Effective Urban Waste Management: An Empirical Study of SCTP Transportation and Garbage Collection in Mettuguda Ward

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As third-year B.Tech students of Digital Techniques for Designing and Planning, we focused on applying digital tools to the management of urban spaces. The three of us have applied our teamwork skills by using Adobe Animate, QGIS, and Google Earth to visualize, analyze spatial distribution, and study urban issues using the medium of projects. The work process involves using tools for the problems encountered, undertaking extensive fieldwork, and using spatial tools for data collection and analysis of urban infrastructure. The investigation itself showcases the growing concerns for the development of sustainable cities and a structured approach to municipal services.

ABSTRACT

The collection of municipal solid waste in India's fast-growing cities has turned into a vital urban challenge owing to increase in population density, expansion of urban spaces and accelerated waste generation. Inefficient collection and transport mechanisms consequently pave the way to poor public health, environmental quality and decreasing urban livability. Waste management is a crucial aspect of urban development, yet conventional urban planning tend to prioritize infrastructure development with scant focus on operational efficacy and organization of waste collection and transfer operations at the ward level.

This project describes an empirical, field-based analysis of garbage collection and transport, towards SCTP locations, in Mettuguda ward of a mixed-use, developing urban area. It aims to analyze ground-level garbage collection practices, movement of waste vehicles and dumping of solid waste, using on-field observation and visual evidence by the team. The collected spatial data for collection points and transport paths were analyzed using QGIS, and connectivity of paths and spatial relationships of collection locations and SCTP locations were examined by viewing Google Earth, while animated paths were drawn by Adobe Animate to present garbage flow from source to transfer points more efficiently.

Despite operational regularities being established in most areas of the ward, various operational limitations were observed during garbage collection, such as redundant collection paths, unequal service to areas, time delays in peak collection periods and limited efficiency in segregation at source; areas with greater load and transport inefficiency were identified by spatially mapping each aspect, thereby creating a clear vision for optimized waste

management. A transparent documentation of the garbage collection and transfer route system, aided by analysis, has paved a way to concrete and operational solutions to urban waste management at the ward level.

INTRODUCTION

Growing urban populations in India are putting a strain on existing services and urban infrastructure systems. Solid waste management, a vital aspect of this service, is emerging as an important issue due to population pressure, consumption patterns, and a scarcity of space in the urban realm. While there is an obvious focus on providing new infrastructure in our growing cities, the importance of everyday municipal operations such as collection and

transportation of garbage also need attention for the preservation of public health, clean environment and livability of our city.

Typically the performance of the municipal waste management system revolves around availability of collection vehicles, number of personnel and disposal locations. Factors like, route efficiency, coverage, timeliness, coordination between collection and Secondary Transfer Collection Point (SCTPs), have a significant influence on effective working of municipal services, but are often neglected. It leads to overfull garbage cans, infrequent collections, road blockages, and unclean conditions especially at the ward level, which generates and manages the garbage daily.

Spatial information systems have already been widely adopted for providing information on physical infrastructure of the city such as roads, land use, service zones. In terms of waste management, spatial systems such as GIS can play an effective role in analysis of the spatial data regarding garbage generation and transportation, and service coverage, and enable spatial visualization to inform decision making in solid waste management. The problem of integrating operational data from the field with spatial data appears to have been very limited across urban localities.

This paper focuses on field-based empirical study of garbage collection and transportation to Secondary Transfer Collection Point (SCTPs) location at Mettuguda Ward. It is a mixed-use ward which has housing complexes, shops and other establishments causing daily accumulation of considerable amounts of waste. The study was an in-team project in which direct observations of garbage collection practices and vehicle operations were carried out and recorded, including time of operation and dumping procedure.

The data regarding collection and transportation coverage were analyzed by mapping along with analysis of route efficiency using QGIS. The coordinates were used along with Google earth for validating the routes and studying the relationships spatially. Adobe Animate was used for visualizing animated waste movement between the sources and the SCTP location for the better understanding.

This paper recommends shifting the paradigm from providing only infrastructure to the effective operation of the system, along with the application of spatial analysis and visual communication in municipal solid waste management, thereby aiding urban planners and municipality to take effective decisions with regards to identification of the gap in services and optimization of transportation.

METHODOLOGY

This research was performed to analyze the operational processes and spatial efficiency of garbage collection and transfer to Secondary Collection Transfer Point (SCTP) sites within the urban ward. The methodology has focused on gaining an understanding of how waste is collected, transferred and managed in the ward, based on field observations and spatial analysis of transportation and collection routes. The workflow has been divided into 4 major steps, namely, data collection, spatial mapping and route analysis, spatial validation and visualization and process visualization. All the processes has been undertaken with the use of open-source and digital visualization tools.

i.Data Collection

The raw data were obtained from direct field observations conducted in Mettuguda Ward, documenting everyday operations, location of collection points, types of containers, schedule of garbage collection, vehicle movement and disposal procedures at SCTP points. The entire process of collection and transport were visually recorded using mobile devices in the form of photos and videos to be analyzed in the next step. Multiple days were utilized to establish consistent daily routines of garbage collection and to investigate various issues like delays in schedule, route overlapping and uneven coverage.

