



Economic Value of Solid Waste for Improved Solid Waste Management in Nandi County, Kenya

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ABSTRACT

Due to rapid population growth and urbanization Nandi County is experiencing challenges of managing urban solid waste especially as this is an economic commodity that may not be optimally allocated through the normal market mechanism system. This is because supply-side management practices have failed and hence there is need for demand-oriented approach. The objectives of this study include; assessing the WTP for improved management of solid waste; evaluate potential income opportunities in managing waste; and provide policy implications. The study used a sample size of 380 households through stratified sampling procedures. Interview guides and questionnaires were used in data collection. Results show that only 27% of individual residents and 18% of corporate organizations paid for these services while the rest (73% and 82% respectively) cannot internalize environmental degradation. High income households expressed the highest willingness to pay (WTP) of 60%. On average respondents WTP is Ksh. 300 monthly for improved services, while corporates had WTP of KSh. 1,000. Regression analysis showed that gender, education level, and household income were significant predictors of WTP. The study concluded that gender, education level, and household monthly income significantly influence individuals' willingness to pay for improved solid waste management in Nandi County. It recommends strengthening regulations to enforce proper waste disposal and introduce equitable tariff structures. Expanding participation through affordable rates will help achieve economies of scale, ensuring sustainable financing for waste management services.

Keywords: *Economic Valuation, Willingness to Pay, Market Mechanism*

INTRODUCTION

Most governments in developing countries are experiencing challenges of managing urban solid waste especially because this is an economic commodity that may not be optimally allocated through the normal market mechanism system. Supply-side management practices have failed and hence there is need for demand-oriented approach. Kassahun *et al.* (2024) shows that by 2016, cities around the world produced 2.01 billion tons of solid waste.

The growing urban population in Africa has significantly increased the demand for effective solid waste management systems. There is evidence of a positive correlation between income levels and waste generation (Batu *et al.*, 2016). Higher incomes lead to increased consumption, resulting in higher waste volumes. Urban households, in particular, are major contributors to waste, generating significant amounts of organic material, which comprises approximately 50–60% of municipal solid waste in many African cities (Kaza *et al.*, 2018). Uncontrolled generation of solid waste and disposal, coupled with poor collection services poses a great threat to environmental quality and human health.

Solid waste is an economic commodity that may not be optimally allocated through the market mechanism. Due to its public good nature, it suffers from free rider problems. This is because supply-side management practices have failed and hence there is need for demand-oriented approach. The objectives of this study include; assessing the WTP for improved management of solid waste; evaluate potential income opportunities in managing waste; and provide policy implications.

Theoretical and Conceptual Framework



This study applies the Utility Theory to provide a comprehensive framework for understanding and optimizing solid waste management in Nandi County. Utility Theory explains how individuals and households make waste disposal choices based on cost-benefit considerations, influencing their willingness to pay for waste management services (Nijkamp *et al.*, 2008). Utility theory explained how households or small enterprises would evaluate the utility derived from participating in activities like recycling, composting, or waste collection, considering potential monetary and non-monetary benefits.

The conceptual framework of this study is guided by the following multiple regression model (*Equation 1*):

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \varepsilon \dots\dots\dots (Eq. 1)$$

Where,

- Y = Improved solid waste management
- β_0 = Coefficient of intercept
- $\beta_1 - \beta_4$ = Corresponding coefficients for the respective independent variables
- X_1 = Socio-economic factors like income levels, education, occupation and family size
- X_2 = Economic value of solid waste
- X_3 = Economic policy implications
- ε = Error term

Operationalization of Variables affecting Economic Value of Solid Waste

The economic value of solid waste pertains to the potential monetary benefits that can be derived from waste through activities such as recycling, composting, and energy recovery. Solid waste, particularly recyclable materials like plastics, paper, and metals, have intrinsic value when processed and sold in secondary markets (Medina, 2010). In this study, the economic value will be operationalized by quantifying the income generated from recycling activities and the market value of materials recovered from waste streams.

