

Economic Valuation of Household Waste Transportation in Yogyakarta City, Indonesia: A Contingent Valuation Approach

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ABSTRAK

Penelitian ini mengkaji aspek ekonomi pengelolaan sampah di Kota Yogyakarta dengan membandingkan Kemampuan Membayar (ATP) dan Kesiediaan Membayar (WTP) rumah tangga. Menggunakan data survei dan analisis regresi Tobit, riset ini mengestimasi nilai ATP dan WTP, serta mengidentifikasi faktor-faktor yang memengaruhinya. Hasil analisis menunjukkan fenomena penting: nilai WTP masyarakat secara konsisten lebih tinggi daripada kemampuan (ATP) mereka. Artinya, masyarakat sebenarnya sangat peduli dan bersedia membayar mahal untuk layanan persampahan, namun terhalang oleh keterbatasan finansial yang nyata. Selain itu, aturan yang menguras tenaga, seperti kewajiban memilah sampah untuk bank sampah, terbukti menurunkan WTP karena masyarakat menganggap usaha fisik tersebut sebagai beban tambahan. Mengingat Kota Yogyakarta belum memiliki standar tarif yang merata, riset ini memberi gambaran bahwa penerapan tarif seragam di masa depan akan sangat tidak adil. Tarif seragam akan membebani masyarakat miskin dan justru menguntungkan rumah tangga kaya. Oleh karena itu, pemerintah disarankan menerapkan tarif progresif dengan sistem subsidi silang, dengan rumah tangga kaya membayar lebih untuk meringankan beban kelompok rentan. Skema pendanaan yang adil ini mutlak diperlukan agar proyek Kerja Sama Pemerintah dan Badan Usaha (KPBU) pada Rencana Induk Persampahan 2022–2031 Kota Yogyakarta dapat berjalan secara layak dan berkelanjutan.

Kata kunci: *ability-to-pay, willingness-to-pay, contingent valuation method, tata kelola sampah, Kota Yogyakarta*

ABSTRACT

This study examines the economic aspects of solid waste management in Yogyakarta City by comparing households' Ability to Pay (ATP) and Willingness to Pay (WTP). Using survey data and Tobit regression analysis, this research estimates ATP and WTP values and identifies their underlying determinants. The findings reveal a crucial phenomenon: WTP consistently exceeds ATP. This indicates that while citizens highly value waste services and are willing to pay more, they are restricted by their actual financial capacity. Furthermore, demanding physical obligations, such as mandatory sorting for waste banks, significantly reduce WTP because households perceive this manual effort as an added burden. Given that Yogyakarta City currently lacks a standardized tariff system, this study warns that implementing a uniform flat-rate tariff in the future would be highly inequitable. A flat-rate system would severely burden vulnerable groups while disproportionately benefiting wealthy households. Therefore, the government is advised to implement a progressive, tiered tariff system. Through cross-subsidization, wealthier households would pay a premium to subsidize low-income populations. This equitable financing scheme is absolutely necessary to ensure the commercial viability and sustainability of Public-Private Partnership (PPP) projects under the 2022–2031 waste management masterplan.

Keywords: *ability-to-pay, willingness-to-pay, contingent valuation method, waste management, Yogyakarta City*

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1. INTRODUCTION

Waste management has unequivocally emerged as one of the most critical environmental and socio-economic challenges in developing economies,

primarily driven by rapid urbanization, population growth, and shifting consumption patterns (Ferronato & Torretta, 2019; Waluyo & Kharisma, 2023). In Indonesia, the scale of this challenge is

unprecedented; national waste production reached 35.95 million metric tonnes in 2022 across 309 districts. Alarmingly, approximately 13.48 million tonnes (37.49%) remain unmanaged, largely due to systemic institutional inefficiencies and the persistent reliance on open dumping practices by local municipalities (Ministry of Environment and Forestry, n.d.). The externalities of such unmanaged waste are multidimensional and severe, cascading from immediate public health crises and land-use conflicts to profound environmental degradation, including rubbish avalanches, localized land fires, and significant greenhouse gas emissions (Omang et al., 2021; Pradana, 2020; Rodrigo-Illarri et al., 2022). Addressing these cascading risks requires substantial capital and operational expenditure. However, a fundamental constraint across developing nations is the limited financial capacity of local governments to provide adequate, long-term waste infrastructure, which remains a vital public good (Organisation for Economic Co-operation and Development, 2019). Ensuring the state's presence in this provision requires not only physical infrastructure but also robust, sustainable financing mechanisms (Quina et al., 2019).

These infrastructure and financing constraints are clear in Yogyakarta City, an important urban center and tourism destination in Indonesia. Tourism activity adds pressure to waste generation and increases demand for reliable municipal waste services (Comerio et al., 2022). Currently, the city generates approximately 200 tonnes of solid waste daily. The existing municipal waste service is predominantly decentralized and semi-formal; household waste is typically collected by community-level operators using non-motorized carts or tricycles, then transferred to temporary municipal depots without systematic sorting. For decades, the final disposal of this massive daily volume heavily relied on a centralized, provincial-level landfill (TPA Piyungan). However, the imminent closure of this severely over-capacitated facility has abruptly shifted the waste-management burden to the city government since 2024. This transition requires the rapid operationalization of localized processing facilities (TPSTs). Consequently, the local government faces expanded responsibilities as both regulator and primary service provider. Managing 200 tonnes of daily waste through decentralized processing exponentially increases logistical and operational expenditures, raising an urgent need for service-financing arrangements that are fiscally sustainable for the government and equitable for households.

