BE CIVIL ENGINEERING
PROJECT REPORT

Solid Waste Management with the Help of Web Development and Geographical Information System in Risalpur Cantonment

Project submitted in partial fulfilment of the requirements for the degree of
BE Civil Engineering

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MILITARY COLLEGE OF ENGINEERING

NATIONAL UNIVERSITY OF SCIENCES & TECHNOLOGY

RISALPUR CAMPUS, PAKISTAN

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This is to certify that the

BE Civil Engineering Project entitled

Solid Waste Management with the help of web development in Risalpur Cantonment

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Engineering Degree

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Professor

Military College of Engineering (MCE),

National University of Sciences and Technology (NUST),

Dedication

We dedicate this research to

Our beloved PARENTS and respected INSTRUCTORS, who prayed for us, and

gave us encouragement and moral support throughout our endeavor.

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بِسْمِ اللهِ الرَّحْمَنِ الرَّحِيمِ

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ABSTRACT

Solid waste management is a crucial process that involves the collection, transportation, treatment, and disposal of waste in an efficient and responsible manner. With the increase in population and industrialization, waste generation has become a major challenge for cities and municipalities across the world. Effective management of solid waste is not only essential for maintaining public health and hygiene, but it is also necessary for protecting the environment.

Web development can be used to create innovative solutions for solid waste management by streamlining waste collection and disposal processes, educating the public on waste segregation and recycling, and encourage public participation in waste management.

Web development, the creation of websites and web applications, can play a significant role in improving solid waste management practices. With the increasing use of technology and the internet, web-based platforms can provide innovative solutions for managing waste.

A web-based application can be developed to streamline the waste collection process including waste pickups, tracking the status of waste disposal, and providing real-time updates to the public, optimize waste collection routes and reduce the time and resources required for waste collection.

Recycling reduces the amount of waste that goes to landfills. A web application can be developed to provide information on recycling, including where and how to recycle different types of waste.

CHAPTER 1

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INTRODUCTION

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1. INTRODUCTION

Solid waste management is an essential process that involves the collection, treatment, and disposal of waste in a responsible and efficient manner. The proper management of solid waste is crucial for maintaining public health and hygiene, protecting the environment, and promoting sustainable development. However, managing solid waste is becoming increasingly challenging due to population growth, urbanization, and the rise of consumerism.

1.1   WASTE COLLECTION

The collection process involves the gathering of waste from households, commercial establishments, and other sources. The waste is then transported to treatment facilities or landfills for disposal. The collection process can be challenging, as it requires the coordination of multiple stakeholders, including waste management companies, municipalities, and citizens.

Web development can be used to develop online waste collection systems that streamline the collection process. These systems can include features such as scheduling waste pickups, tracking the status of waste disposal, and providing real-time updates to the public. By using web-based platforms, waste management companies can optimize waste collection routes, reduce the time and resources required for waste collection, and improve the overall efficiency of the waste collection process.

One such example of a waste collection system is the "smart bin" technology, which uses sensors to monitor the level of waste in the bin and alerts the waste management company when the bin needs to be emptied. This technology can be integrated with web-based platforms to provide real-time updates to the waste management company and the public on the status of waste collection.

1.2   WASTE SEGREGATION

Waste segregation is the process of separating different types of waste, such as organic waste, plastic, paper, and metal, for proper disposal. Waste segregation is important because it reduces the amount of waste that goes to landfills, promotes recycling, and reduces the

Environmental impact of waste disposal.

Web development can be used to create online platforms that educate the public on the

importance of waste segregation and provide tools for waste segregation. These platforms can provide information on the different types of waste and how they should be separated for proper disposal. They can also provide tools for monitoring and evaluating the effectiveness of waste segregation efforts. By using web-based platforms, waste management companies can improve the effectiveness of waste segregation and increase the amount of waste that is recycled.

For instance, an online waste segregation platform can provide information on how to segregate different types of waste, and also provide interactive tools that allow users to learn by sorting waste online. Additionally, the platform can provide information on the environmental impact of different waste segregation practices and how to properly dispose of segregated waste.

1.3   WASTE TREATMENT

Waste treatment involves the processing of waste to reduce its volume and mitigate its environmental impact. There are different methods of waste treatment, including composting, incineration, and landfilling.

Web development can be used to create online platforms that provide information on waste treatment methods and their environmental impact. These platforms can also provide data on the effectiveness of different waste treatment methods in different areas. By using web-based platforms, waste management companies can make informed decisions on waste treatment methods and reduce the environmental impact of waste disposal.

For instance, an online waste treatment platform can provide information on different waste treatment methods and their respective environmental impacts. The platform can also provide information on the waste treatment facilities available in a particular area and their respective capabilities. The platform can also be used to report waste treatment issues, such as equipment malfunctions or pollution incidents, and to track progress in waste treatment.

1.4   WASTE DISPOSAL

Waste disposal involves the final disposal of waste in a landfill or other designated area. Waste disposal is a critical aspect of waste management, as improper disposal can lead to

Environmental pollution and health hazards.

Web development can be used to develop online platforms that provide information on waste disposal methods and their environmental impact. These platforms can also provide data on

the effectiveness of different waste disposal methods in different areas. By using web-based platforms, waste management companies can make informed decisions on waste disposal methods and reduce the environmental impact of waste disposal.

In addition to the above steps, web development can also be used to develop reporting systems for waste-related issues. These reporting systems can be used to report illegal dumping, littering, and other waste-related issues. By using web-based reporting systems, citizens can report waste-related issues in a timely manner, and waste management companies can respond to these issues quickly.

Web development can also be used to develop public awareness campaigns to promote sustainable waste management practices.

1.5 PROBLEM STATEMENT

Solid waste management is the major environmental concern in today's era. Introducing an efficient solid waste management system will result in timely and effective disposal of solid waste. Therefore, a need for development of solid waste management system is required which uses a web application to perform this task.

1.6 OBJECTIVES

- To *investigate* the effect of web development and GIS based solid waste management system in Risalpur cantonment.

- To *evaluate* the optimal performance of web development and GIS based solid waste management system with respect to the current system.

- *To assess* the results and future enhancements in web development and GIS based solid waste management system.

1.7 RESEARCH QUESTIONS

- How to develop a web development and GIS based solid waste management system?

- What all features and options are to be included in that web development and GIS based system so that it becomes user friendly and easy to use?

- What will be its effect on public?

CHAPTER 2
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LITERATURE REVIEW
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2. LITERATURE REVIEW

2.1 GENERAL

In this thesis, we will be doing a detailed study of solid waste management system in Risalpur cantonment. The main focus of this study is on development of a web page which will help in solid waste management.

2.2 INTRODUCTION OF SOLID WASTE

Solid waste is any discarded material that is not a liquid or a gas. It can come from households, businesses, industries, construction sites, or any other human activities. Solid waste can be organic waste such as food waste, paper, and yard waste, as well as inorganic waste such as plastic, glass, metal, and electronic waste. Improper disposal of solid waste can lead to environmental pollution, public health risks, and other negative impacts.

It can also pose health risks to humans and animals, as it can attract disease vectors such as rodents and insects. Additionally, the improper disposal of solid waste can cause aesthetic problems and reduce the quality of life in communities.

Hazardous waste and its open burning can directly harm waste workers, people involved in waste burning and surrounding communities. Vulnerable groups like children are at greater risk of adverse health outcomes. Poor waste collection leads to marine and environmental pollution which results into blockage of water drains. Resulting flooding and other standing waters in waste items generates cholera and vector-borne diseases such as malaria and dengue.

About 54 million tons of e-waste, such as TVs, computers and phones, are created annually (2019 data) with an expected increase to 75 million tons by 2030. In 2019 only 17% of e-waste was documented as being properly collected and recycled. Exposure to improperly managed e-waste and its components can cause multiple adverse health and developmental impacts especially in young children.

2.2.1 MUNCIPAL SOLID WASTE

Municipal solid waste (MSW) is the waste generated by households, commercial establishments, and institutions within a municipality. It typically includes materials such as food waste, paper, plastics, metals, glass, and yard waste. Proper management of MSW is critical to protect public health and the environment. Effective management of MSW involves reducing waste generation, promoting reuse and recycling, and properly disposing of

Remaining waste. This may include methods such as landfilling, incineration, and composting. Municipalities and governments around the world face numerous challenges in managing MSW, including limited space for disposal, increasing waste generation rates, and rising costs. Innovative approaches, such as implementing sustainable waste management practices and leveraging web development technologies, can help municipalities address these challenges and promote sustainable development.