MATERIALS AND METHODS

Research Design

This study applied a correlational research design. A correlational research design investigates relationships between variables without the researcher controlling or manipulating any of them. In the context of this study, correlational research helped identify significant relationships between variables such as household income, education levels, and waste management practices. It also explored connections between socio-economic factors and willingness to pay for formal waste management services.

Statistical tools such as correlation matrices and multiple regression analysis were employed to analyze the data. While correlation matrix provided a holistic view of the interrelationships among variables, multiple regression isolated the effect of each independent variable on a dependent variable, such as household demand for waste management services (Babbie, 2020).

Target Population and Sampling Frame

The target population of this study constitutes 60,251 respondents drawn from the main urban centres in the County. This population includes household heads, learning institutions, business community. Other targeted respondents will be 14 respondents drawn from County Government and National Government ministries (i.e., 5 County government officers, and national government officers comprised of 2 Ministry of Environment, 5 Ministry of Health, 1 National Environment Management Authority (NEMA) and 1 Ministry of Trade).

It is from this population that a representative sample was drawn, and questionnaires administered randomly. The study used a purposeful sampling technique for the government officers since they are the government key informants that are skilled and equally mandated to regulate solid waste management activities in Nandi County and nationally. It also applied the Stratified sampling technique to select the respondents at the household and business community level. This is because the population's characteristics are diverse and the study intended to ensure that every characteristic was represented in the sample. This enhanced generalizability and validity of the



study. The study sample size of the target population was determined to be 939 using the Krejcie & Morgan (1970) model as indicated below:

$$n = \frac{X^2 NP(1-P)}{d^2(N-1)+X^2 P(1-P)} \dots\dots\dots (Eq. 3)$$

Where:

- n – desired sample size
- N – target population size
- P – population proportion (0.5)
- d – degree of accuracy expressed as a proportion (0.05)
- X² – 3.841 at 95% confidence level

$$n = \frac{3.841 \times 60,251 \times 0.5 (1-0.5)}{0.05^2 (60,251 - 1) + 3.841 \times 0.5(1-0.5)}$$

$$n = \frac{57,856.02275}{151.58525} = 939 \text{ respondents}$$

Data Collection Procedures and Analysis

This study applied a pilot study in order to pre-test the instruments prior to conducting the actual study where research assistants were trained on the content of the questionnaire and the general research expectations. Data processing involves collection, recording, organizing, storing and adapting or altering to convert the raw data into useful information. Data processing therefore is comprised of the following six stages: collection, preparation, data input, processing, interpretation, and data storage. IBM SPSS (version 29) software was used to determine causal relationships between different variables. The data obtained from questionnaires, interviews, observations, document analysis and secondary data was subjected to descriptive and inferential statistical analysis such as multiple regressions to determine the strength of association between the independent variables and the dependent variable.

The analysis of the data followed the processes of data editing to ensure completeness and consistency of data, and coding of the data into numeric form using SPSS software. The researcher carried out descriptive statistics, comprised of percentages, frequency distributions, means, and standard deviations which was used to reveal patterns through the analysis of the coded data and percentages for independent variables was comprised of Socio-economic factors influencing solid waste management.

Ethical approvals were obtained from the relevant authorities before commencing this research. This included obtaining a research license from the National Commission for Science, Technology and Innovation (NACOSTI). The Research License Number is NACOSTI/P/24/40713. All participants consents were obtained with confirmation of confidentiality and anonymity. The rights and well-being of the respondents was respected and the Researchers adhered to ethical guidelines throughout the study.

RESULTS AND DISCUSSION

This section reports the study results, conclusions and recommendations. This study was done in the major urban centres in the six (6) Sub-Counties of Nandi County which are, Chesumei, Emgwen, Mosop, Nandi Hills, Aldai and Tinderet Sub-counties. Out of 939 respondents that were consulted, 610 individual residents, among them 325 male and 285 female were responded. The response rate was 100 percent denoting good credibility, validity, and quality of the findings which allows for more reliable generalizations about the target population.