Fig: 1-Data Collection in Field Observation

Fig: 2-Data Collection of the ward

ii. Spatial Mapping and Route analysis

All the collected field data was digitized and spatially mapped and analyzed in QGIS. The various collection points, ward roads and the transporting routes to the SCTP sites were mapped, in order to evaluate the service coverage and to analyze transport routes efficiency. All the associated data was attributed with a spatial feature (for example, collection schedule, number of times vehicle passes the collection point) and hence analyzed for patterns. This aided to uncover any possible operational inefficiencies like duplicated routes, overload points etc.
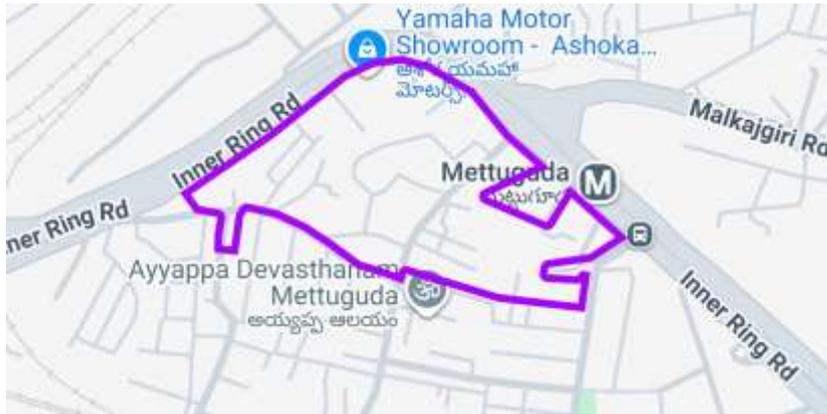
Fig: 3-Spatial Mapping and Route analysis of ward

iii. Spatial Validation and Visualization

The visualized routes were then cross checked using Google Earth in order to determine the actual road conditions and the relative distances between collection points and SCTP sites, along with assessing factors like road width and surroundings. The overall picture from the satellite view also revealed any possible constraints from traffic conditions or terrain.

Fig: 4- Spatial Validation and Visualization analysis of ward

iv.Process Visualization

A pictorial visualization of the entire journey of garbage from collection to the SCTP point has been represented in the form of an animated sequence using Adobe Animate, so that the complete process, with its operational stages and movements, could be better comprehended in a clear and efficient manner.

Fig: 5- Visualization of truck movement in the ward

Fig: 6- Visualization of entire journey

Fig: 7- Visualization of entire journey of SCTP

TOWARD ENHANCED URBAN SUSTAINABILITY THROUGH OPTIMIZED WASTE MANAGEMENT

Effective municipal solid waste management is crucial for developing urban sustainability and enhancing urban environmental quality. In this research, it is clearly demonstrated that the combination of geospatial analysis and digital visualization tools could provide a better implementation in the garbage collection and transportation at the ward level through the identification of overlaps, redundancies and limitations and it also could diminish the amount of on ground inspection, recurring field visit, and on-ground intervention. The approach could be coupled with smart urban system like GPS enable collection vehicles, smart waste bins, real time monitoring devices, etc for future work, which could identify the motion of garbage, efficiency of collection process and decrease the unnecessary field visit or monitoring without continuous coordination with the collection points and the Secondary Transfer Collection Point (SCTP) stations. Based on the spatial understanding, the application of low cost and low environmental impact interventions such as re-design the collection route, schedule the work time and properly locating the collection point, etc could improve resource use and decrease the negative impact.

CONCLUSION

This research has empirically analyzed garbage collection and transportation to SCTP stations at Mettuguda Ward and addressed the importance of the operational efficiency in the municipal solid waste management. Through field survey, spatial analysis and digital visualization tools, on ground situation of the waste collection operation in the mixed use urban ward has been addressed. Operational issues like route overlap, uneven service delivery coverage, time delay, problem in the waste segregation system have been addressed through the field observation, which are rarely attended in conventional urban planning study with the emphasis on the availability of infrastructures. The study has identified the ineffectiveness on the existed system by showing on the maps in terms of collecting points and transportation routes. The research has presented the achievable step-by-step procedure with the use of spatial analysis tools, visualization and animation based on the collection point and transportation route analysis and suggested on low cost, implementable interventions through optimal route planning, service schedule and improvement of the on-site interaction between collecting points and SCTP stations. By paying attention to the operations, instead of reacting in waste handling, and using geospatial tools to plan sustainable and efficient urban waste management, this case study of Mettuguda Ward

suggests how to make the city sustainable and cleaner through the utilization of field based data in the spatial analysis and also provides a framework which could be useful in other urban areas.

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