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ROUTE OPTIMIZATION FOR MUNICIPAL SOLID WASTE COLLECTION (WARD 109, AURANGABAD).

Kushal Khivansara[1], Rushikesh Aher[2], Mahesh Swami[3], Dr.Prashant Awsarmal[4]

[123] B.Tech Civil Engineer Engineering Department,
Maharashtra Institute of Technology, Aurangabad- 431005 (Maharashtra)
[4]Head of Department, Civil Engineering Department,
Maharashtra Institute of Technology, Aurangabad- 431005 (Maharashtra)

Abstract - *A This project consist of collecting data related to solid waste management of Aurangabad city and "ROUTE OPTIMIZATION MUNCIPAL SOLID WASTE COLLECTION (WARD 109, AURANGABAD)".Aurangabad is famous tourist city of the Maharashtra state. The problems associated with solid waste management in the city of Aurangabad require immediate attention and action. At the surface the reasons for improper solid waste management include growing population and city. Optimization of the routing system for collection and transport of solid waste thus constitutes an important component for productive solid waste management system. This study applied GIS and GPS technologies to map municipal solid waste collection system and identify optimum route for solid waste collection in the study area. A geographic information system (GIS) is a structure for gathering, managing, and analyzing data. It analyzes spatial location and organizes layers of information into visualizations using maps this study deals with optimization of routes for municipal waste collection using GIS network. Optimized route for solid waste collections are evaluated for different standards such as less fuel, shortest travel path, and minimum collection time for collection and best practices for future survey throughout the city.*

Index Terms: Geographic information system, Global positioning system, Minimum collection time, Municipal solid waste collection, Optimum route, Shortest travel path, Solid waste management.

1.INTRODUCTION

Waste management (or waste disposal) are the activities and actions required to manage waste from its inception to its final disposal. This includes the collection, transport, treatment and disposal of waste, together with monitoring and regulation of the waste management process. Solid waste collection is a major section in the process of solid waste management (SWM) and it is estimated to consume up to two third of entire SWM budget.

Solid Waste Management in all Municipalities and Corporations. several problems are experienced in solid waste management that include:

I. Inadequate waste collection.
II. Poor routing systems.
III. Accumulation of garbage on streets, on open spaces and on compounds.
IV. Lack of waste treatment and disposal sites.
V. High operational costs and poor cost recovery for solid waste management.
VI. Inappropriate Information Management System.

1.2 GEOGRAPHICAL EXTEND AND BACKGROUND INFORMATION ABOUT STUDY

Aurangabad city is one of the major industrial Aurangabad city is one of the major industrial Waluj, Pandharpur and Paithan MIDC area. Due to urbanization and increase in population solid waste is major source of environmental pollution. Solid waste disposal poses a greater problem because it leads to land pollution if openly dumped, water pollution if dumped in low lands and air pollution if burnt. Aurangabad city is facing serious environmental degradation and public-health risk due uncollected disposal of waste on streets and other public areas, clogged drainage system by indiscriminately dumped wastes and by contamination of water resources near uncontrolled dumping sites. This project gives the brief idea of the current waste- generation, characteristics and management scenario in Aurangabad City, along with the associated environmental impacts.

Table -1: General information about Aurangabad city

Aurangabad, Maharashtra			
Latitude, Longitude	19.8762° N, 75.3433° E	Total household	237559
Area	138.5 Sq. Km	No of Wards	115
Total Population	1175116	No of Zones	09

2. METHODOLOGY

1. The current Collection System of Aurangabad city was studied and it was as follows:
   - Door to Door collection
   - Wet/Dry segregation
2. The Study of Existing Routes was obtained with the help of GPS Essential and Geotracker.
   - Current Routes of vehicles collecting waste.
   - Distance And Time Relationship.
3. The study of Present Transport System in city was as follows:
   - Rear Loader Vehicle
   - Secondary Transport (Compactors)
4. To get the knowledge of waste treatment process the study of existing Treatment Plant was done in different part of city and which are in following areas:

a) Chikalthana Treatment Plant (This plant was in working condition with capacity of waste treating a 150 MT)

b) Padegaon, Kanchanwadi and Harsul Treatment plant (These all treatment plant is under construction)

2.1 STUDY OF EXISTING ROUTES

To optimize collection routes and to determine current collection efficiency it was necessary to study the existing collection routes .This current collection route was identified with the help of GPS essential and Geo tracker.