Despite the urgency of this institutional decentralization, the existing policy framework lacks a rigorous scientific foundation, particularly concerning its cost-recovery mechanisms. Historically, waste service tariffs in Indonesian municipalities, including Yogyakarta, have been determined through administrative, unmetered flat rates rather than an empirical assessment of actual

service costs (Hasbullah et al., 2020). This static pricing model creates a profound quantitative mismatch: the escalating operational costs required to process 200 tonnes of waste daily far exceed the stagnant revenues collected from uniform household retributions, a fiscal deficit pattern commonly observed across developing economies (Kaza et al., 2018). In this context, analyzing Ability to Pay (ATP) and Willingness to Pay (WTP) becomes critically important to resolve this fiscal bottleneck. ATP reflects the household's structural financial capacity to contribute, whereas WTP captures the subjective valuation of the service. Recent environmental economics literature highlights that a uniform flat tariff is fundamentally inefficient because it undercharges affluent households—who typically generate a larger waste volume and possess a higher WTP—while simultaneously overburdening low-income households with tight budget constraints (Awino & Apitz, 2024). Therefore, understanding the intersection of ATP and WTP is not merely a theoretical pricing exercise, but an indispensable policy tool. It provides the empirical basis needed to transition from regressive flat rates to a progressive, differentiated tariff system, ensuring that the rising costs of municipal waste management are recovered equitably without relying entirely on the local government budget (APBD) (Bai & Lin, 2022).

A substantial literature has applied the Contingent Valuation Method (CVM) and Ability to Pay (ATP) frameworks to study municipal solid waste services across different settings (Czajkowski et al., 2014; Ndau & Tilley, 2018). These approaches are often used to estimate tariff feasibility and service valuation under existing local service arrangements. They are commonly used to evaluate household responses to service improvements or tariff changes (Hasbiah et al., 2018; Hasbullah et al., 2020). However, the policy usefulness of these measures depends on whether they are interpreted jointly rather than separately. ATP on its own indicates affordability, while WTP on its own indicates stated valuation. For tariff design, the more relevant question is how the two relate to one another across different households and service scenarios. Previous studies often treat waste valuation as a stand-alone pricing exercise, with more limited attention to how household valuation differs across socioeconomic groups and how such differences matter for tariff design. This limitation is important because simple average valuations can conceal whether higher stated WTP reflects stronger economic capacity, different household characteristics, or differences in how households value specific service attributes. A more relevant gap is that relatively few studies jointly examine affordability and scenario-based valuation at the household level in a way that can directly inform equitable and financially feasible tariff setting. This study therefore treats household valuation not only as a pricing issue, but also as an input for practical tariff design and service-financing decisions.

In response to this gap, this study aims to estimate households' ATP and WTP for waste services in Yogyakarta City and to examine how these measures vary across socioeconomic characteristics. By doing so, this paper offers intertwined empirical and practical contributions. Empirically, it advances environmental service valuation by moving beyond simple average valuations to jointly analyze how affordability and stated valuation are driven by observable socioeconomic heterogeneity. Practically, the resulting ATP and WTP estimates provide policymakers with a rigorous evidence base to evaluate the viability of existing flat tariffs. By demonstrating how household-level payment evidence can directly inform equitable cost-recovery mechanisms, this study ultimately supports a more realistic transition toward differentiated tariff reform, sustainable service financing, and a balanced fiscal relationship between household contributions and municipal support.

2. RESEARCH METHODOLOGY

2.1. Survey Design

This study surveys households in Yogyakarta City between May and August 2023, taking two subdistricts with high number of populations in the city (Statistics Indonesia, 2023): Umbulharjo (47,093 people, 1st rank) and Tegalrejo (20,777 people, 3rd rank). Following a two clustered stratified sampling design, it surveys 4 of the 6 (Semaki, Giwangan, Sorosutan, Muja-muju) and 2 out of the 4 (Bener, Kricak) villages to expand coverage of intra-district variation in dense residential setting, and to provide district representation while maintaining operational feasibility under urban access constraints and anticipated intracluster correlation for Umbulharjo and Tegalrejo Subdistrict respectively. Firstly, this study stratifies the household's population based on the number of household members retrieved from Yogyakarta City Environmental Office; as in Table 1.

Table 1. The Definition of Household Size

No	Type of Household	Household's Member
1	Small	1 - 4 persons
2	Medium	5 - 8 persons
3	Large	More than 8 persons

Following the district and village stratification, this study employed the Slovin method to determine the ideal theoretical sample size. This approach is widely utilized in socio-economic research to efficiently achieve a representative sample from large populations without necessitating complex preliminary calculations (Gliner et al., 2016). As

¹ The margin of error at a 95% confidence level ($Z = 1.96$) assuming maximum population variance ($p = 0.5$) is calculated using standard proportion formula: margin of error = $Z \times \sqrt{\frac{p(1-p)}{n}}$. For the theoretical target ($n = 2033$), margin of error = $1.96 \times \sqrt{\frac{0.25}{2033}} \approx 2.17\%$. For the realized

detailed in Table 2, the theoretical target calculated using this method was 2,033 households. Although the initial districts were chosen purposively, households within each village were selected randomly at the hamlet (*Rukun Warga/RW*) level. This localized approach not only facilitated the enumerators' logistical process but also ensured a rigorous randomization mechanism.

