONS) we can guide the trucks in selecting the shortest path for garbage collection.

III. SYSTEM ANALYSIS

3.1 SYSTEM ARCHITECTURE

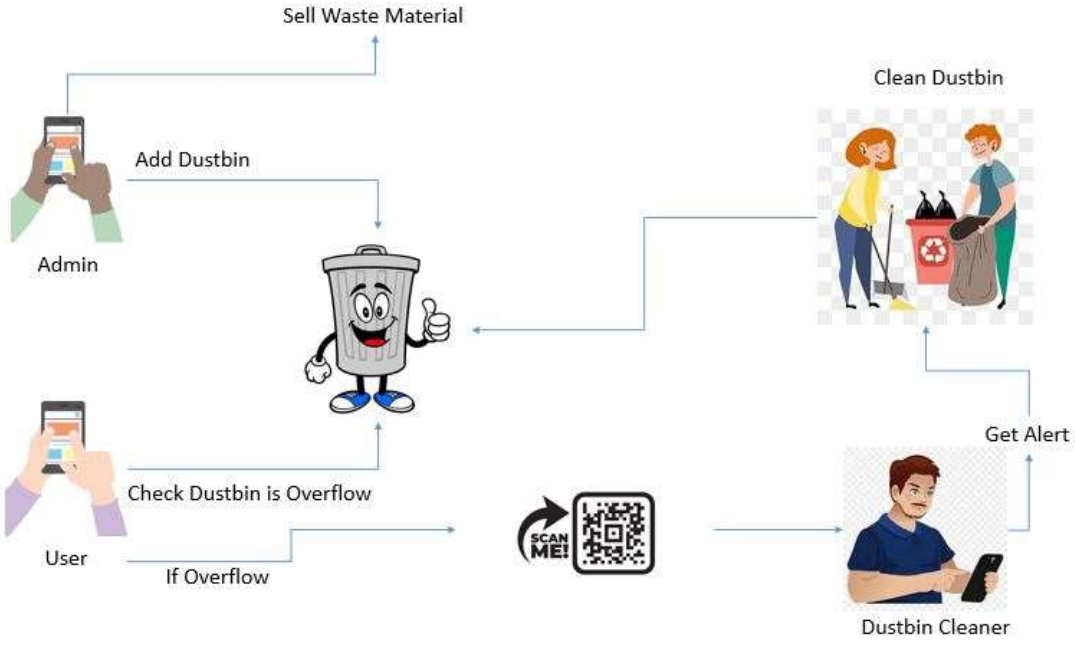

Figure 3.1 Proposed System Architecture

In the Flutter Android application designed for QR-based dustbin location tracking and waste management, the system operates seamlessly to enhance the efficiency of waste disposal and recycling processes. The application employs QR code technology to assign a unique code to each dustbin, allowing for precise location tracking. Users can easily scan the

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QR code using their smartphones, providing real-time information about the status and fill level of the dustbin. The system utilizes GPS technology to pinpoint the exact location of each dustbin, facilitating optimized waste collection routes for sanitation workers.

Additionally, the application incorporates a robust alerting mechanism to notify relevant authorities and sanitation crews when a dustbin reaches its capacity, ensuring timely cleaning and preventing overflow. Users can set preferences for alert notifications, enabling customizable reminders for routine cleaning schedules. The

system not only focuses on efficient waste management but also promotes recycling practices. It features a module that allows users to sell recyclable waste directly to registered recyclers through the application. This Recycler Management System streamlines the recycling process, connecting waste producers with recycling facilities, and contributing to environmental sustainability. The application provides a comprehensive solution for smart waste management, leveraging QR technology, GPS, and real-time alerts to optimize the entire waste disposal and recycling ecosystem.

3.2 Data Flow Diagram

Level 0 DFDs, also known as context diagrams, are the most basic data flow diagrams. They provide a broad view that is easily digestible but offers little detail. Level 0 data flow diagrams show a single process node and its connections to external entities. Level 0 DFD only contains the fundamental elements such as only 1 process and 2 entities. For Level 1 DFD we expand the context diagram's process into multiple sub process. For Level 2 DFD, it is the most detailed DFD which gives detailed view of all the sub process which are present in Level 1 DFD.

