

# **Integrated Approach to Waste Management in Banepa Municipality: Combining Geographic Information System, Analytical Hierarchy Process and Network Analysis for Landfill Site Selection and Route Optimization**

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**Key words:** Cost management; Spatial planning; Young surveyor; Vehicle Routing; Network Analysis; Geographic Information System

## **SUMMARY**

Due to rapid urbanization and population growth, waste management has become a crucial issue in many local levels of Nepal. In Banepa municipality specifically, due to the lack of a landfill site within the municipal boundary, the garbage trucks have been traveling longer distances to dump waste, causing an increase in fuel consumption, and consecutively deteriorating the environment. This research addresses prevailing waste management issues of Banepa municipality, such as missing pickups and overflowing bins, by improving collection routes and timetables to avoid environmental issues and save monetary expenses. The research proposes an integrated approach to optimize the location of waste disposal site and garbage truck routes to reach these sites in Banepa Municipality using the Geographic Information System (GIS), Analytical Hierarchical Process (AHP), and Network Analysis. The optimal location for the landfill site was identified using AHP and GIS, considering various criteria, and verified based on Google Base Map by considering the area needed for the next 15 years. For identifying suitable bin locations within the municipality, Network Analysis location-allocation problem, and vector analysis were used. Numerous waste bins of varying capacities were determined and allocated to each building within the municipality based on the population and waste generated. Based on vehicle capacity and bin size, 19 efficient routes were obtained using Vehicle Routing Problem (VRP) initially and were later revised using the Traveling Salesman Problem (TSP). The efficient route of garbage trucks passing through the bins locations was identified by specifying 17 service areas for Banepa Municipality. For assessing the usability of obtained results, the optimized routes were compared to the present garbage truck's route from municipality to the transfer station, i.e., Bhaktapur. It was found that a total of 1436 waste bins of varying capacities can serve 21418 households. It was found that the proposed route reduced the total traveling distance of the trucks by 213 Km which corresponds to one-third amount (33%) and the total traveling time was reduced by 30%. The result suggests that, upon following the proposed route the petroleum costs of garbage trucks could be reduced by 24% compared to the

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present cost. Hence, the findings of this study highlight the important benefits of integrating GIS, AHP, and network analysis for optimal routes and garbage bin allocation for waste management, which leads to reduced greenhouse gas emissions and operation costs aiding sustainable and efficient waste management practices.

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