"Optimal Routing of Municipal Solid Waste collection vehicle in selected wards of Mysore City using GIS"

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Abstract - Waste collection in developing countries is becoming increasingly complex, particularly in terms of logistics, labour costs, and air pollution emissions. Geographic Information Systems (GIS) were used in studies to streamline the paths that trucks collecting solid waste take (ArcGIS). A day was chosen at random to generate a number of routes that would best match the overall travel distance between the current routes and their ideal counterparts. These routes were created to be great complements to the existing routes.

There are eight waste collection routes in Mysuru, which span Ward 42 (K G Koppal) and 43 (T K Layout). In this case, we investigated a collection vehicle, namely an auto tipper, for waste collection in Mysuru's Ward 42 and 43. The proposed system produced encouraging results. The result reveals that the trip distance of the auto tipper's collection vehicle has been lowered from 19.40 Km to 13.094 Km to 15.53 Km and 20.42 Km, respectively. The saving efficiency of auto tipper is 19.98% and 28.45%, respectively. Additionally, collection and fuel use costs are reduced.

Key Words - ArcGIS, Route optimization, Waste management, transportation, collection bins

1. INTRODUCTION

Increased mobility and urbanization have resulted in previously unheard-of trash accumulation. Garbage accumulation is the most difficult component of waste management operations. This is primarily due to the problem's high costs. Accumulation should be given more attention throughout the time spent managing solid waste because it accounts for 60-70% of the total cost. This is due to accumulation taking up the most time.

It is important to optimize the routes used for solid waste collection because driving, loading, and unloading take up a significant amount of time in urban areas. To ensure that collection crews deliver the best possible service, it is still necessary for them to understand local limits such as one-way streets and road construction. This study looks into how frequently geographic information systems (GIS) are utilized in route optimization studies (GIS). (Francina.J,etal, 2018)

According to the findings of this study, Geographical Information Systems (GIS) are increasingly being employed in studies that investigate route optimization. GIS is an excellent tool for this type of research since it can swiftly store, retrieve, and analyze large amounts of data while also showing visual results. ArcGIS Network Analyst allows users to dynamically simulate correct network setups. Turn and height restrictions, one-way streets, speed limits, and varying travel speeds based on local traffic volume are a few examples.

Mysore is located at 12.30 degrees North, 74.65 degrees East, and 770 meters above sea level (2,526 ft). It has a total land area of 286.42 km2 and is located in southern Karnataka's Chamundi Hills foothills (111 sq m). Kannada is the predominant mode of communication in and around Mysore and its environs.

We chose two Mysore city wards for this project: ward 42 K G Koppal, ward 43 T K Layout. The Mysore City Corporation oversees the city's civil administration, which governs day-to-day operations. By 2022, the city is expected to have 1261000 residents.

2. Methodology

Data collection

The road network was the most important piece of information needed for the investigation. Google Earth provides the metropolitan road network and satellite image. Mysore City Corporation provided the study area border, current road network, location of garbage bins, capacity of bins, existing collection routes, and vehicle fuel usage.

Depending on how the parameters are configured, it may be feasible to characterize or adjust each of the critical factors required to generate a specific condition. As a result, a number of consequences are possible. Finally, the most efficient plan can be determined by taking into account a range of criteria such as the shortest separation, the street system, as well as social and environmental problems.

3. Results

Existing waste collection routes:

The objective was to estimate the total travel distance between the ideal routes and the existing routes on a

random day by planning a variety of routes. The wards 42 and 43 in Mysuru are served by seven waste collection routes. In this post, we looked into collection trucks, often referred to as auto tippers that were employed to gather trash in Mysore's wards 42 and 43. MCC was successful in acquiring the current solid waste pickup routes (Mysuru City Corporation). Figure shows the possible routes from each collection point at the moment.

Optimized Waste Collection Routes:

To find the quickest and most effective routes to collect recyclables, ArcGIS and pre-planned infrastructure (cities, highways, collection points, and landfills) were used. The collection routes were therefore as brief as possible. On the other hand, this study did not take into account how the weather and road conditions affected driving. We chose the route that would get us to each of the collection spots in the quickest amount of time, as shown in the diagram.

Existing waste collection routes of ward 42: K G Koppal

The existing waste collection route distance for auto tippers was 19.40km.
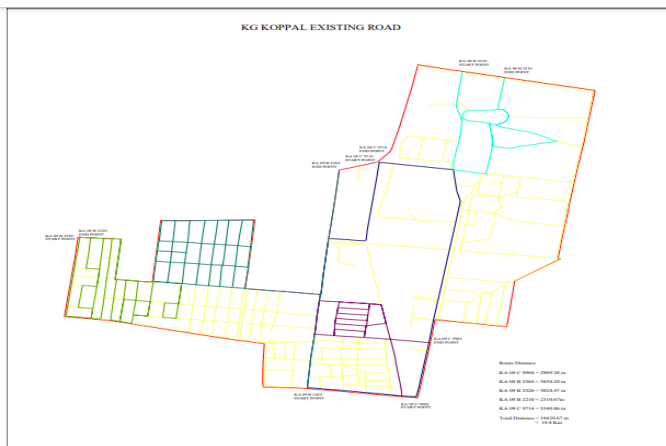

