International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 10 | Oct 2022 www.irjet.net p-ISSN: 2395-0072

A GIS-BASED TRANSPORTATION ROUTE OPTIMIZATION FOR SOLID WASTE MANAGEMENT: STUDY ON WARD95 KANPUR

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Abstract - *This study discusses the present solid waste management practices in the Kanpur municipal region in the Kanpur district of Uttar Pradesh state, India. The exponential growth in population as well as the general advancement of society and businesses are the main causes of the city's rising generation of solid waste. One of the essential components of solid waste management is routing, and optimizing the collection route reduces travel time and disposal expenses. In order to identify the most efficient routes for municipal solid waste (MSW) collections in Kanpur, India, this study integrated the network analyzer tool's algorithms and built-in optimization techniques into the Geographical Information System (GIS) platform. According to our study, there was a 5.59 km decrease in the chosen network.*

Key Words: **ArcGIS, OPTIMIZATION, SWM, TRANSPORTATION, TRANSFER STATION**

1. INTRODUCTION

Different methods are used to handle, store, collect, and dispose of the wastes produced by the many human sports. Therefore, if garbage is not managed appropriately, waste management places a risk on the environment and has a negative impact on public health. Kanpur's system of reliable garbage management is no longer unique among the vast majority of Indian cities. . Kanpur Nagar Nigam (KNN) had the responsibility for collecting, transporting, and casting off the strong waste generated inside the town, predicted at about a thousand tons in keeping with day in Kanpur. As consistent with provisional reports of Census India, the populace of Kanpur in 2011 is 27. Seventy-four Lakhs, Kanpur town is administratively divided into 6 zones and one hundred ten wards. There are 203 lively collection factors in several wards of six zones. Running on Kanpur Nagar Nigam, region 2 wards ninety-five and total waste gathered is 80% dry waste and 20% wet waste.

2. Materials and Methods

2.1 Study Area

Kanpur is the 75th largest city in the world and also is the center of commercial and industrial activities, sprawling over an area of 605 km^2 in the state of Uttar Pradesh, India. The municipal corporation of Kanpur covers an area of 302 km^2 and has the responsibility to manage 1000 tons of generated waste per day. It ranges from latitude 26.4499°N, and longitude 80.3319° E. As per provisional reports of Census India, the population of Kanpur in 2011 is 27.74 Lakhs. area-260 Sq. km. To study in this paper of Nagar Nigam Kanpur, ward95 zone 2 to optimize transportation routes (study area to transfer station). In zone2 collection point which is followed by Nagar Nigam Kanpur, there is all points used by GIS mapping which exist on the field. This study gives information about solid waste collected by Nagar Nigam Kanpur, for which the collection route is optimized and the disposal of solid waste is managed in a better way.

Fig-1: Digitize road map in the ArcGIS imaginary

2.2 Arc G3IS

ArcGIS is a geographical information system (GIS) software that allows handling and analyzing geographic information by layer-building graphical statistics through layer-building maps like climate data and modeling natural system processes and functions. Using that Bend View Arc GIS 10.4, the raster picture that appeared on the pc screen is changed over into vector delineations.

2.3 Digitization

The numerous definite enhancement plan for Zone 2 ward 95 of Nagar Nigam Kanpur have been investigated. Using Arc View via GIS, the filtered images are then digitized. Digitizing: Refers to the process of converting-referenced data to digital format (shape file).

2.4 Collection and Storage of waste

Kanpur Nagar Municipal ward 95 zone 2 generates roughly 400 kg of solid trash each day. Domestically generated MSW is collected in the city by street sweeping with conventional short-handled brooms and the Door to Door collection system. . Waste by collecting TATA ACEE Hoppers of the city. Solid waste in the municipal area is collected. Thesolid waste collection is 100% in the area. Presently sweeping, collection and transportation activities are doneby sanitary workers in the municipality. Further, a tractor is used for transporting the collected waste to the dumping ground.