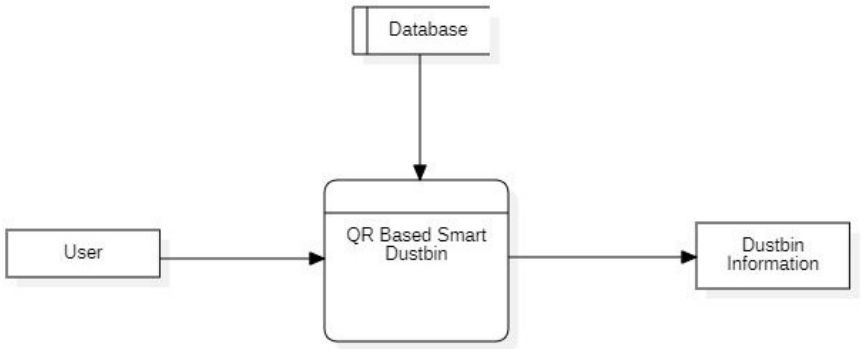

Figure 3.2: DFD Level-0

DFD Level – 1

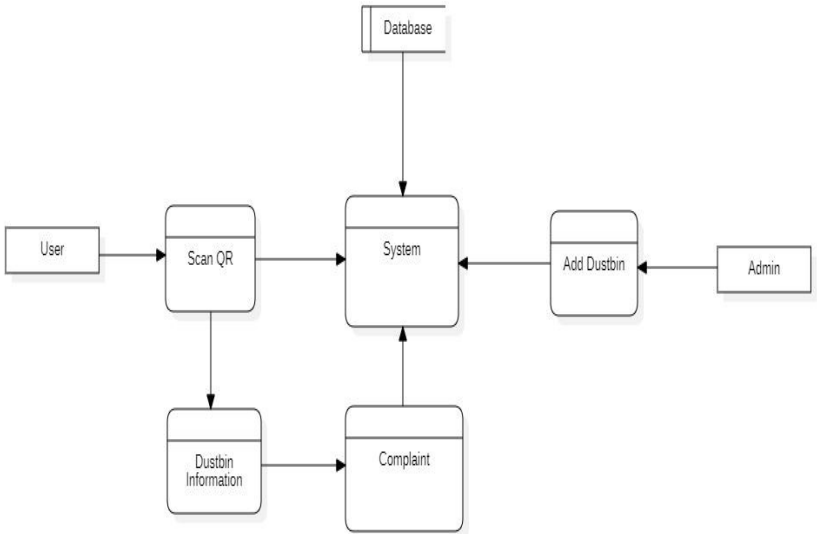

Figure 3.3: DFD Level-1

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DFD Level – 2

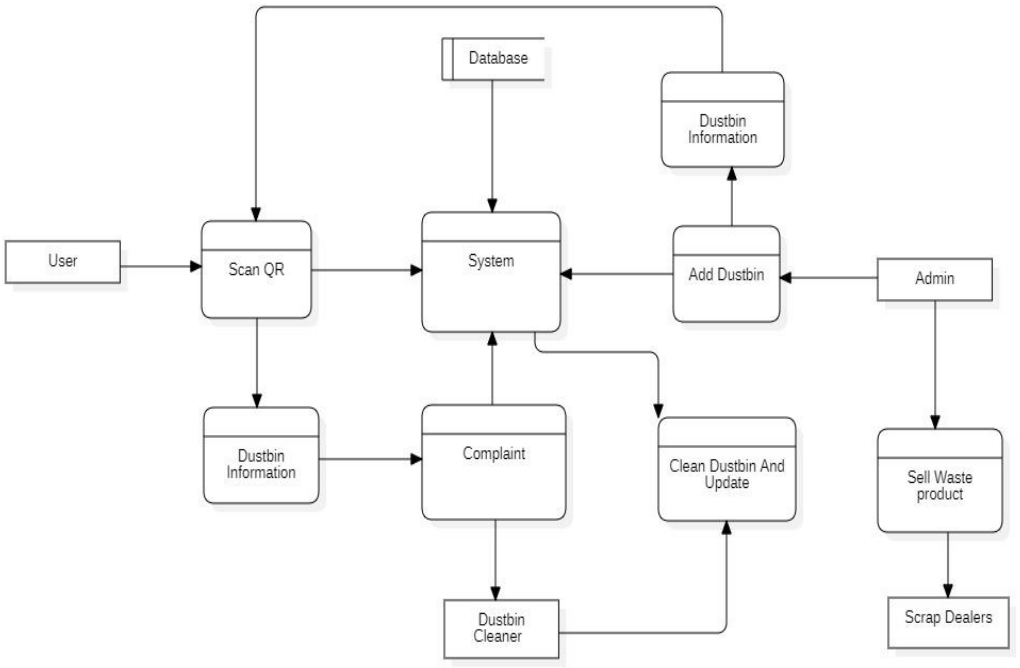

Figure 3.4: DFD Level-2

ENTITY-RELATIONSHIP DIAGRAM

ER Diagram stands for Entity Relationship Diagram, also known as ERD is a diagram that displays the relationship of entity sets stored in a database. In other words, ER diagrams help to explain the logical structure of databases. ER diagrams are created based on three basic concepts: entities, attributes, and relationships. ER Diagrams contain different symbols that use rectangles to represent entities, ovals to define attributes, and diamond shapes to represent relationships. The purpose of ER Diagram is to represent the entity framework infrastructure.

