

Assessment of Barangay Pinagbuhatan, Pasig City's Solid Waste Management System Through the Supply Chain and Value Chain Perspective: Basis for a Strategic Solid Waste Management Plan for Institutionalized Local Governance

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ABSTRACT

Solid waste management (SWM) remains a major challenge for local government units in the Philippines due to increasing waste generation, rapid urbanization, limited resource recovery, and weak institutional coordination. This study aims to assess the Solid Waste Management System of Barangay Pinagbuhatan, Pasig City using the perspectives of Supply Chain Management (SCM) and Value Chain Analysis (VCA) as the basis for developing a Strategic Solid Waste Management Plan for Institutionalized Local Governance. Specifically, the study will evaluate existing SWM practices in terms of waste collection, segregation, processing, transportation, and disposal; examine stakeholder experiences across the waste management supply and value chains; analyze the system's

strengths, weaknesses, opportunities, and challenges (SWOC) alongside political, economic, social, technological, legal, and environmental (PESTLE) factors; and formulate strategic interventions to improve the efficiency, sustainability, and institutionalization of local SWM. A mixed-methods research design will be employed, integrating quantitative and qualitative approaches. Quantitative data will be collected through structured surveys administered to selected residents and stakeholders, while qualitative data will be gathered through key informant interviews and focus group discussions involving barangay officials, waste collectors, environmental personnel, junk shop operators, and community representatives. Descriptive and inferential statistics will be used to analyze survey data, while thematic analysis will be applied to qualitative findings. SWOC and PESTLE analyses will further identify internal and external factors influencing the effectiveness of the barangay's SWM system. The study is expected to provide a comprehensive understanding of the operational flow of solid waste, identify inefficiencies and opportunities for resource recovery, and determine governance and institutional gaps affecting service delivery. The findings will serve as the basis for a strategic SWM plan that promotes supply chain optimization, value recovery, stakeholder collaboration, circular economy principles, and evidence-based local governance, with potential application to other urban barangays in the Philippines.

Keywords: *Solid Waste Management; Supply Chain Management; Value Chain Analysis; Circular Economy; Local Governance; Waste Resource Recovery; Pasig City*

INTRODUCTION

Solid waste management (SWM) is an essential component of sustainable urban development and environmental governance. Rapid urbanization, population growth, industrialization, and changing consumption patterns have significantly increased the quantity and complexity of municipal solid waste worldwide. Inefficient waste management contributes to environmental pollution, flooding, greenhouse gas emissions, and public health risks, particularly in densely populated urban communities (Hoornweg & Bhada-Tata, 2012). Consequently, effective solid waste management has become a critical responsibility of governments in ensuring environmental protection and improving the quality of urban life.

Globally, sustainable waste management supports the achievement of the United Nations Sustainable Development Goals (SDGs), particularly Goal 11 (Sustainable Cities and Communities) and Goal 12 (Responsible Consumption and Production). Effective waste management systems promote waste reduction, recycling, composting, and resource recovery while minimizing environmental impacts and supporting the transition toward a circular economy.

In the Philippines, Republic Act No. 9003, or the *Ecological Solid Waste Management Act of 2000*, serves as the primary legal framework governing solid waste management. The law mandates local government units (LGUs) to implement comprehensive ecological solid waste management programs that prioritize waste minimization, segregation at source, recycling, composting, and environmentally sound disposal. It also requires the establishment of Materials Recovery Facilities (MRFs) and emphasizes community participation as an integral component of sustainable waste management (National Solid Waste Management Commission, 2010).

Despite the enactment of RA 9003, many LGUs continue to encounter challenges in its implementation. Previous studies have identified issues such as inadequate enforcement of regulations, insufficient infrastructure, limited financial resources, weak monitoring mechanisms, and inconsistent compliance with waste segregation requirements (Coracero et al., 2021). These implementation gaps hinder the achievement of waste diversion targets and contribute to the continued reliance on landfill disposal.

Within Metro Manila, local government units demonstrate varying levels of effectiveness in implementing solid waste management programs due to differences in institutional capacity, infrastructure, resource availability, and community participation. Although Pasig City has established comprehensive environmental policies through the Pasig City Ecological Solid Waste Management Code (Ordinance No. 01, Series of 2018), the effectiveness of these policies depends largely on their implementation at the barangay level.

Barangay Pinagbuhatan, one of the largest and most densely populated barangays in Pasig City, presents a unique setting for evaluating local solid waste management practices. Its high population density, mixed residential communities, informal settlements, and flood-prone areas create operational challenges that may affect waste segregation, collection efficiency, transportation, processing, and final disposal. Assessing the existing waste management system within this context can provide valuable insights into local implementation practices and institutional capacity.

To examine these processes comprehensively, this study employs the Supply Chain Management (SCM) and Value Chain Analysis (VCA) frameworks. The supply chain perspective evaluates the flow of waste from generation, segregation, collection, transportation, processing, and final disposal, while the value chain perspective examines opportunities for resource recovery and value creation through recycling, composting, and other waste recovery activities. Integrating these frameworks enables a comprehensive assessment of operational efficiency, institutional performance, and opportunities for improving waste management systems.

Specifically, this study assesses the solid waste management system of Barangay Pinagbuhatan, Pasig City, by examining existing operational practices, stakeholder experiences, institutional challenges, and external environmental factors influencing implementation. Based on the findings, the study proposes strategic interventions aimed at institutionalizing and optimizing the barangay's solid waste management system through a supply chain and value chain perspective.

