FULL COST ACCOUNTING FOR HOUSEHOLD SOLID WASTE MANAGEMENT: A CASE STUDY IN DA NANG, VIETNAM

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Abstract - Municipal solid waste (MSW) is increasing rapidly, requiring more efficient and financially sustainable waste management systems. In Vietnam, MSW collection and treatment are still largely financed through flat household fees that are weakly linked to actual waste generation and depend heavily on public subsidies. This study applies a Full Cost Accounting (FCA) approach to design MSW tariffs for a ward in Da Nang City under three pricing scenarios: per capita/ household, weight based, and volume based. Excluding government subsidies, the estimated tariffs are 38,380 VND per capita per month (238,835 VND per household per month), 1,005 VND/kg, and 302 VND/L, respectively, all substantially higher than the current flat fee of 30,000 VND per household per month. The findings demonstrate FCA's value in supporting the implementation of Pay-As-You-Throw (PAYT) schemes in Da Nang and other Vietnamese cities.

Key words – MSW; Pay-As-You-Throw; Full Cost Accounting; unit-pricing scenarios.

1. Introduction

Amid global efforts to achieve the Sustainable Development Goals (SDGs) and transition toward a circular economy, the management of MSW has become increasingly critical from both environmental and socio-economic perspectives. Global MSW generation was about 2.01 billion tonnes in 2016 and is projected to reach 3.40 billion tonnes by 2050 if no strong interventions are implemented [1]. In Vietnam, statistics from the Ministry of Natural Resources and Environment indicate that, as of 2023, MSW generation is approximately 60,000 tonnes per day nationwide, of which urban areas account for about 60%. This growing volume places increasing pressure on existing collection, transport and treatment systems, requiring local authorities to undertake fundamental reforms, particularly in the design and operation of collection and transport services at the source [2].

Da Nang City, with its rapid urbanization and vision to become an ecological and smart city, is also facing similar challenges in MSW management. Against this backdrop, a key issue lies in the current fee mechanism for MSW management service, which is largely based on flat fees as stipulated in Decision No. 33/2017/QD-UBND of the City People's Committee dated 18 November 2017 [3]. While this approach is simple and convenient for administration and fee collection, and is used in many countries, it reveals three major limitations: (i) it is not equitable under the "polluter pays" principle, as low- and high-generating households pay roughly the same amount; (ii) it does not fully reflect the actual costs of the collection–transport system, requiring substantial budget subsidies from the government budget; and (iii) it fails to create sufficient economic incentives for households to reduce waste generation, separate waste at source, or adopt more sustainable consumption behaviors [4] - [7]. At the policy level, the 2020 Law on Environmental Protection marks an important shift by making source separation of household solid waste mandatory for households and service businesses, and by allowing collection, transport and treatment fees to be charged based on the weight or volume of waste instead of a simple flat fee [8]. Under Consolidated Document No. 09/VBHN-BTNMT dated 25 October 2019, provincial People's Committees assign line departments to develop fee schemes and submit them, via the Department of Finance, for appraisal so that tariff levels reflect local socio-economic conditions [9], thereby confirming a policy trend towards Pay-As-You-Throw (PAYT) models. In practice, however, the roll-out of source separation and weight/volume-based fees in Vietnam still faces major obstacles due to limitations in infrastructure, data availability and transparent cost-accounting tools [10].

The FCA model has emerged as a useful tool for comprehensively quantifying and allocating all costs associated with MSW management systems. The 1997 USEPA handbook on FCA for MSW management shows that the model enables local governments to systematically compile, categorize and report initial capital expenditures, operating costs, overhead and indirect costs related to waste management services. Subsequent studies have applied FCA to assess the cost-effectiveness of source-separated collection schemes, propose more appropriate service fees and support the design of PAYT schemes, thereby enhancing transparency, equity and financial sustainability in MSW management [11]. FCA has been increasingly applied in studies on circular economy and PAYT schemes in developing countries, such as recent work on municipal councils in Egypt and Greece, where FCA underpins PAYT tariffs that integrate environmental, social and economic dimensions for MSW services. These applications show that FCA is not merely an accounting tool but can provide the analytical basis for designing emission-based service tariffs aligned with waste reduction and efficient allocation of public resources. In the United States, where FCA was first developed, it has also been used by public solid waste service providers to prepare competitive bids against private haulers, helping

some divisions save over 5 million USD in the first year of competition [12], [13], [14].

