

MUNICIPAL SOLID WASTE COLLECTION ROUTES OPTIMIZED WITH ARC GIS NETWORK ANALYST

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Abstract:-

In the present paper the ArcGIS Network Analyst is introduced for best routing identification applied in municipal waste collection. The proposed application takes into account all the required parameters for the waste collection so as its desktop users to be able to model realistic network conditions and scenarios. In this case, the simulation consists of scenarios of visiting loading spots in the municipality of Nagpur, in order to collect Municipal Solid Waste that couldn't be collected by the standard waste collection trucks, due to size and other prohibitive obstacles. The Network Analyst is used to estimate interrelations between the dynamic factors, like network traffic changes (closed roads 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 is able to define or modify all the required dynamic factors for the creation of an initial scenario, and by modifying these particular parameters, alternative scenarios can be generated leading to several solutions. Finally, the optimal solution is identified by a function that takes into consideration various parameters, for example the shortest distance, road network as well as social and environmental implications.

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

1. Introduction:-

The environment is heading towards a potential risk due to unsustainable waste disposal. It is a sensitive issue which concerns about serious environmental problems in today's world. 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. "Domestic, industrial and other wastes, whether they are of low or medium level wastes, they are causing environmental pollution and have become perennial problems for mankind.". 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. There has been development of new technologies for improving the waste management systems. GIS is one of the new technologies which have contributed a lot in very less time span to the waste management society. "The Geographic Information System (GIS) helps to manipulate data in the computer to simulate alternatives and to take the most effective decisions."

2. Network Analyst:-

ArcGIS Network Analyst is a powerful extension that provides network-based spatial analysis including routing, travel directions, closest facility, and service area analysis. ArcGIS Network Analyst enables users to dynamically model realistic network conditions, including turn restrictions, speed limits, height restrictions, and traffic conditions at different times of the day. The users with Network Analyst extension are able to:

- Find efficient travel routes,
- Determine which facility or vehicle is closest,

- Generate travel directions, and
- Find a service area around a site.

In the current work, 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

1. Distance criteria: The route is generated taking only into consideration the location of the waste large items. The volume of traffic in the roads is not considered in this case.

2. Time criteria: The total travel time in each road segment should be considered as the: Total travel time in the route = runtime of the vehicle + waste collection of large items time. The runtime of the vehicle is calculated by considering the length of the road and the speed of the vehicle in each road. The time of the waste large items collection would be the total time consumed by the vehicle to collect these objects from all the loading spots. In the second criteria, the length, width and the volume of traffic are taken into account in each road segment.

Using the second criteria, several routes could be generated during a random day in order to compare the total travel time between these predefined time intervals. Hence, routes could be generated during the day time or during the night time in order to compare the total travel time in these different time intervals during the day. The Network Analyst extension allows the user to perform "Find Best Route", which solves a network problem by finding the least cost impedance path on the network from one stop to one or more stops. Network modeling gives the opportunity to the user to include the rules relating to the objects, arcs and events in association with solving transportation problems

3. Case Study:- 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 21°8'N latitude & 79°8'E longitude. The Nagpur city climate is to be 45°C - 47°C in summer and winter 17°C - 20°C 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.

