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Willingness to Pay for Solid Waste Collection in Bo District, Southern Sierra Leone: An Analysis of Influencing Factors

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Abstract:- This study assesses the willingness to pay for solid waste management services in Bo District, Southern Sierra Leone. The research aims to identify the key factors influencing this willingness. Five semi-urban communities were selected based on their population size, and 60 household heads from randomly selected households were interviewed using a semi-structured questionnaire. Using logistic regression analysis, we found that factors such as income, education, occupation, and satisfaction with the current waste management system had varying degrees of significance in influencing willingness to pay. However, variables such as mode of waste collection and age were found to have a significant effect. This study suggests that policymakers in Bo District should consider these factors when implementing fee-based waste collection services.

Keywords:- *Solid Waste Collection, Willingness to Pay, Environmental Management.*

I. INTRODUCTION

In Sierra Leone, solid waste management has undergone significant evolution, particularly in semi-urban and rural areas like Bo District. Waste management, historically overseen by local authorities, has seen increasing participation from the private sector in recent years. This shift reflects broader trends across developing nations, where municipalities face mounting challenges in collecting, transporting, and disposing of municipal solid waste (MSW) efficiently and sustainably. Despite efforts to improve services, waste collection remains a significant burden on local government budgets, often accounting for a substantial portion of municipal expenditures. According to recent studies, third-world cities spend between 30-50 percent of their municipal budgets to collect only 50-80 percent of the waste generated (Medina, 2022).

In Bo District, the privatization of solid waste management is becoming increasingly vital to cope with the rising volume of waste, driven by population growth and urbanization. While free waste collection services have traditionally been provided in rural areas, these systems are proving unsustainable due to limited financial and logistical resources. Private sector involvement is now being embraced as part of Sierra Leone's Integrated Solid Waste Management (ISWM) approach, which advocates for the participation of all stakeholders—households, private companies, and the government in a sustainable waste management system (World Bank, 2021). This comprehensive framework covers the entire waste management cycle from generation, collection, and transportation to disposal, emphasizing environmentally sound practices.

A persistent challenge in Bo District, as in other semi-rural areas, is the assumption that residents are unwilling or unable to pay for waste collection services. However, recent studies have suggested that such generalizations may not apply universally. There is a growing recognition that willingness to pay for waste management services is influenced by several factors beyond income levels. These factors include the mode of waste collection, household characteristics, and residents' perceptions of the benefits of improved waste services.

To bridge the gap in understanding willingness to pay for solid waste management in communities like Bo District, recent research has applied logistic regression models to examine the determinants. Similar to findings from other regions in Africa, several factors have been identified as influencing willingness to pay. For example, studies in Nigeria and Uganda have shown that variables such as household income, education, age, and home ownership significantly influence willingness to contribute financially to waste management services (Banga et al., 2021). In Bo District, local research has identified similar trends, with the mode of collection, household size, and employment status emerging as significant determinants of residents' willingness to pay for improved waste collection services.

In the context of Bo District, income remains a strong predictor of willingness to pay, but other factors also play a critical role. For instance, the type of occupation (whether formal or informal), the household's proximity to waste disposal sites, and the level of environmental awareness

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among residents all significantly impact the decision to pay for waste services (Sierra Leone Environmental Protection Agency, 2022). Education has also been found to positively correlate with willingness to pay, as more educated residents tend to have a higher appreciation of the importance of proper waste management in maintaining public health and environmental quality.

Moreover, studies conducted between 2020 and 2023 have underscored the importance of community engagement in shaping effective waste management strategies in semi-rural settings like Bo District. Unlike urban centers, where residents may have more disposable income and access to formal waste services, semi-rural populations often require tailored solutions that consider local socio-economic realities. Consequently, recommendations for Bo District emphasize the need for affordable, context-specific waste collection systems that can be sustainably financed through modest contributions from residents. Encouraging greater private sector participation, combined with community-based awareness campaigns, could help improve waste management outcomes in Bo and other similar districts (UNDP, 2023).