Economic Valuation of Solid Waste Management

The constructs measuring economic valuation were comprised of willingness to pay tariffs based on household incomes and gender, which produced a Cronbach's Alpha of 0.79. This indicates that the instrument reliably captures variations in households' willingness to pay.

Economic Valuation of Solid Waste for Enhanced Resource Utilization and Sustainable Waste Management

This sub-section examines the relationship between household monthly income levels and the willingness to pay (WTP) tariffs for solid waste management services. It explores how income influences households' ability and readiness to contribute financially to sustainable waste management systems, highlighting the economic disparities and potential policy implications for equitable service delivery.

Status of payment for solid waste management. When the Individual residents were asked whether they were paying for their solid waste disposal, only 27% of them were paying, while the majority (73%) never paid for solid waste management. On the other hand, equally, most of the Corporate organizations (82%) were not paying for disposal of their solid waste. (See Figures 1a & 1b).

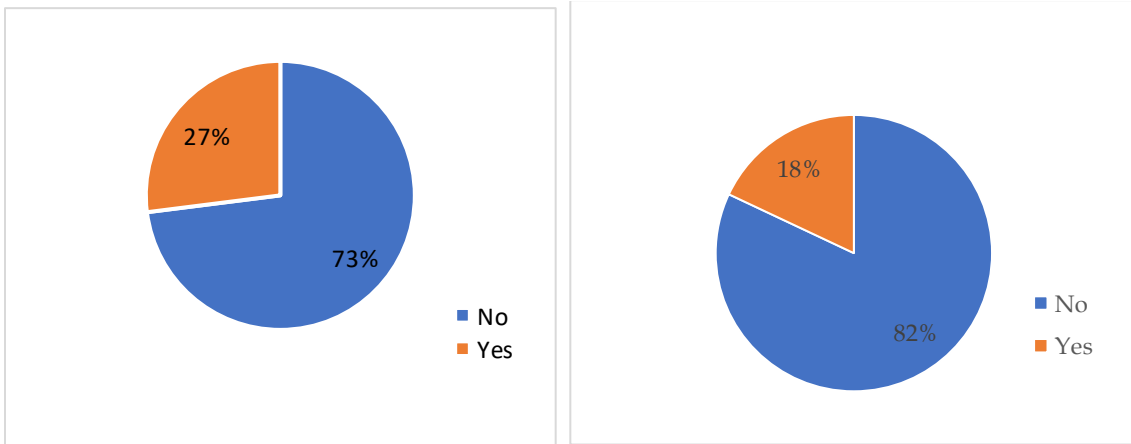


Figure 1(a & b): Status of payment of tariffs for solid waste management

Out of the 166 Individual respondents that were already paying for solid waste management, only 5% were paying to private solid waste collectors while the rest (95%) were being served and therefore paid to the County Government of Nandi. Majority of the monthly payments (73%) ranged between KSh. 3 to KSh. 300. (see Figure 20a). On the other hand, 89% of Individual residents who were served by private waste collectors in waste collection paid between KSh. 100 to KSh. 1,000, which was averagely KSh. 603 (50%) more expensive than the County government charges. (see Figure 2b).