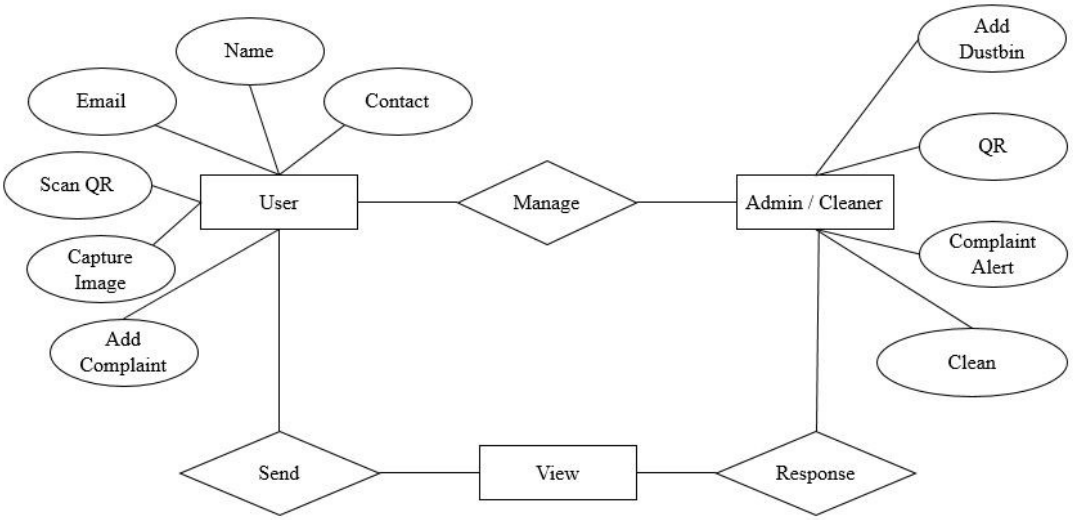

Figure 3.5: ER Diagram

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UML Diagrams

Unified Modeling Language is a standard language for writing software blueprints. The UML may be used to visualize, specify, construct and document the artifacts of a softwareintensive system. UML is process independent, although optimally it should be used in the process that is use case driven, architecture-centric, iterative, and incremental.

The Number of UML Diagram is available such as:

Use case Diagram.

Activity Diagram.

Sequence Diagram.

Class Diagram

Use Case Diagram

A use case diagram is a graphical depiction of a user's possible interactions with a system. A use case diagram shows various use cases and different types of users the system has and will often be accompanied by other types of diagrams as well.