2.2.2 HAZARDOUS SOLID WASTE

Hazardous solid waste refers to any waste material that poses a potential risk to public health or the environment due to its toxic, flammable, or corrosive properties. This waste may include chemicals, batteries, electronic waste, medical waste, and contaminated soils. Improper disposal of hazardous solid waste can lead to pollution of air, soil, and water, and can have serious health impacts on humans and wildlife. Effective management of hazardous waste involves identifying and categorizing it, ensuring safe handling, and disposing of it in a manner that minimizes risk. This may include methods such as treatment, recycling, or disposal in specialized facilities designed to handle hazardous waste. Proper management of hazardous solid waste is critical for protecting public health and the environment**.**

2.2.3 HOSPITAL SOLID WASTE

Hospital solid waste refers to any waste generated by hospitals, medical facilities, or laboratories that may pose a potential risk to public health or the environment. This waste may include medical waste, sharps, pharmaceuticals, chemicals, and radioactive materials. Improper disposal of hospital solid waste can lead to the spread of infectious diseases, environmental pollution, and public health risks. Effective management of hospital solid waste involves proper segregation, handling, transportation, and disposal of the waste in specialized facilities designed to handle hazardous waste. This may include methods such as incineration, autoclaving, and chemical treatment. Proper management of hospital solid waste is critical for protecting the health of healthcare workers, patients, and the environment.

2.3 WEB PAGE DEVELOPMENT

Web development is the process of creating and maintaining websites or web applications. It involves the use of programming languages, frameworks, and tools to design and develop

Websites that are functional, user-friendly, and visually appealing. The process of web development typically involves several stages, including planning, designing, development, testing, and deployment.

Web development can range from creating simple static websites to complex web applications that incorporate advanced functionality, such as e-commerce or social media platforms. It requires knowledge of programming languages such as HTML, CSS, JavaScript, and server-side languages such as PHP or Python.

In recent years, there has been a growing demand for web development services, as businesses and organizations seek to establish an online presence and engage with customers through digital channels. The use of web development has also expanded beyond traditional websites, with the development of progressive web applications and mobile applications that can be accessed through web browsers.

Web development has revolutionized the way businesses and organizations operate, providing new opportunities for growth and innovation. The use of web development has enabled businesses to reach wider audiences, streamline processes, and improve customer engagement. With the growth of technology and the internet, the demand for web development services is likely to continue to increase, making it an important field for businesses and individuals to explore.

2.3.1   WEB DEVELOPMENT VIS A VIS SOLID WASTE MANAGEMENT

Solid waste management requires close coordination between the user and administration. Resultantly, a need for the system arises which can connect them through internet, which is easy to use and user friendly. A system which can show the location of waste bins, the quantity of waste collected in the bins and the shortest route for the waste collection trucks from collection point to dumping site. It will not only save time but efforts and solid waste management expenditure will be curtailed remarkably.

All the developed countries have adopted this method and have become successful in minimizing the hazards of solid waste with excellent management system. It not only provides healthy environment but also reduces environmental pollution.

Web development provides the management team with one window operation. It can exclusively monitor what is the level of solid waste being collected and what all resources are required to collect and dispose it.

2.3.2 DETAIL LIST OFDUST BINS/POINTS IN CANTT AREA

Table 1 List of waste collection points

S.No.	Location	Total No of Rubbish Bins	Total No. of Rubbish Point	Rubbish Point on open areas
01.	BTB-2 Quarter	24	03	01
02.	BTB-2 Line (Khandaq)	--	01	01
03.	BTB-2 (Yarmook)	--	01	--
04.	BTB-1 (Khayber Company)	--	02	01
05.	BTB-1 (Uhood Company)	--	01	--
06.	MI Room	--	--	01
07.	Badar Company	--	02	--
08.	Behind TB-1 Office	--	01	--
09.	CMH	03	01	--
10.	Adm Company	--	01	--
11.	Syce Mandi Quarter	03	02	--
12.	MCE (Inside)	--	04	--
13.	MCE Quarter	06	02	--
14.	MCE Officer Mess	--	01	--
15.	Mushtaq Street	09	03	--

S. No.	Location	Total No of Rubbish Bins	Total No. of Rubbish Point	Rubbish Point on open areas
16.	Liaqat Road	03	01	04
17.	Convent School	--	01	--
18.	Behind Iqra School	--	--	01
19.	Commandant Bungalow	--	--	01
20.	MCE Cadet Mess	--	01	--
21.	Block No. 104	--	--	01
22.	Sultan Road/Colony	15	03	03
23.	CSD	09	01	--
24.	Muhammad Hussain Road	12	--	01
25.	Company Bagh	--	--	01
26.	Block No. 73	03	--	--
27.	Mehmood Road	06	--	--
28.	Near Col. Pir Muslim House	--	01	--
29.	Masjid ul Hudah	06	--	--
30.	MCE Cadet Block	--	--	01

S.No.	Location	Total No of Rubbish Bins	Total No. of Rubbish Point	Rubbish Point on open areas
31.	North Road/Colony	03	01	01
32.	JCO Quarters	15	03	01
33.	JLTS School	--	--	01
34.	Tariq Line	18	01	02
35.	EME Work Shop	--	01	--
36.	35 Company	--	01	--
37.	JLTS	--	01	--
38.	New Cherat Lane	24	--	--
39.	Hidayat Ullah Line	06	01	--
40.	TTT Battalion	--	01	--
41.	Cherat Line	24	--	--
42.	POL Depot	--	04	01
43.	FPO Colony	--	01	--
44.	Prof: Munir Road	--	01	--

S. No.	Location	Total No of Rubbish Bins	Total No. of Rubbish Point	Rubbish Point on open areas
45.	S Company/New Attock Lane (Opposite Gate No 3)	24	02	01
46.	CMH Quarter/Old Attock Lane (Opposite Gate No 3)	--	01	--
47.	Iqbal Road	06	--	04
48.	Shami Street	06	--	03
49.	OD Block	27	01	--
50.	Hallow Block	03	--	--
51.	Sapper Musium	01	--	--
52.	Khattak Shop	09	--	--
53.	Survey Lane	06	--	--
54.	Academy Road	03	--	--
55.	Record Wing	--	02	--
56.	Record Wing	--	02	--
57.	Adnan Park	--	--	01
58.	GMP Lane	06	--	01
59.	Nisar Lane	03	02	01
Total:		**283**	**59**	**64**

2.3.3 VEHICLE DETAIL FOR ARMY CONSERVANCY

Table 2 vehicle details

S.No	Vehicle	Numbers
1.	Tractor Trolleys	02
2.	Chengchi (Consy Cart)	01
Total		**03**

2.3.4   STAFF DETAIL FOR ARMY CONSERVANCY

Table 3 Staff details

S.No	Appointment	Numbers
1.	Sanitary Supervisor	01
2.	Drivers	03
3.	Beldar	06
4.	Sweepers	09
5.	Dog Shooter	01
6.	Mali's	08
Total:		**28**

2.3.5 WASTE COLLECTED ON DAILY BASIS BY CANTT BOARD

2.3.5.1   Tractor No. 01

Table 4 List of daily waste collection points

Location	Total Rubbish Collected from Rubbish Points	Total Rubbish Collected from Rubbish Bins
Masjid Ul Hudah	--	06
Hallow Block	--	03
Commandant House	01	--
73 Block	--	03

2.3.5.2   Tractor No. 02

Location	Total Rubbish Collected from Rubbish Points	Total Rubbish Collected from Rubbish Bins
OD Block Muhammad Hussain Road Survey Lane Hidayat Ullah Lane Khattak Shop	--	57

2.3.6 WASTE COLLECTED ON WEEKLY BASIS

2.3.6.1   Tractor No. 01

Table 5 List of weekly waste collection points

Day	Location	Total Rubbish Collected from Rubbish Points	Total Rubbish Collected from Rubbish Bins
Monday	64 Block, Liaqat Road, Nisar Shaheed Hostel, Alif Khan Canteen	03	03
Tuesday	Mushtaq Street, MCE Officer Mess, 73 Block	04	12
Wednesday	GMP Lane, CMH, Sport Wing, Sapper Musium, MCE College inside	05	06
Thursday	Kyber Unit BTB-1, BTB-1 unit inside, MI Room, 33 Unit	04	--
Friday	New Attock Lane outside Bazar area, FPO Colony outside Bazar area	01	24
Saturday	Hillal Lane (BTB-2), BTB-2 inside, MCE Colony, Qasim Lane (MCE)	06	30