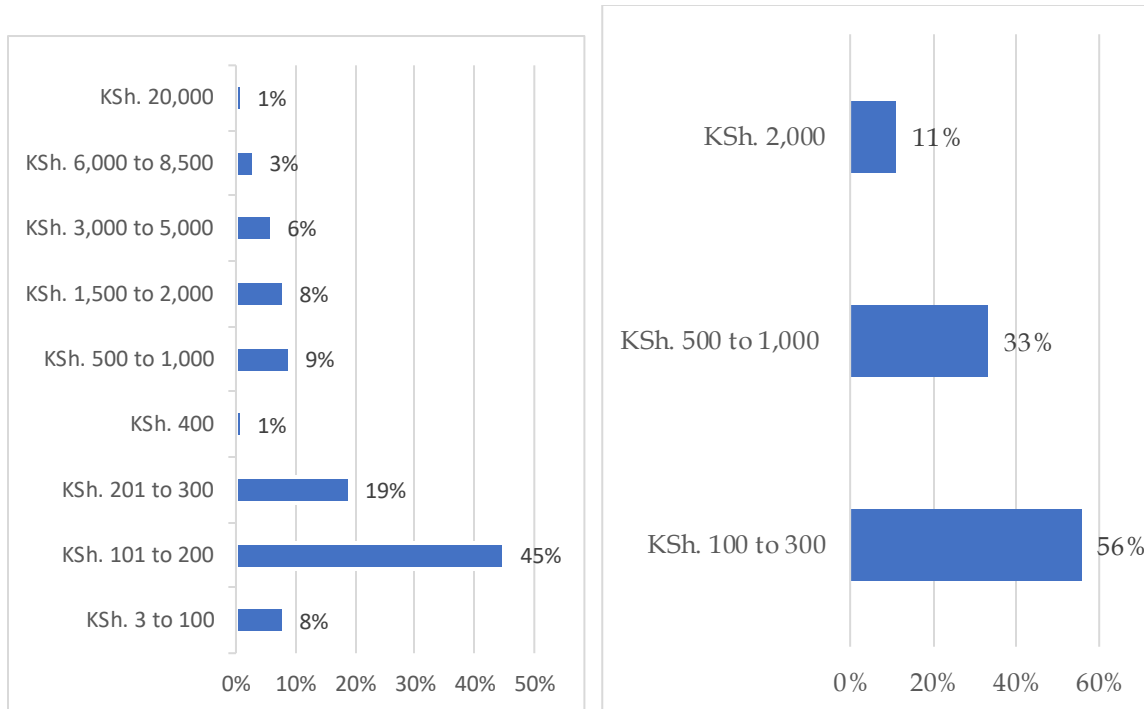


Figure 2 (a & b): Average monthly payment of tariff to County Government & private waste collectors

Reasons given by the unwilling respondents to pay for the solid waste management were as follows: (i) Non-willingness to place a shilling value on the exercise; (ii) Being not well informed about solid waste management; (iii) Inability to pay for improved domestic solid waste management; and, (iv) Perception that solid waste management was of no value. Most of these reasons seemed to be caused by low levels of awareness and indiscipline among residents on the need and value for solid waste management.

Willingness to pay tariff based on household monthly income levels. A question posed on whether the respondents were willing to pay to address the problem of solid waste in the County, the respondents indicated that they were willing to pay a range of between 33% to 60% additional tariff from the currently paid tariff. The category of earners of between KSh. 71,000 to 90,000 recorded the highest WTP at 60% to have the waste management problem addressed, followed by category earning monthly income of between KSh. 91,000 to 100,000 at 50%; thirdly by the category of KSh. 21,000 to 30,000 whose WTP 46%, and lastly by income earners of between KSh. 11,000 to 20,000 with WTP of 35%. This indicates that the high-income earners were leading in WTP than the low-income earners. (See Figure 3).

