A study on Primary collection system of Municipal Solid Waste via GIS in selected wards of Mysore City

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Abstract - *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. The functional element of 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. Hence, Study work is carried out using Geographic Information Systems (GIS) to streamline the routes that were designed to obtain optimal routing for selected wards in Mysore city based on emerging residential wards. The overall aim of this study is to develop a Decision Support System (DSS) which will be applied to two wards of Mysore city i.e. Kuvempunagar and JP Nagar which cover the ward 47 and 63 of Mysuru city to find the optimal routes for solid waste collection vehicle routes. The proposed system demonstrated promising results which indicates that the travel distance of collection vehicle for auto tippers has reduced from 26.40 km to 20.42 km and 19.6 km to 11.3 km respectively. The saving efficiency of vehicle is 22.7% and 42.3% respectively.*

Keywords - route optimization, waste management, decision support system, Geographic Information Systems, Urban Local Bodies

1. Introduction

Municipal solid waste (MSW) is any 'garbage' or 'trash' which is an inevitable by-product of human activity generated by many sources (household, hospitals, shops, hotels, etc.) and are of mainly two types organic (food, fruit, plant leafs, etc.) and inorganic (paper, plastic, glass, dust, etc.) (Minoglou & Komilis, 2013). The number of sources of MSW are increasing due to rise in urbanization, and is leading to the production of a huge quantities of solid wastes which in turn has a high negative impact on collection cost and environment (Sarmah, 2019).

Municipal solid waste management is an obligatory function of Urban Local Bodies (ULB) in India. With growing population and increasing waste generation, solid waste management has become a major environmental issue. ULBs across India face similar challenges in handling and disposal of municipal solid waste: lack of adequate financial and human resources, poor technology and lack of public participation etc.

It is important to optimise the primary collection vehicle routes for collecting solid waste since driving and loading and unloading take up a large amount of time in urban areas. This research work shows the frequency with which geographic information systems (GIS) are used in studies concerning route optimization.

2. Study Area

Mysuru is one of the historic city of south India and ex-capital of Mysuru state. It is one amongst few cities which had the privilege of serving as royal seats under the rulers, who devotedly contributed their own classic beauty to the architectural monuments of the city. Mysuru city is about 770 m height from the mean sea level. Longitude is 76 degree 39' East and Latitude is 12 degree 39' North. The Mysore City Corporation (MCC) is in charge of the city's civil administration, which regulates daily operations. 893,062 people are anticipated to live in the city by 2021. In Mysuru city, about 402MT of solid waste generate daily. 22 tractor trailers, 1 tipper, 2 dumper placers and 5 Lorries are being used by MCC for the transportation of waste and 24 Lorries are used by private contractors. Mysuru city is having a centralized compost plant at Vishveshwara Nagar which is of 200 Tpd capacity (MCC, 2022).

3. Selected wards and Data collection for research work

In this study, two wards, namely Kuvempunagar and JP Nagar were studied to optimize primary collection vehicle system. The road network was the foremost essential data required for the ArcGIS study. The urban road network was provided by the Google earth and is shown in **Table 1**.

After collecting information from various sources, the ideal data was created utilizing Network Analyst to find cost effective travel charges and to figure out which vehicle is nearest to the point. Study proposed the optimal route for primary collection vehicle which covers 100% collection of waste generated in the area and optimal routes were identified using Arc GIS.

Table 1: Data collection for optimization

Data	Source
Study area boundary	MCC
Population density	Census 2022
Satellite image	Google earth and ArcGIS
Road network	MCC and ArcGIS
Location of waste bin	MCC
Vehicle fuel consumption	MCC

(Source: MCC, 2022)

4. Results and Discussion

4.1. Existing waste collection routes

The study was carried out to check and estimate the travel distance between the optimized routes and the existing routes on a random day in a selected wards of Mysore city based on emerging residential areas. The wards 47 and 63 in Mysuru are considered for the study which describes number of routes equivalent to the number of vehicles to serve the area. **Figure 1 and Figure 2** shows the present routes from each collection point of the wards 47 and 63 is 26.40 km and 19.6 km respectively. Here in ward 63, they consider two collection vehicle i.e. Auto tipper and Tata Ace for waste collection and 5 autos, 1 secondary waste collection vehicle (tipper) for ward 47. Existing solid waste collection routes data were obtained by Mysuru City Corporation and is used to draw road networking in ArcGIS.

4.2 Optimized Waste Collection Routes

Collection routes were worked out by using the features of ArcGIS with the planned infrastructure (urban areas, road network, collection points, and landfill sites) to find the shortest and quickest path to reduce total travel distance in each ward. The optimized route was obtained for both ward and is found to be 20.42 km and 11.30 km with total saving efficiency of vehicle is 22.7% and 42.3% respectively shown in **Figure 3** and **Figure 4**. This research work has shown that using advanced routing and procedures can return the significant amount of cost saving, which in turn decreases overall travel distance.

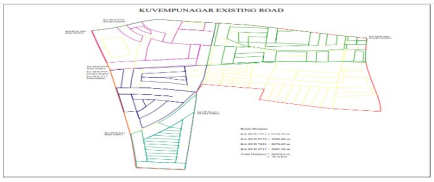

Figure 1: Existing waste collection route of Kuvempunagar

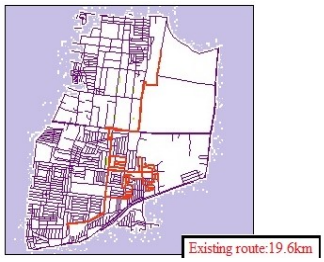

Figure 2: Existing waste collection route of JP Nagar

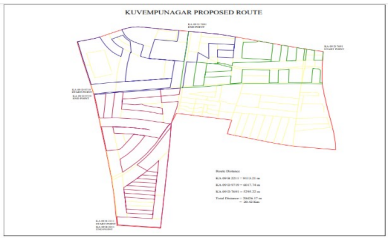

Figure 3: Optimized waste collection route of Kuvempunagar

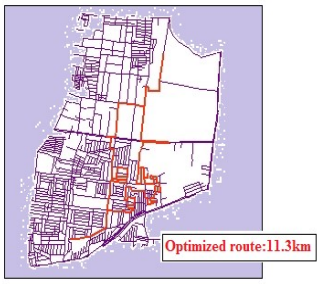

Figure 4: Optimized waste collection route of JP Nagar

5. Conclusion

Network analysis using ArcGIS performed in this study helps to find the optimal route in the primary collection of waste from various waste collection locations in the selected ward of Mysore city.

It reduces the travel distance, cost and time of travel and facilitates most efficient collection of waste using GIS.

Results indicates that the travel distance of collection vehicle for auto tippers has reduced from 26.40 km to 20.42 km and 19.6 km to 11.3 km respectively.

The saving efficiency of auto tipper is 22.7% and 42.3% respectively. The fuel consumption efficiency has found to be 31.5 % and 42.34 % respectively.

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