



Socio-Economic Factors Influencing Solid Waste Management in Urban Centres of Nandi County

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ABSTRACT

Rapid population growth, urbanization, industrialization and economic development have resulted in the generation of big volumes of solid waste in Nandi County. Yet solid waste is an economic commodity that may not be optimally allocated through the market mechanism. Most attempts to solve waste problems in Kenya focus on supply-side of waste disposal and collection, which have not been successful. This study examines the following objectives: Assess the effects of education, age, and gender on management of solid waste; evaluate how household incomes influence SWM in Nandi County; examine various policy options in management of urban solid waste in Nandi County. This study is guided by utility theory which provides a valuable framework for understanding and analysing decision-making processes related to waste management practices. Data were collected through stratified sampling of 380 respondents, where interview guides and questionnaires were applied. Key findings reveal that gender and income levels are significant predictors of solid waste generation. High-income earners (KSh. 91,000–100,000 monthly) are the largest waste generators, while low-income earners (<KSh. 30,000) cumulatively generate less. Industrial and packaging-related waste accounts for 37% of corporate waste, followed by tea waste (20%) and market waste (15%), reflecting the dominance of manufacturing and agricultural trade in the region. A multiple regression analysis proved that gender, and monthly household income, collectively explained up to 50% of the variation of solid waste management. These results indicate the need for development of gender-specific strategies and policies that are oriented to income disparities, to improve solid waste management. The study recommends offering incentives for minimization of waste disposal such as waste-to-energy practices for tea companies and establishment of affordable recycling facilities for low-income households and informal sector players.

Keywords: Solid Waste Management, Waste recycling, Waste segregation

INTRODUCTION

More than half of the world's population (55%) lived in urban areas in 2018, a proportion that is expected to increase to 68% by 2050 (Omollo, 2019). In most urban areas of developing countries, solid waste management (SWM) has become a major issue due to rapid population growth and urbanization. Kala *et al.* (2020) observed that municipal solid waste management is one of the most critical problems in the world, and household waste is an essential part of it. Oluranti & Omosalewa (2012) reiterated that Africa is the fastest urbanizing continent having cities like Cairo, Lagos, Nairobi, and Kinshasa, among others, as cities growing at fast rates that would triple their current sizes by the year 2050.

In Nandi County, the sources of solid waste are diverse; wherefore, households generate significant amounts of waste, mainly organic materials, such as food scraps, vegetable peels, and garden waste, alongside inorganic items like plastics, paper, and packaging materials (Kaza *et al.*, 2018). Tum (2024) indicated that food and agrochemical waste constituted about 65% of the county's waste burden, while Guerrero *et al.* (2013) observed that industries contributed to solid waste, mainly through by-products of manufacturing processes, including metals, plastics, and chemical residues. Collectively, these sources underscore the critical need for an integrated solid waste management system in the county that considers the unique composition and volume of waste from each sector.

Rapid population growth, urbanization, industrialization and economic development have resulted in the generation of big volumes of solid waste in Nandi County. Considering that solid waste is an economic commodity that may



not be optimally allocated through the market mechanism, there is need for a system that can not only reduce waste accumulation but also enhance efficient utilization of the resource for improve income opportunities. However, most attempts to solve waste problems in Kenya focus on supply-side of waste disposal and collection, which have not been successful. This study examines the following objectives: Assess the effects of education, age, and gender on management of solid waste; evaluate how household incomes influence SWM in Nandi County; examine various policy options in management of urban solid waste in Nandi County.

This study is guided by utility theory which provides a valuable framework for understanding and analysing decision-making processes related to waste management practices. Since we have insufficient data on how socio-economic factors influencing waste management behaviors, this study intends to leverage on designing inclusive and sustainable solutions to the problem of SW. Hence, this study will provide critical insights to inform policy, enhance community participation, and create innovative solutions to waste management for integrated environmental sustainability.

Conceptual Framework

In the conceptual framework of this study the improved solid waste management is the dependent variable while socio-economic factors influencing solid waste management.