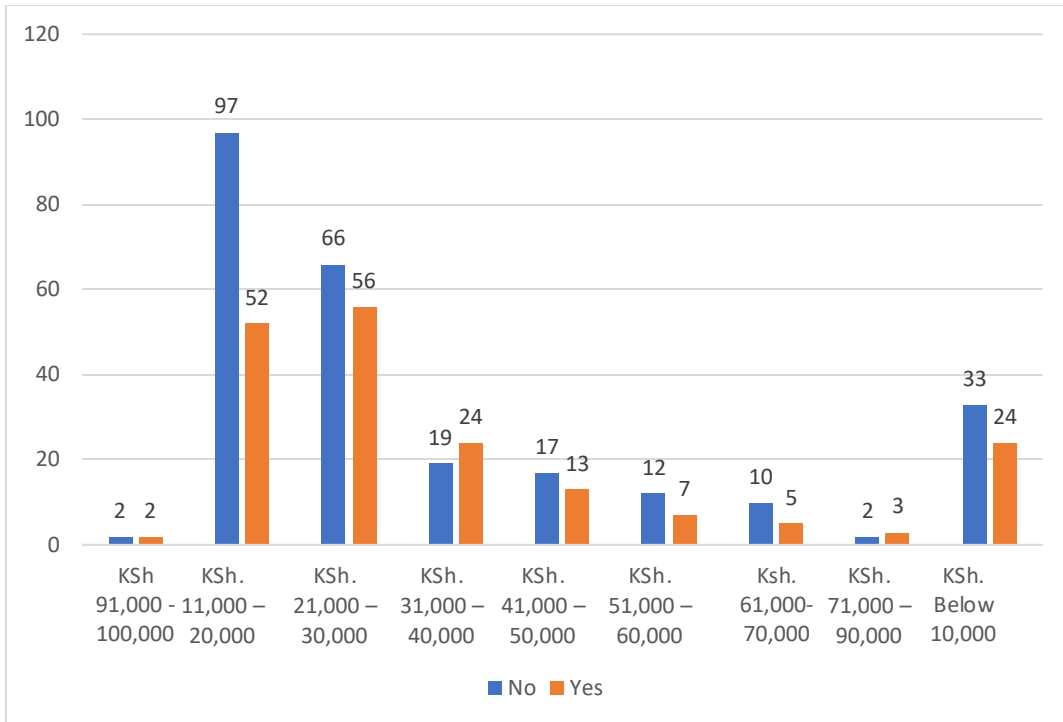


Figure 3: Willingness to pay based on monthly incomes

The findings indicate that willingness to pay (WTP) for addressing solid waste management issues in the county is directly influenced by household income levels. High-income earners, demonstrated the highest WTP at 60%, followed by those in the income bracket of KSh. 91,000 to 100,000 at 50%. This suggests that higher-income households may have more disposable income to allocate toward waste management solutions, reflecting their greater financial capacity to support such initiatives. On the other hand, low-income earners, such as those earning between KSh. 11,000 to 20,000, exhibited a lower WTP at 35%, which could be attributed to financial constraints and competing priorities.

These findings highlight the need for a differentiated tariff structure to ensure equitable access to solid waste management services, balancing affordability for lower-income households while leveraging the higher WTP of affluent groups. The results emphasize the importance of income-sensitive policy-making to achieve sustainable waste management.

Willingness to pay tariff based on Gender category. According to gender categories on the WTP, out of 205 female respondents that previously had not been paying for waste disposal, 91 women (44%) were willing to pay, while on the other hand, out of 239 male respondents, only 95 men (40%) were willing to pay. Therefore, the willingness to pay (WTP) was higher among females than their male counterparts. (see Figure 22).

