Muhammed Alamgir, S.M. Tariqul Islam, Mahmudul Hasan, N.J. Pollen (Eds.)
ISBN: 978-984-35-7297-4

Full Paper of the WasteSafe 2025 – 9th International Conference on
Sustainable Solutions for Waste Management in Developing Countries
22-23 February 2025, Dhaka, Bangladesh

ASSESSING THE EFFECTIVENESS OF NGO PARTICIPATION IN SOLID WASTE MANAGEMENT: A GIS APPROACH IN KHULNA CITY

N. I. Midula[1], P. Das[2] and T. R. Seam[*3]

[1] Graduate student, Department of Civil Engineering, Khulna University of Engineering & Technology (KUET), Khulna-9203, Bangladesh, e-mail: nahidamidula57@gmail.com
[2] Graduate student, Department of Civil Engineering, Khulna University of Engineering & Technology (KUET), Khulna-9203, Bangladesh, e-mail: d.piyas57@gmail.com
[3] Undergraduate student, Department of Civil Engineering, Khulna University of Engineering & Technology (KUET), Khulna-9203, Bangladesh, e-mail: mdseam19@gmail.com

ABSTRACT

Solid waste management is a fundamental urban challenge, especially in frequently increasing cities like Khulna, Bangladesh, where efficient waste collection and disposal are critical to public health and environmental sustainability. The main objective of this study is to figure out the effectiveness of Geographic Information System (GIS) technology in evaluating the performance of Non-Governmental Organizations (NGOs) involved in waste collection in Khulna City and to create a digital map showing the served area. By employing GPS tracking devices on waste collection vehicles, data was collected to trace the movement of these vehicles, identify the areas and households served, and monitor the efficiency of waste collection routes. Google Earth Pro was used to generate shapefiles of the collection regions, which were then imported into GIS software to produce a detailed map demonstrating the spatial distribution of NGO-served zones. The investigation provided the estimation of the percentage of total city area covered by NGO waste disposal services, exposing potential gaps in coverage. The findings shed light on the effectiveness of current solid waste management strategies, with a focus on the role of non-governmental organizations (NGOs) in urban waste collection. This study highlights the value of GIS as a decision-making tool for optimizing waste management systems, and it can serve as a model for other communities experiencing equivalent solid waste management difficulties. In this study, 10 NGOs working in ward no. 14–31 of Khulna city were followed to figure out how much region they served. Ward number 23 has the largest area served, measuring 95.541 acres, or 76.125% of the total area. These NGOs have serviced 0.665 acres (0.099%) of ward number 14, the smallest of any ward. Finally, a map has been created, which highlights areas where solid waste management services have been successfully implemented. It also indicates underserved areas that might need more attention and intervention in the continuous search for comprehensive and effective solid waste management.

***Key words**: GIS; Solid Waste; GPS; Google Earth; NGO.*

INTRODUCTION

Solid waste management is a critical part of modern urban living as it involves collection, transportation, treatment and final disposal of waste. Khulna, the third-largest city in Bangladesh, faces massive challenges in controlling its continually growing solid waste. Solid waste includes trash, building rubble, industrial refuse, sewage and waste disposal sludge, and air quality control plants, among other recyclable items [1]. The quantity of Municipal solid Waste (MSW) produced in developing country cities has increased significantly over the past few decades. A significant amount of MSW is produced in the majority of developing nations [2]. Urbanization, population expansion, and industrial manufacturing are the main factors contributing to the rising amount of solid waste being produced [3]. Like many other urban areas in Bangladesh, Khulna City's non-governmental organizations (NGOs) have come to play a vital part in solid waste management (SWM) by enhancing the city's waste collecting and disposal capabilities. Waste from offices, hotels, supermarkets, shops, schools, and other institutions, as well as from municipal services like street cleaning and recreational area maintenance, are a few examples of sources that produce municipal solid waste (MSW), which

ISBN: 978-984-35-7297-4

is also produced by commercial activities and households [4]. According to the most recent study, none of Bangladesh's cities have an adequate solid waste management system in place. The city authority is not able to handle the rapidly increasing demand for MSW because, in addition to financial and technical limitations, it lacks commitment and has fundamental limitations in how it uses resource [5].