Literature Review

Solid Waste Management and its Principle

The escalation of the global population and the rising demand for food have had significant environmental repercussions, notably increasing the amount of solid waste generated per person. In contemporary society, the prevalence of disposable products has led to a dramatic accumulation of waste, forming vast landfills. This issue manifests in both rural and urban environments where high population density and frequent human activity contribute to substantial waste production. As highlighted by Healthepic.com, waste is a breeding ground for vectors such as cockroaches, flies, mosquitoes, and rodents, which can transmit diseases. For instance, one cubic meter of waste can produce approximately 8 billion flies, known carriers of harmful pathogens that pose serious health risks to humans.

In metropolitan areas, the management of solid waste has become an increasingly critical public health and environmental challenge (Pineda, et. al, 2024). According to a report by the Environmental Management Bureau, each person in Metro Manila generates roughly 0.5 kilograms of waste daily. Local government units (LGUs) manage about 73% of the 5,250 metric tons of waste produced each day using dump trucks. However, approximately 1,417.5 metric tons, or 27%, end up improperly disposed of in canals, open spaces, street corners, markets, rivers, and other locations.

To address the issue of solid waste, particularly from the food sector, compliance with local regulations such as Republic Act No. 9003, also known as the Ecological Solid Waste Management Act of 2000, is crucial (Atienza, 2011). This legislation emphasizes the need for improved environmental cleanliness to prevent disease and enhance public health. Effective waste management requires collective effort: everyone contributes to the problem and can also be part of the solution. The government has enacted laws such as RA 9003 and Republic Act 7160, which mandate the transfer of responsibilities for general sanitation, beautification, and waste management to local authorities (Acanto, 2018).

The challenge of waste management is not new; it has been a concern since prehistoric times (Chandler et al., 1997). As human activities inherently produce waste (Brunner & Rechberger, 2015), effective waste management is essential to minimize waste, reduce pollution, protect groundwater resources, and ensure environmental sustainability. Improper waste disposal results in both direct and indirect environmental impacts, such as land occupation, resource depletion, increased global warming due to methane and other greenhouse gas emissions, water contamination from landfilling, and acidification and toxicity from incineration (Mubaslat, 2021). Technological advancements, economic growth, and urbanization have exacerbated these issues, leading to a significant increase in waste quantities and related health and safety hazards globally (Raghu & Rodrigues, 2020).

In Asia, the generation of municipal solid waste (MSW) has surged (Chintan Environmental Research and Action Group, 2024). In 2016, the region produced an estimated 1.2 billion tons of MSW, with projections indicating an increase to 1.5 billion tons by 2030 and 1.9 billion tons by 2050 (World Bank, 2018). Despite these figures, waste management remains a low priority in many Asian cities compared to investments in infrastructure and transportation (Hondo, Arthur, & Gamaralalage, 2020). The reliance on landfills in Asia is largely due to their lower cost compared to recycling, incineration, or composting (Terazono et al., 2005).

In 2023, the Philippines generated at least 61 million metric tons of waste daily (Cariaso, 2023). Globally, the annual production of MSW is around two billion tons, with high-income countries responsible for about 34% of this waste. The amount of waste generated in low-income countries is expected to more than triple by 2050 (Kaza et al., 2018). This global trend has prompted various nations, including the Philippines, to take measures to mitigate environmental damage and manage waste more effectively. Japan, known for its advanced waste management systems, provides a model of success in this field. However, Japan faced similar challenges decades ago that are still relevant to many developing countries today (Mekonnen & Tokai, 2020).

The Philippines, classified as a developing country, can benefit from adopting successful waste management practices from other nations. According to Coracero, Gallego, Frago, and Gonzales (2021), the Philippines faces long-standing waste management issues due to a framework that, while present, requires more effective and rigorous implementation. Effective waste management is not solely the responsibility of the

government but also involves active citizen participation and the thorough application of expert strategies. Yu and Serrona (2006) identified that Metro Manila has a complex array of environmental and sanitation regulations, with at least 23 different issuances, including executive orders, department orders, and ordinances. This plethora of regulations often causes confusion among stakeholders. The study pinpointed four major issues in Metro Manila's waste management: uncontrolled dumping, opposition to incineration, inadequate recycling technology, and composting challenges.

Despite the enactment of Republic Act No. 9003 (the Ecological Solid Waste Management Act of 2000), recent research by Gamao and Caelian (2023) found that waste generation remains a significant challenge. Their study revealed that 56.6% of respondents reported that neighbors do not practice the 3Rs (Reduce, Reuse, Recycle) due to insufficient information. Another major challenge is the lack of waste segregation during collection, which complicates waste processing and resource recovery.

Ella et al. (2022) emphasized the importance of effective MSW management, noting a direct relationship between MSW generation and economic growth. The Philippines, an archipelagic country in Southeast Asia with a rapidly growing economy, urbanization, and a young population (World Bank, 2020), experiences increasing solid waste production (Castillo & Otoma, 2013). Republic Act No. 9003 defines solid waste as all discarded materials from residents, businesses, institutions, industries, and other sources, including non-hazardous and non-toxic waste. The World Bank (2019) projects a 70% increase in global waste generation by 2050, from 2.01 billion tons in 2016 to 3.40 billion tons. This rise in waste generation presents significant management challenges (Al-Katib et al., 2010). Effective solid waste management involves controlling waste generation, storage, collection, transfer, transport, processing, and disposal in accordance with public health, economic, engineering, conservation, and aesthetic principles (Edith Cowan University, 2022). However, solid waste management often faces neglect (Masood, Barlow, & Wilson, 2009), with issues such as improper waste disposal, inefficient collection, and inadequate facilities being prominent in the Philippines (Matunog & Awa, 2013; Senate Economic Planning Office, 2017). Consequently, the Philippines has been identified as a leading plastic polluter (WWF-Philippines, 2018), and poor waste management poses health risks and environmental problems, including water and soil contamination, air pollution, and flooding (Abu Qdais, 2007; Sharholy et al., 2008; Senate Economic Planning Office, 2017).