2.5 Transportation of waste

Transportation of solid waste includes lifting of closed containers, lifting of dead animals, and lifting of silt from nalla. The transportation of unattended waste in open plots and unwept waste in slums is also done manually or mechanically through a variety of vehicles. Approximately two closed containers of waste are emptied into a bigger tipper at the transfer station which is taken for final transfer to a landfill site.

2.6 Processing of waste

Kanpur Municipal organization has a stable waste management plant, for the processing of biomedical waste and casting off the unsegregated, strong Waste on the dumping floor. Further, the fabric is transferred to the segregation phase where waste is isolated in various forms which include wet, dry, recyclable, and inert wastes. The waste processing and disposal plant is positioned. Most waste being degradable is transferred to the window platform wherein the Bio-culture helps in composting waste.

2.6.1 Composting

Due to a lack of area landfills, biodegradable backyard waste is allowed to decompose in a medium designed for the reason. The handiest biodegradable waste substances are utilized in composting. Its miles a biological process in which microorganisms, specifically fungi, and bacteria convert degradable natural waste into substances like humans. This finished product, which seems like soil is excessive in carbon and nitrogen. Precise fine environmentally friendly manure is fashioned from compost which is a first-rate medium for developing vegetation and can be used for agricultural purposes.

2.6.2 Incineration

In this method, stable wastes are burned at high temperatures until they are reduced to ashes. Incinerators are constructed in such a way that when burning solid waste, they do not produce excessive heat. Waste-to-energy plants are incinerators that reuse thermal energy through furnaces and boilers. Because they need specialized equipment and controls, highly qualified technical staff, and auxiliary fuel facilities, waste-to-energy systems are more expensive to install and operate than simple incinerators. This technique of strong waste management can be finished by people, municipalities and even institutions. The coolest element about this approach is the reality that it reduces the extent of waste up to twenty or thirty of the authentic quantity.

2.6.3 Recycling

Recycling or restoration of sources is the method of taking beneficial however discarded items for subsequent use. Plastic baggage, tins, glass, and boxes are frequently recycled automatically considering, in lots of situations, they're likely to be scarce commodities. Historically, these items are processed and cleaned before they may be recycled. The process targets at reducing power loss, consumption of the latest material, and reduction of landfills. The maximum advanced international locations follow a robust way of life of recycling to decrease volumes of waste.

3. Sources and quantity of municipal solid waste

One such large city in North India is Kanpur, which generates about a thousand tonnes of hazardous trash daily. The kitchen, food scraps, spoiled organic goods, fruits, plants, seed stockpiles, and other items make up the herbal department. Paper, glass, metal, and plastics make up less than 15% of total garbage. . They determine the present kingdom of municipal stable waste management (MSWM) in Kanpur metropolis with the aim of identifying the principle barriers to its efficiency and the potentialities for improvisation of the strong wastecontrol device within the city. The existing strong waste management device within

the city is observed to be distinctly inefficient. Primary and Secondary series, transportation, and open dumping are the most effective activities practiced that too in a non-technical manner.

3.1 Primary collection of solid waste

The primary collection of segregated MSW from individual households and establishments (door-to-door collection) is accomplished through the use of containerized pushcarts, tricycles or small mechanized vehicles, compactors, or tipping vehicles depending on the terrain of the locality, width of streets, and building density.