Building on this context, this study applies FCA to estimate the full costs of MSW collection, transport and treatment in a selected ward of Da Nang City, using empirical data provided by the local service operator (Agency X) and relevant authorities. On this basis, three tariff scenarios are developed and compared: (A) a per capita/household service fee, (B) a weight-based unit fee (per kg), and (C) a volume-based unit fee (per litre), with scenarios (B) and (C) are under PAYT schemes. Data collection and cost calculation under the FCA framework are integrated with the technical norms for MSW collection and transport specified in Decision No. 6672/QD-UBND of the City People's Committee dated 28 November 2017 [15], as this document specifies the detailed procedures for each work category within the MSW management system currently operating in Da Nang City. The expected output is a set of reference tariffs tailored to local conditions that offer higher transparency and equity than the current flat-fee regime, while demonstrating the feasibility of FCA as a decision-support tool for transitioning towards emission-based charging in developing cities and providing a basis for comparison with FCA-based tariff scenarios previously reported in the international literature [13], [14] Additionally, for each PAYT-based pricing scenario, this study also proposes a corresponding management model to support public authorities in coordinating with manufacturers and suppliers of waste containers/ packaging to develop and pilot operational procedures for fee collection and MSW collection, transport, and treatment services in the future.

2. Methodology

2.1. Research Area

The research area was Ward Y, a ward in Da Nang City.

2.2. Data Collection and Service Boundary

In this study, data on demographics, MSW generation and financial information - particularly revenue and expenditure in MSW management - were collected through direct interviews with an official from the Department of Economy, Infrastructure & Urban Development of the local People's Committee. Additionally, to gain a broader understanding of the operation of the MSW management system in Ward Y, direct interviews were conducted with representatives from Agency X, the service provider responsible for MSW management in the area.

Given the sensitive nature of financial data, the study uses anonymized designations - 'Agency X' and 'Ward Y' - to represent the service provider and study area, respectively. All demographic, household, waste generation, and financial data pertain to the year 2025.

For MSW collection and transportation in Ward Y, entities generating 300 kg of waste or more per month are required to sign volume-based collection agreements. This study focuses on entities generating less than 300 kg per month, as they pay a flat fee for collection services. These entities include individuals and households, with or without small-scale business activities.

Waste collection and transport involves two categories: manual collection using three-wheeled vehicles and mechanized collection using compactor trucks. On roads narrower than 5.5 meters, waste is first collected manually by three-wheeled vehicles, then consolidated at collection points and transferred by compactor trucks (≤5 tons) to transfer stations. On roads 5.5 meters wide or more, waste is collected directly by compactor trucks (>5 – ≤10 tons) and transported to transfer stations. At the transfer stations, MSW undergoes preliminary compression to reduce volume and moisture content before being transported to the Khanh Son Landfill. Figure 1 illustrates the current MSW collection and transportation scheme implemented in Ward Y. W_1, W_2, and W_3 denote three work categories labeled to facilitate the compilation of actual work volumes carried out in 2025.