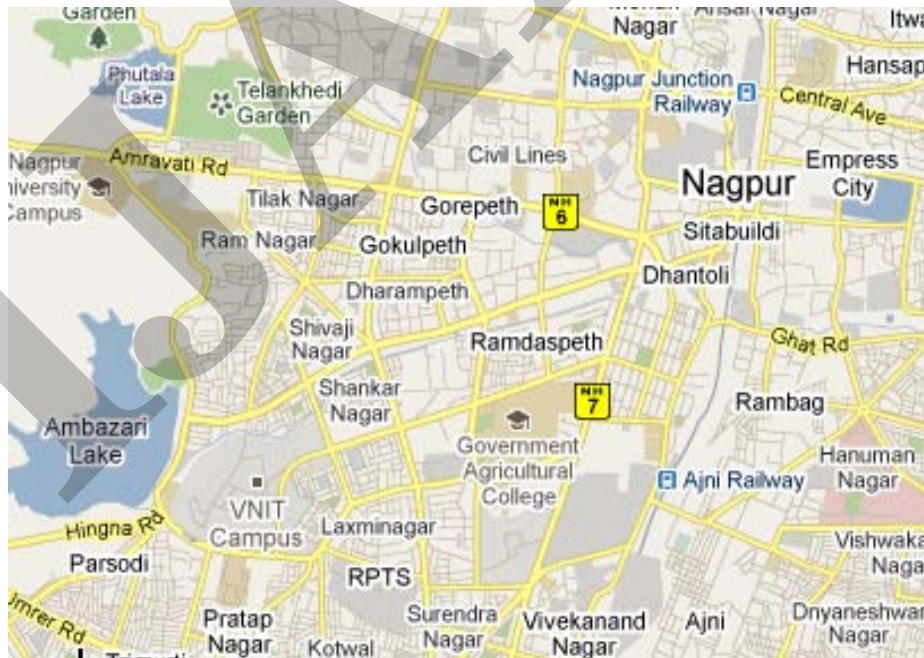


Figure No.1 – Location Of Laxmi Nagar

NMC is contract to kanak resource management for collection , transportation of municipal solid waste of the city . The working hour 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.

4. Result:-

Some essential restrictions were taken into account, such as the streets' directions, no U-Turns rules(with the exception of the dead-ends) and also, the fact that the truck should follow true-shape route. Moreover, Network Analyst was asked to show the results in meters, as the distance criterion was selected, and to reorder the stop-points in order to find the shortest route. It is worth mentioning that, in the special case where some piece of refuse causes traffic problems, Network Analyst can be asked to find the shortest route starting from this certain point, so as to relieve the traffic. Finally, pushing the "solve" button of Network Analyst, the closest route for the solid waste collection was produced. 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 obtain by Arc GIS is 5.1 km. and time are 8 Hr. 35 min. The cost for these operation 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.