2.3.6.2   Tractor No. 02

Day	Location	Total Rubbish Collected from Rubbish Points	Total Rubbish Collected from Rubbish Bins
Monday	JCO Colony, North Colony, Sultan Colony	01	30
Tuesday	Record wing, MT Unit, 35 Compy	03	--
Wednesday	Hidayat Ullah Lane, Audit Office, Old Cherat Lane	02	24
Thursday	New Cherat Lane, TTT Btn, JLTS Unit, Sycel Shop (Khattak Shop)	03	24
Friday	Prof: Munir Road, Near Pir Muslim House	02	--
Saturday	Tariq Lane, 652 Unit, FG Girls School	02	18

2.3.7 DISTRIBUTION AOR
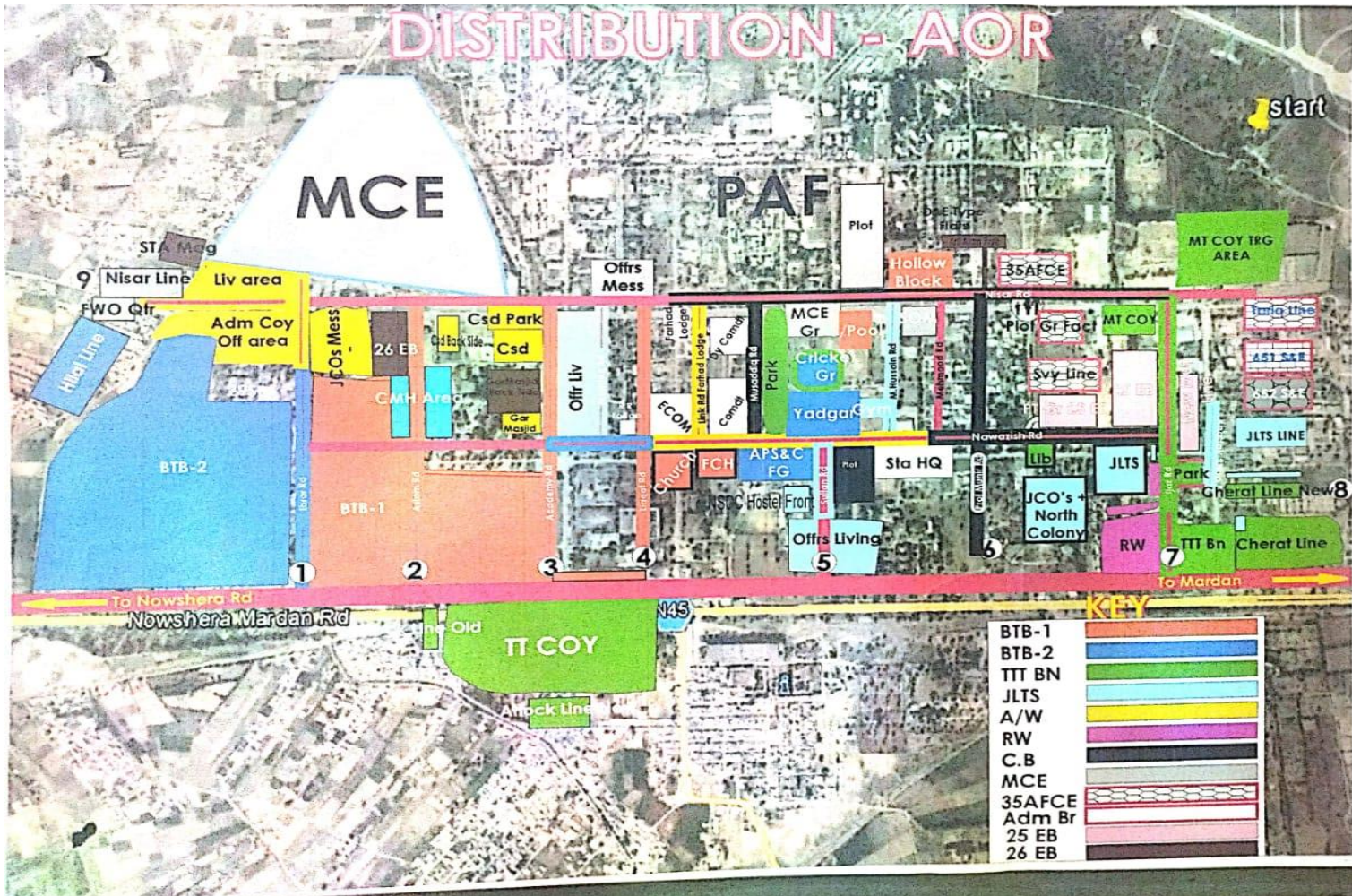
CHAPTER 3
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RESEARCH METHODOLOGY
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3. METHODOLOGY

The approach of research has been explained in this chapter. Methodology includes collection of data from cantonment board, compilation of geographical coordinates of waste bins and dumping site and development of web page.

Our area of study is Risalpur Cantonment which is a city in Nowshera District Khyber-Pakhtunkhwa Pakistan, on the Nowshera-Mardan Road. It is nearly 45 km from Peshawar and 18 km from Mardan and is located at 34°4'52 N and 71°58'21 E.it has a total area of 4217.25 acres and civil population of 28000.

3.1   WEB PAGE DESCRIPTION

Waste management application is built using React, Google Maps, and Firebase, and deployed on Netlify. The app aims to facilitate efficient waste management by enabling different user roles to perform specific tasks. The front end of the app is developed in React. Google Maps is utilized for displaying markers and routing, while Firebase serves as the backend and data storage solution. The app allows administrators to create and delete dustbins and collection points on the map, housekeeping staff to collect trash from houses and dump it into dustbins, and drivers to create optimized routes from dustbins that are filled more than 70% to the dumping site. The dustbins are color-coded based on the trash percentage, with green indicating 0% to 20% filled, orange indicating 21% to 70% filled, and red indicating 71% to 100% filled.

3.2   WEB PAGE CONTENTS

3.2.1   TECHNOLOGY STACK

- • Frontend Framework: React
- • Map Integration: Google Maps
- • Backend and Data Storage: Firebase
- • Repository: GitHub
- • Hosting: Netlify

3.2.2   FEATURES

3.2.2.1   DUSTBIN MANAGEMENT

Admin can perform this function only. This feature allows you to place or mark location of dustbins or waste collection sites on the google map. If a

dustbin location is no longer required, its location can be deleted from the map. Moreover, a location of dustbin can be changed if it is re placed or relocated at some other place or location.

3.2.2.2 TRASH COLLECTION

Housekeeping persons at each house will dump the waste generated in house into the dustbins. A house keeper can also perform this function.

3.2.2.3 ROUTING

Web page has a special feature which shows the route connecting dustbins which are more than 70% full. This will allow the driver to follow that route and empty all the dustbins in route.

3.2.2.4 COLOUR-CODED DUSTBINS

Dustbins are visually represented with color codes indicating the trash level:

Green: 0% to 20% capacity

Orange: 21% to 70% capacity

Red: 71% to 100% capacity

3.2.3 ROLES

3.2.3.1 ADMIN

- Responsible for managing dustbins and collection points on the map.

- Admin creates new dustbins or collection points by placing markers on the map.

- Admin deletes dustbins or collection points if they are no longer needed

- **System Configuration**: The admin is responsible for configuring the web application, setting up user roles and permissions, and defining access levels for different users. This includes managing user registration, authentication, and authorization processes.

- **Database Management**: An admin is typically responsible for managing the database associated with the web application. This involves creating and maintaining the database schema, ensuring data integrity, and performing regular backups to prevent data loss.

- **User Management**: Admins handle user accounts, including user registration, password management, and account-related activities. They may also handle user support and address any issues or inquiries that arise.

- **Security and Privacy**: Admins play a crucial role in ensuring the security and privacy of the web application. This involves implementing security measures such as encryption, user authentication, and authorization mechanisms. Admins may also monitor the system for potential vulnerabilities, perform security audits, and address any security breaches.