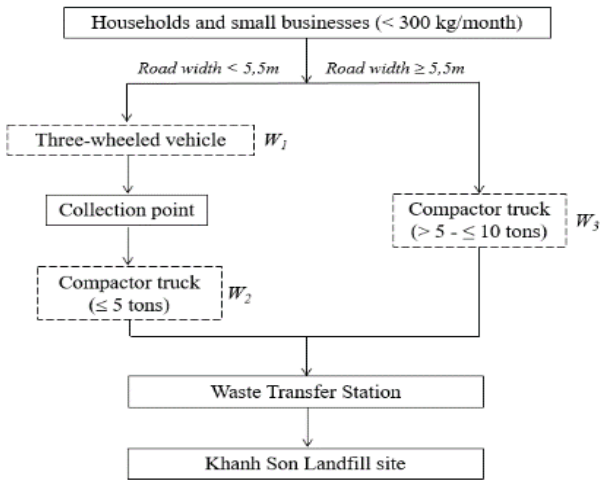

Figure 1. *The current MSW management system in Ward Y*

The cost of MSW treatment is also part of a comprehensive local waste management system. In practice, the flat fee currently paid by residents does not cover the cost of sanitary landfill disposal at the Khanh Son Landfill. In Da Nang City, the tipping fee for MSW treatment is 92,689 VND per ton, as stipulated in Decision No. 09/2023/QD-UBND issued by the Da Nang City People's Committee on April 4, 2023 [16].

2.3. FCA Framework and Research Scope

The classical FCA framework developed by the USEPA distinguishes seven cost categories: up-front, operational, back-end, remediation, contingent, environmental, and social costs. In this Da Nang case study, the scope is deliberately limited to the first two categories - up-front and operational costs. These directly represent the "technical–financial" life cycle of the existing MSW management system, from collection to final treatment, and are commonly prioritized when estimating unit costs or designing practical waste service tariff structures [11], [17].

We acknowledge that this methodological boundary directly affects the absolute comprehensiveness of the calculated results. Specifically, by excluding back-end,

remediation, and contingent costs, the results do not capture the long-term liabilities of end-of-life disposal facilities (such as landfill closure and aftercare). Furthermore, the exclusion of environmental and social costs means that negative externalities - such as greenhouse gas emissions, public health impacts, and landscape degradation - are omitted from the equation. Consequently, the calculated unit costs in this study inevitably underestimate the true societal cost of MSW management and may artificially lower the apparent cost of certain disposal methods like landfilling.

However, this limitation is a pragmatic necessity to ensure data reliability. As noted in previous literature, accounting methodologies for environmental and social externalities have not been fully standardized [17], [18]. Furthermore, locally calibrated coefficients and long-term datasets required for such risk modeling are not yet consistently available in a developing urban context like Da Nang.

Therefore, the results of this study should be strictly interpreted as a purely financial and budgetary assessment rather than a holistic sustainable development evaluation. The scope of this study is summarized in Figure 2.

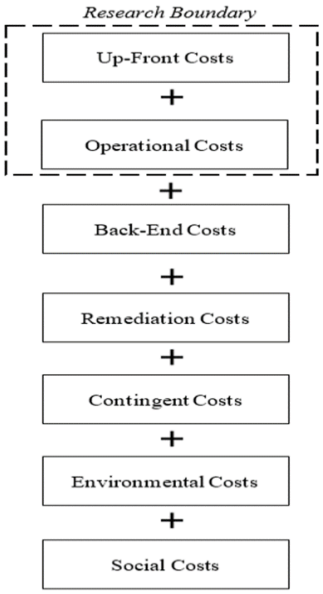

Figure 2. *Research Boundary out of the FCA framework*

The object of this study is the cost of MSW collection, transport and treatment from households to temporary transfer points and/or from these points to the landfill within Da Nang's MSW management system. The empirical application focuses on Ward Y in Da Nang City.

2.4. Tariff Design and Pricing Scenarios

Up-front costs comprise capital expenditures for the purchase and installation of vehicles, equipment and containers used for collection and transport, which are annualized through depreciation and allocated to Ward Y based on technical norms such as the number of trips, tonnes collected and kilometres travelled. Operating costs include wages and allowances for workers, drivers and operating staff, as well as fuel, maintenance, repair and consumable materials, and are calculated using technical–economic norms and the actual cost data reported by Agency X. Overhead and indirect costs cover office and administrative expenses, periodic monitoring, training, communication and supervision activities (e.g. GPS and camera systems), interest payments (where applicable) and other shared costs, which are apportioned to Ward Y accordingly [11].