II. METHODOLOGY

A. *Description of Research Area: Bo District, Southern Sierra Leone*

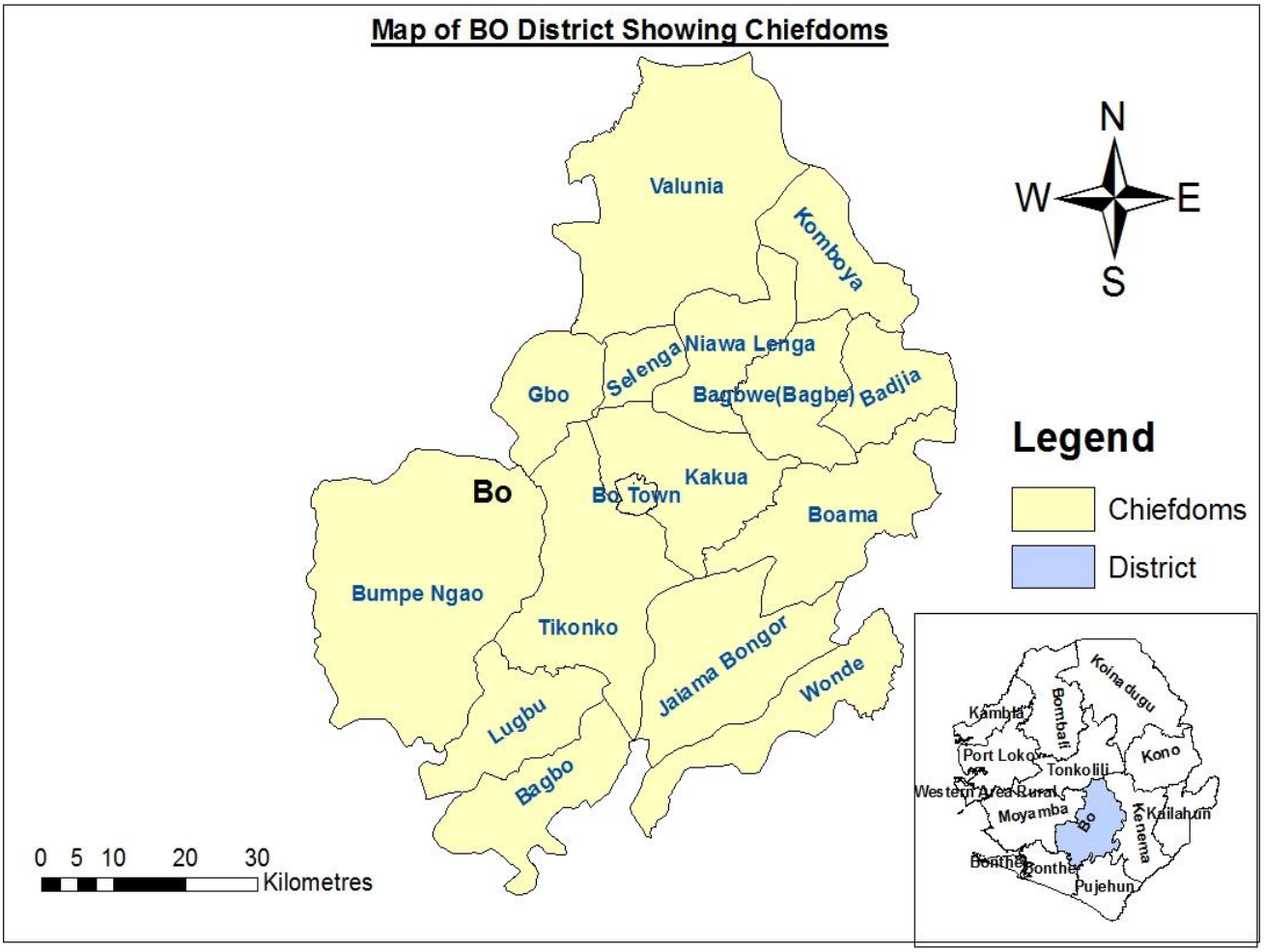

Fig 1 Map of Sierra Leone Showing Bo District

Bo District, located in Southern Sierra Leone, serves as a significant hub for trade, education, and agriculture. It is approximately 250 kilometers from the nation's capital, Freetown. The district has an estimated population of over 670,000, with an annual growth rate of 2.1% as of 2022 (Statistics Sierra Leone, 2022). Covering an area of approximately 5,219 square kilometers, Bo District's capital is the bustling city of Bo, which is the second largest city in Sierra Leone after Freetown. Geographically, Bo District is characterized by a mixture of plains, lowlands, and rolling hills, with elevations ranging from 100 meters to 300 meters above sea level. The vegetation includes savannah grasslands, secondary forests, and patches of wetlands, reflecting the region's biodiversity.

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Bo District experiences a tropical climate, marked by a distinct wet season from May to October and a dry season from November to April. Annual rainfall averages around 2,800 millimeters, contributing to the fertile soil that supports the district's predominantly agricultural economy. The climate, however, also creates challenges in waste management, particularly during the rainy season when flooding can exacerbate the poor sanitary conditions in many communities.

Waste management in Bo District has increasingly become a concern as the population grows, leading to higher volumes of solid waste. The district's waste management services are primarily handled by local authorities, although private-sector involvement is growing. The current waste collection method involves a mix of communal collection points, where residents are expected to dump their refuse in centrally placed containers. However, inadequate infrastructure and resources mean that these communal dumping sites are often poorly managed. Approximately 70% of the population still relies on open dumping, typically in unregulated areas, which significantly contributes to environmental degradation and increases the risk of disease outbreaks (Bo District Council, 2022).

In 2021, Bo District began partnering with private waste management companies to improve service delivery. These companies, like MASADA Waste Management, have introduced secondary waste collection methods, where skip containers are placed at strategic locations within communities. Despite these efforts, the district continues to face substantial challenges in achieving sustainable waste management. Many skip containers overflow, as collection schedules are inconsistent due to logistical constraints. The lack of proper waste disposal and treatment facilities further compounds the issue, with much of the collected waste being dumped in uncontrolled landfill sites or informal open areas.