Fig -2: Twin Bin Vehicle

3.2 Secondary collection of solid waste

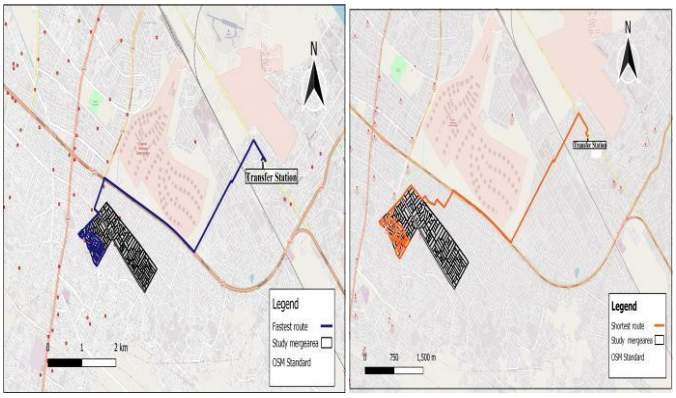
The secondary collection includes selecting up waste from community boxes, waste garage depots, or switch stations and transporting it to waste processing sites or tothe very last disposal site. On the secondary series factors, segregated waste needs to be saved on-website online in separate blanketed containers for similar collection and has to be kept separate in the course of all steps of waste series, transportation, and processing. ULBs need to ensure that onthe secondary garage factors the waste is ought to be attended to each day or before the field starts overflowing.

Fig -3: Skip Truck (Dumper placer machines)

4. RESULTS AND DISCUSSION

The GIS provided detailed information on road network connectivity among different study points. After applying QGIS 'network analyst tool,' and giving the starting nodes, i.e., various wards one by one, and the destination node, i.e., the etransfer station, the algorithm identified the shortest path and provided the same on a GIS map, along with route distance, for each of the desired links. The optimized routes generated from this approach were compared with the current routes that measured the distance between the individual ward to the disposal site at the Transfer station. The QGIS network analyst tool was applied by making the ward number 95 as a starting point of vehicle1 (S1) to the transfer station as a destination as shown in Fig.4. The shortest route was found as 11.63 km (optimized distance), compared to 13.09 km (existing route distance), and vehicle2 (S2) as shown in Fig.5. The shortest route was found as 10.45km compared to 12.05km, and vehicle3 (S3)as shown in Fig.6. The shortest route was found as 10.75km, compared to 11.65km, and for the vehicle4 (S4) as shown in Fig.7. The shortest route was found 10.23km, compared to 11.29km, and for the vehicle5 (S5) as shown in Fig.8. The shortest route was found as 9.22km, compared to 9.79km (exiting route distance), that is practiced by municipal vehicles for transportation purpose. The ArcGIS-optimized route showed that.

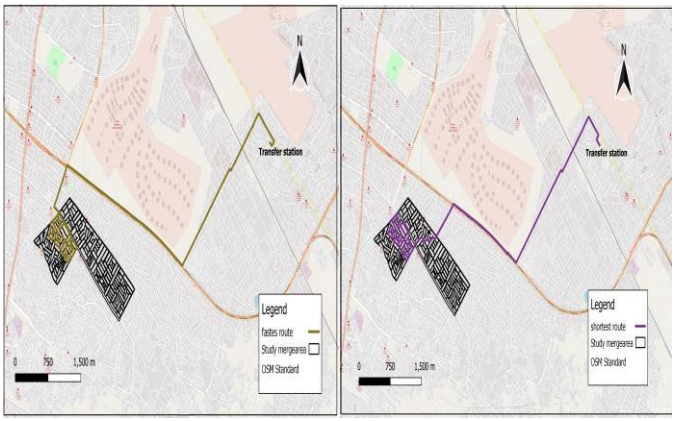
Vehicle1:



Fastest route 13.09 Km Shortest route11.63Km

Fig-4: Optimized solid waste collection vehicle (S1) route.

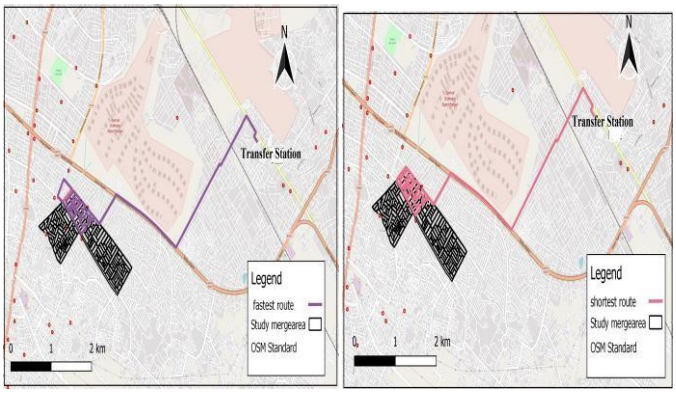
Vehicle Route2:



Fastest route 12.05Km Shortest route 10.45Km

Fig-5: Optimized solid waste collection vehicle (S2) route.