METHODS

Research Design

This study employs a Mixed-Methods Research Design, in which quantitative and qualitative data are collected during the same phase of the study, analyzed independently, and integrated during the interpretation of the findings. This approach provides a comprehensive assessment of the solid waste management (SWM) system in Barangay Pinagbuhatan, Pasig City by combining measurable indicators with the experiences and perspectives of key stakeholders.

The quantitative component evaluates residents' perceptions and practices regarding waste generation, segregation, collection, transportation, processing, and disposal using structured survey questionnaires. The qualitative component explores stakeholder experiences and operational challenges across the solid waste management system using the Supply Chain Management (SCM) and Value Chain Analysis (VCA) frameworks through semi-structured interviews. The integration of both datasets enables triangulation of findings and strengthens the validity of the study.

Research Locale

The study is conducted in Barangay Pinagbuhatan, Pasig City, one of the largest and most densely populated barangays in Metro Manila. The barangay was selected because of its diverse residential communities, commercial establishments, public facilities, and existing solid waste management programs, making it an appropriate setting for assessing local waste management practices and governance.

Participants and Sampling Technique

Quantitative Component

The quantitative respondents consist of residents of Barangay Pinagbuhatan. A simple random sampling technique is employed to provide every resident with an equal opportunity to participate in the study. The sample size is determined using Slovin's Formula:

$$n = \frac{N}{1 + Ne^2}$$

where:

- n = sample size
- N = population size (173,576)
- e = margin of error (0.05)

The computed sample size is 400 residents, which is considered adequate to represent the target population.

Qualitative Component

The qualitative component utilizes purposive sampling to select key informants with direct involvement in solid waste management. Participants include representatives from the Barangay Solid Waste Management Committee, City Environment and Natural Resources Office (CENRO), Pasig City LGU, Barangay Materials Recovery Facility (MRF), waste collectors, junkshop operators, informal waste pickers, commercial establishments, schools, public market administrators, hauling contractors, and selected residents.

These stakeholders represent various stages of the solid waste management supply chain, enabling the study to examine operational processes, institutional coordination, and value-adding activities throughout the waste management system.

Research Instrument

Two researcher-made instruments are utilized:

1. Survey Questionnaire – A structured questionnaire designed to collect quantitative data on respondents' waste generation, segregation, collection, transportation, processing, and disposal practices.
2. Semi-Structured Interview Guide – An interview protocol consisting of open-ended questions that explore stakeholders' experiences, operational challenges, governance practices, and opportunities for improving the solid waste management system using the Supply Chain and Value Chain perspectives.

Data Gathering

Prior to data collection, the researcher secures permission from the Barangay Local Government Unit of Barangay Pinagbuhatan, Pasig City and other concerned agencies.

For the quantitative phase, survey questionnaires are personally administered to the selected residents after obtaining informed consent. Completed questionnaires are checked for completeness before data encoding and statistical analysis.

For the qualitative phase, semi-structured key informant interviews are conducted with purposively selected stakeholders. Interviews are held at mutually convenient locations, and responses are documented through written notes and audio recordings with participants' permission. Field observations are also conducted to document existing waste management facilities, operational practices, and environmental conditions within the barangay.

Data Analysis

Quantitative data are analyzed using descriptive statistics. Frequency and percentage distributions summarize respondents' demographic profiles and waste management practices, while weighted mean determines the level of implementation and respondents' perceptions of the solid waste management system.

Qualitative interview data are analyzed through thematic analysis, involving coding, categorization, and identification of recurring themes related to stakeholder experiences, governance, operational challenges, and resource recovery practices.

Findings from both datasets are integrated through methodological triangulation to compare convergent and divergent results and to provide a comprehensive assessment of the solid waste management system.

Ethical Consideration

The study adheres to established ethical standards throughout the research process. Participation is voluntary, and informed consent is obtained from all respondents and key informants prior to data collection. Participants are informed of the study's objectives, procedures, and their right to withdraw at any stage without penalty.

Confidentiality and anonymity are maintained by protecting participants' identities and securely storing all collected data. The study complies with the Data Privacy Act of 2012 (Republic Act No. 10173) and other applicable ethical guidelines governing social science research.

RESULTS AND DISCUSSION

Assessment of Current Solid Waste Management Practices in Pasig City

The assessment of respondents regarding the current solid waste management (SWM) practices of Pasig City revealed a generally positive perception across five operational dimensions: collection, disposal, processing, segregation, and transportation. The consistently high ratings across these dimensions indicate that residents perceive the city's waste management system as functional, reliable, and capable of delivering essential sanitation services. The findings suggest that Pasig City has established an operational foundation characterized by visible service delivery, regular waste movement, and accessible information mechanisms.

Among the assessed dimensions, waste collection emerged as one of the strongest components of the system. Respondents expressed strong agreement regarding the regularity and predictability of collection schedules, indicating that consistent service delivery represents a significant achievement of local waste governance. The reliability of collection vehicles, responsiveness to residents' needs, and professionalism of waste collectors further contributed to positive perceptions of the system. These findings suggest that routine frontline services play an important role in building public trust because predictable collection schedules allow residents to align their waste disposal practices with government requirements.