- **System Maintenance and Updates**: Admins are responsible for regularly updating the web application, including applying security patches, bug fixes, and feature enhancements. They may also monitor system performance, troubleshoot issues, and optimize the application for better user experience.

- **Data Analysis and Reporting**: Admins may utilize data analytics tools to analyze the collected data related to solid waste management. They can generate reports, statistics, and insights from the data, which can help in decision-making and improving waste management processes.

- **Collaboration and Communication**: Admins often collaborate with other stakeholders involved in solid waste management engage with users of the web application, gather feedback, and communicate updates or changes.

- Overall, the admin in web development related to solid waste management is responsible for ensuring the smooth operation of the web application, managing user accounts, securing data, and supporting the effective management of solid waste through the platform.

3.2.3.1 HOUSE KEEPING

- Collects trash from houses and deposits it into the dustbins.

- Monitors the trash level in each dustbin and reports any overflowing bins.

- Enters the percentage up to which the dustbins or waste collection site is filled

- Report any flaws to admin.

- They are the main waste generators who have the responsibility of dumping waste regularly and correctly.

3.2.3.1 DRIVER

- Views the map and identifies filled dustbins.

- Creates optimized routes from filled dustbins to the collection point.

- Follows the generated route to collect the trash from each dustbin.

- **Job Assignment and Scheduling**: The web application may have a module that assigns waste collection routes to drivers based on factors such as location, capacity, and type of waste. Drivers can access the platform to view their assigned routes, schedule, and any special instructions related to waste collection.

- **Route Optimization**: The web application can provide drivers with optimized routes to minimize travel time, fuel consumption, and overall operational costs. This feature can help drivers efficiently navigate through their assigned collection points and ensure timely waste pickups.

- **Navigation and GPS Tracking**: The application may integrate with navigation and GPS systems to assist drivers in finding the most efficient routes and providing real-time location updates. This functionality can help supervisors monitor the progress of waste collection and respond to any potential issues or delays.

- **Reporting and Documentation**: Drivers may be responsible for documenting waste collection activities, such as the amount and type of waste collected, any issues or incidents encountered, and the condition of collection points. The web application can provide a

platform for drivers to submit these reports electronically, reducing paperwork and improving data accuracy.

- **Communication and Collaboration**: The web application may facilitate communication between drivers and other stakeholders involved in waste management, such as supervisors, maintenance personnel, or customer support. Drivers can use the platform to report issues, request assistance, or provide feedback on collection points.

- **Vehicle Maintenance and Inspections**: The application can include features that remind drivers of vehicle maintenance schedules and inspections. Drivers can use the platform to log maintenance activities, report vehicle issues, and ensure that their vehicles are in optimal condition for waste collection.

- **Data Collection and Analysis**: Drivers may contribute to data collection efforts by providing information on waste quantities, collection frequencies, or other relevant metrics. This data can be used for analysis and decision-making in waste management operations, such as optimizing collection routes or identifying areas with high waste generation.

- Web application itself does not directly involve drivers in the development process, it serves as a tool to streamline and optimize their operational activities within the solid waste management domain

3.2.4   USAGE
3.2.4.1   ADMIN

- Log in to the app using the admin credentials.

- Navigate to the admin dashboard.

- Create new dustbins or collection points by placing markers on the map.

- Delete existing dustbins or collection points if necessary.
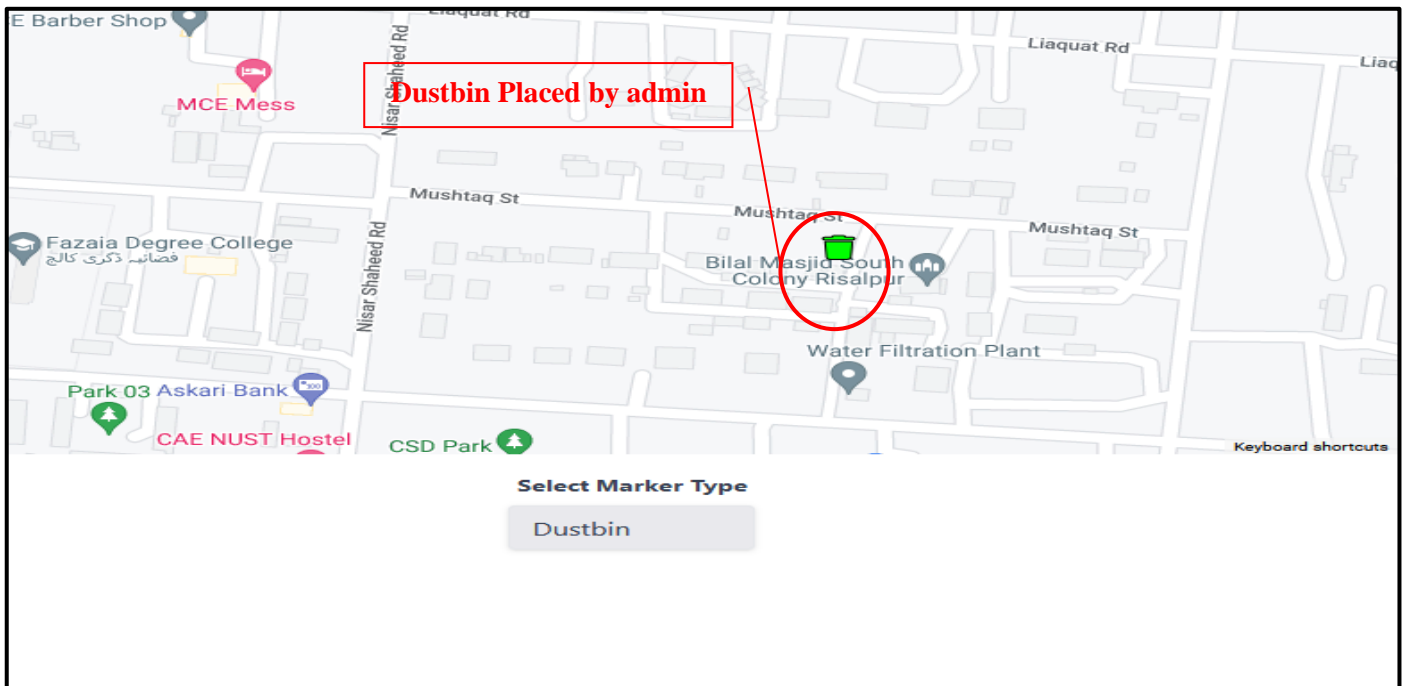

Figure 1 Admin Window

Figure 2 Admin Placed Dust bin on the map

3.2.4.2   HOUSE KEEPING

- Log in to the app using the housekeeping credentials.

- View the map to see the locations of dustbins and their trash levels.

- Collect trash from houses and deposit it into the respective dustbins.

- Report overflowing dustbins to the admin.