Figure - 1: Existing Route Map by Using GIS.

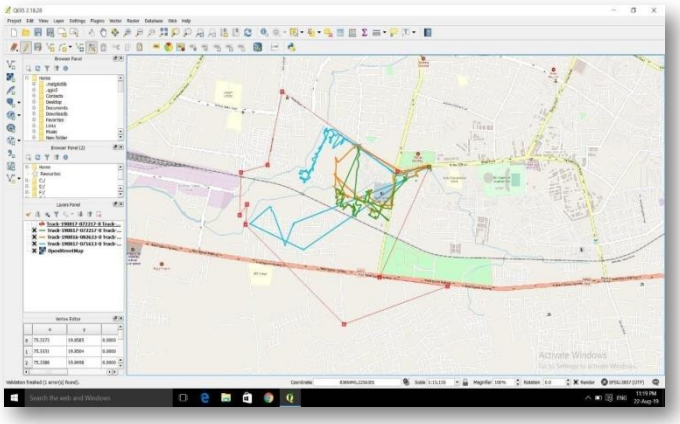


Table -2: Vehicle Number and its Color Representation

Vehicle No: MH-20-659	Orange	Ward No: 109
Vehicle No: MH-20-823	Green	Ward No: 109
Vehicle No: MH-20-832	Blue	Ward No: 109

2.2 LOAD COUNT ANALYSIS

- In this method, the number of individual loads is counted, and the waste characteristics are estimated (type of waste, Estimated volume)
- Weight is estimated, or, if scales are available, weight data are also recorded Unit generation rates are determined using the field data.
- Residential area = 2000 homes, average of 3 people per home
- Observations at the scales (transfer station) per week: total =31751.615kg (5ton/day).

$$Unit\ Rate = \frac{kg/week}{persons} \quad \text{----------(1)}$$

= 5.4 kg/capita/week

= 0..77 kg/capita/day

Hence, according to calculations of Load count analysis it was obtained that the waste generated in our ward Per person was 0.77 kg/capita/day

2.3 REPRESENTATION OF LOAD COUNT ANALYSIS ON GIS

Figure - 2: Areas of ward according to the weight of waste collection on GIS.

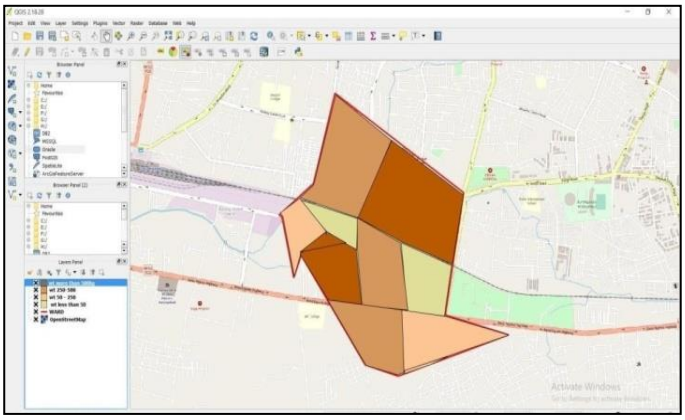


Table -3: Weight of Waste Generation in Ward 109

Color Code	Weight of Waste Generation
Dark brown	>500kg
Light brown	250-500kg
Light pink	50-250kg
Gray	<50kg

2.4 PICKUP TIME

For hauled container systems:

$$Thcs = (Phcs + s + h) \quad \text{----------(2)}$$

Where,

Thcs = timing of each round trip, hr/trip

Phcs = pick-up time per trip, hr/trip

S = at site time (landfill, transfer station) per trip, hr/trip

h = time per trip, hr/trip haul

Using field data for various types of collection vehicles, haul time can be approximated by a straight-line relationship:

$$h = (a + bx)$$

Where:

a, b = empirical constants.

x=average round-trip haul distance, miles.

so, time for each round-trip becomes:

$$Thcs = (Phcs + s + (a + bx)) \quad \text{----------(3)}$$

In our case:

a) Phcs =2hr/trip,

b) S= 1 hour

c) Haul constant: a = 0.016hr/trip, b=0.018hr/trip,

d) x=48 miles

Hence, timing for each round of trip was found to be 3.06hr/trip which was helpful for finding number of trips per day.

