Municipal Solid Waste (Msw) Collection by Geographical Information System (Gis)

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ABSTRACT
Uncontrolled growth of the urban population in developing countries in recent years has made solid waste management an important issue, so the system for collection of solid waste thus constitutes an important component of an effective solid waste management system. In present study describes an attempt is made to design and develop an appropriate collection plan by Geographical Information System (GIS) software for the Laxmi Nagar at Nagpur, a Orange city in Maharashtra, India. A GIS optimal routing model was designed for efficient collection path for municipal solid waste to minimum time, labor, distance efficient collection paths for the solid wastes. A present study is also aimed to proposed location of community BIN. The total cost of the proposed collection systems is estimated to be around 3, 52,225 rupees for the annual operating cost of municipal solid waste collection. A substantial amount 4, 03,200 rupees is currently being spent by Nagpur Municipal Corporation (NMC)on waste collection alone without any proper storage/collection system.

Keyword
Municipal Solid Waste, collection, Optimization, ArcGis9 version, Geographical Information System (GIS).

1. INTRODUCTION
Solid waste generated by the daily activities of the people needs to be properly managed in such a way that it minimizes the risk to the environment and human health. Inadequate collection and disposal of solid waste is a major factor in the spread of disease and environmental degradation. One of the most visible problems in the provision of solid waste management (SWM) is the collection route developed and save the cost of fuel and time of service of the solid waste, which is the subject of this paper. Solid waste management is undoubtedly an increasingly important element in terms of efficiency and profitability for any municipality .The routing optimization problem in waste management has been already explored with a number of algorithms. Moreover, the successful implementation of vehicle routing software has been aided by the exponential growth in computing power since 1950; the emergence of accurate and sophisticated Geographic Information Systems (GIS) technology induced multiple algorithmic solutions.

1.1 Need of the Study
Solid waste management is one of the important areas where the problems arise from time to time. Municipal bodies are unable to provide a 100% efficient system and even are not able to reach to the efficiency of 60%. Solid waste management frequently suffers more than other municipal service when budget allocations and cuts are made. The provision of collection and disposal services for municipal refuse is not perceived as deserving higher priority. Efforts of people employed to collect, dispose and recycle wastes are rarely appreciated. The existing situation is not satisfactory and often there are complaints by the public which adds anxiety to the concerned officials involved in the management. The real problems are mainly of organization, management and planning, yet the favored solutions involve more mechanization. One of the simplest ways to bring innovations in any system is to document and study the existing system and bring the possible reforms by adopting appropriate measures at various levels through the introduction of innovative and cost effective solutions. Very few urban local bodies in the country have prepared long term plans for effective solid waste management in their respective cities. For obtaining a long term economic solution, planning of the system on long term sustainable basis is very essential.

The problems encountered during collection are:
- Variation of waste production over time
- Large extension of area to be served
- Traffic and viability conditions
- Labor costs
- Lack of logistic planning

1.2 Objectives
The objective of present study is to arrive at the optimal route for collection of Municipal Solid Waste in Laxmi Nagar with recourse to GIS
- To determine the optimum route for solid waste collection and disposal.
- To compare the fuel costs between the proposed optimum route and the existing run routes for the vehicles used for disposal

2. EXISTING MUNCIPAL SOLID WASTE MANAGEMENT SYSTEM
Nagpur city one of the major city Maharashtra state, the Nagpur city also known as orange city. The Nagpur city situated at an elevation of 314.79 m above MSL & at 21º8'N latitude & 79º8'E longitude. The Nagpur city climate is to be 45ºC - 47ºC in summer and winter 17ºC - 20ºC and rain should be good for proper working of NMC divided the city in ten different zones, the study area is to be in zone one that is Laxmi Nagar zone, the name of area is study that is Laxmi Nagar ward, the ward no is 87 the population of the ward is 9381 as per 2011 census. NMC is contract to kanak resource management for collection, transportation of municipal solid waste of the city. The working hours of Kanak Resource Management Pvt. Ltd. are 6 am to 3 pm. The NMC has own road sweeping staff as well as the vehicle loaders report daily at the word cabin where their attendance is taken by the concerned sanitary inspector. Their normal working hrs are from 6.00 a.m. to 11.00 a.m. & 3.00 p.m. to 6.00 p.m. with Sunday as a closed holiday. Every Sweeper is assigned a specific area. The handcarts are normally used by male sweepers for transporting silt removed from drains. As there is no proper Supervision over the workers & since the no of handcarts is wholly inadequate, waste often remains uncollected from streets. It is also often observed to get deposited at open collection points. NMC is not fix proper location of community BIN so waste management are difficulty made for collection operator. The Kanak Resource Management Pvt. Ltd. the municipal solid waste collection time 9 Hr. 21 min and distance to be 5.6 km. these work expenditure are daily 1,120 rupees per day, and 33,600 rupees per month and 4,03,200 rupees per year.