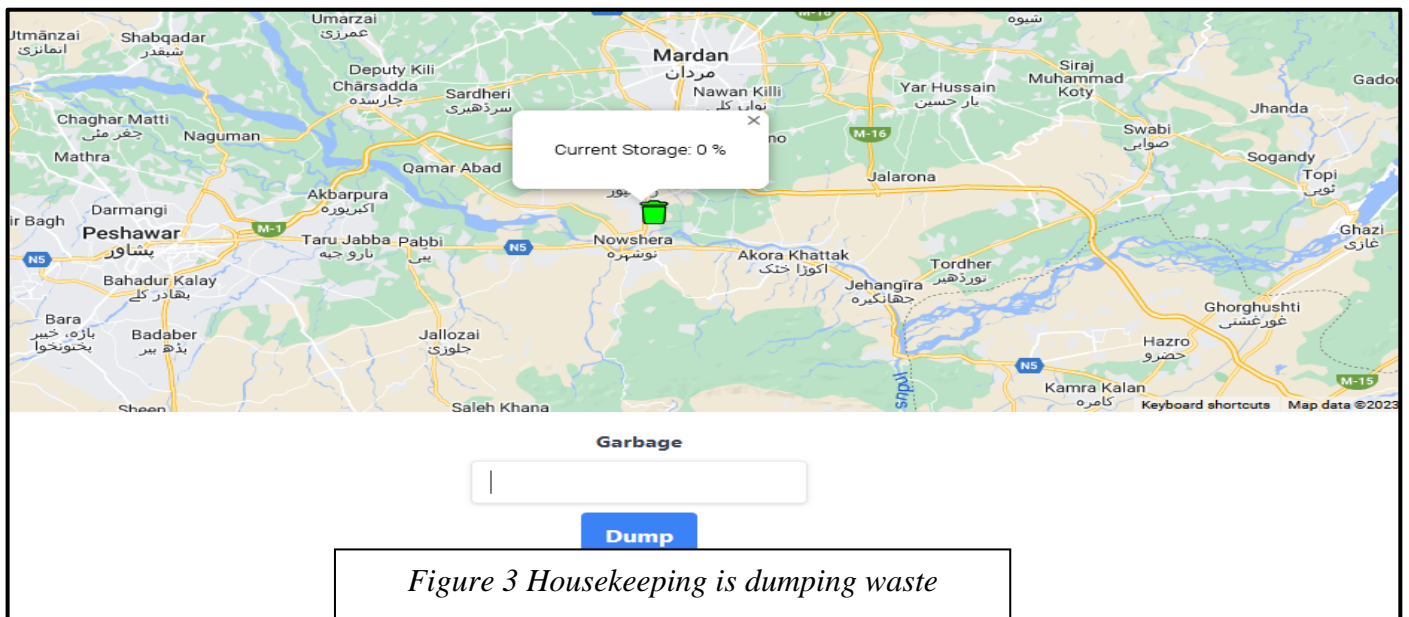- Enters the level up to which waste bin is filled up.
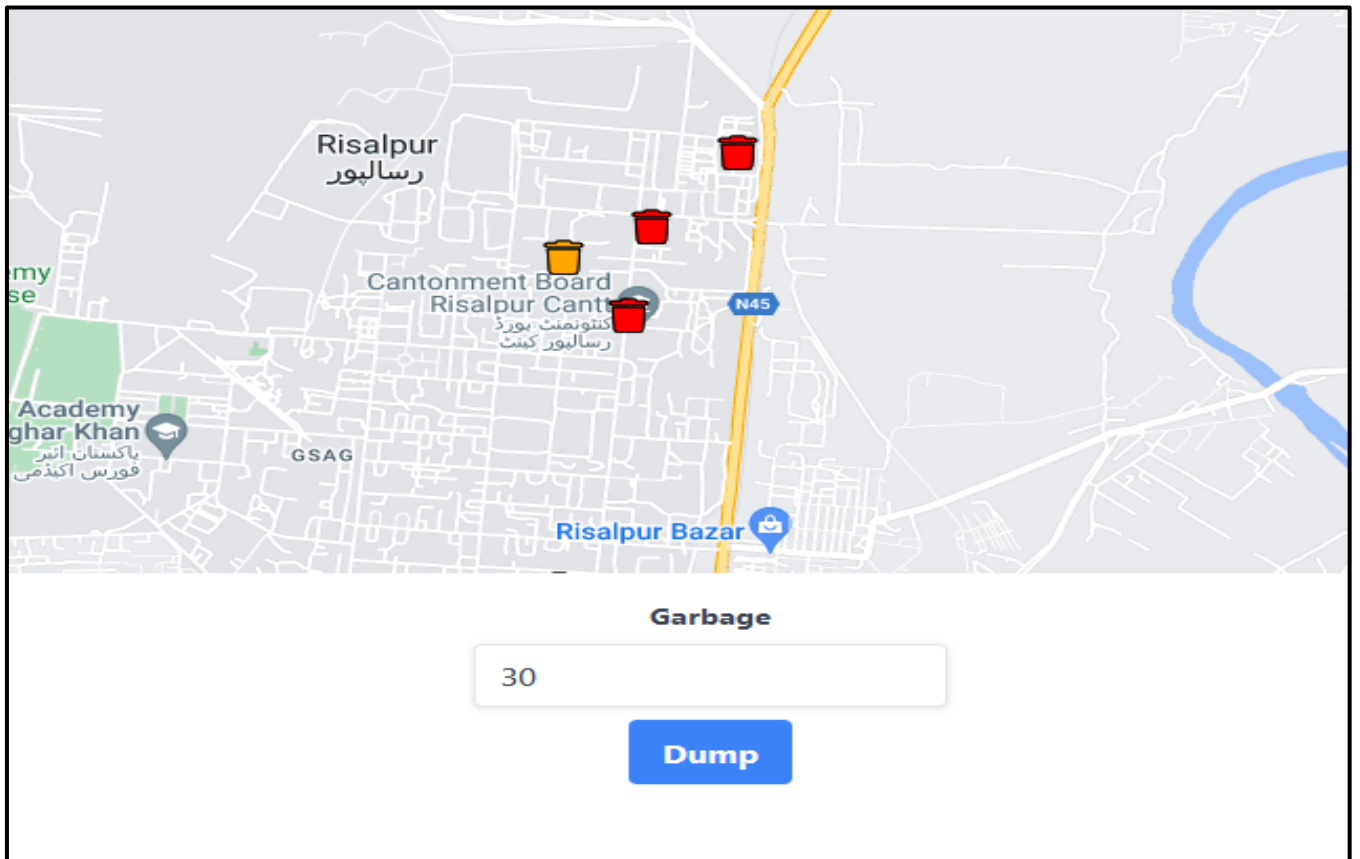

Figure 3 Housekeeping is dumping waste

25

Figure 4 Housekeeping has entered level of dustbin up to which it is filled
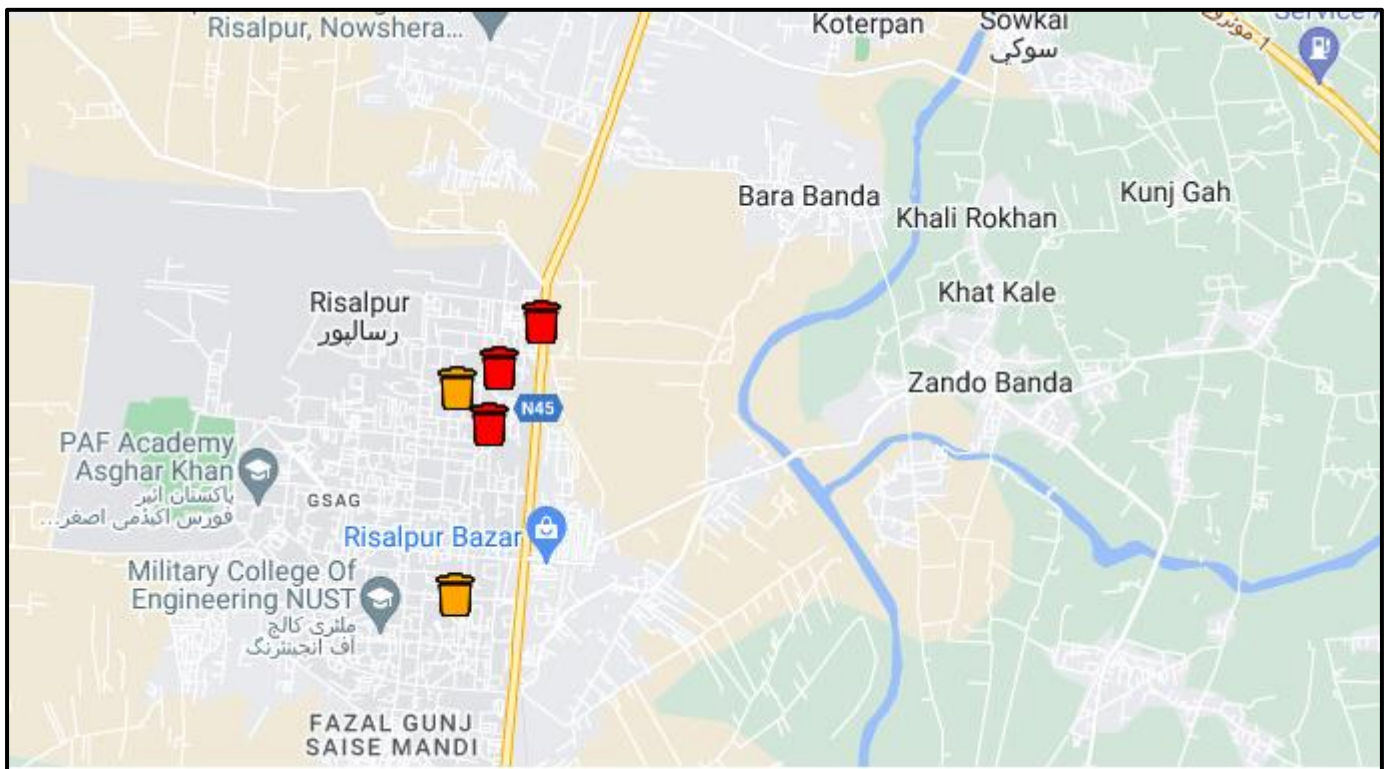

Figure 5 Colors of dustbins changes according to fill level

3.2.4.2   DRIVER

- Log in to the app using the driver credentials.