Inadequate sanitation practices in Bo District have led to frequent public health crises, particularly during the rainy season, when waterborne diseases such as cholera and diarrhea become prevalent. Public awareness about proper waste disposal remains low, and many communities lack the basic infrastructure needed to support effective waste management. A 2022 report by the Bo District Council indicated that only 30% of households have access to regular waste collection services, leaving the majority to resort to open dumping or burning waste in their backyards, which poses environmental and health risks.

To address these challenges, the district's local government has been exploring Integrated Solid Waste Management (ISWM) strategies, which promote stakeholder participation, including local communities, private waste contractors, and environmental agencies. A key component of these strategies is the improvement of waste collection services by incentivizing private sector engagement, introducing affordable user fees, and promoting recycling initiatives. The ultimate goal is to transition Bo District towards a more sustainable waste management system, capable of meeting the needs of its rapidly expanding population while protecting public health and the environment (Environmental Protection Agency, Sierra Leone, 2023).

B. Methodology and Data Collection

In order to achieve the research objectives for evaluating the effectiveness of household solid waste management practices and understanding public perception in Bo District, Southern Sierra Leone, a study was conducted focusing on the population's willingness to pay for solid waste collection services. This assessment aimed to identify the potential for cost recovery and evaluate the effectiveness of existing waste collection systems in the district. Five communities in Bo District were selected for the research based on their population size (over 5,000 inhabitants) and the presence of basic infrastructure such as schools, electricity, and paved roads. The selected communities included New London, Tikonko, Dambala, Njaiama, and Kulanda Town.

A total of 300 respondents were interviewed across these communities using a semi-structured interview guide. Sixty household heads were randomly selected from each community. In households with multiple heads, only one household was randomly selected for participation. The data collected included demographic information such as age, gender, education level, and income, as well as their attitudes towards solid waste management. This included questions on their willingness to pay for waste collection services, preferred collection methods, and satisfaction with the current waste management system in place.