Therefore, 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

MATERIAL AND METHODS

Research Design

This study applied a correlational research design. The correlational research design measures the degree and direction of association between variables using statistical tools such as correlation coefficients. 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 behaviors like recycling, waste segregation, and willingness to pay for formal waste management services. Understanding these relationships provides insights into how socio-economic dynamics influences waste management outcomes (Guerrero et al., 2019).

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

A pilot study was conducted to pre-test the instruments prior to conducting the actual study. Research assistants were trained on the content of the questionnaire and the general research expectations. The study followed the six stages of data processing: 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, observations 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. The independent variable was comprised of Socio-economic factors influencing solid waste management.

Ethical approvals were obtained from the relevant authorities before commencing this research, including obtaining of a research license from the National Commission for Science, Technology and Innovation (NACOSTI). The Research License Number is NACOSTI/P/24/40713. All participants consent was 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 study was carried out in all 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. A total of 939 respondents were consulted. There was a 100 percent response rate which was deemed adequate for further analysis (Saass *et al.*, 2014) and expresses good credibility, validity, and quality of the findings, allowing for more reliable generalizations about the target population.

Socio-Economic Factors Influencing Solid Waste Management

The constructs under socio-economic factors were age, gender, household monthly income levels, education level, and house ownership, which yielded a Cronbach’s Alpha of 0.82. This high reliability suggests that these items cohesively measure the influence of socio-economic factors on solid waste management.

Socio-economic Factors Influencing Solid Waste Management

The socio-economic factors that influenced solid waste disposal and management in the County were comprised of the following: Age; Gender; Household monthly income levels; Education level; and, House ownership.

Findings indicated that age affects attitudes toward waste management; with younger individuals more likely to adopt innovative practices like recycling, while older generations were found to rely more on traditional disposal methods. Gender also plays a role, as women often took primary responsibility for household waste management, influencing practices such as segregation, composting, and disposal. This gendered division of roles was found to impact the efficiency and sustainability of waste management at the household level. Education level is another critical factor, as individuals with higher education were found to have greater awareness of environmental issues and they were more likely to adopt environmentally friendly practices such as waste segregation and recycling. Conversely, lower education levels were associated with limited understanding of proper waste management practices, necessitating targeted awareness campaigns to bridge this gap.

Household income directly affects the capacity to invest in valorization of waste. Higher-income households would afford to pay for waste collection services, and purchase of recycling bins, while lower-income households relied on informal or unsustainable disposal methods due to financial constraints. Finally, homeowners demonstrated greater commitment to maintaining clean environments through proper waste disposal, whereas renters exhibited less engagement due to lack of accountability for waste management infrastructure; hence, leaving that responsibility to the landlords.

Age of individual respondents on solid waste management. The largest generators of solid waste, generating above 10kgs of waste daily, were the Youth of the age between 26 to 35 years at 38%, followed by age group of 36 to 45 years at 25%, while the least category were the old age of over 70 years at 2%. (See Figure 1).

