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## Route Optimisation for Solid Waste Management using ArcGIS Network Analyst: A Review

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**Abstract:** *In this paper, ArcGIS Network Analyst is presented for the best identification of routing applied in municipal waste collection. The proposed application takes into account all the necessary parameters for waste collection, so that users of your desk can model realistic network scenarios and conditions. In this case, the simulation consists of scenarios of visits to loading points in the municipality of Nagpur, in order to collect the Minor Solid Waste that could not be collected by the standard waste collection trucks, due to the size and other obstacles prohibitive Network Analyst is used to estimate the interrelationships between dynamic factors, such as changes in network traffic (roads closed due to natural or technical causes, for example, fallen trees, car accidents, etc.) in the area under study and to produce optimized solutions. The user can define or modify all the dynamic factors necessary for the creation of an initial scenario, and by modifying these particular parameters, alternative scenarios can be generated that lead to several solutions. Finally, the optimal solution is identified by a function that takes into account several parameters, for example, the shortest distance, the road network and the social and environmental implications.*

**Keywords:** *Municipal Solid Waste, collection, Optimization, ArcGIS, Geographical Information System*

### I. Introduction

Due to rapid Industrialization, urbanization, increase in population, and economic growth, the generation rate of municipal solid waste is increasing significantly. Over 377 million urban people are living in 7,935 towns/cities. India is a huge country divided into 29 States and 7 Union Territories (UTs). The present situation of direct dumping of the waste without proper inspection and separation leaves a serious impact of environmental pollution causing a tremendous growth in health related problems [Bhambulkar, A. V., 2011]. In present study describes an attempt is made to design and develop an appropriate collection plan by Geographical Information System (GIS) software. A GIS optimal routing model was designed for efficient collection path for municipal solid waste to minimum time, labour, distance efficient collection paths for the solid wastes [Chimote, et al., 2012]. If this situation is not handled in a proper manner within time then it would lead to worse consequences on a global level. There has been awareness regarding waste management amongst many countries [Bhambulkar, A. V., 2011]. Land, water and air- these three elements form the basis of human life and human activities. One of these activities is transportation of people, goods and material for industry, commerce and recreation. Transportation is about movement from one place to another and, therefore, is a fertile ground for geospatial technology and applications, which can range from route planning to position location, navigation, asset management and surveillance [Siddam, S. et al., 2012]. Waste collection and transportation is the contact point between the waste generators (residential, commercial and industrial establishments) and the waste management system, and this relationship needs to be carefully managed to ensure an effective system [Siddam, S. et al., 2012]. Improper management of MSW constitutes a growing concern for cities in developing nations. Proper management requires the construction and installation of essential facilities and machinery, based on a suitable management plan [Sharholly et. al., 2007]. The present study focused mainly on the use of the geoinformatics technique for the collection and transportation of solid waste from any loading point in the area to the disposal site using an optimized route for particular containers.

#### A. *Network analyst*

ArcGIS Network Analyst is a powerful extension that offers network-based analysis, including routing, travel directions, nearest facilities and service area analysis. ArcGIS Network Analyst allows users to dynamically model realistic network conditions, including turn restrictions, speed limits, height restrictions and traffic conditions at different times of the day. Users with the Network Analyst extension can:

- ) Find efficient travel routes,
- ) Determine which facility or vehicle is closest,
- ) Generate travel directions, and
- ) Find a service area around a site.

Using Network Analyst, an optimum route for the waste collection of large items is generated in the area under study. Network Analyst uses the Dijkstra's Algorithm in order to solve the Routing Problem and it can be generated based on two criteria i.e. distance criteria and time criteria.

#### B. *Route optimization in solid waste management*

The frequency of collection helps to collect the waste in the stipulated time interval. The delay in transporting the waste causes the organic material to begin to deteriorate and makes the handling of the waste more difficult and delicate. Among the many routes available for the collection of MSW, the collection vehicle begins to move from one container to another in an indefinite route to collect the waste. In addition, the part of the waste is not collected in the streets. Many times the collection vehicles travel longer distances because the travel route is not scientifically identified. This leads to the consumption of more fuel and generates more pollution. There is also a delay in the collection of waste from all locations. To reduce the cost of fuel and contaminants emitted by collection vehicles and to ensure effective collection of MSW, optimized collection routes must be found. Therefore, in this document, a model based on GIS is proposed for the route optimization of the MSW.

## II. **GIS - A powerful tool**

GIS is an institutional entity that reflects an organizational structure that integrates technology with a database, experience and continuous financial support over time. It is a powerful tool to collect, store, retrieve at will, transform, analyze and display spatial data of the real world for a particular set of purposes. This technique is used to generate an optimal route to collect solid waste.

## III. **MATERIALS AND METHODS**

#### A. *Required Data collection:*

For generating the optimal routes for the solid waste collection, the following data are required:

1. Study area boundary.
2. Name of the roads and their width.
3. Traffic volume details.
4. No. of storage bins and their location.
5. Capacities of the bins.
6. Time taken for collection of solid waste per bin.
7. Type of vehicles used and its capacity.
8. Existing run routes for the compactor vehicles.
9. Fuel consumption of the compactors.

#### B. *ArcGIS*

ArcGIS is a complete and integrated system for the creation, management, integration, and analysis of geographic data. It consists of a geo-referenced spatial database, which includes all required parameters for MSWM. These parameters involve sanitary wards, collection points, transportation road network, as well as the location and capacity of disposal sites and its connection with different wards.

### C. Route generation

After all the data were given as input, the optimum route was generated using Network Analyst, an extension of ArcGIS software.

## IV. Result

In this work, optimize the solid waste route for vehicles using Arc Map Network Analyst. With the GIS technique, an optimal route was identified that turned out to be profitable and consume less time compared to the existing execution route. The cost is to save up to 14% per month. Software-based analyzes are quick and easy to understand compared to manual analyzes. Then, the software also analyzes the good option for this type of study.

A review of the literature on the cost of municipal solid waste management shows that, due to the multiplicity of factors that influence, costs are a very complex issue. Characteristics of the location, the amount of solid waste, its composition, The type of technology used for collection and transport, distances and labor / landfill expenses are examples of factors that have a large effect on the cost of solid waste management. Therefore, the collection and transport of solid waste in urban areas is a very difficult and complicated problem. It has been estimated that, of the total amount of money spent for the collection, transport and disposal of solid waste, approximately 60-80% is spent in the collection phase [Siddam, S. et. al., 2012]. Therefore, even a small improvement in the collection operation can result in a significant saving in the total cost.

## V. Future scope:

- J To collect and analyze the existing Municipal solid waste collection route and transport data of west zone of Surat city.
- J To carry out ArcGIS analysis and generate optimized route for solid waste collection of west zone of Surat city.
- J To compare the distance, fuel and time analysis of existing and proposed optimized system of collection.

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