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Route Optimization of Solid Waste by using ArcGIS Application in Pune, India

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Abstract: ***Since 2000, new technologies such as geographical information system (GIS) and related optimization software have been used to optimize the haul route distances. The city limits of Pune is 250.56 km^2 in 2011, leading to sub-optimum levels in solid waste transportation of 1600 tonnes per day. After developing a spatial database for the whole of Pune city with 15 wards, the route optimization procedures have been run for the transport of solid wastes for ward no. 14 (generating nodes) to one transfer station (intermediary before landfill), using ArcGIS. The optimization process reduced the distances travelled by 9.93%. Savings in terms of time taken for both the current and shortest paths have also been computed, considering traffic conditions.***
Keywords: ArcGIS, GIS, route optimization, savings; solid wastes management.

I. 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."

II. 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:

A. Find efficient travel routes,
B. Determine which facility or vehicle is closest,
C. 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

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) *Case Study:* - Pune city one of the major city Maharashtra state, the Pune city also known as cultural capital of Maharashtra city. The Pune city situated at an elevation of 559 m above MSL & between 17.5º to 19.2 º North & 73.2º to 75.1 º east. The Pune city climate is to be 22ºC - 41ºC in summer and winter 8ºC - 25ºC and rain should be good, for proper working of PMC divided the city in four different zones, the study area is to be in zone one that is Pune Municipal Corporation zone, the name of area is study that is ghole road ward, the ward no is 14.

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Figure No.1 – Location of Ghole road ward

The working hour of PMC workers are 6 am to 3 pm. The PMC has own road sweeping staff as well as the vehicle loaders report daily at the ward 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. . 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.

III. 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.If there is a presence of any barrier such as water leakage, construction progress, accident etc then in such case the ArcGIS provide another route . In this work optimize the solid waste route for vehicle in Ghole road Kshetriya Karalay by using Arc map Network Analyst. With the GIS technique, optimum route was identified which found to be less time consuming when compared with the existing run route. The route is to be obtain by Arc GIS is 2.5 km but distance travelled by PMC vehicle is 3.2 KM. 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