However, while collection services were positively evaluated, relatively lower ratings were observed in areas concerning coverage of different waste types and overall comprehensiveness of collection services. This indicates that although the city has achieved operational stability in regular collection, opportunities remain to strengthen specialized waste streams and ensure more complete service coverage. The findings support previous studies emphasizing that effective waste management systems depend not only on collection frequency but also on the ability of local governments to manage diverse waste categories within an integrated framework.

The disposal dimension similarly received favorable assessments, particularly regarding government communication on proper disposal practices, availability of disposal facilities, awareness of designated disposal locations, and implementation of penalties for improper disposal. These findings highlight the importance of information dissemination and enforcement mechanisms in shaping public participation. Respondents' positive assessment of disposal-related information supports literature emphasizing that communication strategies improve awareness and increase acceptance of waste management policies.

Nevertheless, the findings also revealed a continuing gap between awareness and actual compliance. Although residents recognized the importance of proper disposal, segregation before disposal received comparatively lower ratings. This suggests that knowledge of proper practices does not always translate into consistent behavior. Similar patterns have been observed in waste management research, where behavioral compliance remains one of the most persistent challenges despite the presence of policies, education programs, and enforcement mechanisms.

The processing dimension demonstrated confidence in Pasig City's ability to reduce landfill dependency through waste recovery activities. Respondents positively assessed the adequacy of processing facilities, recyclable material recovery, government investment in processing improvements, and the contribution of processing activities to reducing waste disposal volumes. These findings indicate that residents recognize the importance of recovery-oriented approaches rather than viewing waste management solely as disposal.

However, lower ratings concerning awareness of specific processing technologies and environmentally sustainable treatment methods suggest limited public understanding of downstream waste operations. While residents acknowledge the outcomes of processing activities, they may have less visibility regarding how waste is transformed, recovered, or treated. This finding reinforces the importance of improving transparency and public communication regarding waste processing systems.

The segregation dimension received consistently strong evaluations, indicating that respondents perceive segregation systems as supported by clear guidelines, information availability, and organized collection practices. The positive assessment of segregated waste collection suggests that residents recognize a connection between their participation and downstream recycling outcomes. This finding supports existing literature identifying source segregation as a critical foundation of waste diversion because the quality of materials entering the system determines recovery efficiency.

The strong assessment of segregation practices also indicates the importance of reliable government support. When residents observe that separated waste is collected and processed appropriately, their willingness to participate increases. However, despite strong perceptions of segregation systems, challenges remain regarding consistent household compliance, particularly in separating complex materials such as multi-layer plastics and mixed packaging.

The transportation dimension revealed generally favorable perceptions regarding vehicle maintenance, collection schedules, route efficiency, and safe handling of hazardous materials. These findings demonstrate that transportation functions as an effective link between collection and disposal or processing activities. However, minimizing spillage and littering during transportation received relatively lower ratings, indicating a potential operational vulnerability. Since transportation represents a point where waste can leak into the environment, improvements in containment practices, vehicle standards, and route monitoring remain necessary.

Overall, the findings demonstrate that Pasig City's SWM system performs strongly in visible operational functions, particularly collection reliability, public information, segregation support, and routine transportation. However, areas requiring deeper systemic integration—such as behavioral consistency, processing transparency, specialized waste handling, and environmental safeguards—remain opportunities for improvement. The results suggest that the city has achieved operational competence but must continue transitioning toward a more integrated and sustainability-oriented waste management system.

Stakeholder Experiences of the Waste Management Supply Chain

The examination of stakeholder experiences through a supply chain perspective revealed that Pasig City's waste management system operates as an interconnected network involving waste generators, barangay implementers, collection workers, processing facilities, recovery actors, and disposal systems. Findings demonstrated that performance at each stage influenced outcomes throughout the entire waste management chain.

At the generation stage, stakeholders reported significant variation in waste composition depending on their activities. Households generated mixed biodegradable and non-biodegradable waste, particularly food waste, plastic packaging, and household containers. Commercial establishments produced large quantities of cardboard and plastic packaging associated with deliveries and retail operations, while schools generated substantial paper waste and food-related packaging. Markets primarily produced biodegradable materials from unsold goods, while Material Recovery Facilities (MRFs) and junk shops received mixed materials requiring additional sorting.

The findings emphasized that waste characteristics at the point of generation strongly influenced downstream recovery potential. Properly segregated materials retained higher economic and environmental value, while contaminated waste reduced recovery efficiency and increased processing requirements. Plastic sachets and multi-layer packaging emerged as major challenges because of limited recycling pathways and market demand.

Operationally, the supply chain depended heavily on coordination between barangays, collection personnel, city offices, and processing facilities. Barangays functioned as critical links between households and municipal systems by organizing collection schedules, monitoring compliance, and coordinating with city authorities. Collection workers highlighted that efficiency depended on residents' compliance with segregation requirements and proper timing of waste disposal.

Transportation emerged as a major logistical component affected by traffic congestion, narrow roads, illegal parking, delayed waste preparation, and route adjustments. These factors increased operational costs and affected collection efficiency. The findings indicate that waste transportation cannot be viewed as an isolated activity because delays or inefficiencies at one stage create consequences throughout the entire supply chain.

The economic dimension revealed that financial limitations affected multiple stakeholders. Barangays experienced constraints related to vehicle maintenance, fuel availability, personnel support, and equipment requirements. Although recyclable sales provided supplementary income, waste management operations remained highly dependent on government funding. Informal recovery actors, particularly junk shops and waste pickers, experienced economic vulnerability due to fluctuating recyclable material prices, storage limitations, and inconsistent market demand.