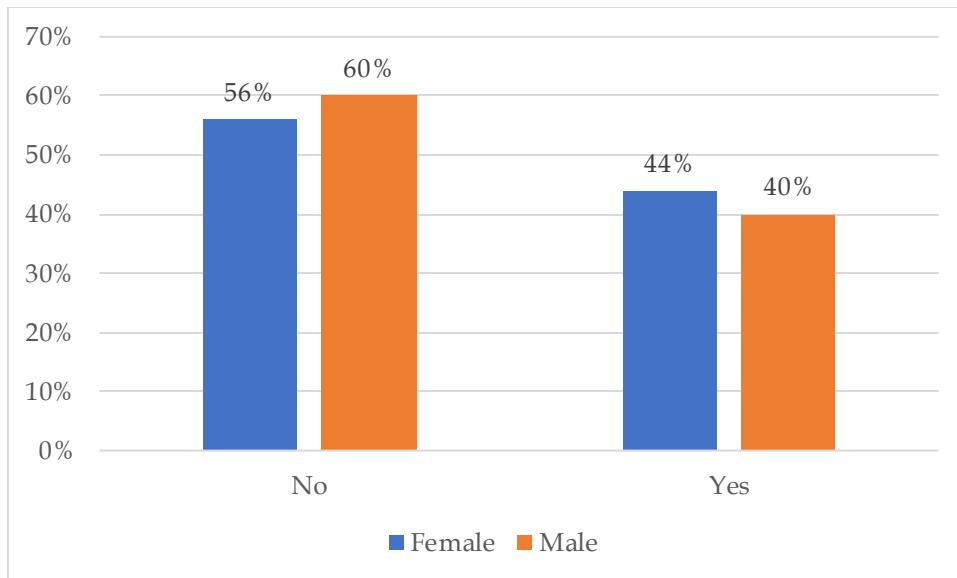


Figure 4 Willingness to pay according to gender

The findings indicate that, in terms of gender, females exhibited a higher willingness to pay (WTP) for solid waste disposal services compared to males. Specifically, 44% of female respondents expressed their willingness to pay, while only 40% of male respondents were willing. This suggests that women were more concerned about and more motivated to contribute to waste management solutions, potentially due to factors such as increased responsibility for household cleanliness and/or a stronger sense of community well-being.

The higher WTP among females could also reflect differences in how men and women perceive environmental and health-related issues, with women being more attuned to the impacts of waste accumulation on their families' health and their living environment. These findings could have important implications for waste management policies and strategies, as gender-targeted approaches would help increase participation in waste management programs, ensuring greater success in waste reduction efforts.

Cumulative Willingness to Pay Additional Tariff - According to the previous *Section above*, the status was that 166 respondents (27%) were already paying for disposal of their solid waste, while 444 respondents (73%) were never paying for solid waste management. Out of the 444 respondents that had never paid for solid waste, expressed interest and Willingness to Pay (WTP) for solid waste management. This therefore means, the cumulative percentage of residents that expressed WTP increased to a total of 352 respondents (58%). That is, a combination of the initial 166 respondents and the additional 186 respondents that expressed WTP.

Among Corporate organizations, 165 out of the 329 respondents (50%) were willing to pay. (See Figures 5a and 5b).