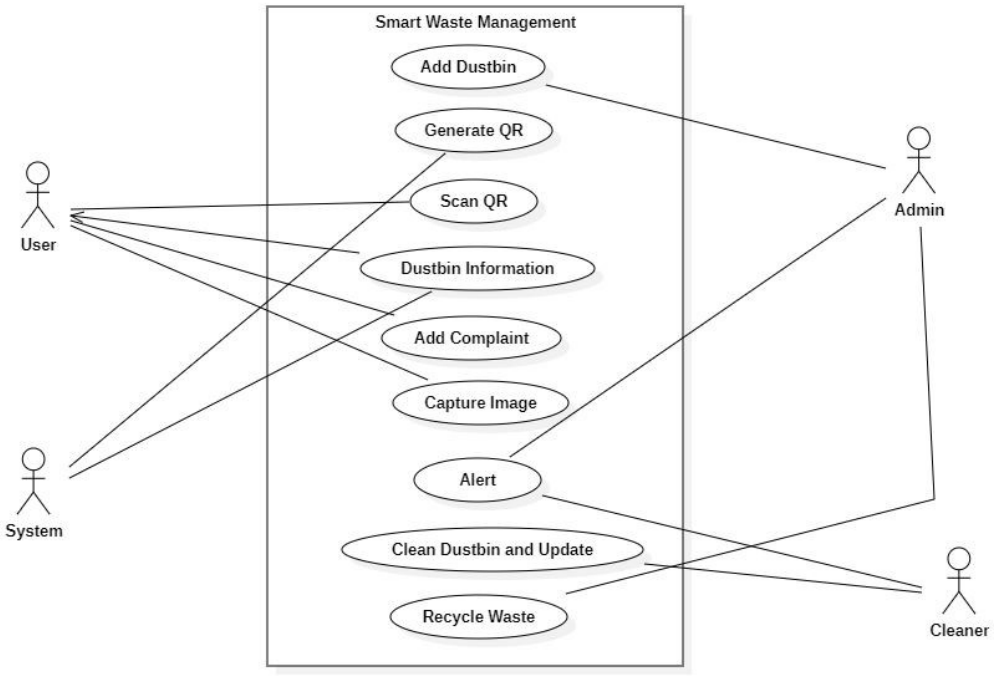

Figure 3.6: Use Case Diagram

Sequence Diagram

A sequence diagram shows object interactions arranged in time sequence in the field of software engineering. It depicts the objects involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario

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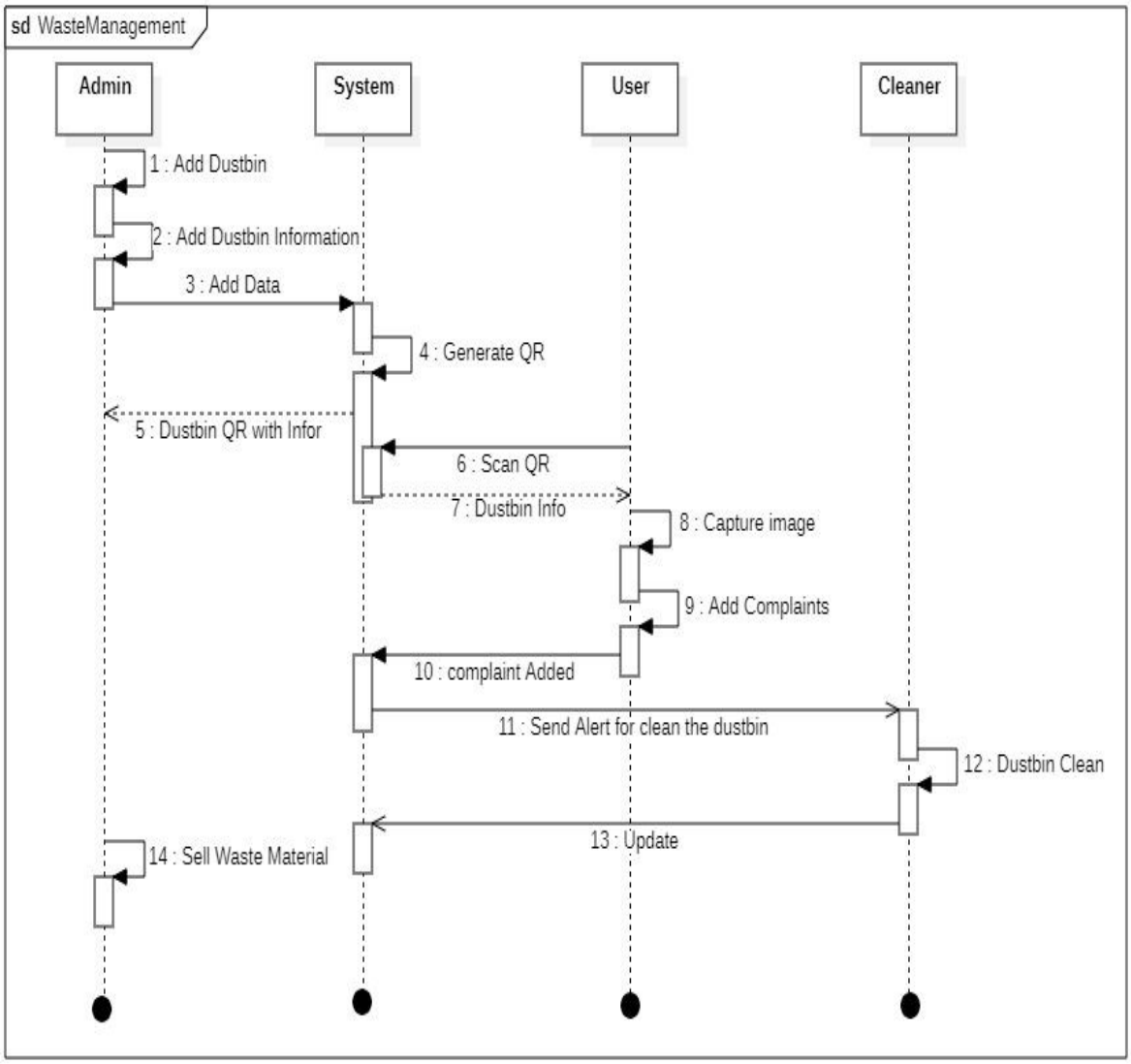

