

## **COMPREHENSIVE ASSESSMENT OF CONVENTIONAL PRACTICES AND SUSTAINABLE PATHWAYS FOR SOLID WASTE MANAGEMENT: INTEGRATING PERSPECTIVES, PRACTICES, AND ENVIRONMENTAL IMPACT**

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### **INTRODUCTION**

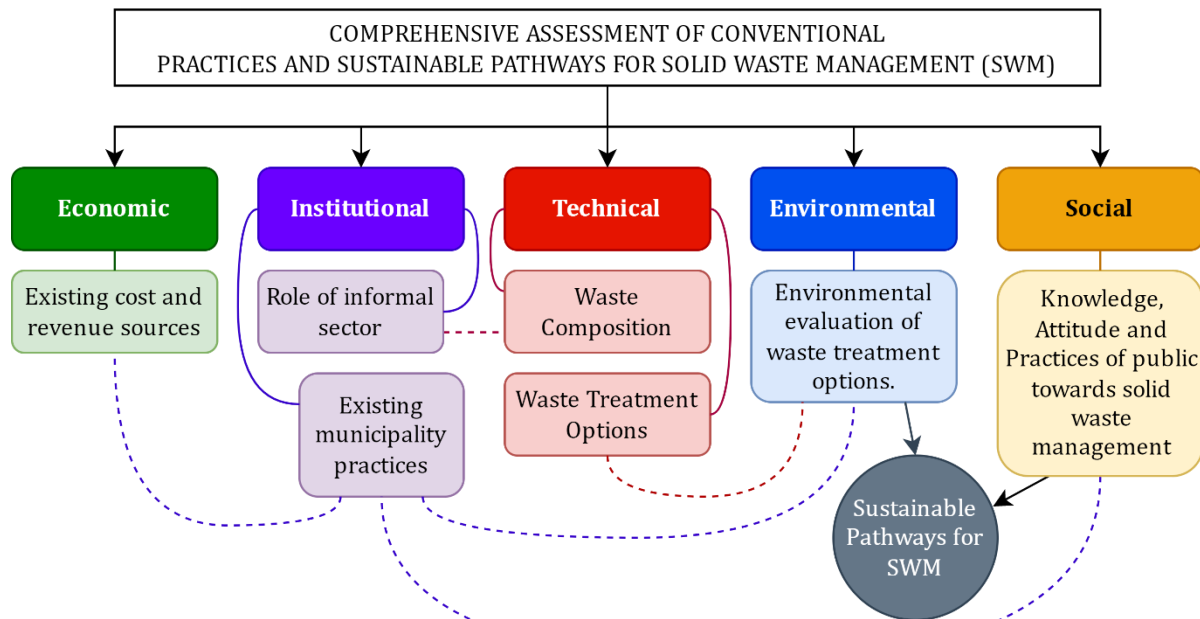
Municipal Solid Waste is being generated at an alarming rate of 2 billion tons annually, and this rate is expected to be doubled by 2050. To visualize this, if a year's worth of solid waste is put in standard shipping containers and arranged in a line, it will cover a distance greater than a return trip to the moon. While official statistics are absent for Pakistan, the country is estimated to generate 32 million tons per year, with a yearly increase of 2.4%. Meanwhile, less than half of the produced solid waste is collected in major metropolitan cities, while waste from rural areas is completely neglected. Typical waste treatment options such as incineration, composting or anaerobic digestion are absent, and there are no functioning sanitary landfills in Pakistan despite its relative affordability. This leads to the open dumping and burning of manually collected waste, which releases cancer causing chemicals, particulates and other pollutants into the environment.

The dilapidated state of solid waste management in Pakistan can be rooted to political negligence, lack of resources, public awareness and behaviors, outdated regulatory framework, and administrative issues. Despite past mistakes, there is an urgent need to correct the path and enact actionable and effective national waste management policies. However, the lack of official statistics and narrow assessment scopes hinder good policy formulation. An effective policy needs comprehensive, reliable, and site-specific assessment of the baseline situation of the various interconnected components of solid waste management. Therefore, this research study is conducted to provide a broad-scoped, comprehensive and translatable assessment of solid waste management at an urban city in Pakistan. Multiple aspects of solid waste management have been covered in this study through an interconnected approach, with consideration from all major stakeholders. These aspects and their relevance are briefly outlined in the methodology, with greater focus on the study findings and subsequent key policy recommendations at the end of this brief.

## METHODOLOGY

The methodology adopted was aimed to analyze various components of Solid Waste Management (SWM) to gain a comprehensive understanding of the issues within each component and their interconnections. As illustrated in Figure 1, the technical component was first addressed by determining the composition of generated waste to understand residents’ consumption behaviors and identify suitable waste treatment options. These options were further validated through expert opinions and assessed for environmental impacts, covering the environmental component of the SWM system. The institutional component focused on evaluating existing municipal practices and the role of the informal sector (IS), a key but often understudied stakeholder. Issues faced by the IS were explored through semi-structured interviews with its members, and potential integration methods with the formal sector were identified using the framework proposed by Velis et al. (2012). The social component involved uncovering residents’ perspectives, including their knowledge, attitudes, and practices regarding SWM, through structured interviews. This component is linked to the institutional component, as residents’ perspectives are shaped by municipal authorities’ actions. Lastly, the economic component was examined by calculating the operational and management (O&M) costs and the revenue earned from selling recyclables, which was revealed through the assessment of municipal practices. The detailed methodology is included in the submitted Final Report.