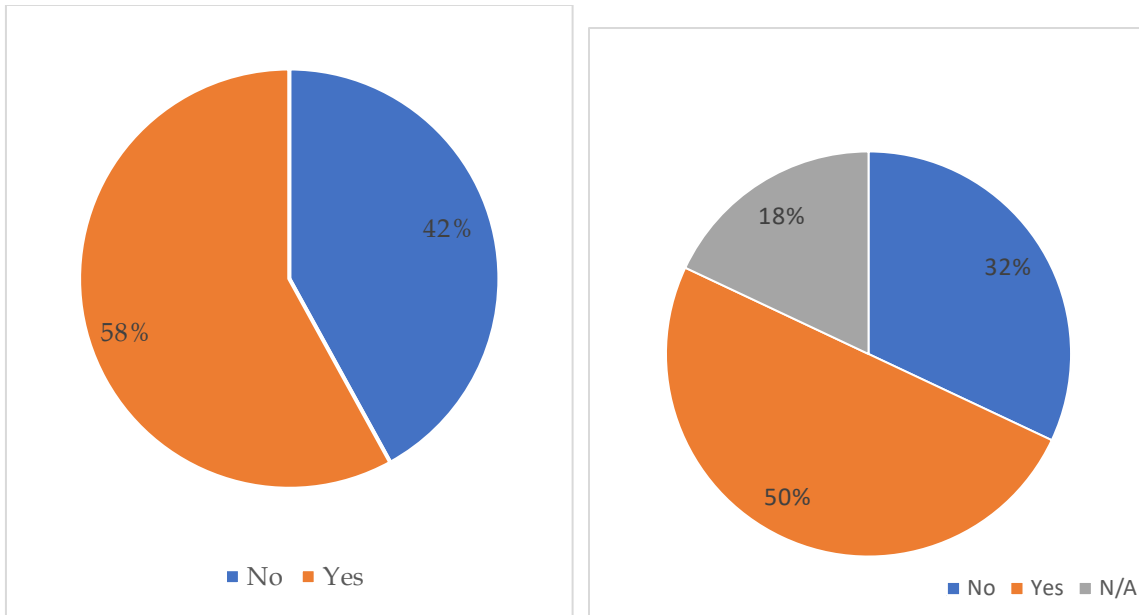


Figure 5 (a & b): Cumulative Willingness to Pay additional tariff

This is a clear indication that with the proposed approaches to address poor solid waste in the County, among the proposed approaches being awareness creation and law enforcement, there is a high likelihood of the rate of Willingness to Pay (WTP) additional tariff, effectiveness and efficiency of solid waste management to increase.

The reasons why some of the residents were not Willing to Pay additional tariff were stated as follows: (i) That the business people were paying for their business licenses and therefore they felt that they already catered for the solid waste disposal fees; (ii) They wanted the County government to take responsibility since as businessmen and women, they were paying for annual business permits and weekly market fees, which they believed should be inclusive of fees for solid waste management; (iii) However, they were ready and Willing to Pay if the services would be better.

4.6.2.5 Maximum monthly tariff Willing to Pay

Majority of the Individual respondents (252 respondents, equivalent to 41%) were willing to pay a maximum of KSh. 300 monthly to facilitate effective solid waste management. This amount (KSh. 300) remains to be the same as that which was being paid by the respondents who were already servicing their solid waste disposal. (Refer to Section 4.12 above, and Figure 24a, below). Three hundred and thirty-eight (338) respondents, equivalent of 55% never committed themselves to any amount. Despite the amount being suggested to be retained at maximum of KSh. 300 monthly, it would be possible to service the solid waste management if many residents/ customers could participate in the monthly payment, wherefore, the County would benefit from economies of scale.

Among the Corporate organizations, 57 of them (18%) were willing to pay a maximum of KSh. 1,000 monthly to facilitate effective solid waste management (see Figure 6b).