In practice, FCA studies rarely follow the two life-cycle stages literally, because each stage bundles many heterogeneous cost items; instead, this study groups all costs associated with the MSW collection, transport and treatment system into two main categories: fixed costs and variable costs. Fixed costs are costs that do not vary with the amount of waste generated on a daily basis, including: Investment costs (related to asset depreciation costs and liquidation incomes), Maintenance costs, General administrative supervision costs and other fixed costs. Variable costs are costs associated with the technical processes of collecting, transporting, and treating MSW on a daily basis. These costs increase as the volume of waste rises. They include: Collection and Transportation costs (mainly fuel cost), Tipping fee and Labor wages. The cost components are illustrated in Figure 3.

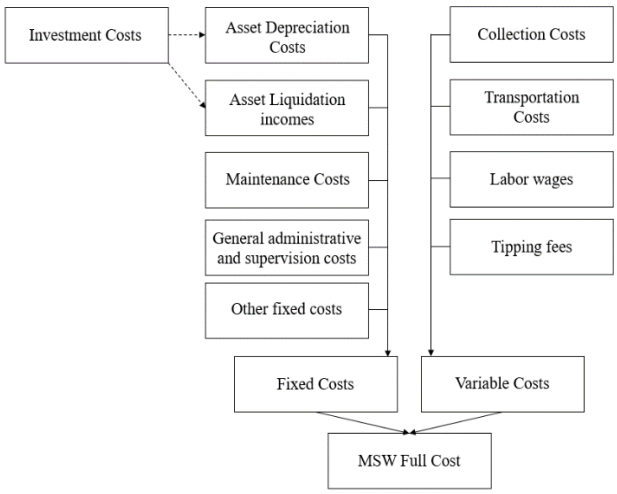

Figure 3. *Total cost components breakdown*

Determining the total cost of using waste containers and collection vehicles begins with estimating the full cost for each asset type, which in FCA requires a clear distinction between costs and cash outlays. While outlays are cash payments made at specific points in time, costs are recorded as resources are actually used or consumed for service provision, regardless of when the cash changes hands, which makes depreciation a crucial element in accurately capturing the full cost of MSW services at the local level [11]. For example, standard financial statements may record the full purchase price of a collection truck in the first investment year, with subsequent years only reflecting operating expenses such as fuel, maintenance and regulatory fees, whereas under FCA the initial outlay for any capital asset used in collection, transport or treatment is allocated over its useful life through depreciation, and any residual value or proceeds from asset disposal at end of life are also incorporated into the FCA cost profile, thereby

significantly improving the accuracy of cost estimates for high-value capital resources [11].

For specialized collection vehicles, this study estimates the annual total cost of use based on the following data: capacity, market purchase price, service life, fuel costs, insurance premiums and maintenance expenditures, all of which are treated as direct costs linked to collection, transport and treatment operations. In addition, for compacting trucks, supervision costs associated with installing and operating GPS tracking systems are included as an indirect cost component within the total vehicle cost.

The following equation yields the total cost (VND/year) for the vehicles:

$$\text{Vehicle cost} = \sum_{n}^{i=1}\left[\left(\frac{(P_i \times Q_i) - Rbp_i}{T_i}\right) + Q_i \times (F_i + IS_i + M_i) + GPS\right]$$

where:

- P_i is the standard purchase price of the vehicle type i;
- Q_i is the actual quantity of the vehicle type i;
- Rbp_i is the salvage value from the disposal of the vehicle type i;
- T_i is the length of service life of the vehicle type i;
- F_i is the operating fuel cost of the vehicle type i;
- IS_i is the mandatory insurance cost of the vehicle type i;
- M_i the maintenance cost of the vehicle type i.
- GPS is the cost of the vehicle GPS management system (only for mechanized collection).

A table is used below to summarize the types of vehicles used and the relevant information. The information presented includes the capacity, actual quantity, and service life of each vehicle type. Additionally, vehicle purchase cost details are withheld; Table 1 shows only the total cost for each vehicle type, calculated according to the relevant formula.