During field implementation, the research team enforced strict ethical and validation protocols, including mandatory informed consent and photographic verification of respondents' houses to ensure external validity and confirm stratification criteria. The questionnaire captured essential metrics for ATP and WTP across three core sections: household characteristics, expenditure, and specific WTP scenarios. Although practical field constraints—such as respondent absences—and a rigorous data-cleaning process to remove incomplete surveys and protest bids reduced the theoretical maximum sample, the final dataset yielded 1,226 valid responses (approximately 60% of the initial target). In Contingent Valuation Method (CVM) studies, prioritizing data fidelity over sheer quantity is paramount to minimize hypothetical and enumerator biases. Ultimately, this finalized sample remains exceptionally robust for environmental valuation; it substantially exceeds the threshold for asymptotic normality in econometric modeling and merely shifts the margin of error from 2.2% to 2.8%¹—well below the acceptable 5% standard—thereby ensuring the stratified data accurately represents the demographic distribution of Yogyakarta City.

2.2. Ability-To-Pay Estimation Procedure

In this study, ATP is defined as a household's financial capacity to contribute to routine waste-service payments within its existing budget constraints. This metric strictly approximates objective affordability, making it analytically distinct from WTP, which captures a household's subjective valuation of a service scenario. To ensure comparability, both variables are standardized as monthly payments in Indonesian Rupiah (IDR). Constructing a fully structural household-budget model to estimate ATP is notoriously difficult due to the complex data required regarding consumption patterns, price awareness, and the time value of money (Castellón et al., 2015; Xu et al., 2018). Consequently, this study avoids the structural model approach in favor of a pragmatic, expenditure-based proxy that accurately reflects a household's observed spending capacity.

sample ($n = 1226$), the error marginally shifts to margin of error = $1.96 \times \sqrt{\frac{0.25}{1226}} \approx 2.79\%$. This 0.62% difference demonstrates that the statistical precision is minimally affected, thoroughly justifying the methodological trade-off in favor of strictly filtering for high-quality, cognitively engaged responses.

Table 2. Population and Sampling Result of ATP and WTP Survey in Yogyakarta's City

No	District	Village	Household Population in 2021*	Sample Based on Slovin Formula	Actual Sample Number Earned
1	Umbulharjo	Semaki	1,174	298	110
		Mujamuju	3,652	360	116
		Giwangan	2,546	345	303
		Sorosutan	5,149	371	309
2	Tegalrejo	Bener	1,230	301	108
		Kricak	3,426	358	280
TOTAL			17,177	2033	1,226 (62,27% from ideal sample)

Note: Based on the most recent data published by the government

To operationalize this proxy without relying on arbitrary normative thresholds, the study derives an empirical affordability coefficient from the 2022 National Socioeconomic Survey (Susenas) Consumption and Expenditure Module. Based on this large-scale representative dataset, we apply a fixed coefficient of 0.52%, which represents the average share of household resources allocated to waste-related spending in the Yogyakarta District. By anchoring the threshold in observed regional expenditure structures, this approach establishes a realistic, data-driven benchmark for the proportion of a budget that can reasonably accommodate routine public service contributions. Operationally, the monthly ATP for each household is calculated simply by multiplying this 0.52% affordability coefficient by the household's total monthly expenditure observed during the survey. Mathematically, ATP is expressed in monetary units rather than percentages:

$$ATP_i = \sigma \times EXP_i$$

where ATP_i denotes the estimated monthly ability to pay of household i , σ is the affordability coefficient set at 0.0052, and EXP_i is the household's monthly expenditure. Under this specification, the ATP estimate represents the maximum routine monthly contribution to waste services that remains consistent with the household's observed expenditure capacity.

2.3. Willingness-To-Pay Estimation Procedure

This study utilizes CVM method to determine the household's WTP for the government's planned trash transportation service. CVM is a widely used approach for estimating individuals' WTP for non-market goods and services, such as environmental improvements or public health benefits. This method involves surveying individuals to elicit their WTP for specific changes or improvements, providing a measure of the economic value they place on these changes (Mitchell & Carson, 2013). This method is also used in determining public goods provision, particularly in environmental valuation (Carson, 2000).

Subsequently, this study offered households alternative service scenarios by combining additional municipal waste management components. Specifically, four core service attributes were employed for the scenario design: sorting service, trash bank participation, waste limit, and carrying frequency. These four components were selected because they represent the fundamental attributes

that jointly define a household's perceived net utility of municipal waste transportation in an urban setting. Furthermore, they map directly onto the main behavioral and economic channels through which WTP is formed: service reliability and convenience based on carrying frequency (Jin et al., 2006), required household effort for source sorting (Czajkowski et al., 2014), capacity constraints through waste limits or unit pricing (Jenkins et al., 2003), and the availability of institutional substitutes, like community-based trash banks, that alter behavioral compliance and waste reduction (Sekito et al., 2013).