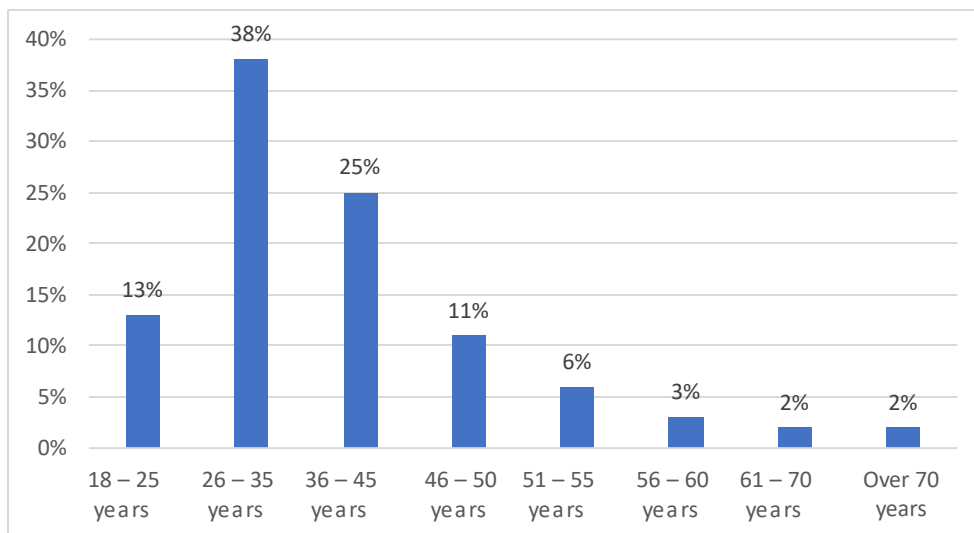


Figure 1: Age brackets on solid waste disposal

These findings imply that solid waste generation in Nandi County was strongly influenced by age demographics.

Following the significant implications for solid waste management strategies, policies and interventions should prioritize targeting younger and middle-aged populations, as they are the primary waste generators in the county. Tailored programs focusing on waste reduction, segregation, and recycling should be designed to engage these active age groups effectively. Additionally, these findings highlight the need for educational campaigns to instill sustainable consumption and disposal habits among the most waste-intensive demographics.

Gender of individual respondents on Solid waste management. Men were found to be the highest generators of waste than their female counterparts. While 40 out of 325 male respondents (12%) of men generated 10kgs and above per day, on the other hand, 24 out of 285 female respondents (8%) of female generated more than 10 kgs of waste per day. This implies that men were the greatest generators of solid waste on a daily basis compared to their female counterparts (see Figure 2).

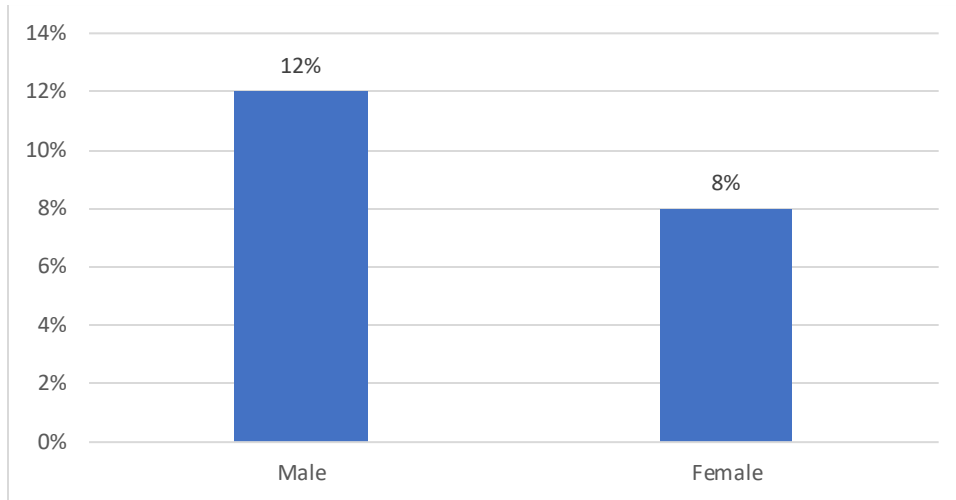


Figure 2: Gender on solid waste disposal

The findings suggest that men are the primary contributors to solid waste generation in Nandi County, as indicated by the higher proportion of men (12%) generating 10kgs or more of waste per day compared to women (8%). The findings imply that men should be involved more in solid waste management initiatives, especially waste reduction, recycling, and responsible consumption behaviours. Policies on solid waste management should also be developed with gender-sensitivity.

