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Households' Willingness to Pay for Improved Solid Waste Management Services: Evidence from Dhangadhi Sub-Metropolitan City, Nepal

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Abstract

Solid waste management (SWM) remains one of the most pressing urban environmental challenges worldwide, particularly in developing countries where rapid urbanization, population growth, and limited municipal capacity have overwhelmed existing waste systems. In Nepal, these challenges have become increasingly visible in medium-sized cities such as Dhangadhi, where inadequate collection and disposal practices pose serious threats to environmental quality and public health. This study examines households' willingness to pay (WTP) for improved SWM services in Dhangadhi Sub-Metropolitan City using primary data collected from 411 households during 2024. The Contingent Valuation Method (CVM) was employed to elicit households' maximum WTP, while a Tobit regression model was used to identify the socioeconomic and service-related factors influencing payment decisions.

Results indicate that approximately 89% of households are willing to contribute financially for better waste management, with reported monthly WTP ranging from NRs. 25 to 100 (mean = NRs. 53.25). Education, household income, home ownership, gender, and satisfaction with current services significantly influence WTP, suggesting that both economic capacity and user experience shape environmental behavior. The study's findings are consistent with evidence from similar urban contexts in South Asia and sub-Saharan Africa, highlighting the critical role of awareness, trust in local institutions, and perceived service reliability in determining household participation. Overall, the results provide empirical insights for local policymakers seeking to design equitable, community-based, and financially sustainable solid waste management systems. This research contributes to the limited empirical literature on household valuation of municipal SWM services in Nepal and other developing urban settings.

Keywords: Solid waste management, Willingness to pay, Contingent Valuation Method, Tobit regression, urban services

Introduction

Rapid urbanization has become a defining feature of developing and least-developed countries, exerting significant pressure on urban infrastructure and service delivery systems (Aryal & Adhikary, 2024). Among the critical challenges associated with this urban

expansion is the management of municipal solid waste (SWM), which has become increasingly complex due to the rising population density, changing consumption patterns, and growing economic activities in urban centers (Gebreeyosus, 2018). As cities expand, they generate large quantities of waste that must be efficiently collected, transported, and disposed of to maintain environmental health and urban livability. However, in most developing countries, including Nepal, the institutional capacity and financial resources of local governments are insufficient to address these challenges effectively.

Solid waste management is essential for public health, environmental protection, and sustainable urban development. Inefficient waste management systems often lead to indiscriminate dumping, roadside burning, and contamination of soil and water resources, severely affecting human health and environmental quality (Bhardwaj et al., 2020). Despite its importance, SWM has historically received less policy attention compared to other urban environmental issues such as air pollution and wastewater treatment (Girma at al., 2022). Even where municipalities allocate a substantial portion of their budgets to waste management, only 50–70% of residents receive waste collection services, and a large share of the generated waste remains uncollected (Abdel-shafy et al., 2018). Consequently, uncollected waste is often burned or disposed of in open spaces and waterways, exacerbating environmental degradation and posing serious health risks to urban populations (Sembiring & Nitivattananon, 2010).

In Nepal, the Solid Waste Management Act of 2011 assigns local bodies including metropolitan and sub-metropolitan cities the responsibility for providing waste collection and disposal services. These services can be managed directly by local governments, outsourced to private or community organizations, or operated under public-private partnerships. Service providers are authorized to levy user fees to recover costs and ensure sustainability (Government of Nepal, 2011). However, due to inadequate technical and financial resources, most municipalities struggle to deliver consistent and efficient SWM services (Bhattarai et al., 2017). Budgetary constraints, lack of trained personnel, and inadequate infrastructure further aggravate the problem (Ren et al., 2020). As a result, large amounts of waste remain unmanaged, contributing to air, water, and soil pollution (Bharadwaj et al., 2020).

The challenge of SWM is particularly acute in Dhangadhi Sub-Metropolitan City, one of the major urban centers in far-western Nepal. The city has experienced rapid urbanization over the past decade, resulting in increased household and commercial waste generation. However, the waste collection and disposal system remains inefficient, with irregular collection schedules, limited coverage, and insufficient disposal facilities. Many households resort to open dumping and burning, reflecting both infrastructural deficiencies and limited public awareness about proper waste disposal practices. Despite these challenges, households' participation in waste management through behavioral change and willingness to contribute financially remains a potential solution for sustainable urban sanitation.