Table 3. CVM Scenarios used in ATP and WTP Survey

Scenario	Carrying Frequency (Weekly)	Waste Limit	Waste Bank Participation	Sorting Service
1	1	Yes	No	No
2	2	Yes	No	No
3	3	Yes	No	No
4	1	No	No	No
5	2	No	No	No
6	3	No	No	No
7	1	Yes	Yes	No
8	2	Yes	Yes	No
9	3	Yes	Yes	No
10	1	No	Yes	No
11	2	No	Yes	No
12	3	No	Yes	No
13	1	Yes	No	Yes
14	2	Yes	No	Yes
15	3	Yes	No	Yes
16	1	No	No	Yes
17	2	No	No	Yes
18	3	No	No	Yes
19	1	Yes	Yes	Yes
20	2	Yes	Yes	Yes
21	3	Yes	Yes	Yes
22	1	No	Yes	Yes
23	2	No	Yes	Yes
24	3	No	Yes	Yes

During the elicitation process, these combined scenarios are presented to the households to determine their initial acceptance. If respondents accept a presented scenario, they are subsequently required to state their minimum and maximum WTP values. The respondents are engaged continuously

through an iterative bidding process until they decline the suggested improvements. Theoretically, as each additional scenario offers an incrementally better waste transportation service, the estimated WTP is expected to correspondingly increase. Table (3) below outlines the specific WTP scenarios formulated for the households, although not all scenarios were uniformly presented to avoid cognitive overload. The detailed selection of these presented scenarios and their subsequent empirical justifications are elaborated upon in the Results section.

2.4. Econometrics Approach

To comprehensively evaluate household ATP and WTP, this study integrates descriptive and econometric methodologies. Initially, descriptive statistics—including central tendencies, variances, and mean difference tests across various socio-demographic cohorts—establish the baseline distributional patterns of the valuation data. Because descriptive measures alone cannot isolate individual covariate effects, the analysis subsequently employs a multivariate Tobit model to identify the specific household determinants of WTP, appropriately accounting for the bounded, left-censored nature of the elicited monetary responses.

Because monetary responses elicited from contingent valuation scenarios are inherently non-negative and structurally bounded, the Tobit specification provides the most robust econometric framework. The model is estimated separately across distinct service scenarios—including basic collection

and waste-bank participation—to rigorously evaluate how household socioeconomic characteristics and expenditure patterns systematically drive the subjective valuation of municipal waste service improvements.

$$WTP_i^* = a + X_i'\beta + \varepsilon_i$$

$$WTP_i = \max(0, WTP_i^*)$$

where WTP_i^* denotes latent willingness to pay, WTP_i is the observed WTP response, and X_i is the vector of household covariates.

3. RESULT AND DISCUSSIONS

3.1. Ability-to-Pay Estimates for Waste Services

The analysis of ATP is based on a finalized sample of 1,226 valid household observations, representing 62.27% of the theoretical Slovin target of 2,033 households. The sample reduction was primarily due to field constraints, including respondent refusals and incomplete interviews. Applying an affordability coefficient of 0.52% to the monthly household expenditures, the baseline estimations yield a mean ATP of IDR 11,642 and a median of IDR 7,800. The pronounced divergence between the mean and the median indicates a right-skewed distribution, demonstrating that the financial capacity for waste management services is heavily concentrated at lower expenditure levels, while the upper tail is extended by a small cohort of households with significantly higher spending capacity.

Table 4. Descriptive Statistics of ATP Estimates (in Indonesia Rupiah)

No	Characteristics	Mean	Median	Standard Deviation
Observation: 1.226 Individuals				
1	General Result	11,642	7,800	13,497
2	Gender			
	Male	14,720	8,840	17,321
	Female	10,101	7,800	10,786
3	Household Size			
	Small	10,280	7,280	11,974
	Medium	13,891	8,840	15,407
	Large	20,461	15,600	18,922
4	Household Income Distribution			
	1st Quartile	1,469	1,560	1,279
	2nd Quartile	6,073	5,200	1,270
	3rd Quartile	12,234	11,960	2,311
	4th Quartile	31,030	24,596	17,439
5	Region			
	Umbulharjo (D)	12,161	7,800	13,074
	Mujamuju (V)	15,351	10,400	16,679
	Semaki (V)	10,546	7,800	10,647
	Sorosutan (V)	10,942	7,800	10,316
	Giwangan (V)	12,791	7,800	14,572
	Tegalrejo (D)	10,520	6,240	14,322
	Bener (V)	8,686	5,200	11,895
	Kricak (V)	11,231	6,760	15,117
6	Educational Background			
	No Education	6,483	2,600	7,947
	Primary School	7,768	5,200	10,701
	Middle School	9,857	7,280	11,065
	Higher School	18,357	14,040	17,338
7	Household With Business			
	Yes	12,106	7,800	12,742
	No	11,310	7,800	14,012

Data disaggregation and mean-difference analyses, utilizing independent t-tests and Kruskal-Wallis tests, confirm that ATP varies significantly across distinct socio-demographic characteristics. A statistical gender difference is observed, with female-headed households recording a lower mean ATP (IDR 10,101) compared to male-headed households (IDR 14,720). Additionally, larger households exhibit a mean ATP of IDR 20,461, nearly double the capacity of smaller households (IDR 10,280). Across income stratifications, the lowest quartile (Q1) records a mean ATP of IDR 1,469, whereas the highest quartile (Q4) demonstrates a capacity of IDR 31,030. Educational attainment and home-based economic activities also correspond with varying ATP levels; households headed by individuals without formal education record an ATP of IDR 6,483 compared to IDR 18,357 for senior high school graduates, while households operating a home-based business show an ATP of IDR 12,106 versus IDR 11,310 for those without such enterprises.