Household monthly income levels on Solid waste management. The leading category in generating solid waste per day are the high-income earners of between KSh. 91,000 to 100,000, with 1 out of 4 respondents (25%) generating 10kgs and above per day, followed by the category of KSh. 71,000 to 90,000 where 1 out of 5 respondents (equiv. to 20%) generated 10kgs and above per day. The category with the least generation of waste per day were earning between KSh. 31,000 to 40,000 who were 4 out of 64 respondents (equiv. to 6%). This implies that the high-income earners were in a position to purchase high quantities of goods that end up being disposed of as stale, compared to the least income earners.

However, the high-income earners are few in number (about 2% of the majority category that earn between KSh. 11,000 to 20,000). Therefore, as focus is given to the highest income earners, much more focus should be given to the least income earners of below KSh. 30,000 (who cumulatively are 49 out of 461, equiv. to 11%) to reduce their daily generation of solid waste. (See Figure 3).

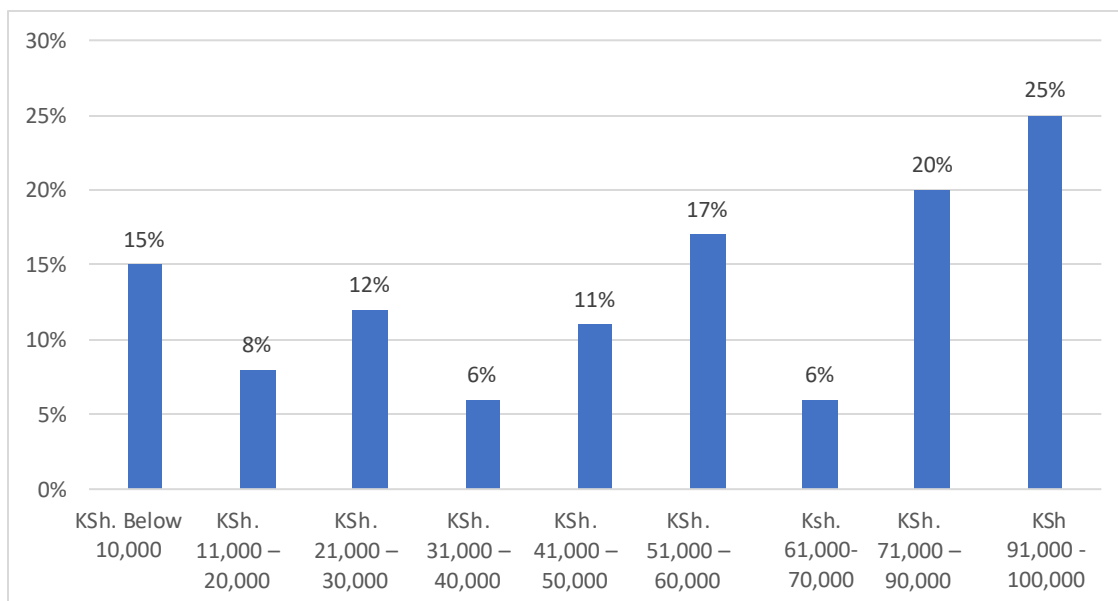


Figure 3: Household income levels on rate of solid waste disposal

The findings indicate that high-income earners are the primary contributors to solid waste generation in Nandi County, with those earning between KSh. 91,000 to 100,000 generating the largest amount of waste (25% of respondents producing 10kgs or more per day). This is followed by the KSh. 71,000 to 90,000 income category, where 20% of respondents generate significant waste volumes.

In contrast, the income group earning between KSh. 31,000 to 40,000 generated the least amount of waste, with only 6% of respondents producing 10kgs or more of waste daily. This lower level of waste generation reflected more modest consumption patterns, possibly due to financial constraints that limited the ability to purchase waste-intensive goods or services.

The implication for solid waste management strategies is that higher-income groups should be specifically targeted for waste reduction initiatives, such as promoting recycling, waste segregation, and composting. These groups could also be encouraged to adopt sustainable consumption practices, given their significant contribution to waste generation. On the other hand, lower-income households, who generate less waste, required more affordable waste management solutions, but they were the majority in number compared to the high-income earner. Therefore, more focus should equally be directed to them to reduce their contribution to waste generation.