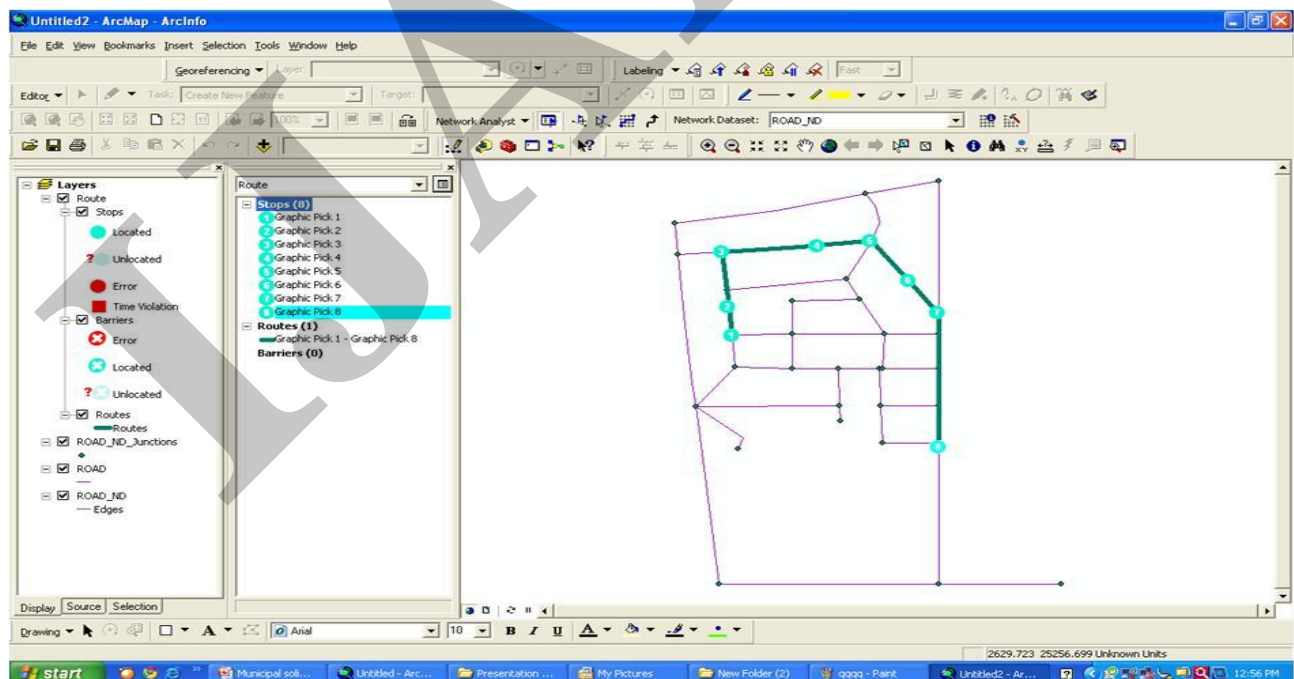


Figure No. 2 Route 1 Analysis Software

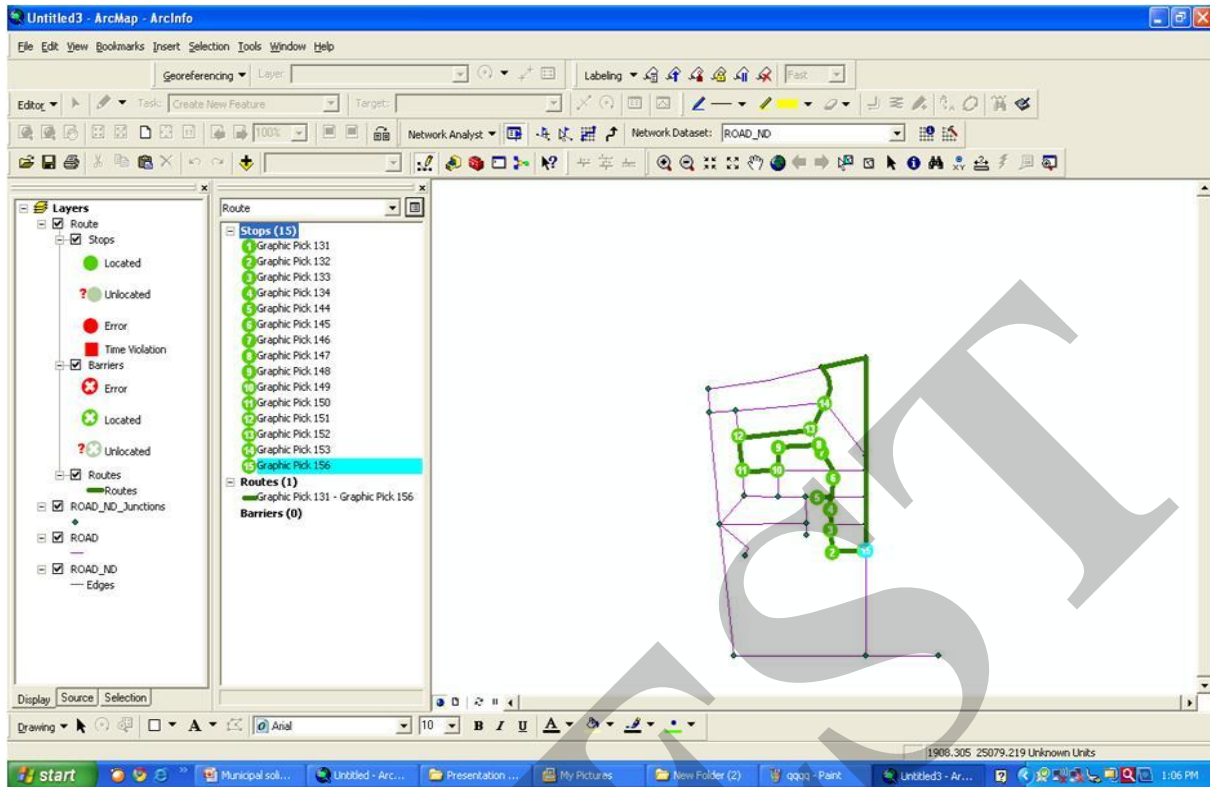


Figure No. 3 Route 1 Analysis Software