Table 1. *Annualy vehicle total cost (in billion VND)*

Vehicle type	Capacity	Quantity	Service life (years)	Total vehicle cost
Three-wheeled vehicles	660 liters	21	3	0.0315
Compactor truck	≤ 3 tons	5	10	0.5400
Compactor truck	> 3 - ≤ 5 tons	4	10	0.6120
Compactor truck	> 5 - ≤ 10 tons	2	10	0.4140

Similarly, for waste containers, the study considers the following parameters to estimate the annual total cost of use: number of bins by type and volume, market unit price, service life, maintenance and fixing costs, and cleaning expenses.

The following equation yields the total cost (VND/year) for the bins:

$$\text{Bin cost} = \sum_{n}^{i=1}\left[\left(\frac{(P_i \times Q_i) - Rbp_i}{T_i}\right) + Q_i \times (M_i + Cl_i)\right]$$

where:

- P_i is the standard purchase price of the bin type i;
- Q_i is the actual quantity of the bin type i;
- Rbp_i is the salvage value from the disposal of the bin type i;
- T_i is the length of service life of the bin type i;
- M_i is the maintenance cost of the bin type i;
- Cl_i is the clean cost of the bin type i.

Table 2 summarizes the waste bins used in the MSW management system in Ward Y, including their capacity, actual quantity, service life, and total annual usage cost for each bin type.

Table 2. *Annualy bin total cost (in billion VND)*

Bin type	Capacity	Quantity	Service life (years)	Total bin cost (VND/year)
HDPE bin	660 liters	168	2.5	0.396

Regarding labor costs, total wages paid to staff are summarized in Table 3 according to work categories W_1, W_2, and W_3. The overall wage data are sourced from the MSW management service contract in Ward Y. For work category W_1 (manual collection), workload is measured by the total kilometers traveled for collection in a year. For categories W_2 and W_3 (mechanized collection), workload is measured by the total tons of MSW collected annually. Based on actual workloads recorded in 2025 and the number of staff assigned to each task in Ward Y, the number of labor-days per worker can be determined. Using the wage calculation guidelines specified in Circular No. 17/2019/TT-BLDXH dated 06 November, 2019, labor-days are converted into the corresponding monthly wages for each employee [19]. The total labor cost for each work category is then obtained by summing the wages of all assigned personnel. However, due to the anonymized nature of the contract data, the author presents only the aggregated total for each category.

Table 3. *Annualy workload and total labor cost (in billion VND)*

Work Category	Workload	Unit	Total labor cost
W_1	27,150.00	Km/year	21.170
W_2	17,654.87	Tons/year	3.654
W_3	33,354.69	Tons/year	15.670

Other costs included in the total MSW management system expenses comprise: annual environmental monitoring and quality control costs; loan repayment fees; and other incidental expenses.

The total cost of the MSW management system in Ward Y is determined as the sum of the previously identified cost components. The final calculated total cost amounts to 53,399,620,015 VND per year.

With respect to tariff design, this study examines three fee scenarios: (A) a per capita or per household waste fee, (B) a weight-based fee (weight-based pricing) and (C) a volume-based fee (volume-based pricing). An overview of the data collection procedures and the costing steps for each scenario is presented in Figure 4.

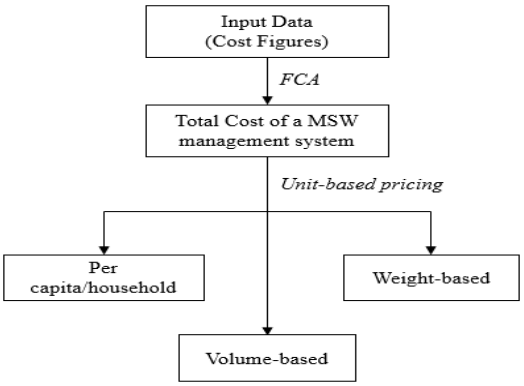

Figure 4. *Data collection and caculation procedure*

For scenario (A), the service cost is calculated on a per capita or per household basis using the total cost and demographic information on the number of people and number of households in the study area (Ward Y). The two equations below specify the monthly service cost per capita and per household, respectively.