- View the map to see the locations of dustbins and their trash levels.

- Identify dustbins that are filled above 70% capacity.

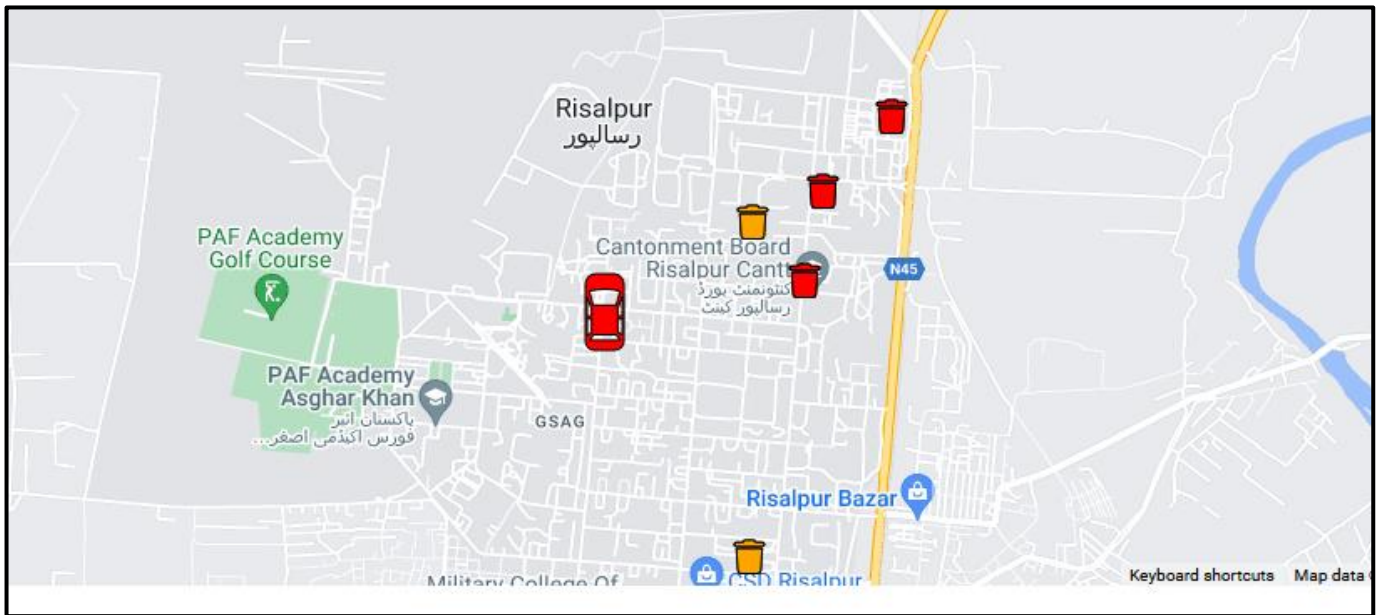- Click on the collection point to generate an optimized route for collection.

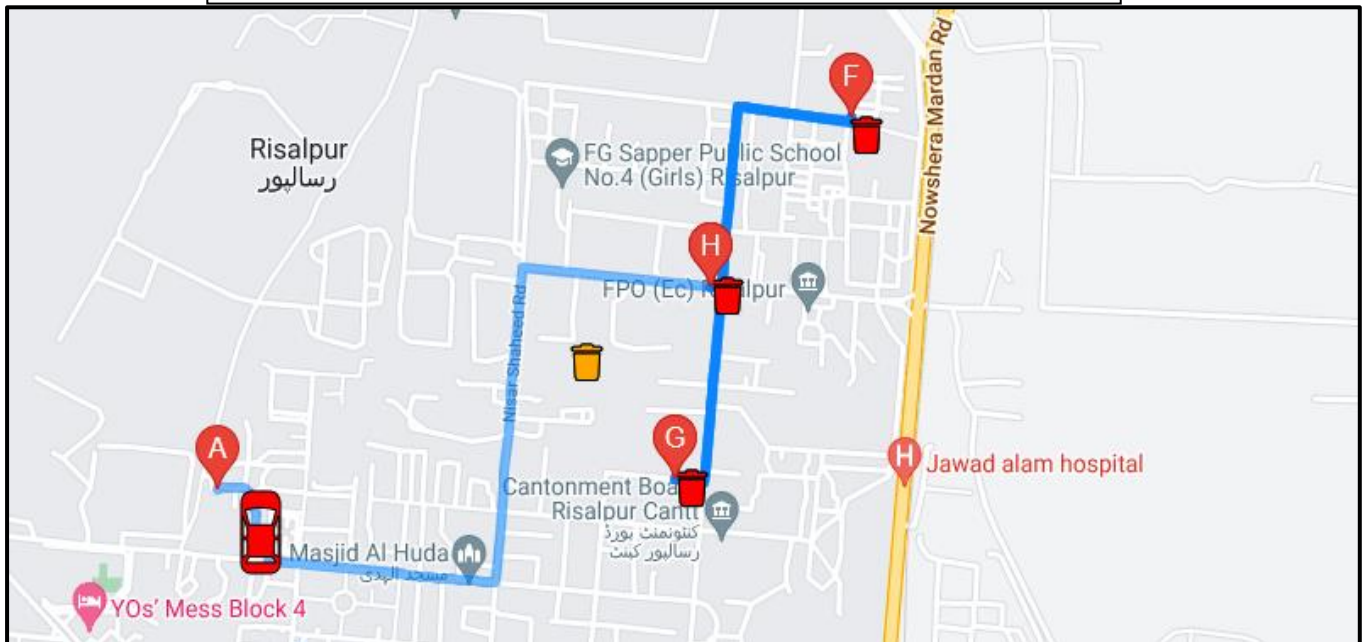*Figure 6 Location of waste collection vehicle and dustbins*

Figure 7 Route marked on map connecting all dustbins above 70% fill level

3.2.5   USER INTERFACE

- **Map View:** Displays the location of dustbins, collection points, and their respective trash levels.
- **Dustbin Markers:** Represented on the map with color-coded icons based on trash levels.
- **Create/Delete Actions:** Available to admins for managing dustbins or collection points.
- **Routing:** Drivers can visualize and follow optimized routes from filled dustbins to the collection point.

3.2.6   FUTURE ENHANCEMENTS

- **Real-time Updates:** Implement real-time updates for trash level changes in dustbins.
- **Notifications:** Send notifications to admins, housekeeping, and drivers for critical events.
- **Analytics and Reporting**: Generate reports on trash collection efficiency, bin usage, and route optimization.
- **Mobile App:** Develop a mobile application version for on-the-go access and convenience.