Spatially, the ATP estimates display distinct regional variations. The average payment capacity in Umbulharjo District (IDR 12,161) is statistically higher than that in Tegalgrejo District (IDR 10,520). At the micro-spatial level, Mujamuju Village records the highest localized mean capacity (IDR 15,351), contrasting with Bener Village, which records the lowest capability (IDR 8,686). Furthermore, the data reveals a statistically significant gap in the estimated financial capacity between active formal waste service subscribers and non-subscribers within the surveyed urban population.

3.2. Willingness-to-Pay Estimates for Waste Services

To capture households' stated valuation of waste services, WTP was estimated using two contingent valuation scenarios. Both scenarios maintain baseline parameters of waste collection three times per week, no volume limit, and mandatory source sorting, differing exclusively in whether household participation in a community waste bank is required. The overall estimates indicate that the mandatory waste-bank requirement corresponds with a lower stated WTP. Specifically, the mean minimum WTP decreases from IDR 31,639 under the non-mandatory scenario to IDR 29,362 when participation is required. Similarly, the mean maximum WTP decreases from IDR 45,758 to IDR 43,305. However, the median values remain constant across both scenarios, holding at IDR 25,000 for the minimum WTP and IDR 40,000 for the maximum WTP, indicating that the overall mean reduction is driven by downward shifts in the upper tier of the response distribution rather than a change in the central median.

Disaggregation by household characteristics demonstrates distinct variations in WTP across socio-demographic groups. WTP consistently exhibits an upward trend in relation to household size and income levels; larger families and higher-income

quartiles report greater stated WTP, with a descriptive mean dip observed only within the top income quartile. Regarding educational attainment, higher education levels generally align with higher WTP, although a descriptive anomaly is present within the data where respondents with no formal education reported a higher mean WTP than those with only basic education. Finally, spatial differences and household business ownership did not yield statistically meaningful differences in stated WTP, confirming that significant variations within the sample are primarily concentrated along structural household and income dimensions.

3.3. Determinant of Households' Willingness-To-Pay

This study utilizes a multivariate Tobit model to examine the determinants of stated WTP across five distinct service specifications. The estimation results identify household income as the most consistent and robust predictor of WTP. In every specification, the coefficient for log income remains positive and statistically significant, ranging from 0.128 to 0.186. This finding indicates that higher-income households systematically report a higher stated valuation for waste services. Conversely, expenditure variables demonstrate statistical instability; log food expenditure shows a positive and statistically significant effect in only one specification, while log non-food expenditure maintains a negative and statistically insignificant relationship across all models.

Regarding socio-demographic factors, the multivariate results indicate that household size and educational attainment fail to exert robust independent effects on WTP once the models control for other covariates. The coefficients for medium and large households remain statistically insignificant across the controlled specifications, demonstrating that broader socioeconomic characteristics completely absorb the previously observed descriptive variations. Similarly, education makes a weak and model-dependent independent contribution. Although the coefficient for basic education shows a negative and statistically significant effect in a single specification relative to the base group, this effect dissipates in alternate models, and higher education categories fail to yield consistently significant results.

Beyond economic and demographic variables, the estimations reveal a statistically significant negative relationship between the number of waste types a household generates and its stated WTP. Households generating four distinct waste types exhibit significantly lower WTP in scenarios that add service conditions, producing coefficients of -0.527 in the "WTP + Bank" model and -0.452 in the "WTP + Bank + Pilah" model. Ultimately, the multivariate analysis confirms that household income and the number of generated waste types act as the primary statistically

significant determinants of WTP, while specific demographic traits and short-term expenditure metrics lose their significance when the model accounts for the full set of observed covariates.

3.4. The Affordability-Valuation Gap

In the context of municipal public goods, ATP and WTP measure fundamentally different economic dimensions. ATP represents the structural affordability ceiling strictly governed by a household’s budget constraint, whereas WTP captures the subjective valuation vector driven by perceived utility and service efficiency. Consequently, the observed gap between ATP and WTP in this study is best understood as an affordability-valuation discrepancy—the absolute difference between what households possess the financial capacity to accommodate versus what they empirically deem

worth purchasing. Crucially, it is the WTP—not the ATP—that establishes the foundation for consumer surplus. Consumer surplus emerges only when the actual tariff paid is lower than the household’s stated WTP. The finding that the estimated WTP systematically exceeds the ATP across all socio-demographic strata highlights a profound valuation-affordability constraint. It demonstrates that households do not derive negative or low value from waste services; rather, they assign a highly positive valuation to environmental sanitation but are structurally restricted by their objective financial capacity. This corroborates recent evidence in environmental economics that financial capacity is merely a binding baseline, while perceived service quality and institutional trust ultimately dictate the high magnitude of net utility households expect to extract as surplus (Apio et al., 2024).