Education level on Solid waste management. Majority of the respondents (264 out of 610, equiv. to 43%) had highest education level of college, followed by secondary school level at 207 (34% of respondents), while the least category were 5 Postgraduates (0.8%) (see Figure 4).

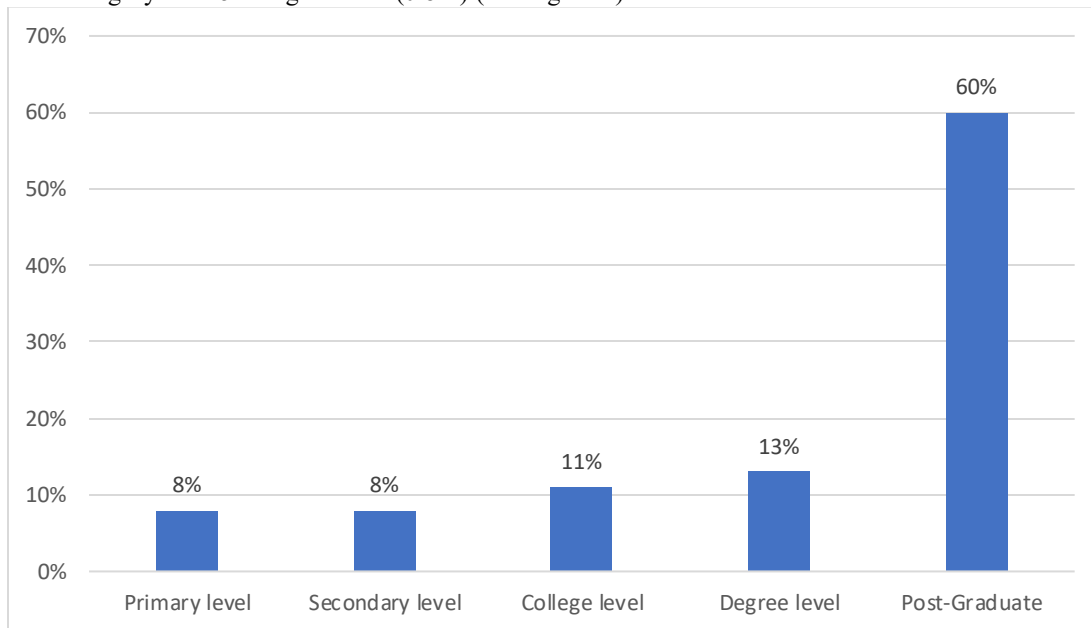


Figure 4: Education level on solid waste deposits

The findings indicate that the majority of respondents in Nandi County had college-level education (43%), followed by those with secondary school education (34%), and a small proportion having postgraduate degrees (0.8%). This educational distribution suggests a relatively well-educated population, with a larger proportion holding post-secondary qualifications, which influences both their awareness of waste management practices and their ability to access and adopt waste management strategies.

Interestingly, the findings show that postgraduate respondents are the highest generators of waste, with 60% of them generating above 10kgs of waste per day, followed by degree holders (13%). The higher waste generation in the more educated categories could be associated with lifestyle factors such as high consumption of packaged goods and involvement with industrial and other activities that generate more waste.

These findings imply that level of education influence both the amount of waste generated and the adoption of improved solid waste management practices. Among the lower educated categories, strategies for waste

management should be focused towards cost-effective waste reduction and recycling methods. The findings underscore the need for development of policies that are education-level-specific.

House ownership on solid waste management. Private house owners led in generation of more solid waste than tenants in rental houses, as evidenced that 29 out of 165 respondents (18%) generated more than 10 kgs per day, compared to 35 tenants out of 445 respondents (equiv. to 8%) (See Figure 5). Private house owners were characterised with high-income levels. Therefore, this result is in agreement with the previous result that high income earners generated more solid waste than their low-income counterparts.