Understanding households' willingness to pay (WTP) for improved SWM services is therefore essential. Measuring WTP helps policymakers assess the potential for cost recovery and the feasibility of introducing user-based service charges that reflect public preferences (Tassie & Endalew, 2020). From an economic perspective, assessing WTP provides insight into the perceived value of public goods such as SWM, which are non-excludable and non-rival in nature (Afroz et al., 2009). Since SWM services are not traded in conventional

markets, the Contingent Valuation Method (CVM) has been widely used to estimate the monetary value residents assign to improved waste management (Afroz et al., 2009). This valuation enables municipalities to design efficient pricing mechanisms, allocate resources effectively, and implement demand-driven waste management strategies (Tassie & Endalew, 2020).

Empirical studies from developing countries have consistently shown that a significant proportion of households are willing to pay for improved SWM services. For instance, Parini, (2022) found that 79.8% of households in Kathmandu, Nepal, were willing to pay for better waste collection services, while Afroz et al. (2009) reported an average WTP of 13 Bangladeshi Taka per month in Dhaka City. Similarly, Ezebilo (2013) found that over 80% of respondents in Nigeria supported residential waste management services, with a mean WTP of USD 24 per year. These findings underscore that when residents perceive the benefits of improved waste management, they are often willing to contribute financially to sustain such services.

In the Nepalese context, empirical evidence on WTP for improved SWM remains limited. While several municipalities have introduced nominal garbage fees, these are often irregularly collected, poorly enforced, and insufficient to cover operational costs. Moreover, there is limited research examining the socio-economic determinants of WTP for improved SWM at the household level. Given the growing urbanization pressures and environmental concerns in Dhangadhi, understanding the economic and behavioral aspects of residents' participation in waste management is crucial for designing sustainable policies and user-based cost recovery mechanisms.

Dhangadhi Sub-Metropolitan City has undertaken several initiatives to improve the efficiency of solid waste management (SWM) in response to rapid population growth and accelerating urbanization. However, the overall performance remains inadequate, as uncollected waste continues to accumulate along streets, in marketplaces, and around residential areas. This situation underscores the need for inclusive and sustainable waste management strategies that ensure equitable benefits, particularly for vulnerable communities. Streamlining various components of the waste management system can lead to more effective waste disposal while optimizing the use of limited financial resources.

Against this backdrop, the present study aims to assess households' willingness to pay (WTP) for improved solid waste management services in Dhangadhi Sub-Metropolitan City, Nepal. Specifically, it seeks to (i) examine the current status of SWM in the study area, (ii) estimate households' WTP for improved services, and (iii) identify the socio-economic and perceptual factors influencing WTP. By doing so, this study contributes to evidence-based policymaking for sustainable urban waste management and provides empirical insights into the potential for demand-side financing in Nepalese municipalities.

Methodology

Study Area

This study was conducted in Dhangadhi Sub-Metropolitan City, the administrative center of Sudurpashchim Province, Nepal. Located in Kailali District at an altitude of 109 m (28°41′–28°44′ N, 80°33′–80°37′ E), the city covers 271.74 km² and is divided into 19 wards.

Established as a municipality in 1976 and upgraded to sub-metropolitan status in 2015, Dhangadhi lies 750 km west of Kathmandu and shares its southern border with India. According to the 2021 Census, it has a population of 204,788 across 32,249 households, with a near-equal gender distribution. As one of the fastest-growing urban centers in far-western Nepal, the city faces mounting challenges in solid waste management due to rapid population growth, rural urban migration, and increasing waste generation. Constraints such as limited landfill capacity, inadequate segregation, and irregular collection heighten environmental and public health risks, making Dhangadhi a critical case for assessing households' willingness to pay (WTP) for improved solid waste management services.

Study Design and Sampling Procedure

This study employed a cross-sectional research design based primarily on primary data, supplemented by secondary sources such as published reports and journal articles to strengthen contextual understanding. Data collection was conducted between June and July 2025 after obtaining formal authorization from the Dhangadhi Sub-Metropolitan City Office. A structured questionnaire was administered through direct household surveys to collect relevant information. A multi-stage stratified random sampling technique was adopted to ensure representativeness. In the first stage, Dhangadhi Sub-Metropolitan City was purposively selected due to its rapid urban expansion and escalating challenges in solid waste management. In the second stage, five wards (Wards 2, 5, 8, 13, and 19) were purposively chosen to capture areas characterized by higher population density and visible waste accumulation. According to the National Population and Housing Census, 2021, Dhangadhi consists of approximately 32,249 households. Among these, the five selected wards comprise around 11,620 households, which constituted the sampling frame for this study. The required sample size was determined using the Cochran (1977) formula for sample size estimation, expressed as: $n_0 = \frac{(Z)^2(p)(1-p)}{(e)^2}$