From a governance perspective, waste management operated through a multi-level institutional structure involving national legislation, city ordinances, and barangay implementation. Republic Act No. 9003 provided the policy foundation, while local implementation relied on enforcement, monitoring, education campaigns, and community participation. However, findings revealed that policy effectiveness depended heavily on consistent implementation, coordination, and sustained behavioral engagement.

Socio-cultural factors emerged as significant determinants of system performance. Stakeholders emphasized that awareness alone was insufficient to ensure compliance. Household routines, community norms, generational differences, and social influence shaped residents' willingness to segregate and properly dispose of waste. Community cooperation and peer influence encouraged compliance, while inconsistent participation created inefficiencies throughout collection and recovery operations.

Overall, the supply chain analysis demonstrates that Pasig City's waste management system functions through strong interdependence among actors. Weaknesses at one stage—particularly source segregation, financial limitations, coordination gaps, and inconsistent behavior—create cascading effects throughout collection, transportation, processing, and disposal. These findings highlight the need for integrated management approaches that address technical operations alongside governance, economic, and social factors.

Value Chain Analysis of the Solid Waste Management System

The value chain analysis revealed that Pasig City's solid waste management system functions beyond the traditional concept of waste disposal and operates as a network where material, economic, and public value are continuously created, preserved, degraded, or recovered. The findings demonstrated that the effectiveness of the system depends on maintaining material quality from the point of generation until final recovery or disposal. Each stage of the value chain—generation and segregation, primary collection, transportation, processing and treatment, and final disposal—determines whether waste remains a potential resource or becomes an environmental and economic burden.

At the generation and segregation stage, households, schools, and commercial establishments emerged as critical entry points where the future value of waste is determined. Proper segregation enabled recyclable materials such as paper, cardboard, bottles, and cans to retain economic value and supported recovery activities through recycling networks. Residents who practiced segregation contributed not only to environmental protection but also to resource recovery by allowing materials to enter recycling pathways rather than disposal streams. Similarly, schools and commercial establishments created opportunities for value recovery through organized collection and storage of recyclable materials.

However, the findings revealed that value preservation at the source remained constrained by inconsistent segregation practices, unclear material classification, and the increasing prevalence of difficult-to-recycle packaging. Plastic sachets, multilayer materials, and mixed packaging were repeatedly identified as major challenges because these materials often lacked established recovery markets. Contamination caused by improper

segregation reduced material quality, increased sorting requirements, and lowered the economic value of recoverable waste. These findings reinforce the importance of source segregation as the foundation of a circular waste system because downstream recovery potential depends heavily on the quality of materials entering the system.

Primary collection represented a crucial transition stage where previously preserved value could either be maintained or degraded. The findings showed that reliable collection schedules supported waste quality by reducing accumulation, contamination, and exposure to environmental conditions. When collection occurred according to schedule, residents were more capable of maintaining segregation practices and preparing materials properly. Conversely, delayed collection resulted in waste accumulation, increased contamination risks, and reduced recovery potential.

Waste collectors were identified as essential actors in maintaining value within the system. Their work directly reflected the outcomes of upstream practices because properly segregated waste improved collection efficiency, while mixed waste increased handling difficulty and occupational risks. Despite their important role, findings indicated that waste workers often experienced limited institutional support, including challenges related to equipment, protection, and recognition. The value chain perspective highlights that improving system performance requires not only technological and infrastructural improvements but also investment in the workforce responsible for maintaining system continuity.

Transportation functioned as the connecting mechanism between collection activities and processing or disposal facilities. The findings demonstrated that transportation efficiency influenced both operational costs and material preservation. Road congestion, limited access routes, illegal parking, and scheduling disruptions affected hauling efficiency and increased the possibility of environmental leakage through spillage or delayed movement. Transportation challenges demonstrated that waste value could be lost even after successful segregation and collection if containment and movement systems were inadequate.

The processing and treatment stage represented the primary value recovery point within the system. Material Recovery Facilities (MRFs) served as important nodes where recyclable materials were separated, classified, and prepared for recovery markets. However, findings indicated that processing efficiency was strongly dependent on the quality of incoming materials. Mixed and contaminated waste required additional labor and reduced recovery rates, limiting the potential economic and environmental benefits of recycling activities.

Junk shops and informal recovery actors played significant roles in extending the value chain by converting discarded materials into marketable commodities. Junk shops added value through sorting, aggregation, storage, and market connections with larger recycling buyers. Waste pickers contributed to early-stage recovery by extracting recyclable materials before disposal. However, these actors operated under economic uncertainty due to fluctuating market prices, unstable income, limited protection, and weak integration into formal waste governance systems.

Final disposal represented the stage where unrecovered value exited the system. Although disposal remained necessary for residual waste, the findings demonstrated that landfill dependency reflected value losses occurring earlier in the chain. Waste that reached disposal facilities often represented materials that could not be recovered due to contamination, lack of market demand, inadequate processing capacity, or ineffective segregation. The continued dependence on landfill disposal emphasized the importance of improving upstream interventions rather than focusing solely on end-stage waste management.

Overall, the value chain analysis revealed that Pasig City possesses a functioning recovery network but has not yet fully developed an integrated circular waste economy. Value creation occurs through segregation, recycling, recovery facilities, junk shops, and informal workers; however, value losses continue through contamination, limited processing capacity, weak market integration, and inconsistent participation. Strengthening the value chain requires improving material quality, expanding recovery infrastructure, formalizing recovery actors, and establishing stronger connections between waste generation and resource recovery.