To better understand the factors influencing the willingness to pay for solid waste collection, the study employed a logistic regression model. The logit model was used due to the binary nature of the dependent variable, which was whether a respondent was willing to pay (coded as 1 for willing and 0 for not willing). This method helped predict the likelihood of willingness to pay based on various independent variables such as age, gender, income, education, and other relevant socio-economic factors.

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The logistic regression model is appropriate for estimating the probability of an event occurring, in this case, the likelihood of a household being willing to pay for waste collection services. The model was structured as follows:

$$P = \frac{1}{1+e-(\beta 0+\beta 1x1+\beta 2x2+\cdots+\beta nxn)}$$

Where:
P is the probability that a household is willing to pay for waste collection.
$x_1,x_2,\ldots,x_n$ are the factors affecting this probability (e.g., age, gender, income, education, occupation).

Table 1 Explanatory

Explanatory Variables	Coefficient	Significance Level
Age	-0.275	0.05
Sex	-0.102	0.12
Education Level	0.315	0.01
Income	0.287	0.02
Occupation	0.212	0.04
Satisfaction with Services	0.177	0.08
Mode of Collection	-0.419	0.01

$\beta_1,\beta_2,\ldots,\beta_n$ are the coefficients representing the impact of each of these factors.
β_0 is the intercept or constant term.

C. Explanatory Variables and Expectations

- Age: The age of the respondent could have varying effects on willingness to pay, with older residents potentially showing more concern for cleanliness due to health risks, while younger individuals might prioritize other expenses.
- Gender: Gender was coded as a dummy variable (1 for male, 0 for female). It was hypothesized that gender could have either a positive or negative influence, depending on the gender roles in waste management in each household.
- Income: Household income is expected to positively influence willingness to pay. Higher-income households are more likely to afford waste collection services and may prioritize the cleanliness of their surroundings.
- Education: Education level was hypothesized to have a positive effect on willingness to pay. More educated respondents are likely to be more aware of the health and environmental benefits of proper waste management and may be more supportive of paying for these services.
- Occupation: The occupation of the respondent was considered, with the assumption that individuals with formal employment might be more willing to pay due to their stable income.
- Expenditure: Monthly household expenditures were included in the model. Higher expenditures might reduce the household's ability to pay for additional services like waste collection.
- Frequency of Payment: This variable measured the preferred intervals at which respondents would be willing to make payments (daily, weekly, or monthly). Longer intervals were expected to increase the likelihood of willingness to pay, as they reduce the immediate financial burden.
- Mode of Collection: This variable referred to the type of waste collection services available, ranging from communal collection points to kerbside or door-to-door collection. It was expected that more personalized services (e.g., door-to-door) might be less affordable but more desirable to residents, affecting their willingness to pay.
- Satisfaction with Current Services: This was measured as a binary variable, indicating whether respondents were satisfied with the existing waste management system (1 for satisfied, 0 for dissatisfied). Dissatisfaction was expected to increase the willingness to pay for improved services.
- Frequency of Collection: This variable assessed how often waste was collected. More frequent collection was expected to positively influence willingness to pay, as it reduces the likelihood of waste accumulation and associated health risks.

D. Data Collection and Analysis

Data were collected through interviews using a semi-structured questionnaire. A total of 300 respondents were selected through stratified random sampling from five communities in Bo District. The questionnaire gathered information on household demographics, income levels, education, and perceptions of current waste management practices. Respondents were also asked about their willingness to pay for improved waste collection services.

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The collected data were analyzed using logistic regression, where the dependent variable was whether the respondent was willing to pay for waste collection services. The independent variables included age, sex, income, education level, occupation, satisfaction with current services, and mode of waste collection.