$$= \frac{(1.96)^2(0.5)(1-0.5)}{(0.05)^2}$$

$$= 384$$

Where n_0 denotes the initial sample size, Z represents the standard normal value corresponding to a 95% confidence level (1.96), p is the assumed proportion of households willing to pay for improved solid waste management services, and e indicates the margin of error, set at 5%. The final adjusted sample size incorporated the finite population correction and an allowance for potential non-response to enhance statistical reliability. Consequently, the effective sample size for this study was 411 households.

A structured questionnaire, adapted from Bhattarai (2015) with contextual modifications, was developed to achieve the study objectives. A pilot survey involving 40 households in Dhangadhi Sub-Metropolitan City was conducted to test its reliability and clarity. Feedback from the pilot led to revisions in question sequencing and wording. Based on the pilot results, four bid amounts NPR 25, 50, 75, and 100 per month were established for the contingent valuation exercise. The contingent valuation (CV) scenario formed the core of the questionnaire, providing respondents with a realistic description of the proposed improved solid waste management (SWM) service. The scenario stated that waste would be collected by a truck or tractor two times a week on predetermined days. The vehicle would

stop briefly at designated junctions while collectors visited each household to collect waste containers or plastic bags, emptying containers neatly at the curbside. Residents would simply place their waste outside before collection, and in return for this improved service, households would be required to pay a fixed monthly fee to the service provider. This scenario ensured respondents clearly understood the nature of the proposed service, allowing for accurate elicitation of their willingness to pay (WTP) under the contingent valuation framework.

Empirical Model

This study applies the Contingent Valuation Method (CVM), a well-established stated preference technique used to estimate households' willingness to pay (WTP) for non-market environmental services. CVM constructs a hypothetical market framework that allows respondents to express their preferences for improved environmental quality, such as enhanced waste collection and disposal (Adhikari et al., 2017). Unlike revealed preference methods, CVM directly elicits monetary valuations of service improvements, providing a reliable measure of user demand and perceived benefits (Adhikari et al., 2017).

CVM is particularly appropriate for urban public goods like solid waste management (SWM) services, where market signals are absent. It captures the full range of benefits including health, aesthetic, and environmental gains thereby supporting integrated SWM planning (Tassie & Endalew 2020). This study adopts a single-bounded dichotomous choice design, followed by an open ended question to refine WTP estimates and reduce starting-point bias (Maskey & Singh 2017). Respondents were asked whether they would pay a proposed bid for improved SWM services, consistent with the utility framework (Khadka, 2023). The resulting WTP estimates reflect households' perceived value of service enhancements and provide key insights for designing cost-recovery schemes and financially sustainable SWM systems. Applying CVM in Dhangadhi Sub-Metropolitan City provides evidence to guide municipal policy decisions, promote community-based waste initiatives, and strengthen demand-side financing mechanisms essential for achieving sustainable urban waste management in Nepal and other developing countries.

Tobit Model

To identify the determinants of households' willingness to pay (WTP) for improved solid waste management (SWM) services, this study employs the Tobit regression model. Originally proposed by Tobin (1958), the Tobit model is appropriate when the dependent variable is censored, as in WTP data where many responses are zero. Unlike Logit or Probit models, which handle binary outcomes, the Tobit model utilizes both the probability of participation and the intensity of payment, yielding unbiased and consistent estimates (Vij, 2012; Girma et al., 2022). In the context of SWM, WTP values derived from open-ended contingent valuation responses are typically continuous but truncated at zero, justifying the use of Tobit regression (Upadhyay, 2022; Thapa et al., 2022). The model captures how demographic and socio-economic factors jointly influence both the likelihood of being willing to pay and the magnitude of the stated amount (Getachew & Fufa, 2018). Formally, the Tobit model is specified as:

$WTP_i^* = \beta X_i + \mu_i, \quad \mu_i \sim N(0, \sigma^2)$

Where WTP_i^* is a latent (unobserved) variable representing the household's true willingness to pay, Xi is a vector of explanatory variables, β is a vector of coefficients, and μ_i is a normally distributed error term. The observed variable WTPi is defined as:

$$WTP_i = \begin{cases} WTP_i^*, & \text{if } WTP_i^* > 0 \\ 0, & \text{if } WTP_i^* \leq 0 \end{cases}$$

The model parameters are estimated using maximum likelihood estimation (MLE). The Tobit specification allows simultaneous assessment of (i) the probability that a household is willing to pay and (ii) the expected payment amount, conditional on being willing to pay. The mean WTP for the sample is calculated as the arithmetic mean of the reported WTP values.