SWOC and PESTLE Analysis of Pasig City's Solid Waste Management System

The SWOC and PESTLE analyses revealed that Pasig City's solid waste management system demonstrates operational strength while facing structural challenges associated with long-term sustainability. The findings indicate that the city has developed effective routine service delivery mechanisms but must address deeper systemic issues involving behavioral compliance, recovery capacity, financial sustainability, technological integration, and environmental performance.

The major strengths of the system were identified in its reliable service delivery, particularly in waste collection, segregation support, public information, and transportation operations. Respondents recognized the regularity of collection schedules, accessibility of disposal information, and availability of segregation guidance as significant achievements. These strengths demonstrate the effectiveness of local governance mechanisms in providing visible public services and establishing resident confidence in waste management operations.

Another major strength was the presence of a recovery network involving MRFs, junk shops, recyclers, and informal waste workers. These actors contribute to resource recovery by diverting recyclable materials away from disposal pathways. The findings indicate that Pasig City already possesses elements of a circular waste system, although these components require stronger coordination and institutional support.

Despite these strengths, several weaknesses were identified. The most significant challenge involved the gap between awareness and consistent waste management behavior. While residents understood segregation requirements, actual compliance remained inconsistent. This behavioral gap affected material quality, increased contamination, and reduced recovery efficiency throughout the supply chain.

Limited processing capacity also emerged as a major weakness. Although MRFs contribute to waste diversion, their capacity remains insufficient to significantly reduce landfill dependency. Recovery activities continue to favor materials with established markets, while low-value plastics and mixed packaging frequently become residual waste. Additionally, informal recovery actors remain insufficiently integrated into formal governance structures despite their contributions to waste diversion.

The findings revealed several opportunities for improving system performance. Strengthening source segregation through incentives, monitoring, and community-based programs represents a major opportunity because improving material quality at the source would enhance all downstream operations. Expanding organic waste recovery through composting and biological treatment also presents significant potential because biodegradable materials constitute a substantial portion of the waste stream.

Improved coordination among government offices, barangays, businesses, schools, recycling enterprises, and informal workers provides another opportunity for system optimization. Establishing stronger partnerships and information-sharing mechanisms could improve material flow, reduce inefficiencies, and increase recovery rates. Digital monitoring systems, performance tracking, and transparent reporting were also identified as opportunities to strengthen evidence-based decision-making.

The major challenges affecting the system include increasing waste volume, complex material composition, financial constraints, behavioral resistance, and dependence on landfill disposal. The growing prevalence of single-use plastics and mixed packaging creates difficulties because these materials often lack economically viable recovery options. Financial pressures also remain significant because waste management requires continuous investment in personnel, equipment, vehicles, facilities, and operational maintenance.

The PESTLE analysis further demonstrated that waste management outcomes are shaped by interconnected political, economic, social, technological, legal, and environmental factors. Political factors influence system effectiveness through leadership commitment, institutional coordination, and policy implementation. Economic factors affect operational sustainability through budget requirements, recyclable market conditions, and incentive structures. Social factors strongly influence compliance through community norms, household practices, and public participation.

Technological factors determine the efficiency of collection, transportation, monitoring, and processing systems, although technology alone cannot improve performance without proper governance integration. Legal factors provide the regulatory foundation through national laws and local ordinances, but implementation capacity

remains essential. Environmental factors highlight the consequences of ineffective waste management, including pollution risks, landfill dependence, and ecological degradation.

The combined SWOC and PESTLE findings indicate that Pasig City's waste management system is operationally functional but requires continued transformation toward a more integrated, circular, and sustainable model. The city's primary challenge is not establishing basic services but improving system integration, resource recovery, and long-term institutional sustainability.

Strategic Implications for an Integrated Waste Management Framework

The findings provide the foundation for developing a strategic framework that transforms waste management from a collection-centered public service into an integrated supply chain and value chain system. Since the current system demonstrates functional performance, the proposed direction focuses on optimization rather than replacement of existing structures.

The strategic framework emphasizes six major priorities: strengthening governance systems, improving segregation performance, enhancing processing and recovery capacity, modernizing transportation operations, developing sustainable financing mechanisms, and institutionalizing community participation.

Governance improvement requires stronger coordination among city offices, barangays, recovery facilities, businesses, and community organizations. Establishing standardized reporting systems, clear performance indicators, and accountability mechanisms would strengthen institutional continuity and reduce dependence on individual leadership.

Improving segregation remains the most critical operational priority because source quality determines the efficiency of all downstream processes. Programs focused on behavior change, incentives, monitoring, and community participation can convert existing awareness into consistent practice.

Enhancing MRF operations, expanding organic waste recovery, strengthening recycling partnerships, and integrating informal recovery actors would increase resource recovery and reduce landfill dependency. These interventions would allow waste materials to retain economic and environmental value throughout the system.

Transportation improvements should focus on route optimization, vehicle maintenance, spill prevention, and digital monitoring. Since transportation connects all stages of the waste chain, improvements in this area would reduce environmental leakage and increase operational efficiency.

Financial sustainability requires recognizing waste management as a long-term investment rather than merely an operational expense. Cost accounting, recovery tracking, recycling market partnerships, and resource value capture mechanisms can support more sustainable financing structures.

Finally, sustained public participation remains essential. Education campaigns must evolve from information dissemination toward long-term behavior change programs involving households, schools, businesses, and community organizations.