Figure 4.7: Sequence Diagram

Activity Diagram

An activity diagram is a behavioral diagram i.e. it depicts the behavior of a system. An activity diagram portrays the control flow from a start point to a finish point showing the various decision paths that exist while the activity is being executed.

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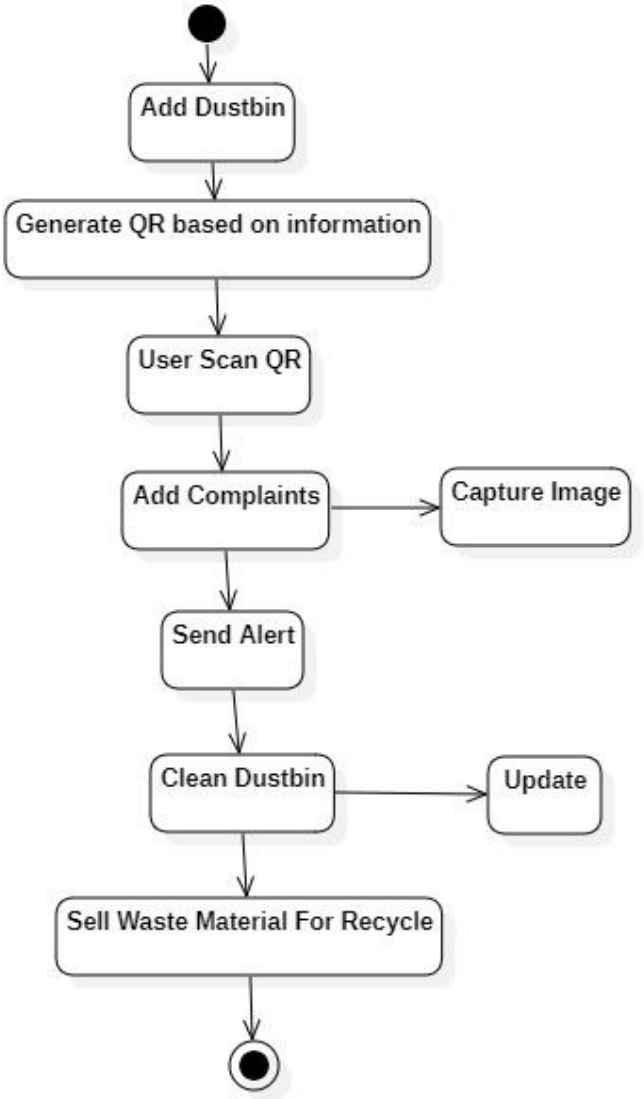

Figure 3.8: Activity Diagram

Class Diagram

The Class Diagram is a static structure type that describes the structure of the system by showing the system classes, its attributes, operations(or methods), and relationships among objects. Class Diagrams are the main building block in Object-Oriented Modelling. The Class Diagram represents the static view of the application.