The log-likelihood function for the Tobit model is given by (Khadka, 2023)

$$\log L = \sum_{Y_i>1} -\frac{1}{2}\left[log(2\pi) + log\sigma^2 + \frac{(Y_i - X_i\beta)^2}{\sigma^2}\right] + \sum_{Y_i=0} log\left[1 - \phi\left(\frac{X_i\beta}{\sigma}\right)\right]$$

Where, ϕ is the standard normal cumulative distribution function. The maximum likelihood estimates of the parameters are calculated by maximizing the likelihood function with respect to β and σ. In the case of open- ended questions, the mean value of WTP can be calculated by averaging the total amount that the households are willing to pay, which is given as:

$$\textbf{Mean WTP} = \frac{1}{n}\sum_{i=1}^{n} Y_i$$

Where, n is the sample size, and each Y is a reported WTP. A wide range of factors can influence households' willingness to pay (WTP) for improved solid waste management (SWM) services. Based on theoretical insights from environmental economics and empirical evidence from valuation studies in developing-country settings (Shahzadi et al 2018), the explanatory variables included in the Tobit model were selected to reflect both economic capacity and behavioral attitudes (Khadka, 2023). Economic variables such as income, education, and household size represent the ability and opportunity cost dimensions of WTP, while perceptual factors such as satisfaction with existing SWM, perceived importance of environmental quality, and awareness of waste-related health risks capture the behavioral and informational aspects of decision-making. Table 1 provides a detailed description of the variables used in the model, including their definitions, measurement scales, and hypothesized effects on WTP.

Table 1: Variables and Definitions

Variable	Description	Mean	VIF
Bid amount	Respondents were offered monthly garbage fee ranging from Rs 25 to Rs 100 per month	Rs 53.234	1.12
Age	Age of the respondent in years	43 years	1.27
Gender	Sex of the respondent (Male = 1; otherwise = 0)	0.367	1.10
Household size	Household size of the respondent, i.e., total no. of people living in respondent's household	5.428	1.09

Education	Highest level of education attained by the respondent Non formal education = 1, secondary level education = 2, bachelor degree and above =3,	0.574	1.80
Marital status	Marital status of respondent; married = 1 otherwise = 0	0.936	1.14
Present waste collection service	Waste collection service received by respondent; yes = 1, otherwise = 0	0.51	1.22
Household income	Monthly household income of respondent in Rs	16496.35	1.73
Ownership of house	Ownership of house 1= Own house; 0 = In rent	1.22	0.52
Solid waste problem	The problem of solid waste collection 0 = There is no problem, 1 = Yes, there is problem.	1.23	0.63
Frequency of collection	Frequency of collection service 1 = Once a week; 2 = Otherwise	1.929	1.10
Service Satisfaction	Level of satisfaction with current collection service 1 = Very satisfied; 2 = Not satisfied	1.32	1.21
Mean VIF			1.30

Source: Author's creation.

Based on the given variables discussed in the table 1, the final regression model can be expressed as:

WTPi = α + β1 bid amount + β2 age + β3 sex + β4 household size + β5 education + β6 marital status + β7 waste collection service +β8 household income + β9 ownership of house + β10 waste problem +β11 frequency of collection +β12 Service Satisfaction + ui

Where α is the constant and βi are the coefficients of explanatory variables.

Results and Discussion

Socio-Demographic and Economic Characteristics of Respondents

A total of 411 households were surveyed, yielding a high response rate of 93%, which enhances the representativeness and reliability of the findings. Of these, 90.27% of respondents expressed a willingness to pay (WTP) for improved solid waste management (SWM) services, while 9.73% were unwilling to pay. This high level of positive response suggests broad recognition of the importance of improved waste management in Dhangadhi Sub-Metropolitan City. The mean bid amount offered for monthly waste collection was NPR 53.23, with proposed fees ranging from NPR 25 to NPR 100. The average household income was NPR 16,496 per month, reflecting a predominantly low to middle-income urban population. The mean household size was 5.43 persons, and the average age of respondents was 43 years, indicating that middle-aged individuals largely represent household decision-makers. Approximately 36.7% of respondents were male, and 93.6% were married, which implies stable household structures and shared responsibility in waste management decisions. The educational attainment level averaged 0.57 on a scale from 1 (non-formal) to 3 (bachelor's degree or above), showing moderate literacy levels among respondents. About 51% of households reported receiving regular waste collection services, though only 1.32 (on a scale of 1–2) expressed satisfaction, suggesting room for service quality improvement.