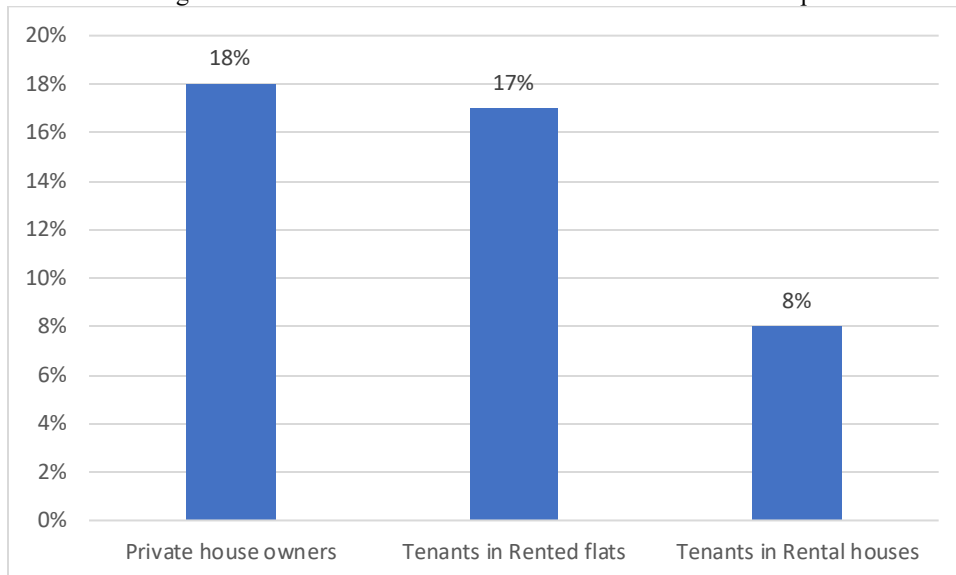


Figure 5: House-ownership in urban areas on solid waste disposal

Main sources of solid waste generated by corporate organizations. These findings underscore the dominance of industrial and agricultural-related waste streams and highlight opportunities for targeted waste management strategies to address these specific types of waste effectively (see Figure 6).