In order to manage MSW in the various KCC wards, nine CBOs and thirteen NGOs work alongside [6]. However, due to issues and limitations with administrative restraints, resource availability, and other relevant variables, the organization has not been able to effectively manage the entire task of disposing of solid waste [7]. For analyzing the overall performance of organizations, a digital map of the city was created using GIS which shows the percentage of served, underserved, and overserved areas will be helpful in understanding the overall scenario of how effectively these Organizations are accomplishing their goals. This step required the use of spatial data.

This study employs a Geographic Information System (GIS)-based analysis to evaluate the efficacy of NGO involvement in SWM. This study aims to identify the weaknesses and strengths in present practices, by creating a digital map of waste collection showing the regions where services have provided.

METHODOLOGY

Selection of Study Area:
Khulna City Corporation (KCC) is the study area. The NGOS have been actively working in Ward No. 14–31, which has been designated as the research area.

GPS Tracking of Collection Vehicles:
GPS tracking of the collection vans working for different organizations was done. Some portable and rechargeable GPS devices were given to the van drivers, who are the waste collectors. They collect waste from door to door. Tracking of the route of the collection was done with GPS devices. Route of collection of waste and the coverage area of each van were recorded from the tracking. The tracking data were recorded and tabulated for analysis. GPS Tracker & GPS tracking process is shown in Figure 2.1 & Figure 2.2 respectively.

Figure 2.1 GPS Tracker

Figure 2.2 GPS Tracking

Finding the Coverage Area Using Google Earth Pro:
In GPS tracker, the GPS password was input. The starting and ultimate trip times were entered. The tracking data was exported as a KML file via the history option. After downloading the KML file, Google Earth Pro displayed the route width. The toolbar was then located at the top, and the "Ruler" icon was clicked, followed by the "Polygon" option for measuring areas. Then clicking on the map to make points that outlined the area to measure was done, and the work had been finished after generating the polygon. After making the polygon, the measurements were displayed, including the area of the identified zone. In Fig 2.3, served area has been shown.

Figure 2.3 Coverage area using Google Earth Pro

In Figure 2.4, the coverage areas are shown when zoomed in.

Figure 2.4 Coverage area(zoom) using Google Earth Pro

Creation of Digital Map Using GIS:
The tracking route's KML files were found using the GPS tracker. These files were opened in QGIS and then converted into shape files. All files that have been opened up at this point could be seen on the left side of the screen. These files were exported as shape files on the computer. After exporting, the coverage area's shape appeared in QGIS. The shapes files were then opened in ArcGIS and it was used to build a complete map of Khulna city, served by the Non-profit organizations (Listed in KCC). The process has been shown in Figure 2.5, Figure 2.6 & Figure 2.7.