In terms of housing characteristics, most respondents owned their homes (mean = 1.22), while the average frequency of waste collection was once per week (mean = 1.93). A large proportion of participants reported solid waste problems in their neighborhood (mean = 1.23), highlighting inefficiencies in the current waste management system. The mean Variance Inflation Factor (VIF) across explanatory variables was 1.30, well below the conventional threshold of 10, indicating no significant multicollinearity among the variables included in the model.

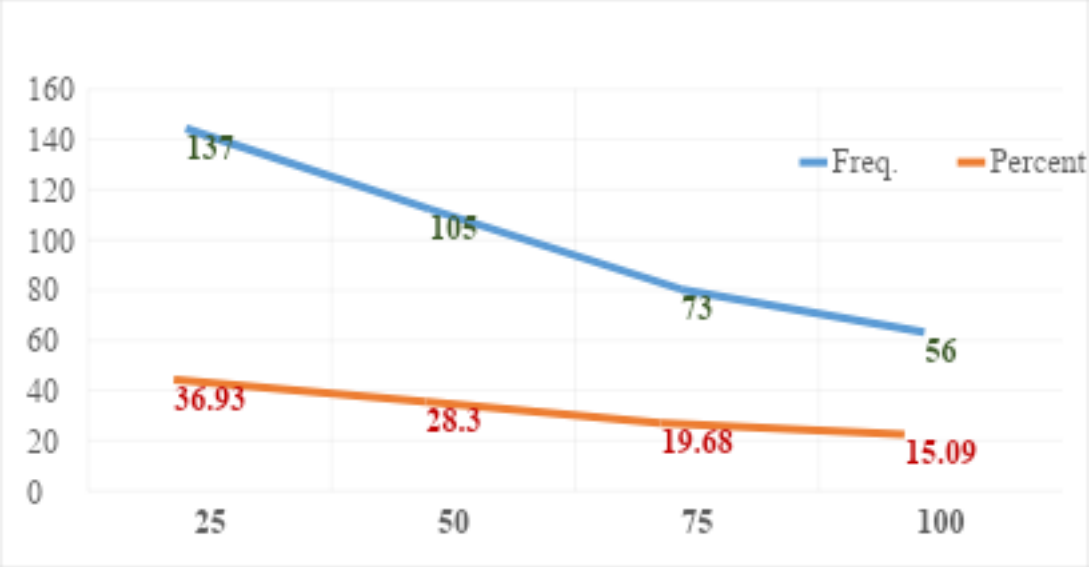
These socio-demographic trends are broadly consistent with findings from similar urban contexts in South Asia and sub-Saharan Africa. For example, studies by Khadka, (2023) in Nepal, Suthar and Singh (2015) in India, Afroz et al. (2009) in Bangladesh, and Ma et al., (2017), in China also reported that middle-aged, married, and moderately educated household heads exhibited higher awareness and WTP for improved waste services. Similarly, Kassim and Ali (2006) in Tanzania found that household income and family size were key determinants shaping public participation in municipal waste programs. The current results, therefore, align with the general empirical evidence that socio-economic status and service satisfaction strongly influence households' WTP for better solid waste management (Kim & Kim 2023).

Table 2: Household Solid Waste Generation, Satisfaction, and Environmental Awareness (Dhangadhi Sub-Metropolitan City, Nepal)

Variables	Description	Frequency (%)
Solid waste generated (per week)	< 5 kg	265 (64.47)
	6 kg to 15 kg	c. (24.57)
	> 15 kg	45 (10.95)
Perceived satisfaction (n = 411)	Not very satisfied	17 (4.14)
	Not satisfied	34 (8.27)
	Neutral	25 (6.08)
	Satisfied	115 (27.98)
	Very satisfied	220 (53.53)
Awareness about the environment	Good awareness	270 (65.67)
	Poor awareness	141 (34.30)

Source: Author's calculation, 2025.

The majority of households (64.5%) generated less than 5 kg of waste per week, while 11.0% produced over 15 kg. Most respondents were satisfied with current services (53.5% very satisfied, 28.0% satisfied), although approximately 12.4% expressed neutral or negative satisfaction. Environmental awareness was relatively high, with 65.7% of households demonstrating good awareness of proper waste management practices. These findings underscore the importance of integrating service quality improvements with community awareness programs to enhance participation and WTP for solid waste management in Dhangadhi Sub-Metropolitan City.