Overall, the findings demonstrate that Pasig City has developed a strong foundation for effective waste governance. However, achieving long-term sustainability requires shifting from a disposal-oriented model toward an integrated circular economy approach where waste is managed as a resource, recovery opportunities are maximized, and all stakeholders participate in preserving environmental, economic, and social value.

CONCLUSION

1. The findings indicate that the current waste management practices of Pasig City are generally effective, reliable, and positively recognized by residents across the five operational dimensions of collection, disposal, processing, segregation, and transportation. This conclusion is supported by the consistent pattern of favorable assessment across all major areas of service delivery, suggesting that the city has established a functioning and visible waste management system that responds to everyday sanitation needs. In practical terms, the results show that residents do not experience waste management as irregular, disorganized, or absent; rather, they perceive it as a routine public service with a stable operational presence in their communities. This broad pattern reflects a level of institutional functionality that is important in urban governance, since waste management becomes

credible not only when waste is removed, but when services are delivered with enough consistency to shape public expectations and behavior.

The strongest conclusion emerging from the findings is that Pasig City's system performs best in its routine and visible service functions. Waste collection stands out as a particularly strong area, with respondents emphasizing regular schedules, predictable service, and timely arrival of collection vehicles. These findings suggest that collection has become one of the most trusted aspects of the city's waste operations. Its significance extends beyond logistics because regular collection helps build confidence in local institutions and encourages residents to coordinate their disposal practices with the system. Similarly, positive perceptions of disposal indicate that residents recognize the presence of facilities, information, and enforcement measures that support proper waste handling. This suggests that the city has succeeded in making waste disposal not only operationally available but also publicly understood. In the same way, favorable responses regarding segregation and transportation imply that the city has established service structures that are sufficiently clear and reliable to support participation and orderly waste movement.

At the same time, the findings also show that the system's strengths are more pronounced in frontline delivery than in deeper aspects of environmental and behavioral performance. While respondents generally assessed all five dimensions positively, the less emphatic responses in certain areas point to limits in overall system completeness. These areas include coverage of all waste types, consistent residents' segregation before disposal, public clarity regarding environmentally sound processing methods, and minimization of spillage during transport. This pattern suggests that Pasig City has achieved operational competence in the functions that residents most directly observe, but has not yet fully resolved issues that depend on stronger behavioral consistency, broader technical transparency, and more integrated environmental control. The conclusion, therefore, is that the city's waste management system is effective at the level of visible public service delivery, but still evolving in relation to full sustainability, comprehensiveness, and deeper system integration.

2. The findings demonstrate that stakeholders experience Pasig City's waste management system as an interconnected supply chain in which each stage of waste movement influences the efficiency of the next. Rather than functioning as a set of isolated activities, the system operates through linked processes that begin with waste generation and continue through collection, transportation, sorting, processing, recovery, and disposal. The evidence shows that stakeholders across residents, barangays, collection operations, recovery facilities, and recycling-related activities encounter the system as one in which upstream conditions directly shape downstream performance. This leads to the conclusion that the city's waste management system is best understood as a chain of interdependent functions whose overall effectiveness depends on coordination, timing, compliance, and material quality across all stages. In this sense, stakeholder experience confirms that waste management is not solely a municipal service concern, but also a matter of process continuity and actor interdependence.

A central conclusion from the findings is that source conditions exert a decisive influence on the rest of the supply chain. Waste composition varies across residents, markets, schools, and businesses, yet a common issue across these sources is the effect of segregation quality on downstream operations. Clean, properly separated materials support smoother movement, easier handling, and greater recovery potential, whereas mixed or contaminated waste weakens the efficiency of transport, increases sorting burdens, reduces material usability, and enlarges the volume of residual waste. This means that the supply chain does not begin with collection trucks or facilities; it begins where waste is first handled by generators. The broader implication is that residents and institutional behavior forms part of the chain itself rather than merely serving as an external influence upon it. The findings therefore support the conclusion that effective waste management depends as much on upstream user behavior as on downstream operational capacity.

The evidence further indicates that logistical coordination is a defining element of stakeholder experience. Collection, hauling, and routing are not passive support functions but active mechanisms that connect generators to processing and disposal points. Stakeholders experienced smoother operations when collection schedules were followed, waste was prepared on time, and routes remained manageable. Conversely, traffic, access constraints, delayed waste readiness, and route disruption weakened system efficiency and created operational adjustments that affected later stages. Economic constraints, inconsistent enforcement, and social habits also shaped how the

supply chain functioned in practice. Taken together, these findings show that Pasig City possesses a working waste management supply chain, but one whose performance remains vulnerable to disruptions caused by contamination, budget limitations, behavioral inconsistency, and uneven coordination. The conclusion is that stakeholder experience reveals a functioning but still fragile chain in which system-wide efficiency depends on strengthening both operational linkages and the behaviors that support them.

3. The findings indicate that Pasig City's solid waste management system functions not only as a service chain for waste removal but also as a developing value chain in which waste may retain, gain, or lose value depending on how it is handled from source to final destination. The evidence demonstrates that waste is not uniformly without worth; rather, its value depends on segregation quality, transport integrity, processing capacity, and access to recovery pathways. This means that waste management in the city already contains the structural logic of a recovery-oriented system, where certain materials can move away from disposal and toward reuse, recycling, or other productive outcomes. The broader conclusion is that Pasig City's waste system has already moved beyond a purely disposal-centered model in conceptual and operational terms, even though its value recovery mechanisms remain uneven and incomplete.