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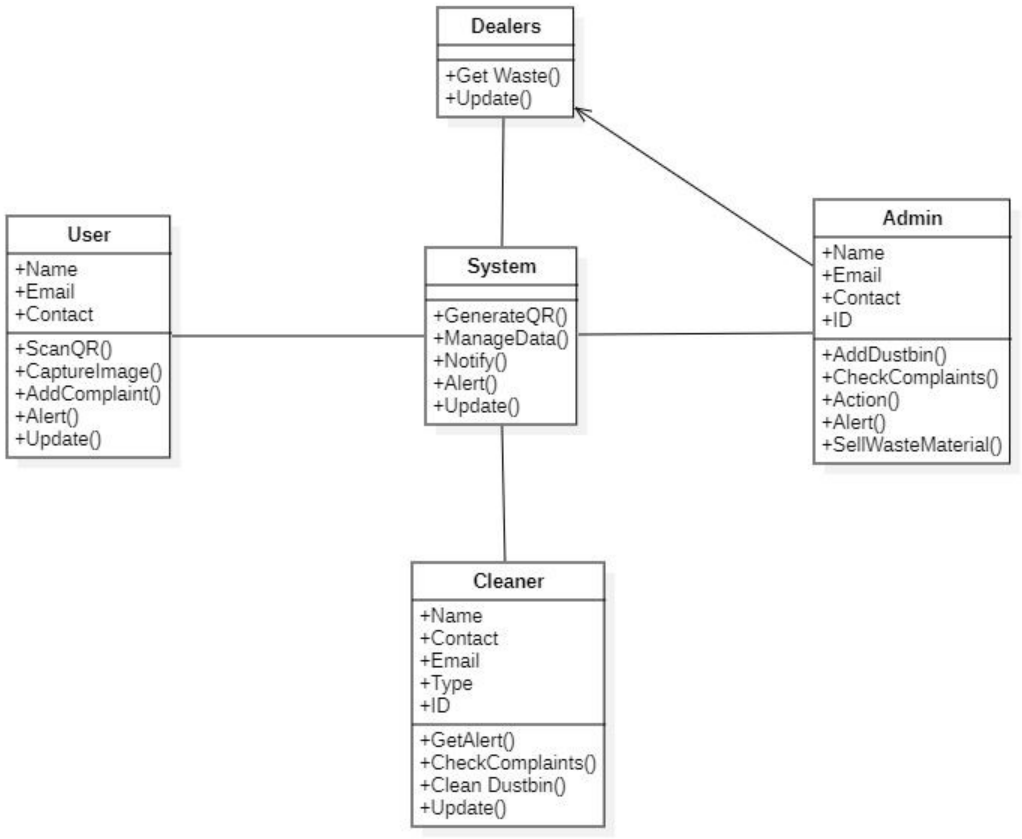

Figure 3.9: Class Diagram

IV. PROJECT PLAN

OVERVIEW OF PROJECT IMPLIMENTATION

The implementation of the Flutter Android application for QR-based dustbin location tracking, alerting for cleaning, and selling waste material for the Recycler Management System involves a multifaceted approach to seamlessly integrate various features. The project encompasses the utilization of Flutter, a versatile UI toolkit, to create a dynamic and user-friendly Android application. The primary functionality revolves around QR code-based tracking, where users can scan designated dustbin QR codes to pinpoint their locations. The application will send alerts for cleaning based on predefined thresholds, ensuring timely and efficient waste management. Additionally, it incorporates a unique feature enabling users to sell waste materials directly through the app, fostering a sustainable ecosystem by connecting them with recyclers. The Recycler Management System integrates seamlessly, providing a platform for recyclers to efficiently manage incoming waste materials. Overall, the project aims to enhance waste management practices through technology, offering a comprehensive solution that promotes cleanliness, timely maintenance, and encourages the recycling process for a more sustainable environment.