Table 5. Scenarios of WTP Estimation Chosen

Scenario	Carrying Frequency (Weekly)	Waste Limit	Sorting Service	Waste Bank Participation
1	3	No	Yes	No
2	3	No	Yes	Yes

Table 6. General Result of WTP Estimates (in Indonesia Rupiah)

Scenario	Mean		Median	
	Minimum	Maximum	Minimum	Maximum
Scenario 1	31,639	45,758	25,000	40,000
Scenario 2	29,362	43,305	25,000	40,000

Table 7. WTP Estimates by Respondent's Gender (in Indonesia Rupiah)

Gender of Head of Household	Scenario	Mean		Median	
		Minimum	Maximum	Minimum	Maximum
Male	Scenario 1	31,924	51,250	30,000	40,000
	Scenario 2	30,364	48,846	25,000	40,000
Female	Scenario 1	28,422	42,958	25,000	40,000
	Scenario 2	26,557	40,535	25,000	35,000

Table 8. WTP Estimates by Household Type (in Indonesia Rupiah)

Household Type	Scenario	Mean		Median	
		Minimum	Maximum	Minimum	Maximum
Small Household	Scenario 1	29,110	46,818	25,000	40,000
	Scenario 2	27,913	44,640	25,000	40,000
Medium Household	Scenario 1	29,877	41,754	30,000	37,500
	Scenario 2	26,974	39,374	25,000	35,000
Large Household	Scenario 1	33,966	49,828	25,000	40,000
	Scenario 2	30,443	44,971	25,000	40,000

Table 9. WTP Estimates by Quartile of Income (in Indonesia Rupiah)

Household Monthly Income	Scenario	Mean		Median	
		Minimum	Maximum	Minimum	Maximum
1st Quartile	Scenario 1	24,616	41,191	20,000	30,000
	Scenario 2	22,763	37,620	20,000	30,000
2nd Quartile	Scenario 1	25,931	38,240	25,000	35,000
	Scenario 2	24,809	36,925	20,000	30,000
3rd Quartile	Scenario 1	34,350	53,882	25,000	40,000
	Scenario 2	32,445	51,592	25,000	40,000
4th Quartile	Scenario 1	32,522	48,626	30,000	50,000
	Scenario 2	30,905	46,876	30,000	50,000

Table 10. Tobit Estimates of ATP and WTP (Log Specification)

	WTP Penggerobak	WTP Penggerobak	WTP + Pilah	WTP + Bank	WTP + Bank + Pilah
Log Income (pendapatan_atp)	0.186*** (0.0354)	0.174*** (0.0425)	0.128*** (0.0425)	0.129*** (0.0446)	0.147*** (0.0402)
Log Food Expenditure		0.0469 (0.0359)	0.0778** (0.0364)	0.0472 (0.0399)	0.0578 (0.0362)
Log Non-Food Expenditure		-0.0444 (0.0475)	-0.0430 (0.0441)	-0.0522 (0.0511)	-0.0124 (0.0420)
Medium Households		0.0755 (0.0755)	0.0135 (0.0770)	-0.0450 (0.0787)	-0.0998 (0.0722)
Large Households		0.0242 (0.136)	0.00658 (0.138)	-0.0554 (0.145)	-0.210 (0.135)
Primary Education		-0.548** (0.256)	-0.457 (0.282)	-0.257 (0.270)	-0.227 (0.265)
Secondary Education		-0.366 (0.247)	-0.296 (0.273)	-0.152 (0.261)	-0.0960 (0.256)
Higher Education		-0.319 (0.254)	-0.258 (0.279)	0.0817 (0.271)	0.0810 (0.263)
2 Types of Waste Generated		-0.139 (0.159)	-0.0349 (0.154)	-0.0807 (0.180)	-0.0469 (0.164)
3 Types of Waste Generated		-0.128 (0.154)	0.00452 (0.148)	-0.202 (0.174)	-0.115 (0.158)
4 Types of Waste Generated		-0.255 (0.186)	-0.207 (0.182)	-0.527*** (0.201)	-0.452** (0.185)
5 Types of Waste Generated		0.275 (0.237)	0.210 (0.215)	-0.0959 (0.245)	0.0754 (0.217)
6 Types of Waste Generated		0.170 (0.472)	0.522 (0.405)	0.0245 (0.471)	0.409 (0.385)
Constant	7.384*** (0.509)	7.988*** (0.794)	8.099*** (0.787)	8.489*** (0.832)	7.491*** (0.745)
Pseudo R ²	0.033	0.056	0.042	0.034	0.047
Observations	403	399	409	531	534

Note: Standard errors are in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The behavioral dynamics underlying this affordability-valuation gap and the erosion of consumer surplus are vividly illustrated by the study's specific findings regarding waste bank participation. As the empirical results demonstrate, the mandatory inclusion of a community waste bank significantly depressed households' stated WTP. This phenomenon can be explained through the lens of opportunity costs and surplus preservation. When a service configuration requires households to exert physical effort and time—such as sorting and transporting recyclables to a waste bank—households implicitly commodify this "sweat equity" and deduct it from their monetary WTP. In other words, the household perceives the required behavioral compliance as a non-monetary tax that artificially inflates the 'shadow price' of the service. Recent modeling of community-

based waste management in urban Indonesia confirms this exact behavioral constraint: to defend their net utility and maintain a positive consumer surplus, households naturally contract their monetary valuation when physical compliance burdens increase (Asih et al., 2026). Therefore, tariff designs must mathematically compensate for the time and labor households invest, otherwise the loss of consumer surplus will trigger systemic non-compliance.