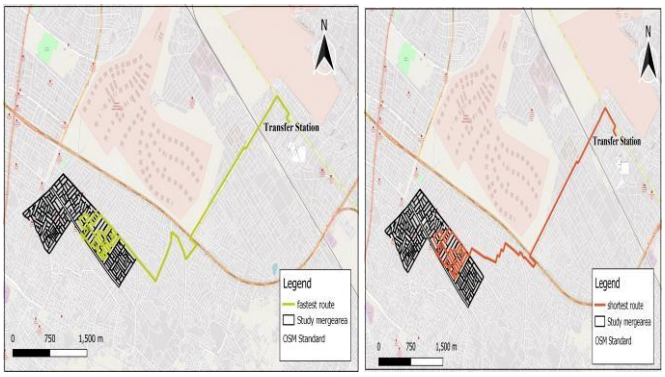
Vehicle Route3:



Fastest route 11.65Km Shortest route 10.75Km

Fig-6: Optimized solid waste collection vehicle (S3) route.

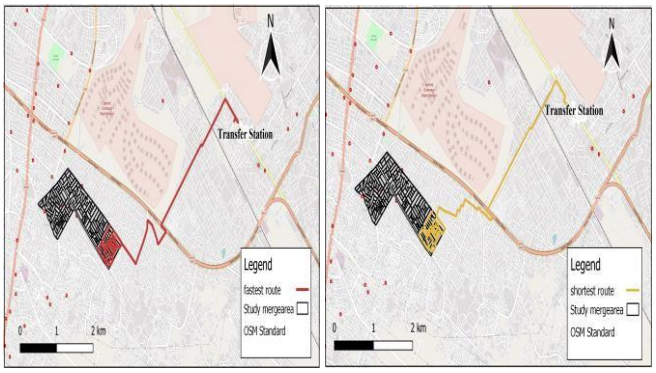
Vehicle Route4:



Fastest route 11.29Km Shortest route 10.23Km

Fig-7: Optimized solid waste collection vehicle (S4) route.

Vehicle Route5:



Fastest route 9.79Km Shortest route 9.22Km

Fig-8: Optimized solid waste collection vehicle (S5) route.

Table-1: Results from the approach by comparing current distance v/s optimized distance (Km).

Vehicles points	Destination points	Practicing distance(km)	Optimized distance(km)	Saving distance(km)
S1	TS	13.09	11.63	1.64
S2	TS	12.05	10.45	1.6
S3	TS	11.65	10.75	0.9
S4	TS	11.29	10.23	1.06
S5	TS	9.79	9.22	0.57
Total		57.87	52.28	5.59

5. CONCLUSIONS

From the above data these are results with the help of ArcGIS10.4 and QGIS 3.24 route optimization. And it gives the

optimized route with distance covered, (study area to transfer station) which used in a collection of solid waste of Zone2, Nagar Nigam Kanpur. Five vehicles are working to collect the waste from the ward, it is optimized by two routes the shortest and fastest route. The network analyst tool in the GIS was utilized in modeling the optimal routes for MSW collection at Kanpur. This study finds the reductions in haul distance as 5.59Km for locations. And the distance between the nodes, the location of collection points, and the location of transfer sites were provided as input parameters in the modeling system. The future scope of this study may include savings in hauling time taken for both the current and shortest paths by considering traffic conditions. The approach in this study can be used as a tool for MSW management meant for the entire city in the study area, and the researchers can investigate the management scenario of MSW in other similar cities in developing countries.

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BIOGRAPHIES

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