Route Analysis for the Roads of Delhi using GIS

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ABSTRACT

In densely populated cities like Delhi, finding the most efficient route for emergency response is crucial for ensuring prompt service delivery and minimizing delays. This study leverages the capabilities of Geographic Information Systems (GIS) technology to determine optimal travel routes, significantly enhancing the efficiency of emergency response times. Our comprehensive analysis reveals that GIS-based best route algorithms considerably improve travel times compared to traditional shortest route methods, achieving an 11.55% improvement for light vehicles and a 7.67% improvement for heavy vehicles. These findings underscore the potential of GIS technology in transforming emergency response systems in urban environments.

INTRODUCTION

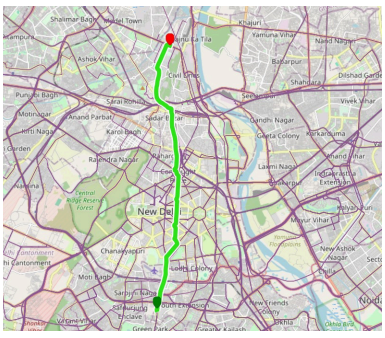
Efficient routing is a fundamental aspect of emergency response systems, aimed at minimizing travel time and improving the effectiveness of service delivery. In densely populated urban areas like Delhi, traditional shortest path algorithms, which primarily focus on minimizing distance, often fail to account for real-world conditions such as traffic congestion, road width, and other factors impacting travel time. In emergency situations, the best path is the one that minimizes travel time, thereby enhancing the efficiency of response efforts and potentially saving lives.This research seeks to address these limitations by using travel time as the primary parameter for route optimization, rather than distance. By employing Geographic Information Systems (GIS), the aim is to create a best route solver tool with the incorporation of traffic data and other relevant parameters into the GIS analysis allows for a more accurate and practical determination of optimal routes, significantly benefiting emergency services.

RESARCH METHODOLOGY

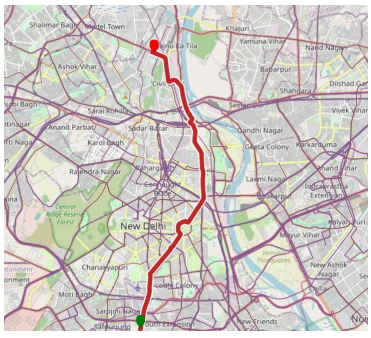
The methodology for this study involved a multi-step process, beginning with the collection of comprehensive road network data from Delhi, supplemented by traffic data obtained from monitoring systems and GPS applications. We utilized QGIS, a powerful tool for spatial data processing, alongside the Network Analyst Extension for advanced route optimization. The procedure included several key stages: preparing the road network data and traffic information, creating a detailed geo-database, and conducting both best route and shortest route analyses. The best route analysis prioritized minimizing travel time by considering real-time traffic conditions and other critical factors, whereas the shortest route analysis focused solely on minimizing distance.

RESULTS

The results of our analysis revealed significant differences between the shortest route and the best route. The shortest route analysis, which concentrated on minimizing distance, was illustrated using a route from the Cluster Innovation Centre (CIC) to AIIMS for both light and heavy vehicles. In contrast, the best route analysis aimed at minimising travel time by taking into account traffic conditions and other relevant factors. Graphical representations, including figures depicting the shortest and best routes, provided a clear visual illustration of these findings.To demonstrate the superiority of the best route over the shortest route, we conducted the analysis for various destination locations, considering both light and heavy vehicles. For each scenario, we calculated the difference percentage of the shortest route time and the fastest route time. The results of these analyses are presented in Table 1(for heavy vehicles) and Table 2(for light vehicles). This comparative analysis underscores the critical importance of using travel time as the primary parameter in route optimization for emergency services.This result shows that the best route travel time is 11.55% more efficient than the shortest route travel time in case of light vehicles and 7.67% more efficient than the shortest route travel time in case of heavy vehicles.



AIIMS Shortest Route For heavy vehicles



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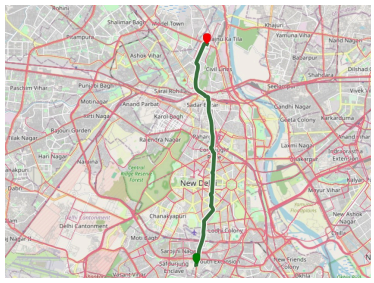
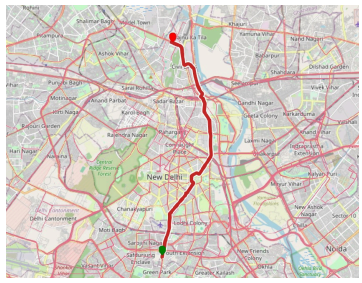
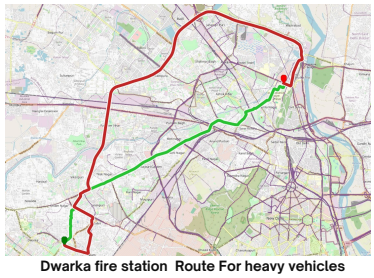


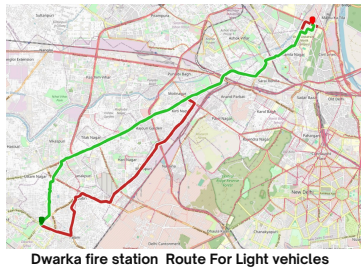
AIIMS Shortest Route For Light vehicles



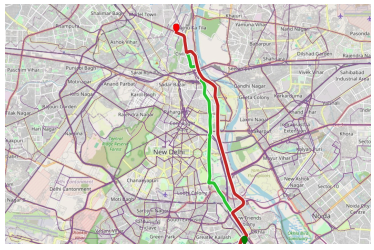
AIIMS Best Route For Light vehicles



Dwarka fire station Route For heavy vehicles



Dwarka fire station Route For Light vehicles



Okhla Police station Route For heavy vehicles

Okhla Police station Route For Light vehicles

Destination	Shortest Route		Best Route	
	Distance	Time	Distance	Time
AIIMS Hospital	16.313	0.374	17.814	0.366
BLK Hospital	8.171	0.210	9.508	0.191
Dwarka Firestation	21.13	0.554	33.456	0.514
Moti Nagar Firestation	9.406	0.226	9.918	0.198
Qutub Minar Police Station	21.546	0.505	23.063	0.495
Okhla Police Station	20.397	0.464	20.641	0.422

Table 1 For heavy vehicles

Destination	Shortest Route		Best Route	
	Distance	Time	Distance	Time
AIIMS Hospital	16.313	0.374	17.814	0.360
BLK Hospital	8.171	0.210	8.815	0.180
Dwarka Firestation	21.13	0.554	23.572	0.454
Moti Nagar Firestation	9.406	0.226	9.918	0.197
Qutub Minar Police Station	21.546	0.503	23.063	0.487
Okhla Police Station	20.397	0.458	20.641	0.409

Table 2 For light vehicles

CONCLUSION

This study successfully implemented an enhanced GIS-based network analysis on the road network of Delhi, demonstrating substantial improvements in travel times for emergency response scenarios. The best route analysis, which prioritized travel time over distance, proved to be significantly more effective than traditional shortest route methods. Our findings suggest that the best route algorithm is highly suitable for use in emergency situations, able to save 7% to 11% of travel time depnding on the type of vehicle offering significant time savings and thereby improving the overall efficiency of emergency response services. Looking forward, incorporating live traffic data into the analysis is recommended to further optimize routing and enhance the responsiveness of emergency services.

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