Beyond the commodification of household effort, this uncalibrated valuation gap also generates profound market distortions, perfectly exemplified by the study's findings on household size and the asymmetric extraction of consumer surplus. Given that the current municipal flat-rate tariff in Yogyakarta is positioned well below the estimated WTP, a positive, albeit poorly distributed, consumer

surplus currently exists. However, this uncalibrated surplus facilitates a systemic free-rider problem, as evidenced by the anomaly where medium-sized households exhibit a lower mean WTP than smaller households. This demographic appears to exploit the unmetered, flat-rate nature of the current system, extracting maximum utility and a disproportionately large consumer surplus without bearing a proportional financial burden. As highlighted in recent critical reviews of the Global South, relying on rigid flat rates inevitably exacerbates socioeconomic inequity and limits cost-recovery (Awino & Apitz, 2024). Ultimately, the observed ATP-WTP gap should not be viewed as a market failure, but rather as a critical "policy buffer zone". This zone represents a strategic financial space where the local government can introduce structural tariff reforms—such as volume-based pricing or progressive socio-economic tiers—to capture a portion of this unpriced consumer surplus from high-valuation households. As long as these price adjustments are strictly accompanied by upgraded service attributes and remain protective of the ATP limits for the vulnerable, the municipality can safely optimize the waste sector without entirely eroding the welfare generated by consumer surplus.

3.5. Heterogeneity in Household Valuation

Building upon the behavioral dynamics of the affordability-valuation gap, the empirical results further underscore that household valuation of municipal waste services is profoundly heterogeneous. While the initial descriptive statistics indicated that WTP fluctuates across a wide array of socio-demographic categories, the multivariate Tobit estimations provide a critical refinement to this narrative. Once confounding variables are controlled for, household income emerges as the most robust and statistically consistent determinant of stated WTP. In the Tobit models, the income variable remains strictly positive and significant across all specifications, whereas several other peripheral social characteristics lose their explanatory power. This econometric confirmation suggests that while valuation heterogeneity is systemic, its primary structural engine is fundamental economic resource capacity rather than surface-level demographic distinctions, a pattern consistently validated by recent empirical studies on environmental valuation in developing urban centers (Bai & Lin, 2022).

However, economic capacity alone does not dictate market acceptance; this heterogeneity is equally driven by the complex interaction between household profiles and specific service designs. Echoing the previously discussed opportunity cost of "sweat equity," the multivariate estimates reveal that households managing more complex waste profiles—specifically those generating a wider variety of waste types—report systematically lower WTP when confronted with scenarios demanding mandatory sorting or waste-bank participation. For these specific households, the imposition of additional environmental obligations is perceived not as a value-adding service enhancement, but as a compounding logistical burden. This aligns with current behavioral waste management literature, which demonstrates that when the perceived physical and temporal costs of compliance increase, households naturally penalize the service by contracting their monetary willingness to pay (Knickmeyer, 2020). Consequently, practical tariff design must recognize that a household's willingness to subscribe is a multidimensional calculus, meticulously weighing the nominal price against the embedded compliance efforts and convenience of the service package.

Finally, relying on robust econometric modeling effectively rectifies several descriptive anomalies that might otherwise mislead municipal policy formulation. For instance, the descriptive observation highlighting a dip in the mean WTP for the highest income bracket (the fourth quartile) relative to the third quartile should not be misinterpreted as a structural decline in valuation among the wealthy. The Tobit results definitively override this, confirming a consistent positive income effect and suggesting that the descriptive dip is merely a statistical artifact driven by high dispersion and specific outliers within the top-income cohort. A similar methodological caution applies to the descriptive irregularity where respondents with no formal education stated unexpectedly high WTP; this pattern lacks robust, consistent significance in the multivariate estimations. Ultimately, resolving these anomalies demonstrates the inherent danger of designing municipal tariff policies based solely on unadjusted subgroup averages, reinforcing the contemporary methodological consensus that covariate-adjusted econometric insights are strictly indispensable for establishing valid, equitable, and effective environmental governance (Johnston et al., 2017).

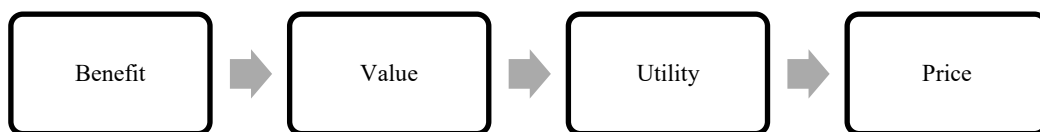


Figure 1. Logical Framework Developed in Relation to Price Calculated from ATP and WTP