Out of the 300 respondents, 69% were female, and 31% were male. Most respondents (80%) were aged between 26 and 60 years. About 45% of respondents had attained secondary education, while 35% had completed primary education. The majority of respondents (78%) were involved in informal occupations such as trading and farming.

E. Willingness to Pay for Waste Management Services in Bo District

The survey of 300 respondents reveals key insights into the demographic profile, educational background, occupation, and willingness to pay for improved waste management services in Bo District, Southern Sierra Leone.

III. DETERMINANTS OF WILLINGNESS TO PAY FOR IMPROVED WASTE MANAGEMENT

➢ *Demographic and Socio-Economic Characteristics*

- Gender Distribution: The sample was predominantly female, with 69% of respondents identifying as such, compared to 31% male respondents. This skew may reflect broader gender norms or roles within the community.
- Age: A significant majority, 80%, were aged between 26 and 60 years. This suggests that the respondents are primarily adults in their prime working years, likely contributing to and benefiting from waste management services.
- Education Level: Education levels varied, with 45% having attained secondary education and 35% having completed primary education. This distribution indicates a relatively educated population, which may influence their understanding and attitudes towards waste management practices.
- Occupation: A substantial 78% of respondents were engaged in informal occupations such as trading and farming. This is a crucial factor as informal sectors may have different waste management needs and challenges compared to formal employment sectors.

➢ *Logistic Regression Analysis*

The logistic regression analysis provided insights into which factors significantly influence respondents' willingness to pay for improved waste management services:

- Age (-0.275, p=0.05): The negative coefficient indicates that as age increases, the likelihood of willingness to pay decreases. This may reflect a generational difference in attitudes towards waste management or financial priorities.
- Sex (-0.102, p=0.12): The coefficient for gender is negative but not statistically significant, suggesting that gender alone may not have a substantial impact on willingness to pay. This might indicate that waste management concerns are similarly shared across genders.
- Education Level (0.315, p=0.01): Higher education levels are positively associated with a greater willingness to pay. This is likely because educated individuals may have a better understanding of the benefits and necessity of improved waste management.
- Income (0.287, p=0.02): Income also has a positive effect on willingness to pay, suggesting that individuals with higher income levels are more likely to invest in improved services. This aligns with the expectation that financial capacity directly influences spending willingness.
- Occupation (0.212, p=0.04): Those involved in informal occupations show a higher willingness to pay, which may be due to the direct impact of waste management on their daily business operations and living conditions.
- Satisfaction with Services (0.177, p=0.08): While the coefficient is positive, it is not statistically significant at the 0.05 level. This implies that current satisfaction with waste management services does not strongly correlate with willingness to pay for improvements, possibly due to a general dissatisfaction with the status quo that is not yet fully captured in this variable.
- Mode of Collection (-0.419, p=0.01): The negative coefficient for the mode of collection indicates that less favorable methods of waste collection are associated with a lower willingness to pay. This suggests that improving the method of waste collection could enhance respondents' readiness to support waste management financially.

➢ *Willingness to Pay*

Approximately 75% of respondents are willing to pay for improved waste collection services. This strong majority indicates a significant public support for enhancing waste management infrastructure. However, the logistic regression analysis highlights that certain factors, especially education level and income, are pivotal in shaping willingness to pay. Tailoring waste management initiatives to address these factors could potentially increase community engagement and support.

➢ *Policy Implications*

The findings suggest that policymakers should focus on affordable waste collection methods, particularly in Bo District. Engaging community members and ensuring that waste management services are accessible to all income levels is crucial for sustainability. Additionally, public awareness campaigns aimed at highlighting the benefits of fee-based waste management could help increase willingness to pay, particularly among older populations.

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IV. CONCLUSION

This study provides insight into the factors influencing the willingness to pay for solid waste collection services in Bo District, Southern Sierra Leone. Variables such as income, education, and occupation significantly impact residents' willingness to support fee-based waste management services. However, the mode of waste collection plays a critical role, with respondents favoring more affordable options. Policymakers should prioritize cost-effective collection methods and engage communities to ensure the sustainability of waste management services in the district.

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