TOOLS AND TECHNOLOGY USED

Programming Language : Dart.
Platform : Android Studio, Flutter

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SOFTWARE INFORMATION

Flutter:

Flutter is an open-source UI software development toolkit created by Google for building natively compiled applications for mobile, web, and desktop from a single codebase. Specifically designed for developers to create high-performance applications with a native look and feel, Flutter uses the Dart programming language. One of Flutter's key features is its widget-based architecture, where UI components are customizable and reusable, allowing for a consistent user experience across platforms.

Flutter's "hot reload" feature enables developers to quickly experiment, build UIs, add features, and fix bugs in real-time, enhancing the development workflow. The framework also comes with a rich set of pre-designed widgets, making it easier for developers to create visually appealing and responsive interfaces.

One significant advantage of Flutter is its ability to compile to native ARM code, providing near-native performance. This makes Flutter suitable for building high-performance applications, including those for Android. Additionally, Flutter's single codebase approach simplifies maintenance and updates, as changes made to the code are reflected across all supported platforms.

Flutter has gained popularity in the Android app development community due to its efficiency, flexibility, and the ability to deliver a consistent user experience across different devices and screen sizes. It has been embraced by developers and organizations for its ease of use, rapid development capabilities, and the potential for cost savings in multi-platform app development.

Dart:

Dart is the programming language at the core of Flutter, the open-source UI toolkit for building natively compiled applications across mobile, web, and desktop platforms. Developed by Google, Dart is designed to be easy to learn and efficient for building high-performance applications. One key feature of Dart is its Just-In-Time (JIT) compilation during development, enabling a faster development cycle with hot reload functionality in Flutter. This allows developers to see the immediate impact of code changes without restarting the entire application. Dart also supports Ahead-Of-Time (AOT) compilation, which results in optimized and fast-running code for production, making it well-suited for mobile app development.

In the context of Android app development using Flutter, Dart serves as the primary language for creating the logic and functionality of the application. Its reactive programming model, coupled with Flutter's declarative UI approach, facilitates the development of visually appealing and highly performant applications. Dart's strong typing system enhances code reliability, and its asynchronous programming capabilities are crucial for handling tasks such as network requests and user input responsiveness in mobile app development. Overall, Dart plays a central role in the success of Flutter, providing a robust foundation for building modern and feature-rich Android applications.

Android Studio:

Android Studio is the official integrated development environment (IDE) for Android app development, providing developers with a comprehensive and feature-rich platform. Developed by Google, Android Studio streamlines the entire app development process, offering a robust set of tools for designing, coding, testing, and debugging Android applications. Its user-friendly interface and powerful functionalities, such as a visual layout editor, code analysis tools, and a versatile emulator for testing, make it an essential tool for developers. Android Studio supports the use of Java, Kotlin, and C++ languages, providing flexibility in choosing the programming language that best suits the developer's preferences and project requirements. With continuous updates and improvements, Android Studio remains at the forefront of Android app development, offering a stable and efficient environment for creating high-quality mobile applications.

In addition to its development features, Android Studio seamlessly integrates with the Android Software Development Kit (SDK) and other essential tools, simplifying the process of incorporating APIs, libraries, and third-party dependencies into projects. The IDE also facilitates collaboration among developers through version control integration and supports the latest Android platform updates, ensuring that developers have access to the latest features and optimizations for their applications. Overall, Android Studio stands as a cornerstone in the Android app development ecosystem, empowering developers to create innovative and reliable mobile experiences for a diverse range of Android devices.