A key conclusion from the findings is that value is preserved or lost primarily through material quality. Properly segregated waste retains greater utility because it can be more easily processed, marketed, or diverted from residual disposal. In contrast, mixed or contaminated waste loses both practical and economic value as it moves through the system. This confirms that the point of generation is also the point at which value recovery either begins or is undermined. Residents, businesses, schools, and other generators therefore play a direct role in determining whether waste becomes a recoverable resource or a disposal burden. The significance of this conclusion lies in its shift of emphasis: value recovery is not created only at the facility level but is conditioned by the earliest stages of handling. The findings therefore suggest that the quality of waste entering the chain is the basic determinant of whether value can be sustained downstream.

The evidence also shows that the city's value chain is carried by a network of actors rather than by formal government structures alone. Material Recovery Facilities, junk shops, waste pickers, buyers, and generators all contribute to value preservation and diversion. However, the findings indicate that the recovery system remains selective, favoring materials with clearer market demand and more practical reuse or resale pathways, while lower-value or mixed materials tend to become residual waste. This means that value recovery exists, but not yet on a fully inclusive or comprehensive basis. It also shows that informal recovery actors play a significant role even when they are not fully integrated into formal coordination systems. The conclusion, therefore, is that Pasig City's waste value chain is real and operational, but still constrained by contamination, uneven marketability, limited processing depth, and incomplete institutional recognition of all contributors. The system already demonstrates the basic principle of turning waste into recoverable value, but it has not yet fully institutionalized that principle across the entire chain.

4. The findings indicate that Pasig City's solid waste management system is characterized by clear operational strengths, significant structural weaknesses, meaningful opportunities for improvement, and continuing challenges that affect its long-term sustainability. Overall, the system appears functional, visible, and generally effective in its routine service dimensions, particularly in collection, communication, segregation support, processing, and transportation. These strengths demonstrate that the city has established a workable governance and service framework capable of maintaining urban sanitation and public confidence. The regularity of collection, the presence of information mechanisms, and the existence of recovery structures suggest that local government has developed a waste management system that residents can recognize as credible and organized. This conclusion is important because it shows that the city is not starting from institutional failure, but from a platform of operational competence that already delivers observable public value.

At the same time, the findings clearly demonstrate that the system remains structurally incomplete in important respects. The most persistent weakness is the gap between awareness and consistent behavior. Residents may understand segregation and disposal rules, but knowledge does not always translate into uniform practice, resulting in contamination and reduced recovery quality. Other weaknesses include limited recovery capacity, uneven enforcement and monitoring, incomplete data systems, and the weak formal integration of informal

recovery actors. These findings suggest that the city's most visible functions are stronger than its less visible but equally important capacities for sustained diversion, institutional coordination, and ecological performance. Thus, while the system works well enough to preserve order and sanitation, it does not yet fully achieve the level of behavioral discipline, recovery efficiency, and institutional consolidation required for complete systemic maturity.

The opportunities and challenges identified in the findings reinforce this conclusion. There are clear opportunities to build on existing awareness, strengthen residents' routines, improve coordination among actors, expand composting and recycling pathways, and make the system more evidence-based and recovery-oriented. However, these opportunities exist alongside continuing challenges such as behavioral inconsistency, increasing waste complexity, financial pressure, coordination difficulties, limited processing depth, and environmental vulnerability. Political, economic, social, technological, legal, and environmental factors all shape whether the system can move beyond visible competence toward long-term sustainability. The conclusion, therefore, is that Pasig City's waste management system is best understood as operationally effective but not yet fully mature. It has strong foundations and genuine improvement potential, yet its future success depends on resolving the structural and behavioral issues that continue to constrain full integration, recovery, and sustainability.

5. The findings demonstrate that the development of a proposed strategic plan for Pasig City's solid waste management system is justified because the city already has a functioning operational base but continues to face gaps that require institutionalized and system-wide improvement. The evidence shows that respondents generally assess the existing system positively, which means that strategic planning can proceed from a position of functionality rather than crisis. This is a significant conclusion because it suggests that the city does not need to rebuild its waste management system from the ground up. Instead, it needs a coherent plan that consolidates its strengths, addresses its weaker points, and aligns future action with the realities of supply chain coordination and value chain recovery. In this sense, the rationale for the proposed strategic plan rests on the existence of a credible service platform combined with clearly identifiable areas where optimization remains necessary.

The findings further indicate that the most important targets for strategic action are the points where system continuity and value preservation are weakest. These include incomplete waste-type coverage, inconsistent segregation behavior before disposal, limited public understanding of processing methods, uncertainty regarding environmental sustainability in processing, and concerns related to spillage during transportation. These weaker areas are not peripheral; they occur at critical points in the movement and transformation of waste. From a supply chain perspective, they represent disruptions in quality control, containment, and flow continuity. From a value chain perspective, they represent points at which recoverable materials may lose value before reaching appropriate recovery channels. The conclusion, therefore, is that the strategic plan is warranted because it directly addresses the parts of the system where both operational efficiency and resource recovery are most vulnerable.

The evidence also shows that a strategic plan grounded in supply chain and value chain perspectives is appropriate to the city's actual conditions. Waste management in Pasig City involves multiple actors, linked processes, and varying forms of recoverable value. The current system already reflects these dynamics, even if not yet fully institutionalized. A strategic framework that emphasizes coordination, accountability, behavior, recovery, and sustainability is therefore consistent with how the system already functions and where it currently falls short. The conclusion is that the proposed strategic plan offers a necessary pathway for transforming waste management from a predominantly service-delivery activity into a more integrated governance and recovery system. It is justified not only because challenges remain, but because the findings show that the city has already developed enough operational capacity and public trust to support deeper institutionalization and optimization.

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