$$\text{Cost per capita} = \frac{\text{Total cost}}{\text{Population} \times 12}$$

(VND/capita/ month)

$$\text{Cost per household} = \frac{\text{Total cost}}{\text{Number of households} \times 12}$$

(VND/per household/month)

For scenario (B), the service cost is calculated per unit of mass, expressed in kilograms or tonnes of MSW, using the total cost and the total annual quantity of waste collected.

$$\text{Cost per kilogram} = \frac{\text{Total cost}}{\text{Total waste collected} \times 365}$$

(VND/kilogram of waste)

To obtain the result for scenario (C), the volume-based service fee is derived by multiplying the cost per kilogram by the density of MSW.

Table 4. *Demographic data, MSW characteristics in Ward Y*

Location	Population	Households	Collected amount of waste (tons/day)	Density of waste (kg/m^3)
Ward Y	115,944	18,632	145.52	300

Source: [20]

2.5. Research Methods

The study adopts a mixed-methods approach that combines several research methods:

- Literature review is used to analyse and synthesize previous studies and published documents on FCA and PAYT mechanisms in MSW management, and to compile demographic data and waste generation figures from income data.

- In-depth interviews are conducted with experts and with the local service providers responsible for collection and transport of MSW in the study area to obtain detailed contextual and operational information.

- Quantitative analysis is applied to compute service costs and to construct the alternative fee scenarios.

- Descriptive analysis is used to summarize and interpret the cost data; it is also employed in the Results section to describe in detail and compare the advantages and disadvantages of each fee scenario, accompanied by schematic representations of the proposed implementation processes.

3. Results and Discussion

3.1. FCA-based costing results

According to the FCA results, and excluding any governmental budget subsidies, the estimated charges are 38,380 VND per capita per month and 238,835 VND per household per month for the per capita/household scenario, 1,005 VND per kilogram for the weight-based scenario, and 302 VND per litre for the volume-based scenario, revealing a stark contrast with the current flat fee of only 30,000 VND per household per month. To enhance the visual clarity of the results, the tariffs under scenarios B and C will be compared with those reported in previous studies employing FCA.

According to a study conducted in Greece, the authors calculated PAYT tariffs under two scenarios: with waste reduction and without waste reduction. The corresponding unit prices converted to VND were 5,823 VND/kg and 6,436 VND/kg, respectively. When applying a volumetric fee based on 60-liter waste bags, the average unit price was approximately 37,697 VND per bag, equivalent to about 628 VND per liter [21]. In contrast, a study conducted in Italy reported an average unit price for MSW management services of approximately 2,452 VND/kg; however, this study did not design a volumetric-based fee[17]. Additionally, a similar study in Egypt reported an average unit price of 1,582 VND/kg [22]. The above unit prices were sourced from the referenced studies and converted into Vietnamese Dong (VND) at the corresponding exchange rates as of March 2026.

In addition to the aforementioned studies, Hoi An City has implemented a volumetric-based fee system, where residents pay in advance for bags of predetermined sizes. Common bag types include 10-liter bags priced at 1,900 VND per bag and 40-liter bags priced at 15,000 VND per bag [23].

As can be observed from the comparisons above, the costs calculated in this study may differ significantly from those reported in previous studies. Several objective factors may account for these discrepancies, including differences in exchange rates between countries and variations in waste generation practices and habits. Notably, the aforementioned results do not include subsidies from government budgets, which may introduce further discrepancies when making cross-study comparisons. In reference to the case of Hoi An City, the cost per liter observed in previous pilot studies was higher due to the inclusion of packaging costs. Therefore, the results of this study can be considered as a basis for setting tariffs when implementing a PAYT fee system in the future, provided that financial sustainability for the public budget and the residents' willingness to pay (WTP) for the service are appropriately balanced.