3.3 APPLICATION OF GIS

3.3.1 GEOREFERENCING OF COLLECTION POINTS

- Geo referencing means that the internal coordinate system of a digital map or aerial photo can be related to a ground system of geographic coordinates

- In general, there are Four Steps to georeference your data:

  o Add the raster dataset that you want to align with your projected data

  o Using georeference tab to create control points, to connect your raster to known positions in the map

  o Review the control points and the errors

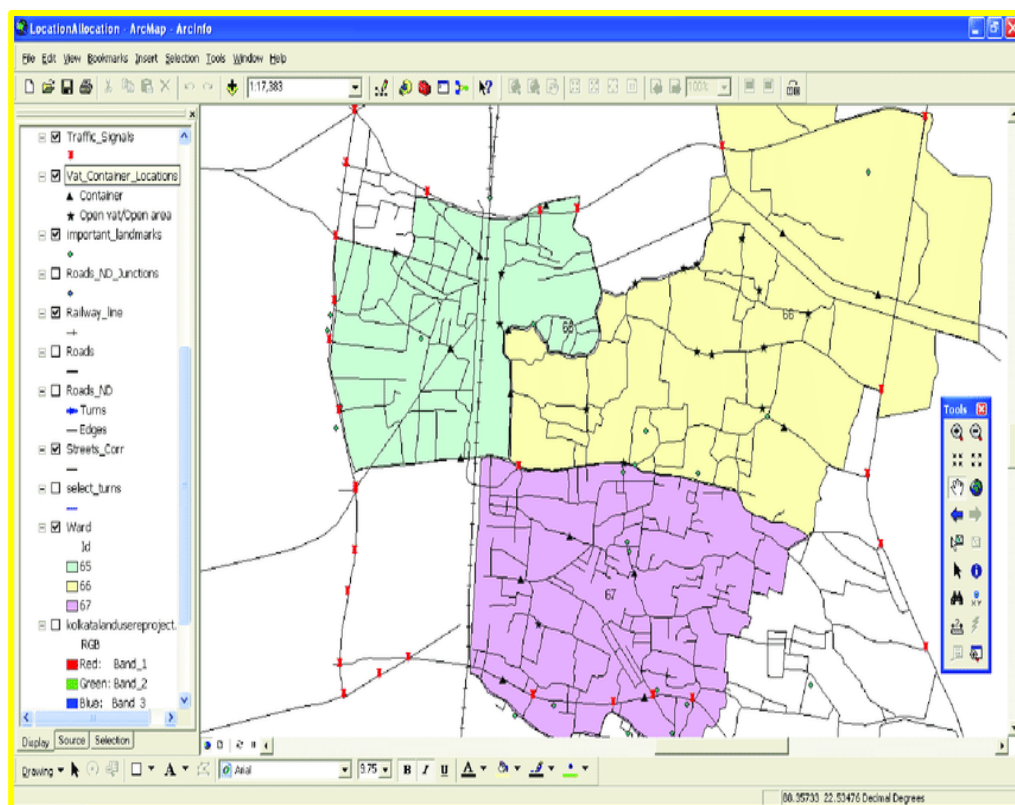 o Save the georeferencing result, when you are satisfied with the alignment

Figure 8 Geo Referencing Using ArcGIS

3.3.2 GEOREFERENCING OF BINS/ DUMP SITES

- Steps For locating dumping site for solid waste

  - Locate the place in google earth

  - Convert these point to shape file from conversion tools in arcgis

  - Right click on solid point layer add field in the attribute table (i.e. biodegradable , non biodegradable and others)

  - Add data in the field

  - After adding data right click on the layer

  - Go to symbology and then click to charts and then click to pie charts

  - Add the field you want to show in the pie charts

  - Add base map for background

  - Add essentials of maps from insert tools (i.e. title scale bar , legend etc)
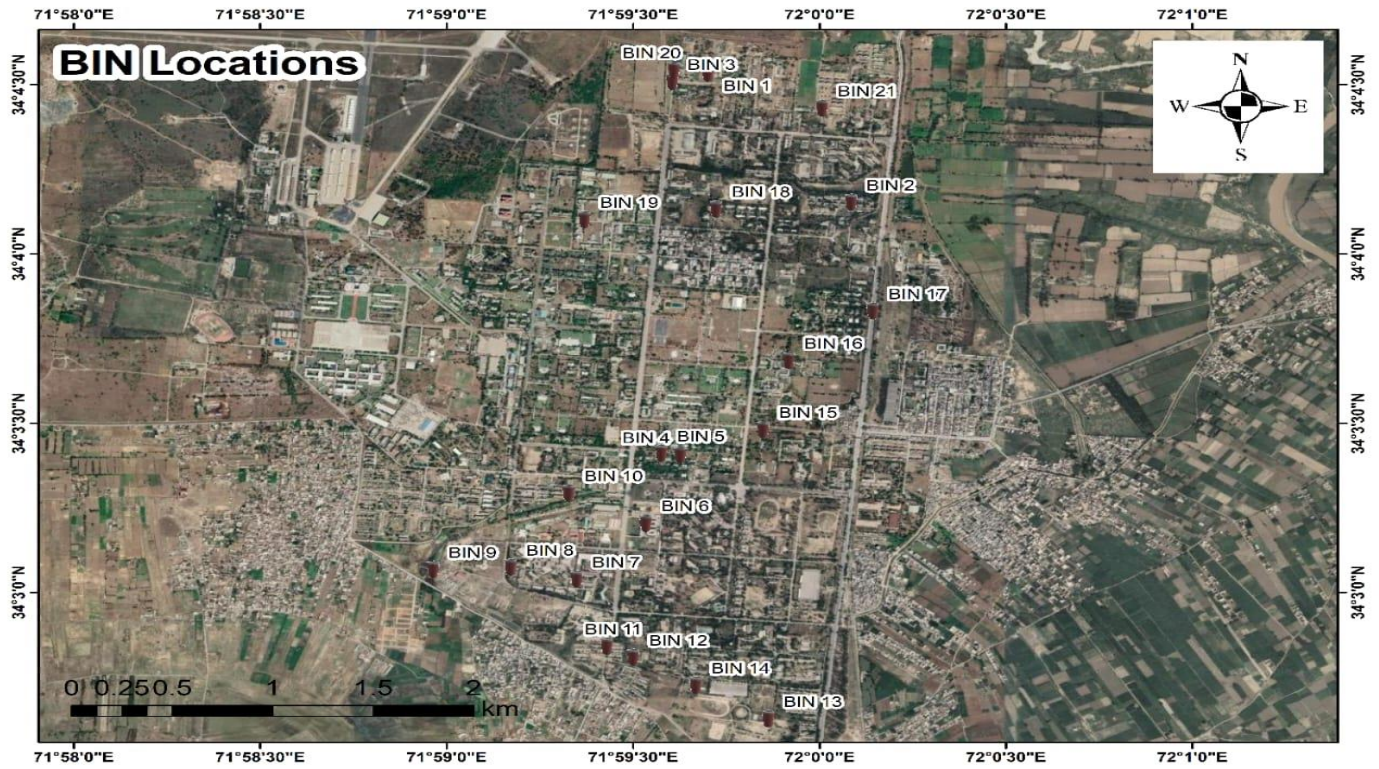
29