ISBN: 978-984-35-7297-4

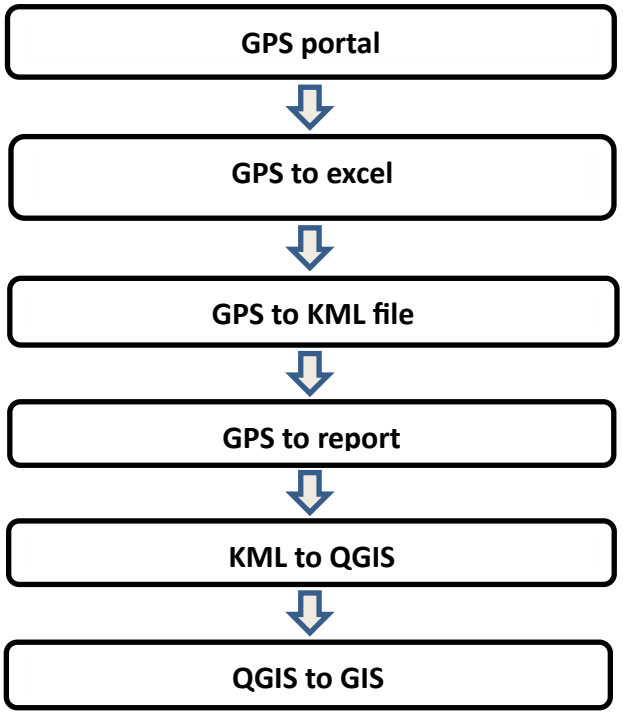

Figure 2.5: Mapping framework

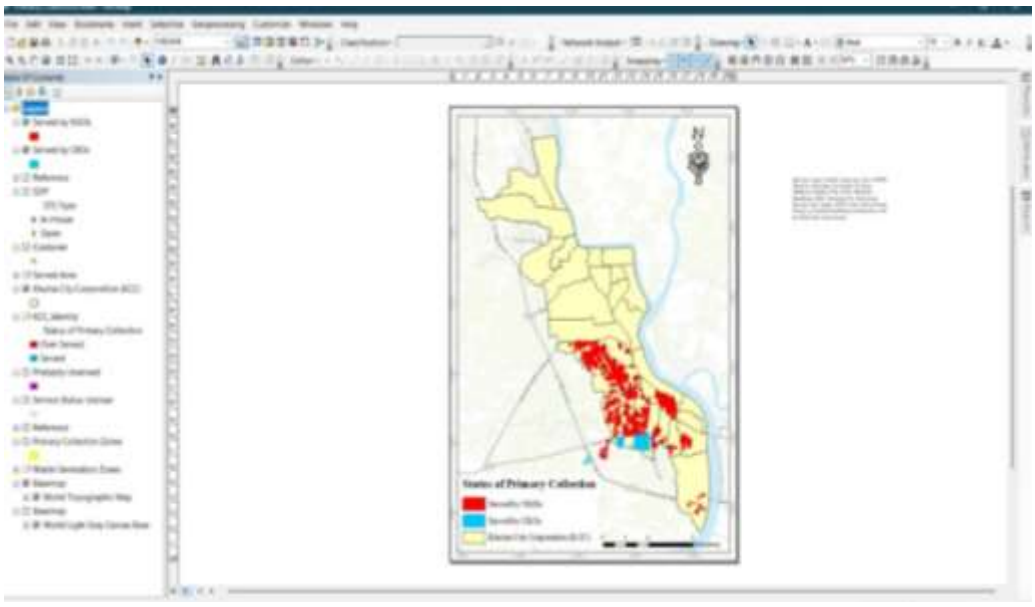

Figure 2.6: Shape files creation

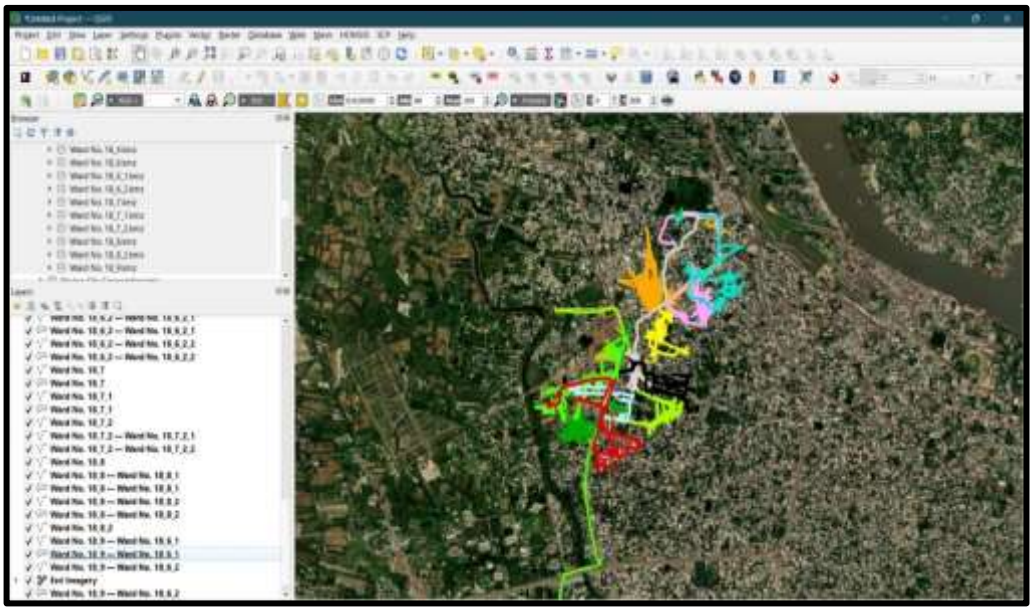

Figure 2.7: Digital map creation

RESULTS AND DISCUSSION

A clear and numerical summary of the Organization's influence is provided by Table 3.1 showing the percentage of areas that the organization serves in terms of solid waste management and shows how successful their solid waste management efforts are.

Table 3.1 Percentages of Served Area by Organizations (Ward Wise)

Ward	Area in Acre	Served Area (%)	Unserved Area (%)	
Ward No 14	0.665		0.099	99.901
Ward No 16	127.941		22.425	77.575
Ward No 17	178.713		30.738	69.262
Ward No 18	94.98		23.47	76.53
Ward No 19	21.689		17.581	82.419
Ward No 20	7.055		5.855	94.145
Ward No 21	3.155		0.932	99.068
Ward No 22	1.883		1.118	98.882
Ward No 23	95.541		76.125	23.875
Ward No 24	104.09		27.34	72.66
Ward No 25	59.78		32.43	67.57
Ward No 26	66.77		40.67	59.33
Ward No 27	33.58		16.28	83.72
Ward No 28	12.422		6.831	93.169
Ward No 29	6.308		3.856	96.144
Ward No 30	31.726		10.713	89.287
Ward No 31	13.191		1.421	98.579

Table 3.1 makes it obvious that the majority of NGOs have been providing services in the following wards: 23 (76.125%), 26 (40.67%), 25 (32.43%), 17 (30.738%), and 24 (27.34%). These are the five wards from 14 to 31 with the highest service provision rates. Conversely, the five regions that receive the least amount of services are ward no 14 (0.0995%), 21 (0.932%), 22 (1.118%), 31 (1.421%), and 29 (3.856%).

ISBN: 978-984-35-7297-4

Generating Map through ArcGIS

The impact of the organizations is visually represented by the Geographic Information System (GIS) map in Figure 3.1 that shows the areas that the organizations in solid waste management serve. The map, which highlights areas where solid waste management services have been successfully implemented. It also indicates underserved areas that might need more attention and intervention in the continuous search for comprehensive and effective solid waste management.