2.5 NUMBER OF TRIPS PER DAY

$$N_d = (H(1 - W) - (t_1 - t_2)) \div (Thcs) \quad \text{----------(4)}$$

Where,

N_d = number of round trips per day

H = length of a work day, hours/day

W = off-route factor (lunch, pit-stops, etc),expressed as a fraction

t_1 = time to drive from garage to first pickup, hours

t_2 = time to drive from last pickup to garage, hours

Thcs = time for one round trip, hr/trip

This allows us to estimate the number of pickups, trips and vehicles that are required for a community collection system.

In our case:

a) H=8 hrs/day,

b) W=15%=0.15,

c) t_1=3hr,

d) t_2=0.4hr,

e) Thcs=3.06

Hence, Number of trips per day was found to be 2 trips/day.

2.6 DESIGN A NEW COLLECTION SYSTEM

1. **Determining time available for pick-up per trip (Pscs)**

$$Pscs = (H(1-W)-(t1+t2)-(s+a+bx)))/N_d \text{ -------(5)}$$

2. **Determining Pick-up time per location (tp):**

   2-person = 1.35 collector-min/location (from field observations = 0.675*2)

3. **Determining Number of pick-up locations completed per trip (Np):**

$$Np = Pscs \times (n \div (tp)) \quad \text{----------(6)}$$

Where,

Pscs = Pickup time available per trip

t_p =Pickup time per pickup location, collector-min/location

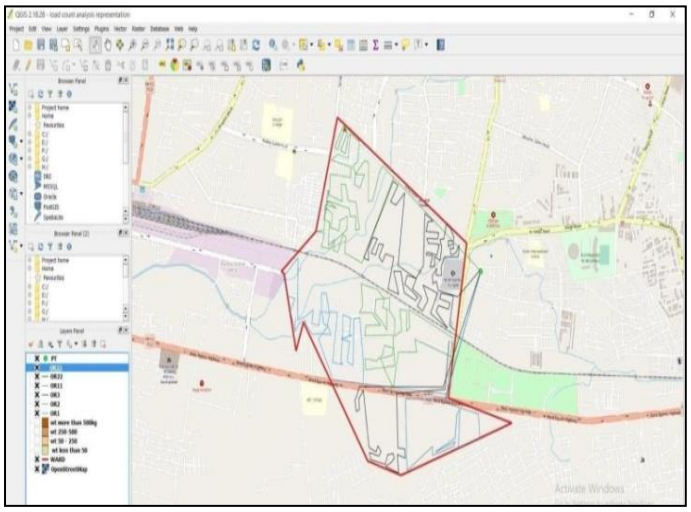
n = number of collectors

Hence, Number of pick-up locations completed per trip was obtained as 204 Locations/trip.

2.7 OPTIMIZED ROUTE

According to all the calculations and rules of Environmental Protection Agency (EPA) a new optimized route was designed using QGIS software as shown in fig no 3 which shows now most of the area in ward is getting cover and hence efficiency of waste collection is been increased .

Figure - 3: Optimized route map



3. RESULT AND DISCUSSIONS

1. The current collection routes are not efficient to collect waste of whole ward in a particular day.
2. The numbers of vehicles are not sufficient for collection of waste.
3. It was observed those crews were not wearing safety equipments such as gloves, mask, shoes etc.
4. It was also observed maintenance, repairing, washing of collection vehicle was not properly done.
5. On Chikalthana, Waste Treatment Plant there was not any fire safety arrangement.

4. CONCLUSIONS

Total amount of money spent for collection, transportation and disposal of solid waste, approximately 50 to 70 percent is spent on the collection phase. This fact is important as small percentage improvement in the collection operation can effect a significant saving in the overall cost use of QGIS application and our calculations in Aurangabad city has shown reasonable improvement in length of the routes and travel time minimization.

The existing locations per trip were 300 and according to optimized routes no. of locations per trip are 408. Hence collection routes are optimized by 26.5%

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