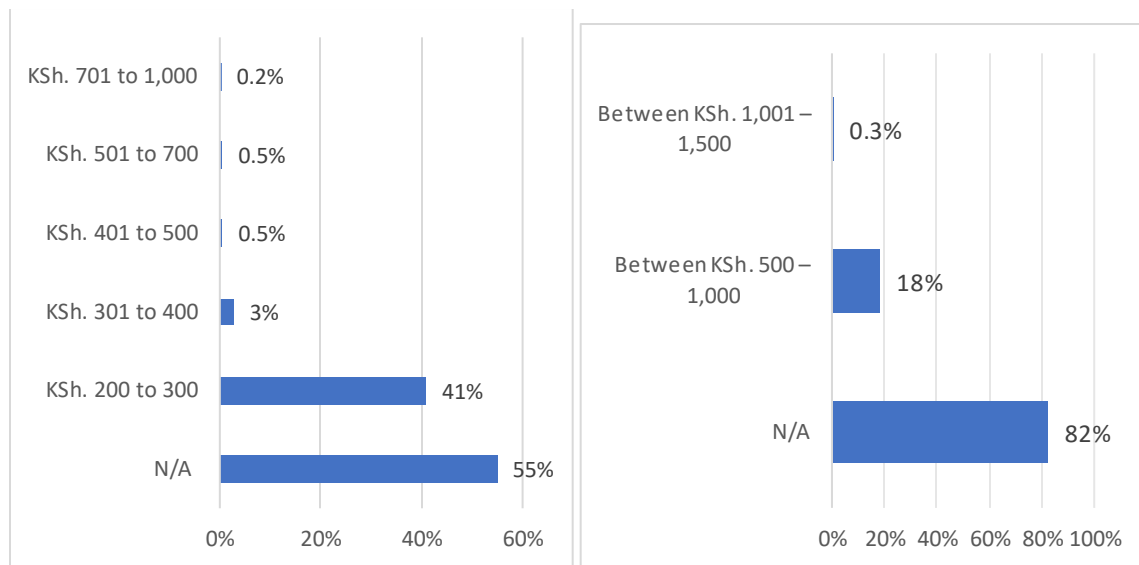


Figure 6 (a & b): Maximum monthly tariff willing to pay

The findings suggest several key implications for solid waste management in the county. The majority of individual respondents (41%) are willing to contribute up to KSh. 300 per month, which is consistent with the amount they were already paying for solid waste disposal services. However, a significant portion of respondents (55%) expressed no commitment to pay any amount for waste management, highlighting a potential challenge in achieving widespread participation. The willingness of individuals to pay KSh. 300 per month, despite the relatively low amount, implies that the community may be open to contributing to waste management, but financial constraints and lack of awareness were the barriers for others. If a larger portion of the population commits to paying this amount, it could provide the county with the economies of scale needed to efficiently manage solid waste services at a lower cost per capita.

Overall, the findings suggest that a combination of individual and corporate participation in waste management payments could enable the county to establish a sustainable waste management system, though efforts to increase individual contributions, especially from those unwilling to pay, was equally necessary for the success of such a program.

Examining Economic Value of Solid Waste Using Regression

Table 1: Regression analysis & Hypothesis testing for Economic value on improved solid waste management

Model	Unstandardized Coefficients		Standardized Coefficients	t	F	Sig.	R Square	95.0% Confidence Interval for B	
	B	Std. Error						Lower Bound	Upper Bound
1 (Constant)	1.740	.088		19.778	3.460	<.001	.37	1.567	1.913
Gender	.001	.037	.001	.029	<.001	.977		-.071	.073
Highest education level	-.045	.022	-.086	-2.059	.977	.040		-.088	-.002
Household monthly income	.035	.012	.121	2.865	.040	.004		.011	.059

- Dependent Variable: Willingness – To – Pay for Improved Solid Waste Management
- Predictors: (Constant); Gender, Highest education level, Household monthly income

$$y = 1.740 + 0.001 - 0.045 + 0.035$$

Where:



y is the dependent variable (WTP for Improved Solid Waste Management)

X_1 is the independent variable (Gender).

X_2 is the independent variable (Education level).

X_3 is the independent variable (Household income level).

A multiple regression was run to predict Willingness – To - Pay for Improved Solid Waste Management from Gender, Education level, Household monthly income. The three variables statistically significantly predicted Willingness – To - Pay for Improved Solid Waste Management; with $F = 3.460$, $R^2 = 0.37$. The R^2 of 0.37 meant that the two independent variables explained up to 37% of the variation of the Dependent variable, and therefore, the regression model is a good fit; while F - value at 3.460 is higher than the critical value of 2.95 in the F table and therefore the regression model is significant.

The findings indicate that the regression analysis has revealed a statistically significant relationship between the three independent variables (Gender, Education level, and Household monthly income) and the dependent variable (Willingness-to-Pay for Improved Solid Waste Management).

The F -value of 3.460, being greater than the critical value of 2.95, confirms that the regression model is significant, meaning that the independent variables collectively provide a meaningful explanation for variations in the dependent variable. This implies that these factors, Gender, Education level, and Household monthly income, play a significant role in predicting individuals' willingness to pay for improved waste management.

The R^2 value of 0.37 suggests that the three variables together explain 37% of the variation in willingness to pay. While this is a moderate explanatory power, it implies that other factors not included in the model could be influencing the willingness to pay, and further research might consider additional variables. Nevertheless, the model is still a good fit, as it indicates that nearly 40% of the variation in willingness to pay can be attributed to these three factors.

In conclusion, the findings highlight those demographic and economic factors such as gender, education level, and household income as important predictors of willingness to pay for improved solid waste management, though additional factors may also contribute to this decision.

CONCLUSIONS AND RECOMMENDATIONS

The study concluded that gender, education level, and household monthly income significantly influence individuals' willingness to pay for improved solid waste management in Nandi County. It recommends strengthening regulations to enforce proper waste disposal and introduce equitable tariff structures. Expanding participation through affordable rates will help achieve economies of scale, ensuring sustainable financing for waste management services.

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