3.2. Discussion of the different pricing scenarios

This subsection discusses the main characteristics and the advantages and disadvantages of each pricing scenario, together with two typical charging structures (SUP – Simple Unit Pricing and TTP – Two-tiered pricing), with a view to assessing their suitability for a developing context such as Vietnam.

Per capita or per household charging remains the most traditional and administratively straightforward approach, as fees are set according to the number of residents or at a flat rate per household, without the need to measure individual waste generation. It ensures revenue stability and is easy to implement where monitoring infrastructure is limited, but provides almost no economic incentive for waste reduction and raises equity concerns because low-waste households pay the same as high-waste ones; in Vietnam, this model is still widespread and may be acceptable in the short term, but it is poorly aligned with long-term PAYT objectives.

Weight-based pricing, by contrast, links fees directly to the mass of waste generated and is widely regarded as the most accurate and behaviorally effective PAYT variant, strongly incentivizing waste reduction, recycling and source separation. However, it requires sophisticated weighing and identification technologies and robust enforcement, which significantly increase transaction and administrative costs; recent discussions around implementing weight-based charging in Ho Chi Minh City, especially in high-rise apartment buildings, highlight practical difficulties in attributing weights reliably to individual households [18], [22], [24]. A weight-based pricing management mechanism can be implemented following the schematic illustrated in Figure 5. Under this volume-based fee mechanism, three main parties are involved: service users (residents), local authorities, and the MSW service provider. The local authorities are responsible for establishing the unit price and annual collection plan, while the successful contractor provides collection services (including weighing of waste) and transportation to the disposal site (Khanh Son Landfill). Cash flows within the system are represented using directional arrows.

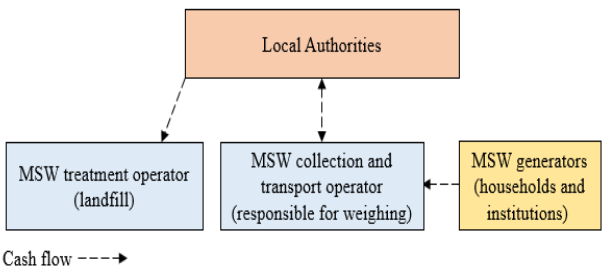

Figure 5. *Weight-based Pricing System*

Volume-based pricing charges households according to the volume of waste disposed, typically via standardized bags or containers, and is therefore technically simpler to administer than weight-based schemes while still providing a clear marginal price signal for additional waste [22]. Its precision is limited by variation in waste density and potential misuse (e.g. over-compaction or use of non-official bags), yet international experience and recent pilots in Hoi An - where households pay via designated bags and initial results show reduced landfilled waste - suggest that volume-based PAYT represents a particularly feasible transitional option for Vietnamese cities [23]. The management mechanism applying unit prices based on the volume of waste can be designed and operated in a similar manner to the model shown in Figure 6. Accordingly, this model is similar to the weight-based pricing system. However, under a volumetric fee mechanism, additional containment equipment - such as bins, bags, or stickers (mainly used for bulky waste) - is required. In this system, local authorities continue to play the primary management role, setting plans and policies for MSW management and issuing tenders to the relevant agencies. In addition to the agency responsible for collection and transportation, a separate entity manufactures and supplies the volumetric containment equipment. Cash flows and the movement of waste bags (representing other containment devices) are correspondingly tracked throughout the full life cycle of MSW management.