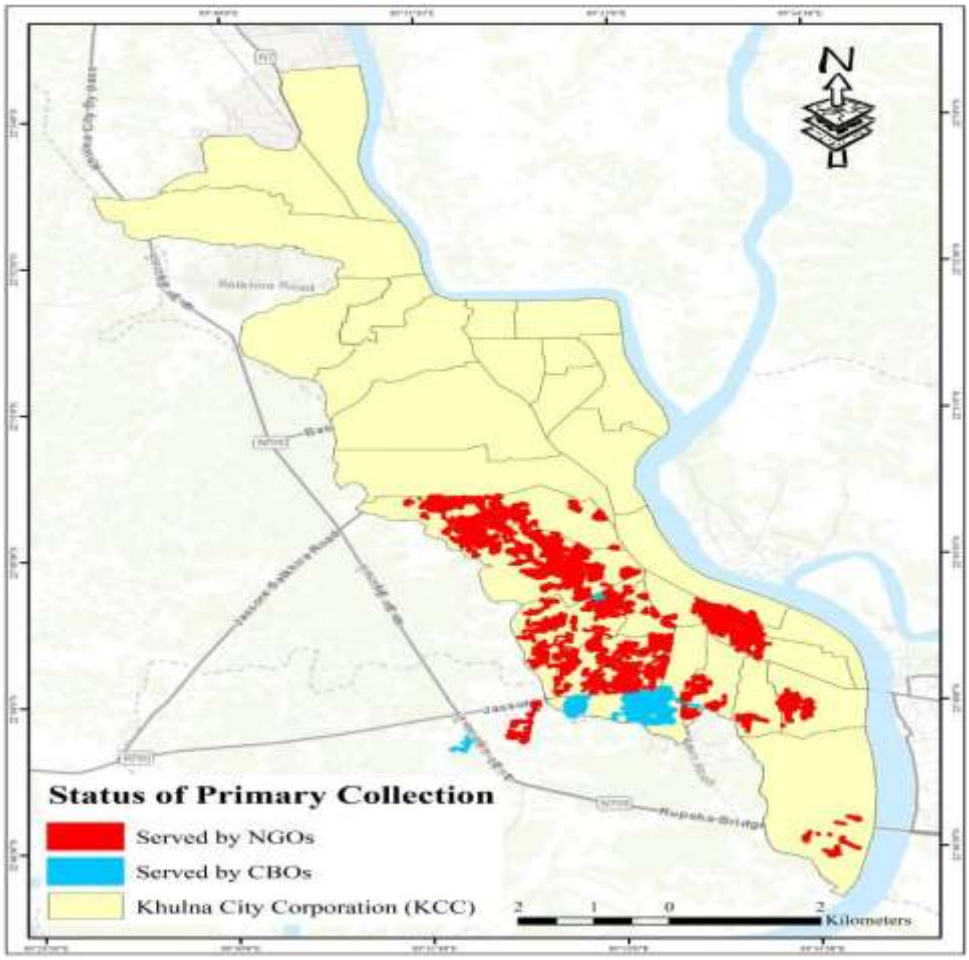

Figure 3.1: Map of Khulna city showing the served area by Organizations

CONCLUSION

The assessment of non-governmental organization (NGO) participation in solid waste management in Khulna City revealed major service coverage discrepancies. he findings of the research show a substantial difference in solid waste collection service coverage among regions, with the most-served area having 76.125% coverage and the least-served area receiving only 0.099%. This extreme contrast indicates a significant service gap, particularly in underprivileged areas, which may worsen environmental and public health problems. This service gap underlines the need for enhanced coordination and resource allocation between NGOs and municipal authorities. To address this inequality, local governments and non-governmental organizations (NGOs) must implement targeted interventions to increase service delivery, particularly in underserved areas. To overcome the service gap in NGO participation in solid waste management, more coordination between NGOs and local governments is required to enable more equitable allocation of services. Increasing financial and logistical support to NGOs can help them expand their reach into disadvantaged areas. Furthermore, adopting a data-driven strategy through GIS can help detect unserved zones in real time. Closing this gap would not only improve the overall efficiency of solid waste management, but it will also help the impacted populations live better lives.

REFERENCES

1. Ahasan, R. (2020). *Community Based Approach for Solid Waste Management in Khulna City.*
2. Ahsan, A., Alamgir, M., Imteaz, M., Daud, N. N., & Islam, R. (2012). *Role of NGOs and CBOs in waste management.* Iranian journal of public health, 41(6), 27.
3. Alam, P., & Ahmade, K. (2013). *Impact of solid waste on health and the environment. International Journal of Sustainable Development and Green Economics (IJSDGE),* 2(1), 165-168.
4. Chaudhary, S., & Mishra, S. (2019). *Phytotoxicity assessment of four different season's kitchen waste compost at different level of concentration on mung beans (Vigna radiata (L.)*
5. Chowdhury, K. H., Islam, M. R., Akter, J., & Alamgir, M. *PRESENT STATUS OF MUNICIPAL SOLID WASTE MANAGEMENT IN BARISAL CITY CORPORATION.*
6. Jodder, P. K., Leya, R. S., Rana, M. S., & Sarkar, B. (2022). *GENERATION AND CHARACTERISTICS OF HOUSEHOLD SOLID WASTE IN KHULNA CITY, BANGLADESH*. Khulna University Studies, 105-115.
7. Ngoc, U. N., & Schnitzer, H. (2009). *Sustainable solutions for solid waste management in Southeast Asian countries.* Waste management, 29(6), 1982-1995.