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Firebase:

Firebase is a comprehensive mobile and web application development platform powered by Google, offering a suite of tools and services that simplify and accelerate the development process. For Android app development, Firebase provides a real-time NoSQL database that allows developers to store and sync data across multiple clients in real-time. This feature is particularly valuable for applications that require instant updates, such as chat applications or collaborative tools. Additionally, Firebase Authentication streamlines user authentication by providing secure authentication methods, including email/password, social media logins, and more, ensuring a robust and reliable user identity verification system. Firebase also includes Cloud Functions, enabling developers to run server-side code in response to events triggered by Firebase features and HTTPS requests. This allows for the creation of serverless applications with ease. Furthermore, Firebase Cloud Messaging facilitates reliable and efficient messaging between the server and devices, making it an essential tool for implementing push notifications in Android apps. Overall, Firebase serves as a powerful and integrated backend solution for Android app developers, offering real-time data synchronization, authentication, serverless computing, and cloud messaging to enhance the functionality and user experience of applications.

V. METHODOLOGY

ALGORITHM DETAILS

QR code Generator and Scanner

In Android app development, QR code generators and scanners play a crucial role in enhancing user interactions and providing efficient data handling. A QR code generator is a component that enables developers to dynamically create QR codes containing specific information, such as URLs, text, or contact details. This is particularly useful for applications involving user authentication, sharing information, or generating unique identifiers.

On the other hand, a QR code scanner is a feature that allows users to capture and interpret QR codes using their device's camera. In Android apps, developers can integrate scanning functionality to extract the encoded data from QR codes swiftly. This is widely used for processes like product identification, accessing web links, or quickly adding contacts.

The integration of both a QR code generator and scanner in an Android app can provide a seamless experience for users. For example, in the context of the project you mentioned, the app may use the scanner to locate and identify QR codes on designated dustbins for tracking purposes. The generator could also be employed to create unique QR codes for user profiles, waste material listings, or other relevant data within the recycling ecosystem. Together, these components contribute to a more efficient, interactive, and user-friendly experience in the Android application.

Creating a Flutter Android application for QR-based dustbin location tracking, alerting for cleaning, and selling waste material for a recycling management system involves several components. Below is a brief algorithmic overview of how the application could work:

- User Registration and Authentication:
- Users need to register and authenticate themselves in the application.
- Use Firebase Authentication or a similar service for user management.
- QR Code Generation and Placement:
- Each dustbin is assigned a unique QR code.
- The QR code is generated and placed on the dustbin.

Scanning QR Codes:

Users can scan QR codes using the mobile device's camera within the application.
The scanned QR code is used to identify the specific dustbin.

Dustbin Location Tracking:

The application uses the device's GPS to track the location of the scanned dustbin.
Location data is sent to a server for storage and retrieval.

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Cleaning Alert System:
Implement a schedule or a complaint based system on the dustbin to determine when it needs cleaning.
When the dustbin is full or needs cleaning, an alert is sent to the responsible personnel through push notifications.

Waste Material Sale:
Admin can report the availability of waste materials in the dustbin.
Implement a marketplace within the app where recyclers can view available waste materials.

Recycler Management System:
Recyclers can register on the platform and specify the types of materials they are interested in purchasing.
Recyclers receive notifications when waste materials matching their preferences are available.

Transaction Handling:
When a recycler expresses interest in purchasing waste material, a transaction is initiated.
Implement a secure payment gateway for transactions if monetary transactions are involved.

User Feedback and Rating:
Implement a feedback system where users and recyclers can rate and provide feedback on each other.
This helps in building a trustworthy community.

Data Security and Privacy:
Ensure that sensitive data like user information, location, and transaction details are securely stored and transmitted.
Implement encryption and follow best practices for data security.

Monitoring and Analytics:
Set up monitoring tools to track application performance and user interactions.
Use analytics to gather insights into user behavior and improve the application

VI. CONCLUSION

In conclusion, the Flutter Android application designed for QR-based dustbin location tracking, alerting for cleaning, and facilitating the sale of waste material for a comprehensive recycler management system represents a significant stride towards fostering environmental sustainability and efficient waste management. By seamlessly integrating QR technology, the application not only enables precise dustbin monitoring but also empowers timely cleaning alerts, ensuring a cleaner and healthier environment. Furthermore, the incorporation of a waste material selling feature establishes a circular economy by connecting users with recyclers, promoting responsible disposal practices. This holistic approach, encapsulated within the user-friendly Flutter framework, underscores the potential of technology to address contemporary environmental challenges while fostering a collaborative ecosystem for sustainable waste management

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