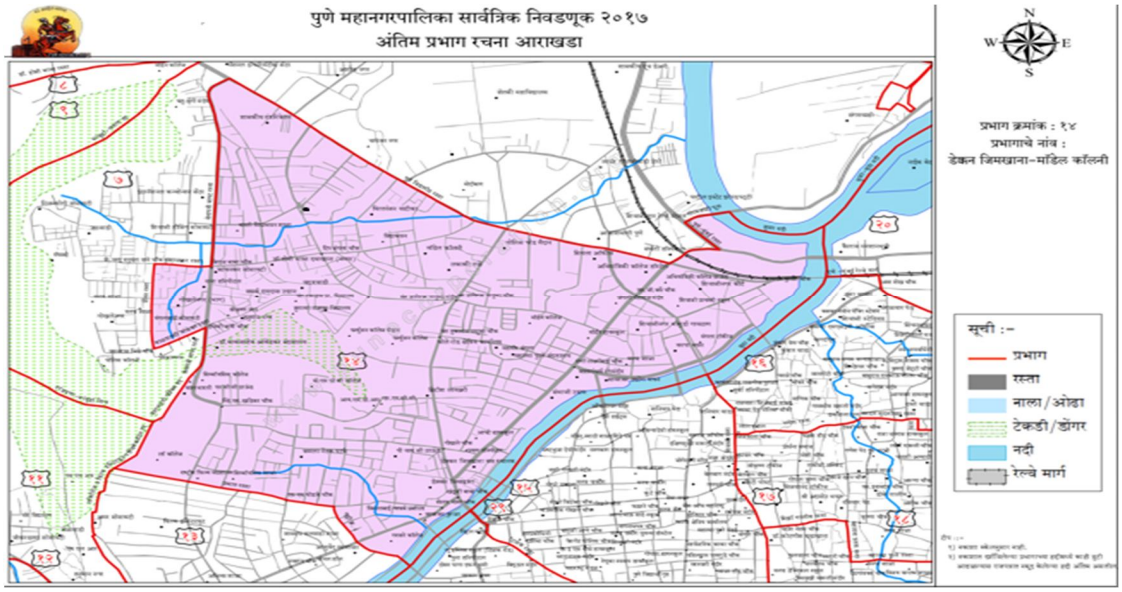

Fig :- original map

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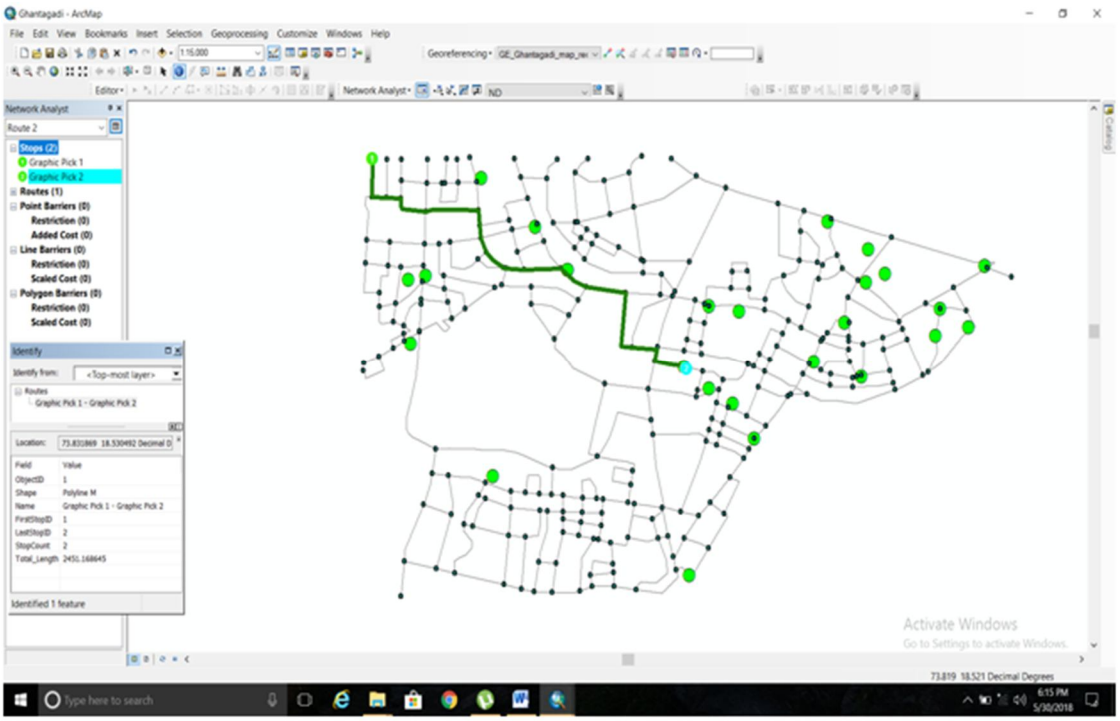

Fig 2:- route 1 (shortest route)

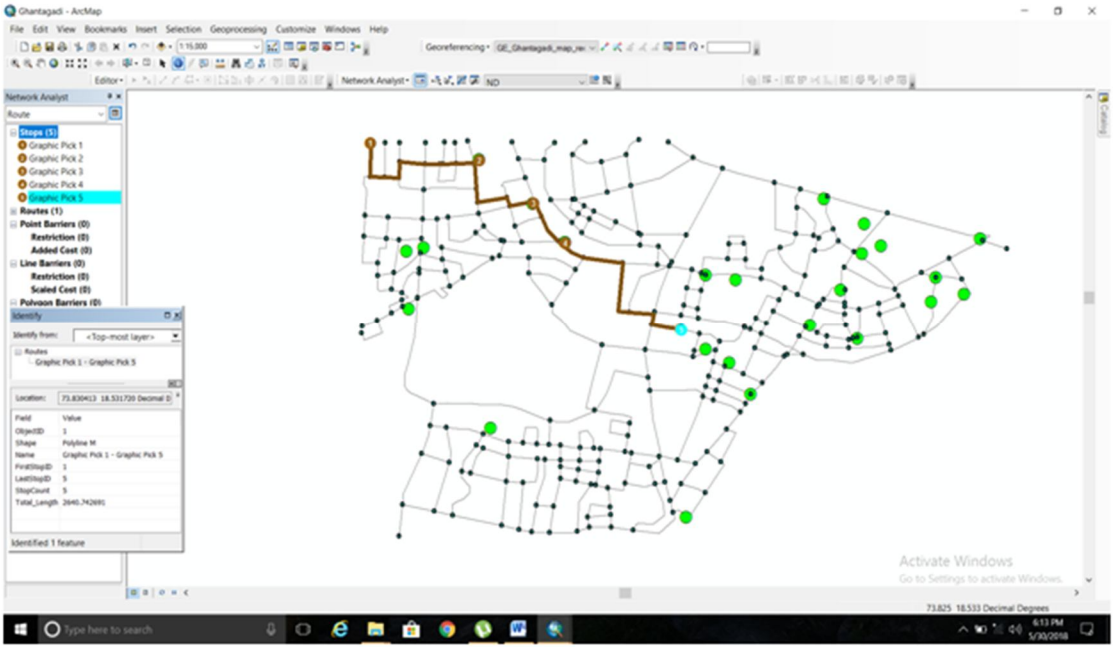

Fig 3:- route 2 (when barrier is their)