Source: Author's calculation, 2025.

Figure 1: Effect of increase in bid amount on the improved solid waste management

The Tobit regression results (Table 3) reveal several key determinants influencing households' willingness to pay (WTP) for improved solid waste management (SWM) services in Dhangadhi Sub-Metropolitan City. The overall model is statistically significant (Prob > χ^2 = 0.000), confirming that the explanatory variables collectively affect WTP. The Gender variable is statistically significant at the 1 percent level. Since male respondents were coded as 1 and female as 0, the positive coefficient (31.53) indicates that male respondents exhibit higher WTP for improved SWM than females. This aligns with Chinh et al. (2021) and Khatoon, (2020) found similar gender-based differences in WTP behavior.

The Age and Household Size variables are negative but not statistically significant, suggesting that these demographic factors have minimal influence on payment decisions. In contrast, House Ownership is positive and significant at the 1 percent level (β = 49.44), implying that homeowners are more willing to contribute to SWM improvement than tenants. This reflects stronger place attachment and property-related concern for environmental cleanliness. The Education Level of respondents is highly significant ($p < 0.01$) with a coefficient of 20.78. Each higher level of education increases WTP by roughly 21 units, suggesting that education enhances environmental awareness and appreciation of service quality. Similarly, Household Income positively affects WTP (β = 18.26, $p < 0.01$), confirming that households with higher earnings are more capable and willing to pay for better waste collection services. This finding is consistent with Mulat et al. (2019).

Finally, Service Satisfaction is significant at the 1 percent level, demonstrating that satisfied users are more willing to pay to maintain or enhance service standards. Overall, the findings highlight that socioeconomic capacity (income, education, ownership of house) and service perception (satisfaction) are the principal drivers of WTP for improved SWM services. Policymakers should therefore emphasize public awareness, equitable tariff systems, and customer satisfaction to strengthen sustainable waste management financing in urban Nepal.

Table 3: Tobit regression results of factors affecting willingness to pay for improved waste management services

VARIABLES	Max WTP		
Age	-0.564	Ownership of house	49.44***
	(1.878)		(13.94)
Gender	84.06*	Solid waste problem	18.26***
	(42.81)		(4.37)
Marital_Status	-125**	Frequency of collection	-19.21***
	(87.53)		(9.7)
Education	0.375***	Service Satisfaction	16.90***
	(0.067)		(5.54)
HH_size	-19.50**	Constant	-149.6
	(9.898)		(128.3)
HH_Income	6.19***	Prob > chi2	0.000
	(1.35)	Pseudo r-squared	0.028
WCS	50.21**	Akaike crit. (AIC)	5547.530
	(22.50)	Bayesian crit. (BIC)	5587.716
	(21.41)	Observations	411

*** *p<.01, ** p<.05, * p<.1*

Source: Author's calculation, 2025.

Conclusion

The study findings confirm that households in Dhangadhi Sub-Metropolitan City demonstrate a clear willingness to pay (WTP) for improved solid waste management (SWM) services, although the amount they are willing to contribute varies across socioeconomic and service-related factors. Education, household income, and service satisfaction emerged as the most influential determinants of WTP. The strong positive association between education and WTP suggests that enhancing public environmental awareness through education and outreach programs can significantly improve participation in waste management initiatives. Hence, local governments should prioritize continuous community education campaigns and ensure access to schooling for all children, as education fosters long-term behavioral change toward environmental stewardship. Income level also plays a critical role, indicating that households with higher earnings are more capable of supporting service costs. Therefore, implementing income-generating and livelihood-improvement programs can indirectly strengthen households' capacity to contribute financially to sustainable SWM systems. Furthermore, service quality and user satisfaction were found to directly affect payment willingness. Improving the reliability, frequency, and efficiency of collection services would not only enhance public trust but also justify moderate fee adjustments to maintain cost recovery and service sustainability.

Overall, the results emphasize that an integrated and participatory approach is essential for effective SWM in urban Nepal. Local governments should design policies that combine infrastructural improvement, financial incentives, and public awareness initiatives. Introducing equitable and transparent user-fee systems, along with targeted subsidies for low-income households, could ensure both social fairness and environmental sustainability. Strengthening institutional capacity and citizen engagement will ultimately lead to cleaner, healthier, and more resilient urban environments.

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