Figure 9 Geo Locations of Bins

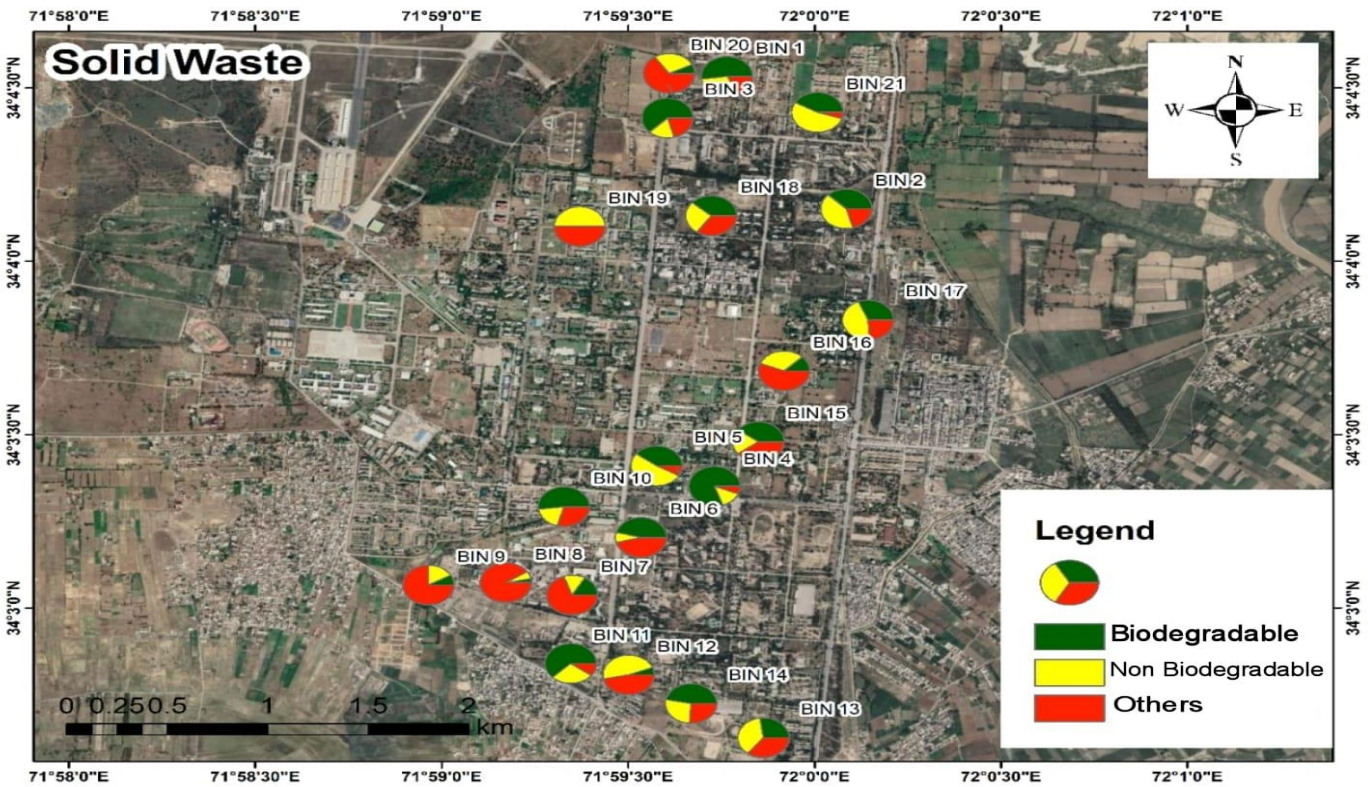*Figure 10 Bio degradable Waste*

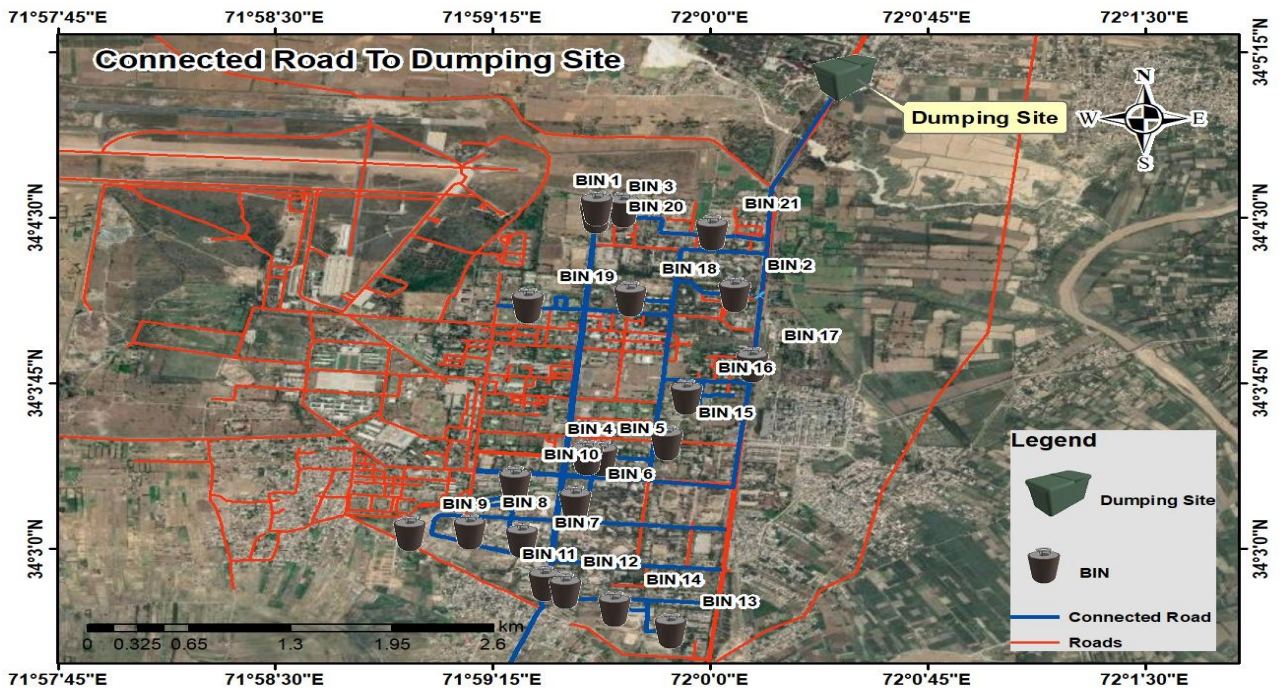*Figure 11 Non Bio degradable Waste*

Figure 12 Solid Waste

Figure 13 Route Optimization

CHAPTER 4

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RESULTS

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4.1   ECONOMY OF FUEL

- Current practice doesn't have any fix schedule of clearing the dustbins. Cantonment board staff visits every dustbin and waste collection site and collect waste in their trolleys or loader rickshaws.

- This practice involves high fuel consumption as collection vehicle has to visit each and every dustbin/waste collection point irrespective of whether these points are filled up or not.

- Waste management web gives a smart solution and shows only those dustbins/waste collection points which are more than 70% full.

- In this way cantonment board staff will only visit those points and collect wastes in their trolleys/ loader rickshaws.

- This will result into high fuel economy and saving in fuel expenses

4.2   SMART MANGEMENT SYSTEM

- Current mechanism doesn't have any system in which an admin can look after all the waste collection points on one screen.

- If an admin wants to check the waste collection points and their fill level, he can't do it.

- Web page provides smart window to admin in which he can look after all the waste collection points on one screen.

- This system provides a smart solution to admin for all the above mentioned issues.

4.3   TIME EFFICIENCY

- Currently a lot of time is wasted in checking all the collection points one by one on daily/weekly basis.

- This not only increases fatigue and tiredness in staff but also reduces the efficiency of waste management system

- Web page system increases time efficiency by notifying waste collection staff the collection points which are more than 70% full.

- By this way other dustbins or waste collections points which are less than 70% full will be excluded from the loading plan.

4.4 CONTROLS ILLEGAL DUMPING AND GENERATION OF WASTE POINTS

- Currently there is no system of controlling illegal dumping of waste by households.

- Anyone can throw anything anywhere which results into illegal dumping and waste generation points.

- Web page system involves geomapping of all the legal dumping points established by cantonment board.

- Those points will be marked and saved in database.

- Resultantly if a cantonment board staff wants to cross check any dumping point he can do it by looking into database.

4.5 WASTE COLLECTION AND SCHEDULING

- Web app will help in online collection a scheduling of waste.
- This will reduce manual coordination efforts, improves efficiency of the management system and ensures timely collection.
- Overall strenuous management will be turned into smart management.

4.6 DATA ANALYSIS AND INSIGHTS

- GIS and web app development can help in collection and analysis of data related to waste generation, collection, recycling rate and more.
- It can identify trends, optimize waste management strategies and make informed decisions based on evidence
- It can help in long term planning, resource allocation and policy guidelines.

4.7   SUITABLE LOCATION OF WASTE BINS

- Currently the waste bins are located without any planning
- All the waste bins are located according to the community they are installed at.
- GIS system will give the most suitable location of waste bins depending on its usage and population around.
- Therefore GIS can be used to locate waste bins on suitable locations.

4.8   SMART OFFICE AUTOMATION SYSTEM

- As a result of the project we get a smart office automation system in terms of;
  - Web application
  - ARCGIS
  - Microsoft office

4.9   ROUTE OPTIMIZATION

- GIS system allows the user to use the most suitable route like web app.
- It uses factors like traffic and route of bins to be emptied to give optimized route

CHAPTER 5

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CONCLUSION

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5.1 CONCLUSION

Solid waste management has been a major concern in the modern world owing to its hazards and threats to environment and life. A lot of efforts have been made worldwide to convert its management from manual to smart system.

Risalpur cantonment board has the responsibility of managing solid waste and it is completely manual based. Our web based development system will provide a platform where admin, user and driver will be integrated and interact with each other. They will get real time situation of the solid waste as it will help the cantonment board staff to make their system more regular and efficient.

Public awareness campaigns are very important for this purpose to educate public on how to use this system and become a responsible resident to make this smart management system run smoothly and effectively.

Overall, GIS and web app development can enhance the efficiency, transparency, and effectiveness of solid waste management processes. It promotes sustainable practices, educates the public, and enables data-driven decision-making, ultimately contributing to a cleaner and healthier environment.

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