3. MATERIALS AND METHODS

3.1 Data collect

For generating the optimal routes for the solid waste collection, the following data were obtained from NMC and Kanak Resource Management Pvt. Ltd. Nagpur.

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.

3.2 GIS - A powerful tool

GIS is an institutional entity, reflecting an organizational structure that integrates technology with a database, expertise and continuing financial support over time. It is a powerful tool for collecting , storing, retrieving at will, transforming , analyzing, and displaying spatial data from the real world for a particular set of purposes. This technique is used to generate optimal route for collecting solid waste.

3.3 Digitization

The separate detailed development plans of Laxmi Nagar at a scale of 1:5000 were scanned. The scanned images are then digitized using Arc View GIS 9

3.3.1 Arc View GIS 9

Arc View GIS 9 is a powerful, easy-to-use tool that brings geographic information to your desktop Arc View GIS 9 gives you the power to visualize, explore, query and analyze data spatially. Arc View GIS 9 is made by Environmental Systems Research Institute (ESRI), the makers of ARC/INFO, the leading geographic information system (GIS) software. It helps to solve spatial problems. Using Arc View GIS 9, the raster image displayed on the computer screen is converted into vector graphics. This process is known as heads up digitizing. The digitized files will be in the .shp format.

3.3.2 Geoprocessing Wizard

The Geoprocessing Wizard offers six Geoprocessing options to create or augment feature themes comprising of dissolve, merge, clip, intersect, union, assign data by location. Merge process will create one theme that contains the features of two or more themes. The new theme will contain the fields of one of the input themes. The option 'Merge themes together' was used to join the three individual shape files together.

3.4 Adding attribute

Non spatial data such as road name, speed limit, number of bins and travel time in each road are added.

3.4.1 Road name

The digitized roads were identified using each city map and their names were assigned.

3.4.2 Speed limit

The speed limit of the collecting vehicle is assumed to be 5,10 or 12 km/hr depending upon the width and volume of traffic in each road.

3.4.3 No. of bins

The number of bins collected in each segment of the road during the day and night shifts of the compactor are accounted.

3.4.4 Travel time

The collection time is summed up with the run time of the vehicle to obtain the total travel time.

3.5 Route generation

After all the data were given as input, the optimum route was generated using Network Analyst, an extension of Arc View GIS 9.

3.5.1 Network analyst

The Arc View Network Analyst is an extension product designed to use networks more efficiently. It can solve common network problems on any theme containing lines that connect. Network Analyst can,

1. Find efficient travel routes.
2. Determine which facility or vehicle is closest.
3. Generate travel directions.
4. Find a service area around a sit.

The optimum route for the collection of solid waste is generated using Network Analyst. It is generated based on two criteria.