Fig 1: Existing waste collection routes of K G Koppal

Generating Optimal Waste collection Route: K G Koppal

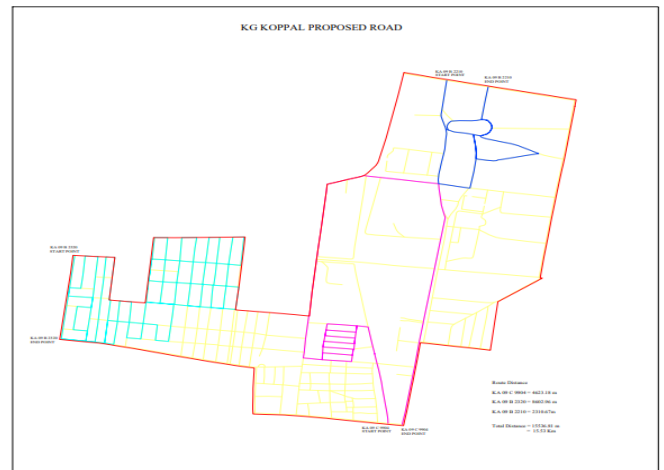The obtained optimal waste collection route distance for auto tippers was km.

Fig 2: Optimized waste collection routes of K G Koppal

Comparison of the Existing waste collection route and the Optimized route: K G Koppal

Table -1: Comparison of the existing route and optimized route of K G Koppal

Collection vehicle	Auto tipper		% Efficiency
	Existing route	Optimized route	
Route distance in Km	19.40	15.53	19.95
Fuel consumption in L	1.03	0.824	20.00
Fuel consumption in Rs	103	82.4	20.00
Difference in Km	3.87		-
Total saving efficiency in %	19.98		

Overall results indicate that the travel distance of collection vehicles of auto tippers have reduced from 19.4 Km to 15.53 Km. This research has shown that using advanced routing and procedures can return the significance cost savings, this can achieved by decreasing overall travel distance. The impact of reducing travel distance can also reduce the carbon emission. The saving efficiency of auto tippers is 19.98%.

Existing waste collection routes of ward 43: T K Layout

The existing waste collection route distance for auto tippers was 13.094km.
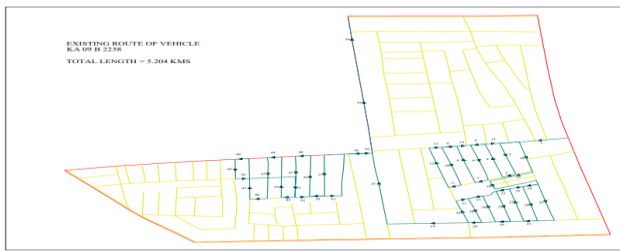
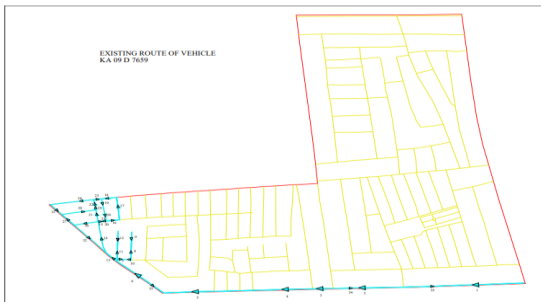**Fig 3: Existing route covered by auto 1 (T K Layout)**

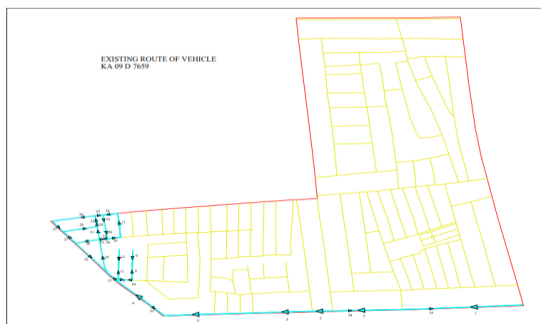**Fig 4: Existing route covered by auto 2 (T K Layout)**

Fig 5: Existing route covered by auto 3 (T K Layout)

Generating Optimal Waste collection Route: T K Layout

The obtained optimal waste collection route distance for auto tippers was 7.58km.

Fig 6: Optimized waste collection route for T K Layout

Comparison of the Existing waste collection route and the Optimized route: T K Layout

Table 2: Comparison of the existing route and optimized route of T K Layout

Collection vehicle	Auto tipper		% Efficiency
	Existing route	Optimized route	
Route distance in Km	13.094	7.58	42.11
Fuel consumption in L	0.894	0.495	44.63
Fuel consumption in Rs	99.01	54.80	44.63
Difference in Km	5.514		-
Total saving efficiency in %	43.80		

3. CONCLUSIONS

- Municipal governments have the ability to employ geo-information as a decision-support tool because of its greater precision and wider application.

- The study's conclusions have offered solutions to a wide range of problems, including effective and economical garbage collecting, where to place waste collection containers, and how to classify waste materials.

- Result indicates that the travel distance of collection vehicle of auto tipper has reduced from 19.40 Km and 13.094 Km to 15.53 Km and 20.42 Km respectively.

- The auto tipper's effectiveness at reducing costs varies from 19.98% to 28.45% to 43.80%, respectively.

- By choosing the route that saved us the most time and effort, we were able to reduce the quantity of fuel we needed while reducing our overall miles by half.

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