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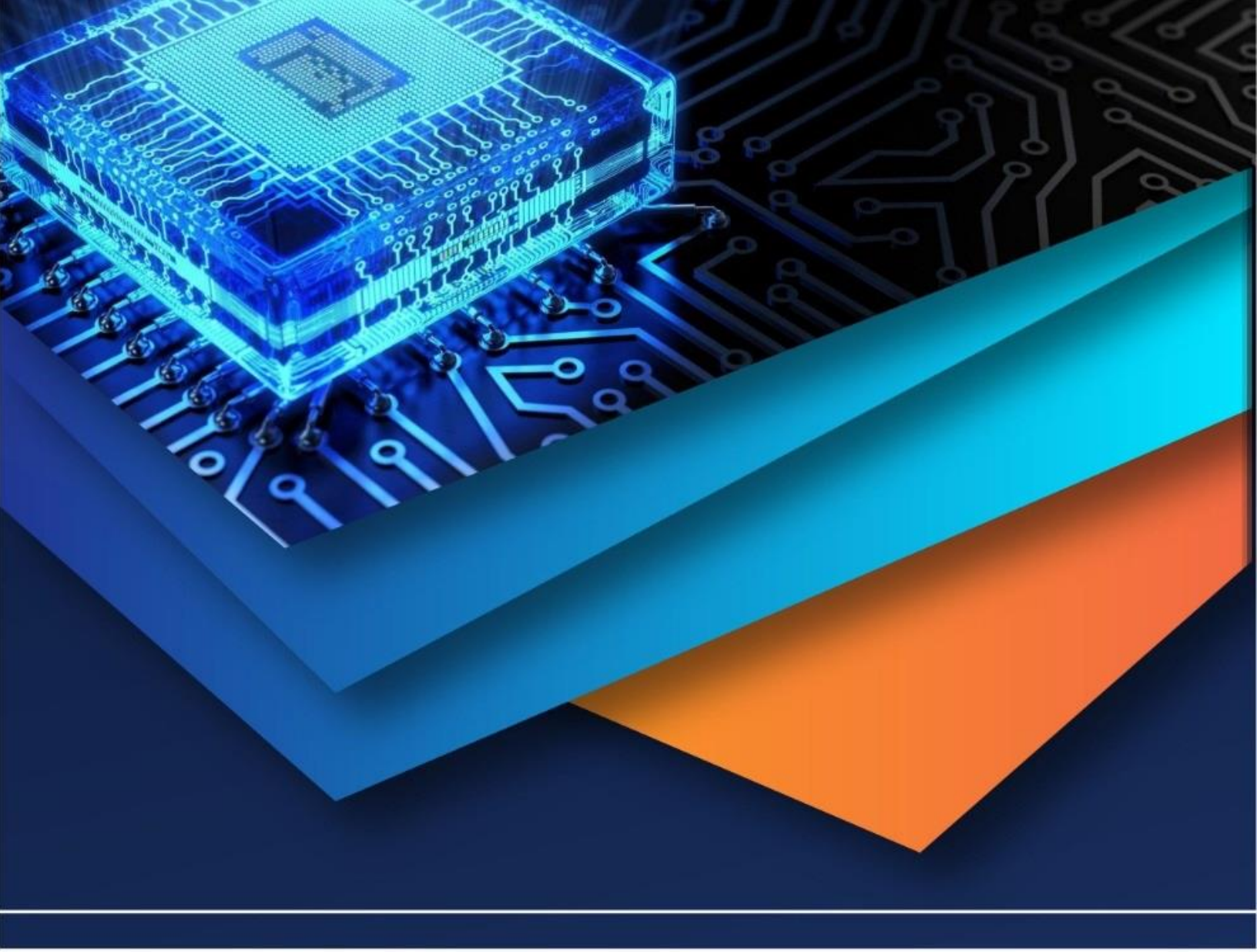

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