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Application of Technology for the Municipal Solid Waste Management System: The Case Study of Mysuru City

Parinitha T Niranjan[1], Sadashiva Murthy B M[2], D Istalingamurthy[3] and Prashanth B[4]
[1]Research Scholar, Environmental Engineering Department, JSS Science and Technology University, Mysuru, Karnataka, India
Email: parinitha@sjce.ac.in
[2,3]Professor, Environmental Engineering Department, JSS Science and Technology University, Mysuru, Karnataka, India
[4]Professor, Civil Engineering Department, Government Engineering College, K R Pete, Karnataka, India

***Abstract*—In Indian cities, managing solid waste is a crucial component of urban and environmental governance. Solid waste management stands as an urgent global concern, necessitating data-driven solutions for environmental sustainability and public health. Waste collection is getting harder and harder to do in developing countries, especially when it comes to logistics, labor, and pollution. Integrated solid waste management (ISWM) is a cutting-edge and scientific strategy for managing solid waste. One of the most urgent environmental challenges of our time is the proper management of solid waste due to rising global production and rapid population growth. Studies were carried out using Geographic Information Systems to streamline the routes that carry solid waste to disposal point.**

The administration of Mysuru city's solid waste is under the control of the Mysuru City Corporation (MCC). MCC is divided into 65 wards and generates 402 TPD of waste of which the entire waste is openly dumped in pits at the landfill site extended up to 34 acres at Vidyaranyapuram, Sewage farm. Now, the City Corporation stepped forward to find a solution for the scientific treatment of disposal of waste.

This study seeks to identify the most effective routes for vehicles used for the collection and transportation of solid waste by utilizing GIS technology. The proposed case considered Ward 51- Agrahara of Mysuru city for optimizing the route for collecting primary solid waste. The proposed system shows an encouraging result. It reveals that the trip distance of the auto tipper's collection vehicle has been lowered from 25.19 km to 18.15 km with a saving efficiency of 27.9 % respectively. Additionally, collection and fuel costs were also reduced.

***Keywords*— ArcGIS, Optimized Waste Collection Route, Waste Management.**

I. INTRODUCTION

Population inflation, higher living standards in cities, expansion of urban areas, and changes in consumption behaviour have led to a considerable increase in the volume of the generated solid wastes in urban areas (Hatamleh et.al., 2020). Solid waste collection is a major section in the process of solid waste management (SWM) and it is estimated to consume up to two-thirds of the entire SWM budget.

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The functional element of the collection includes not only the gathering of solid wastes and recyclable materials but also the transport of these materials, after collection, to the location where the collection vehicle is emptied (Malakahmada et.al., 2014). One of the main component of solid waste management is estimating routing of vehicles. Optimization reduces travel distance and time which could reduce total disposal cost. Different approaches such as mathematical programming, specialized software and geographic information system have been developed to optimize waste collection process.
Mysuru is the second largest city in Karnataka after Bangalore. Mysuru is spread over an area of about 128 sq. km with a fast-growing population at a faster rate due to the influx of many service industry activities. Due to this condition, the generation of municipal waste both garbage and sewage has been on the rise. Mysore City Corporation (MCC) is responsible for handling solid waste management in city. The city administration has been decentralized in 8 zones and there are 65 wards in the city generating approximately 450 tonnes of solid waste every day (Chandra and Devi, 2009). This research is therefore aimed at determining route optimization of solid waste generated in selected ward of Mysuru city and propose the optimal waste collection route using ArcGIS, as a model case.

II. METHODOLOGY

For the investigation, the most significant element was the road network to optimize the route. Google Earth offers a road network, as well as a satellite image. The study area involves the present road network, the collection routes in place, and the vehicle fuel used. The most effective plan can be identified by considering a variety of factors, including the shortest distance, time duration, the street structure, number of workers, and fuel cost. The main data sources for the study will include satellite photos, GPS data, and topographic maps of the study location. The ArcGIS tool is used to create the maps which are useful for route optimization.

III. RESULT AND DISCUSSION

A. Existing Waste Collection Route

Agrahara has a population of 8800 with an approximate waste generation of 6.5 – 7 TPD. The Map was extracted by using ArcGIS and the routes were optimized using a network analysis tool. The primary objective of the study was to determine the distance between the optimized (desired) route and the existing route by constructing a series of routes. The collection vehicle used for the study was an auto tipper and a tractor was used to transport the solid waste to a secondary collection point. Fig 1 illustrates the existing waste collection routes of Ward 51 Agrahara. The existing waste collection route distance for auto tippers was 25.19 km.

Fig 1: Existing waste collection routes of Agrahara

B. Optimized Waste Collection Routes

ArcGIS was used in conjunction with pre-defined infrastructure (i.e., urban areas, road network, collection locations) to identify the shortest and most effective collection routes. However, the road conditions and weather impact on driving were not part of this study. By using ArcGIS, the shortest route or optimal route from each collection point was obtained. As illustrated in Fig.2, it shows the shortest path of the collection route. The obtained optimal waste collection route distance for auto tippers was 18.15 km with overall saving % efficiency of 27.9%.

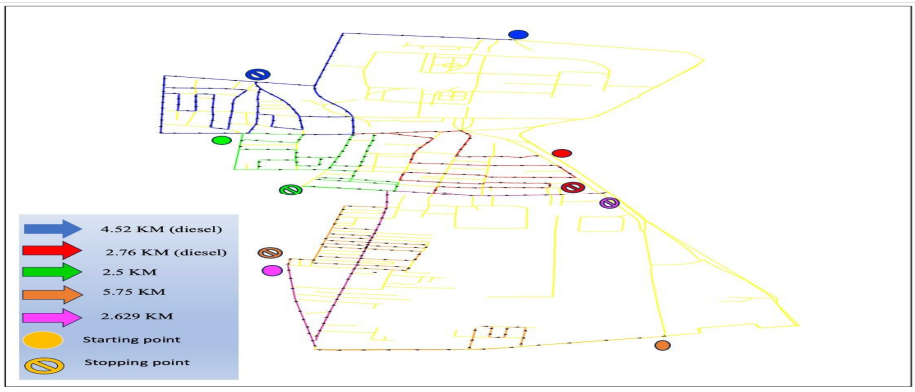

Fig 2: Optimized waste collection routes of Agrahara

Comparison of the Existing waste collection route and the Optimized route: Agrahara

The existing distance and optimized routes distance of Agrahara were found to be 25.19 km and 18.15 Km and the overall saving efficiency is 27.9 %. Therefore, the fuel cost was reduced by 48.12 Rs to 42.43 Rs in diesel vehicle and 114.2 Rs to 73.5 Rs in petrol vehicle. Overall results indicate that, the travel distance of collection vehicles of auto tippers has reduced with 27.9%. This research has shown that using advanced routing and procedures can return significant cost savings, which can be achieved by decreasing overall travel distance. The impact of reducing travel distance can also reduce carbon emissions.

IV. Conclusion

This study will provide insight into the decision-making process for waste transportation, fuel usage, and the creation of work plans for both personnel and vehicles. Network analysis performed in this study helps to find the optimal route for collecting waste from various waste collection locations in the selected ward of Mysuru city. Using the GIS approach, an optimal path was discovered that required less time than the current run route. This model aids in determining the shortest route, quickest turnaround, and most affordable collection strategy for moving solid waste to a landfill. The result indicates that the travel distance of the collection vehicle of the auto tipper of Agrahara has reduced from 25.19 km to 18.15 km, respectively. This study has revealed that implementing advanced routing and procedures can lead to considerable cost savings, which can be achieved by reducing the overall duration of the trip.

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