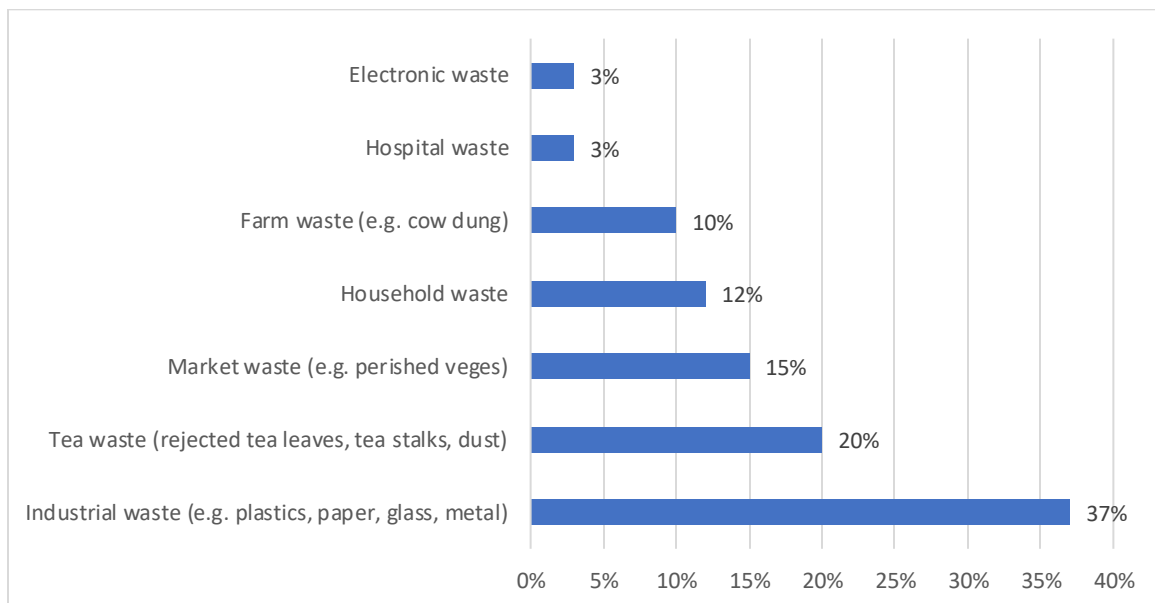


Figure 6: Main types of waste generated by corporate organizations

The implications of these findings are multifaceted and highlight critical areas for waste management interventions in Nandi County, such as:

Industrial waste dominance: With industrial waste constituting 37% of total waste, it underscores the need for robust policies and initiatives to manage non-biodegradable waste, such as plastics and metals. This could involve recycling programs, extended producer responsibility (EPR) initiatives, and public-private partnerships to minimize environmental pollution.

Another area is significance of tea waste: Tea waste, contributing 20%, reflects the prominence of tea production in the county. This presents opportunities for innovative waste utilization, such as converting rejected tea leaves and stalks into compost, animal feed, or energy production through biogas.

Market and household waste: Market waste (15%) and household waste (12%) highlight the prevalence of organic waste, emphasizing the need for composting and organic recycling programs. Establishing collection centres or promoting community-driven composting initiatives could help address these waste streams sustainably.

Farm waste utilization: Farm waste, including cow dung (10%), presents an opportunity for circular economy practices. This waste can be converted into organic fertilizers or biogas, providing both environmental benefits and income-generating opportunities for farmers.

Low hospital and electronic Waste: Hospital and electronic waste, each at 3%, require specialized disposal methods to prevent hazardous impacts. Proper segregation, disposal, and recycling systems for e-waste and medical waste should be prioritized to prevent contamination and protect public health.

Policy and awareness needs: These findings emphasize the need for tailored waste management policies that address specific waste types. Additionally, awareness campaigns targeting households, businesses, and institutions are crucial to enhance segregation at source and encourage waste reduction practices.

Analyzing Socio-Economic Factors' Influence on Solid Waste Management Using Regression

Table 1: Regression analysis & Hypothesis testing for Socio-economic factors on improved solid waste management

Model	Unstandardized Coefficients		Standardized Coefficients Beta	T	F	Sig.	R square	95.0% Confidence Interval for B	
	B	Std. Error						Lower Bound	Upper Bound
1 (Constant)		.172		9.097	4.072	<.001	.50	1.224	1.899
Gender	-.143	.088	-.067	-1.626	<.001	.105		-.315	.030
Monthly income	.025	.028	.036	.882	.105	.378		-.031	.080

- a. Dependent Variable: Quantity of solid waste (Kgs) generated per day
- b. Predictors: (Constant): Gender, Monthly income

$$y = 1.561 - 0.143 + 0.025$$

Where:

- y is the dependent variable (Quantity of solid waste generated per day)
- X₁ is the independent variable (Gender).
- X₂ is the independent variable (Monthly income).

A multiple regression was run to predict Quantity of solid waste (Kgs) generated per day from Gender, and Monthly income. The two variables statistically significantly predicted Quantity of solid waste (Kgs) generated; with F (2.95) = 4.072, R² = 0.50. The R² of 0.50 meant that the two independent variables explained up to 50% of the variation of the Dependent variable, and therefore, the regression model is a good fit; while F- value at 4.072 is higher than the critical value of 2.95 in the F table and therefore the regression model is significant.



CONCLUSIONS AND RECOMMENDATIONS

In conclusion, this study established that gender and monthly income are significant socio-economic factors influencing the quantity of solid waste generated per day in urban centres of Nandi County. The regression model, with an R^2 value of 0.50 and a statistically significant F-value of 4.072, demonstrated a reliable and moderate predictive capability. These findings underscore the importance of integrating socio-economic factors into waste management strategies, particularly through gender-specific approaches and policies tailored to varying income levels.

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