3.6. Implication for Tariff Design

Currently, Yogyakarta City lacks a standardized municipal tariff framework for solid waste services. Consequently, household waste collection is largely delegated to fragmented private and semi-informal operators who charge highly variable, unregulated prices. This decentralized arrangement produces a severely suboptimal outcome: it resolves the waste problem only partially at the micro-level—effectively clearing waste from individual households—but structurally shifts the burden downstream, leaving the Local Government logistically and financially overwhelmed when managing the massive accumulated volumes at temporary transfer stations (TPS) and the final landfill (TPA). The empirical evidence of profound socioeconomic heterogeneity in this study strongly dictates that resolving this systemic failure cannot be achieved by merely formalizing the current unregulated system into a single, undifferentiated flat municipal tariff. Such an administrative shortcut is not only economically inefficient but inherently regressive. Recent environmental economics literature highlights that under a rigid flat-rate system, municipal waste management functions as a flawed utility where low-income households bear a disproportionate financial burden relative to their capacity, while wealthy, large households systematically underpay (Awino & Apitz, 2024). To rectify this market distortion, internalize downstream municipal costs, and align local governance with the Polluter Pays Principle, tariff design in Yogyakarta City must pivot towards a progressive price discrimination strategy centered on socioeconomic equity.

Within this progressive framework, the established inequality between ATP and WTP serves as the primary mechanism for tariff segmentation. For low-income and small households, financial capacity acts as a rigid, binding constraint. Even if these demographics highly value waste management, imposing a market-rate tariff that exceeds their ATP inevitably triggers severe payment defaults and negative environmental externalities, such as illegal dumping and lack of system compliance (Awino & Apitz, 2024). Therefore, policy dictates that this vulnerable segment must be placed in a protective Subsidy Zone, where the imposed tariff is structurally subsidized to remain strictly below their ATP limits, thereby ensuring universal access to basic sanitation.

Conversely, the policy approach must be radically different for high-income and large households. These demographics possess both a larger environmental footprint and a substantially higher stated valuation for the service. For this affluent segment, the local government should strategically peg the tariff closely to their maximum stated WTP. By anchoring the price to their high subjective valuation rather than a generic average cost, the municipality effectively extracts the existing consumer surplus (Bai & Lin, 2022). In this context, demanding that wealthier and larger households pay a premium is not a punitive measure,

but a necessary restoration of vertical equity (those with greater capacity pay more) and horizontal equity (those who generate more waste pay more).

Crucially, this progressive price discrimination strategy provides the vital financial architecture needed to operationalize the Public-Private Partnerships (PPP) outlined in Yogyakarta City's Solid Waste Management Masterplan 2022–2031. Private operators require guaranteed, aggregate revenue streams to recover the high capital expenditure associated with household collection logistics and advanced centralized processing facilities (TPST). However, as universally acknowledged in global solid waste policy, municipal fiscal constraints and risk allocation failures frequently stall PPP operationalization in developing economies (Kaza et al., 2018). A progressive tariff resolves this bottleneck by enabling internal cross-subsidization. The premium tariffs collected from affluent, high-waste households generate a revenue surplus that directly finances the Viability Gap Fund (VGF) or the subsidies required for the low-income segment. Ultimately, this evidence-based, segmented tariff model offers a sustainable PPP blueprint: it ensures commercial bankability for private partners, enforces environmental accountability among top-tier waste generators, and firmly safeguards the welfare of the city's most vulnerable populations.

4. CONCLUSION

This study examined households' ATP and WTP for waste services in Yogyakarta City to assess affordability, stated valuation, and their relevance for tariff design. The findings reveal a crucial valuation-affordability constraint: household WTP systematically exceeds ATP. This indicates that while citizens highly value environmental sanitation and are willing to pay more, their financial contributions are strictly restricted by their actual financial capacity. Descriptive results and Tobit estimates consistently show that economic capacity, particularly income, is the most stable correlate of this higher WTP. However, valuation is also highly sensitive to service design; their valuation changes when the service bundle changes, particularly when additional physical obligations such as waste-bank participation are introduced. This confirms that households implicitly commodify their opportunity costs and physical effort as an added burden.

These empirical insights demonstrate that the current lack of a standardized system and any future implementation of a uniform flat-rate tariff would be inherently regressive. A flat-rate system facilitates a systemic free-rider problem, where wealthy households extract unpriced consumer surplus while vulnerable groups are severely overburdened. To rectify these structural market distortions, the Local Government of Yogyakarta City is advised to implement a progressive, tiered tariff system. Through cross-subsidization, the municipality can anchor tariffs for affluent households closer to their

maximum WTP, generating a premium to internally subsidize low-income populations. Ultimately, abandoning homogeneous pricing assumptions in favor of this progressive financing scheme is absolutely necessary to ensure the commercial viability and sustainability of Public-Private Partnership (PPP) projects under the 2022–2031 waste management masterplan.

Despite providing an evidence-based financing framework, this study acknowledges certain limitations. First, in the absence of a standardized municipal tariff, the WTP estimates rely on stated-preference scenarios, which are inherently susceptible to hypothetical bias. Second, the analysis focuses exclusively on demand-side valuation and household capacity, omitting the supply-side operational costs required by private service providers. To address these gaps, future research should integrate comprehensive supply-side cost analyses to determine the precise funding requirements and viability gaps for the PPP scheme. Furthermore, subsequent studies must critically evaluate the administrative readiness and political feasibility of implementing progressive, cross-subsidized tariff structures within local municipal governance.

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