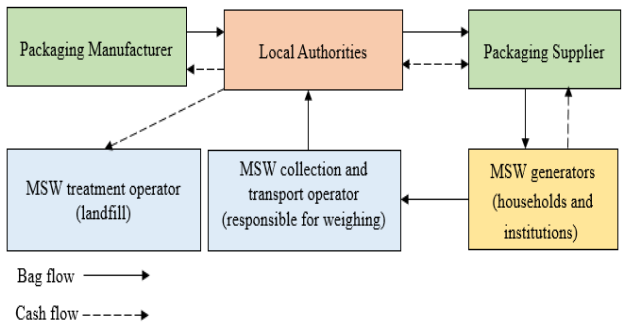

Figure 6. *Volume-based Pricing System*

Besides the fee mechanism itself, the method of implementing the fee in an appropriate manner also warrants discussion. SUP - a pricing scheme in which households are charged a constant rate for every unit of waste generated (e.g., per bag, kilogram, or liter) - delivers strong and continuous incentives for waste reduction but can raise affordability concerns for low-income households with limited scope to cut waste further. TTP, by contrast, combines a basic allowance or fixed service fee with higher marginal charges applied only when waste generation exceeds a defined threshold. This structure softens distributional impacts and often improves political acceptability, but typically yields weaker behavioural responses because only excess waste faces a meaningful marginal price. For Vietnam, a pragmatic pathway could be to move from flat per-household fees toward a volume-based SUP or mild TTP design - building on the Hoi An experience - while considering weight-based PAYT only as a longer-term target as digital infrastructure and enforcement capacity improve [24].

3.3. Limitations and Future Research Direction

This study has several limitations that should be acknowledged. As the research was conducted at an individual level, access to comprehensive datasets, particularly sensitive financial information, was limited compared with large-scale, government-funded studies in other countries. Consequently, although the cost estimation was performed within the FCA framework in a transparent and systematic manner, several parameters relied on reasonable assumptions due to data constraints, and their accuracy could be further improved with access to more comprehensive datasets. In addition, the present analysis does not encompass all seven conventional FCA cost categories, particularly remediation, contingent, environmental, and social costs, primarily because MSW management infrastructure in Vietnam remains underdeveloped and standardized approaches for monetizing environmental and social externalities are still lacking. Furthermore, the optimization of waste collection routes, which can substantially influence collection and transportation costs across different service areas [25], was not considered in the current analysis. Future research should address these limitations by incorporating more comprehensive datasets, including all FCA cost components, and integrating collection route optimization to provide a more robust and holistic assessment of MSW management costs. Such improvements will become increasingly feasible as source separation programs are fully implemented and MSW treatment technologies continue to advance with stronger institutional and financial support.

The methodology and calculations of this study are relatively straightforward and can be applied in other localities, provided that all necessary data can be collected transparently. However, this study has some limitations in result accuracy, as the author could not fully access hidden or indirect data. Given its nature as a financial model, a sensitivity analysis should be conducted to further assess the reliability of the results.

Furthermore, regarding changes in public financial policies, in addition to applying a transparent model for government management, public consensus is necessary. In the environmental sector in particular, policies must be clearly communicated and thoroughly explained to achieve citizen acceptability [26]. Therefore, the calculated tariffs in this study (which do not yet include subsidies from the public budget) should be used to interview residents in the study area to collect information on their actual WTP. This would enable the determination of optimal government subsidies and more efficient allocation of social resources.

4. Conclusion

In this study, the FCA framework is applied to calculate and propose tariff structures for MSW collection, transportation, and treatment services under three scenarios: per capita/household, per kilogram (weight-based), and per liter (volume-based). The estimated costs without any subsidy from the state budget are 38,380 VND per capita per month, 238,835 VND per household per month, 1,005 VND per kilogram, and 302 VND per liter, respectively, revealing a substantial gap compared with the current flat fee of 30,000 VND per household per month. In parallel, the comparison of characteristics, advantages, and disadvantages of each scenario, together with the proposed operational schemes for implementing each pricing mechanism in the future, provides an overall perspective that can support the design of public policies on MSW service fees. Moreover, the study shows that FCA is a highly promising starting point for any country aiming to manage solid waste (not only household waste) under a PAYT scheme. Future research should aim to collect additional cost components for incorporation into the FCA framework, particularly environmental and social externality costs. Moreover, results should be presented to local residents to elicit their preferences and WTP, enabling cost–benefit analyses that determine optimal government subsidies and support the efficient allocation of public resources.

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