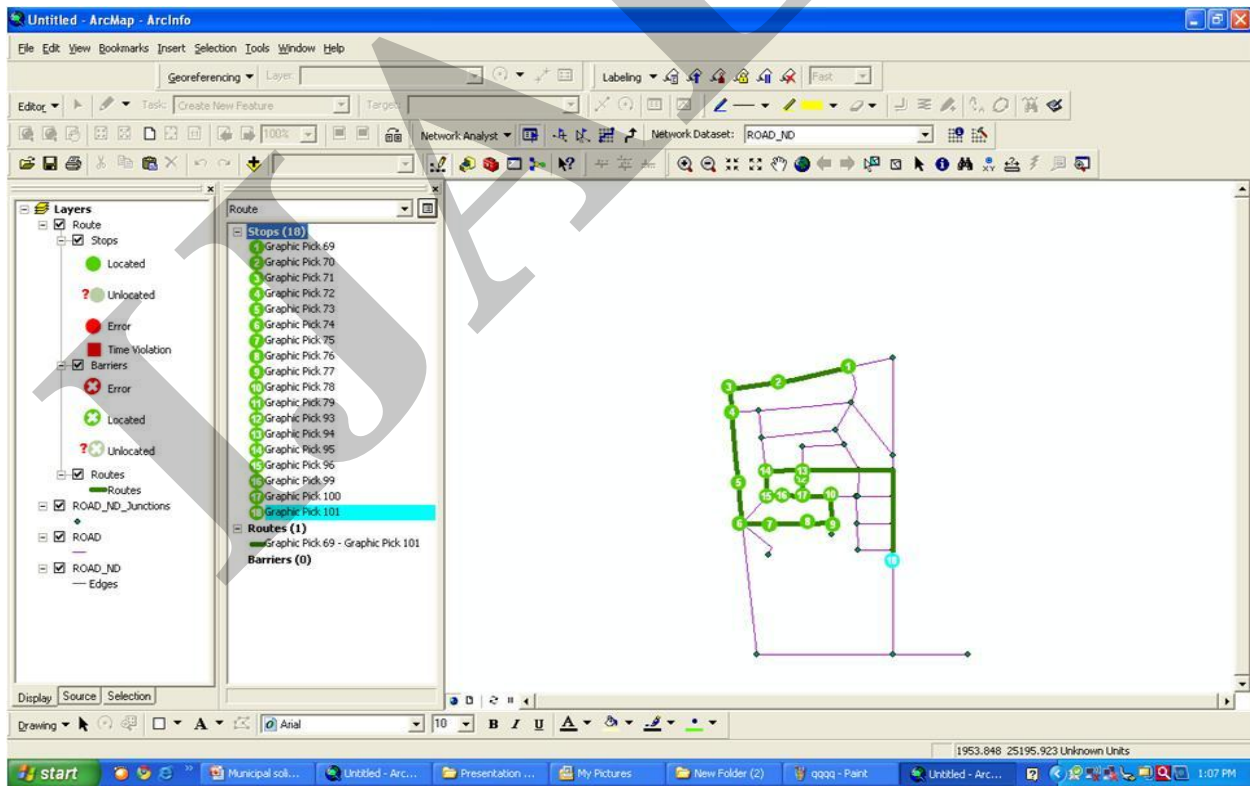


Figure No. 4 Route 1 Analysis Software

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