1. Distance criteria.
2. Time criteria.

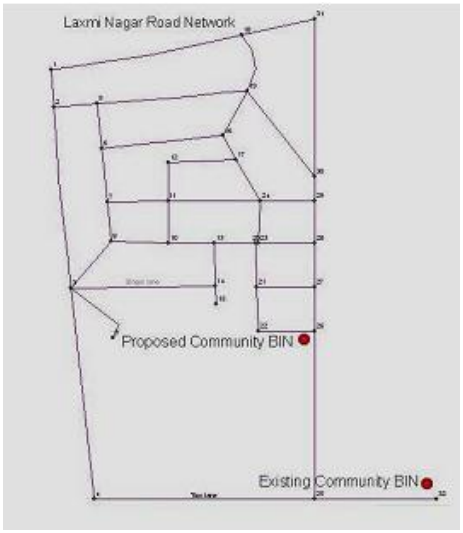

Fig 1: Software image of Laxmi Nagar Road, Nagpur Network

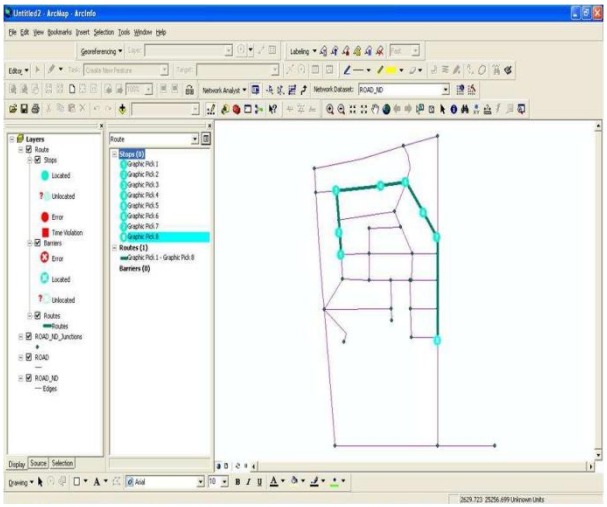

Fig 2: Route 1 Analysis Software

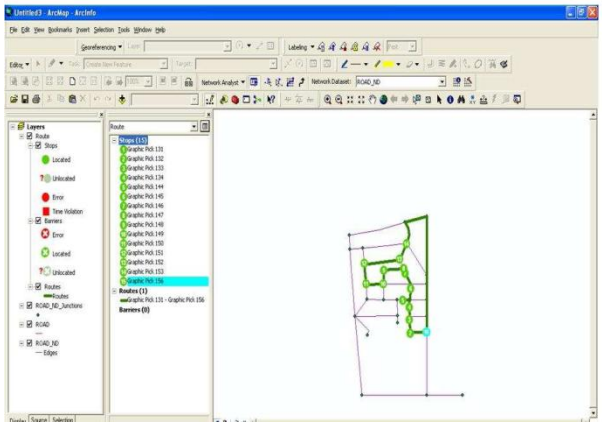

Fig 3: Route 2 Analysis Software

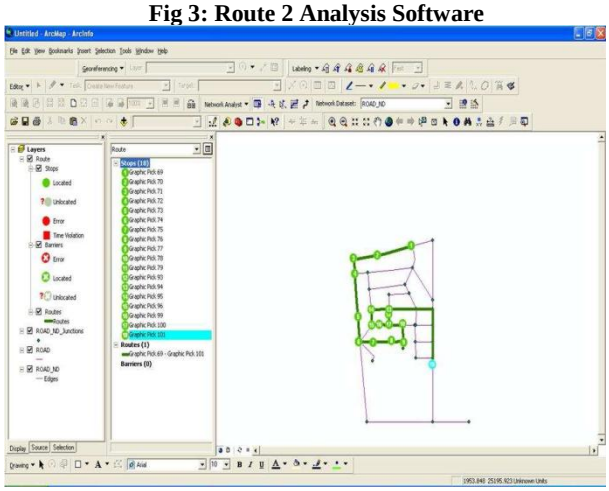

Fig 4: Route 3 Analysis Software

3.5.1.1 Distance criteria

The route was generated taking the location of bins only into consideration. The volume of traffic in the roads was not considered in this case.

3.5.1.2 Time criteria

The total travel time of the compactor in each road segment is considered in this case. Total travel time in each road = runtime of the vehicle + bin collection time. Network Analyst software determines the best route by using an algorithm which finds the shortest path, developed by Edgar Dijkstra. Dijkstra's algorithm is the simplest path finding algorithm, even though these days a lot of other algorithms have been developed. Dijkstra's algorithm reduces the amount of computational time and power needed to find the optimal path. The algorithm strikes a balance by calculating a path which is close to the optimal path that is computationally manageable.

4. CASE STUDY AREAS

In this research work, a Laxmi Nagar Nagpur was chosen as the case study area. This paper describes a study of planning vehicle routes for the waste collection of large items in the Laxmi Nagar area .Laxmi Nagar area using Network Analyst - a userfriendly extension of ArcGIS, which provides efficient routing solutions in a simple and straight forward manner. Network Analyst gives the user the ability to produce a map and directions for the quickest route among several locations. The user can define the locations through a database management system(DBMS)with the approximate locations in respect to geographic coordinates this database includes information such as the address and street name for each location, municipal solid waste collection time, distance traveling of road, also waste generation. In the study area the municipal solid waste is to be collected by kanak Resource Ltd. In the area locality are some individual houses / bungalow, and flat scheme are present. The municipal solid waste is to generated 1.1 to 1.2 tones per day they are storage into the community BIN and then it is to be transported to the dumping yard at Bhandewadi.

5. RESULT

In this work optimize the solid waste route for vehicle in Laxmi Nagar by using Arc map Network Analyst. With the GIS technique, optimum route was identified which found to be cost effective and less time consuming when compared with the existing run route. The route is to be obtaining by Arc GIS is 5.1 km. and time is 8 Hr. 35 min. The costs for these operations are 965 rupees per day 28,950 rupees per month 3, 52,225 rupees per year. The cost is save up to 14 % per month. The software based analyses is quickly / fast and easy to understand as compared to manual analyses. So software analyses also the good option for these type of study.

6. CONCLUSION

In the present study an attempt has been made to optimize the solid waste route for vehicle in Laxmi Nagar by using Arc view Network Analyst. With the GIS technique, optimum route was identified which found to be cost effective and less time consuming when compared with the existing run route. NMC is not decide the community BIN location so waste storage problem are made many other health problem regarding. So NMC is to be decide the community BIN location, and the below drawing are the management of community BIN. In this drawing community BIN is to be constructed outer brick masonry wall and one side open for movement of container and the wall height should be mention

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