Figure 1: Methodological Framework

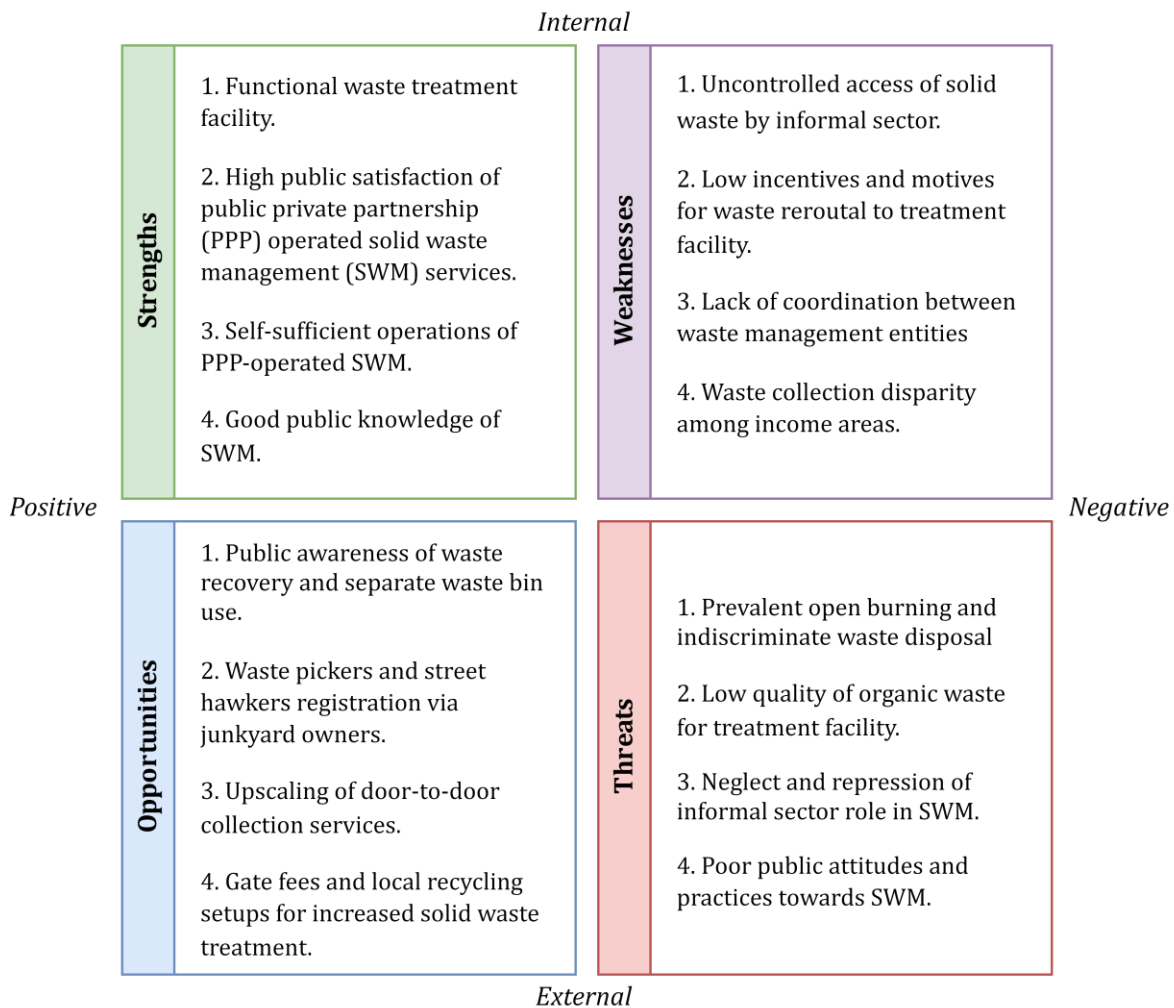


Source: Authors compilation.

## FINDINGS AND CONCLUSIONS

Multiple shortcomings and some strengths were seen for each of the five aspects of SWM in this assessment. These are summarized as a SWOT analysis in *Figure 2*. Briefly, several prevalent issues of SWM throughout Pakistan were also observed in this assessment, such as administrative issues and lack of public awareness. The administrative problems arose from low coordination between the waste management organizations, and failure to implement easily actionable rules such as registering informal sector workers and controlling access to dumpsite. The public, meanwhile, showed poor behavior towards SWM: For instance, respondents understood the health and environmental risks of open burning and excessive plastic bag use, yet openly admitted to performing both practices. The overall findings and conclusions are listed as follows:

*Figure 2: Summary of Findings Illustrated via SWOT Analysis*



1. Greater recyclable waste was found in door-to-door waste versus skip and tubs, and this waste is traced to active collection by the IS. About 36% of the participants' waste collection was collected by the IS.
2. More than 5% of total daily waste comprised of plastic bags, despite their light weight. Respondents were knowledgeable on the environmental harm posed by plastic bag use.
3. Composting and anaerobic digestion are potential waste treatment options based on high amounts of organic waste (55%) and yard waste (1.7 tons per day).
4. Sanitary Landfill, Material Recovery Facility (MRF)/ Recycling, and Incineration were additional shortlisted waste treatment options based on experts' opinions. Additionally, composting was preferred over anaerobic digestion as it is cheaper and easy to setup.
5. Two waste management entities operated in the city: a Public-Private Partnership (PPP) and a public entity. The PPP provided door-to-door waste collection, supported by a treatment facility with a Material Recovery Facility (MRF), compost and pellet lines. The public entity collects waste from skips and tubs and disposed all waste to the dumpsite. The PPP maintained a regular collection schedule.
6. The PPP-managed door-to-door waste collection areas showed reduced incidents of open burning and dumping. This method also increases the recovery of recyclables, making it an effective and environmentally friendly collection mode.
7. A major challenge for the PPP in treating organic waste was its low quality, as residents did not segregate waste despite the provided separate bins. This highlights the need for active measures to improve organic waste quality, given its dominance in the waste stream.
8. The PPP installed a weighing bridge at its facility to record the incoming waste from both PPP and public entities. However, no waste limitation or gate fee was imposed, a practice recommended in the literature to encourage waste treatment.
9. Waste management services varied significantly across the city, with low-income areas and suburbs receiving less collection visits and possessing fewer waste bins or skips, highlighting disparities with income levels.
10. Bureaucratic barriers existed between waste management entities, as PPP was denied access to the public entity's waste for treatment.
11. There was no integration of services between the formal and informal sectors in solid waste management. Key issues for informal sector observed: lack of controlled access to waste, repression and neglect of the informal sector (IS), absence of a database for waste pickers and hawkers, public discrimination, inadequate authority support, lack of informed initiatives, child labor, no penalties for open burning, lack of recycling-friendly policies, minimal NGO advocacy, absence of PPEs, poor healthcare access, and exploitation by recycling industries.
12. Public knowledge (90%) was significantly higher than attitudes (73.3%) and practices (64.7%). There was a negative perception of waste and limited knowledge about key waste management practices like the 3Rs and segregation. Younger respondents were more knowledgeable, and those with higher education were more willing to pay for waste services. Social media was the preferred source for those with higher education, while TV was preferred by those with lower education. Respondents served by PPP reported higher satisfaction and more frequent waste

collection than those served by the public entity, though they were less willing to pay. Practices like open burning and plastic use were concerning, given Pakistan's environmental challenges.

13. The Cost Benefit Analysis (CBA) indicated strong revenue potential, with revenues (PKR 40,00,000) just 600,000 PKR short of O&M costs (PKR 46,00,000). Revenues could rise significantly if waste segregation is practiced by households, allowing compost to be sold.
14. Environmental evaluation of shortlisted waste treatment options showed positive results for the Composting, Anaerobic Digestion and Material Recovery Facility (MRF), two of which were currently operational in the study area (Composting and MRF).

## KEY POLICY RECOMMENDATIONS

The following key policy recommendations are suggested in view of the research findings:

1. The government mandates the Composting and MRF setups for all municipalities throughout the country.
2. The PPP mode of operations is recommended for better quality of waste management services and higher satisfaction levels of the residents.
3. Maximum possible transition from skips and tubs to door-to-door waste collection to limit the informal sector's uncontrolled access to waste, reducing open burning incidents. This shift would also enable waste management entities to recover more recyclables.
4. Installation of separate bins (two bins, i.e., dry and wet waste instead of three bins) at the household level for simpler waste segregation.
5. Visually attractive and interactive awareness campaigns on social media and TV, and curriculum changes in education institutions are recommended to ensure public understanding and practice of separate bin use for waste.
6. Introduction of gate fee after installing weighing bridges at the dumpsite to promote recycling and other management options.
7. Waste management services, including collection methods, frequency, and bin placement, should be standardized across the city. Priority should be given to low-income areas, ensuring inclusivity for underserved communities and informal sector stakeholders.
8. Integrating the formal and informal waste management sectors is crucial. Key policy measures include: i) providing controlled access to IS at treatment facilities or dumpsites, ii) registering waste pickers and street hawkers by mandating already documented junkyards to purchase only from registered members, iii) supplying registered members with uniforms, ID cards, and large containers, iv) enforcing strict action against unregistered members and child labor, v) involving informal sector stakeholders like junkyard owners in planning, vi) offering affordable loans to registered workers, vii) incentivizing parents of child waste pickers to enroll them in schools, viii) promoting positive environmental contributions of informal workers to improve public acceptance, and ix) supporting unions and NGOs that advocate for their rights.

9. Strict fines must be imposed on indiscriminate waste disposal and open burning to ensure compliance.