



# **Solid Waste Management & Recycling: Operational and Financial Model**

**Learners' Republic Policy Fellowship Research Report**

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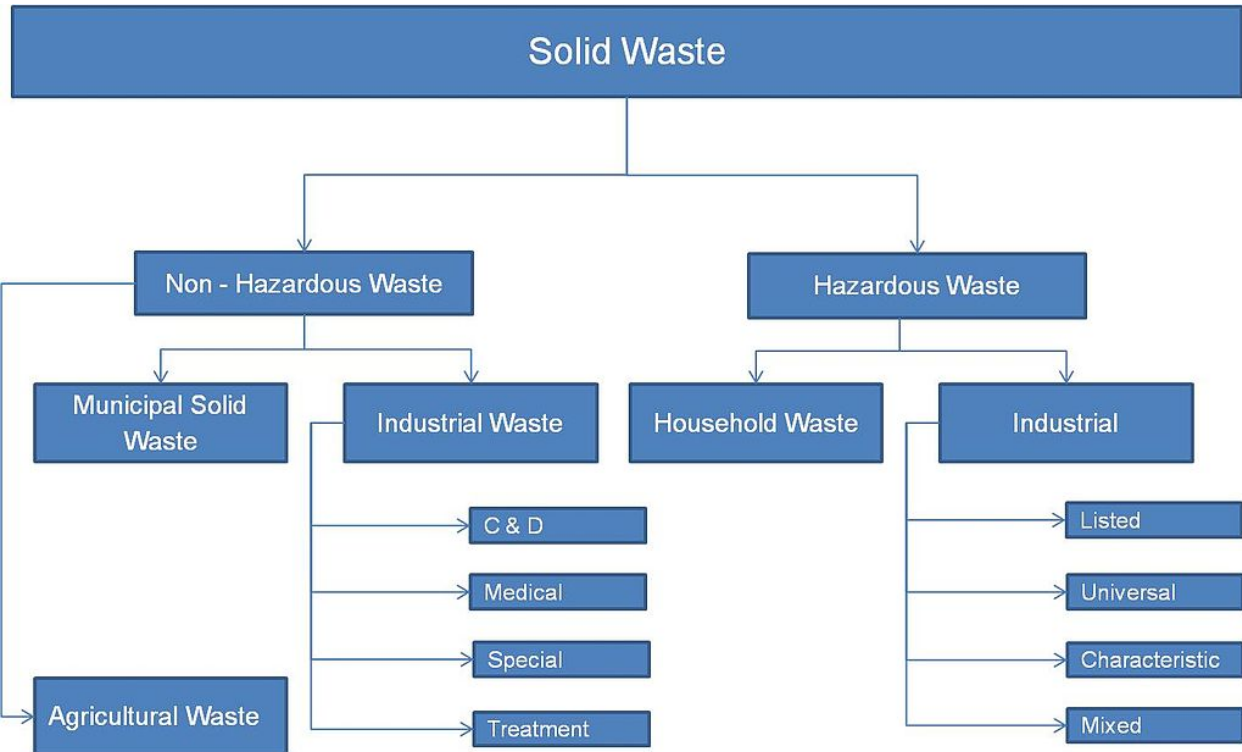
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## **Executive Summary**

The increase in usage of packaging in consumer products along with the ever-increasing population has led to an exponential rise in land pollution. Meanwhile developed countries are making huge leaps in reducing and recycling the waste, developing countries like Pakistan are remotely prepared to fix the problem. Piles of garbage in the middle of streets and shopping bags clogging waterways are a common sight due to the lack of a proper solid waste management system. This lack of proper solid waste disposal leads to flooding in areas next to waterways, groundwater contamination and poses health risks to communities. These issues further lead to loss of economy, human capital and damage to the infrastructure. In a large number of countries, solid waste management has been either done through public entities or it is outsourced to private firms. In either case, the consumer of services pays a meagre amount for disposal of their solid waste. The collection of solid waste serves as a good revenue source for any entity involved in collection since most of the items in solid waste are sold back to manufacturers for recycling purposes. Moreover, this strategy serves as a valuable tool in disposal of hazardous waste thus keeping the environment clean. This project report evaluates the solid waste management services from a business perspective. To develop the operational and financial model, the region of Gulshan-e-Iqbal in Karachi was considered for the base case. According to the survey conducted by UN habitat, the average household in the area generates 1.54 kg of solid waste which yields approximately 280 tons collectively. Most of this waste either can be recycled or can be utilized for energy or biogas generation. This provides an ample opportunity for investors to consider solid waste recycling as a profitable venture.

## **Introduction**

Solid waste is composed of food, plastic, glass, metal, paper, textile and other. Sources of solid waste generation can be different. Waste is generated from residential areas, commercial spaces, institutions, industries, agriculture etc. Municipal Solid Waste (MSW) is generated primarily by households, commercial spaces, offices and institutions. It can be further categorized as hazardous and non-hazardous waste. Below graph summarizes the kinds of solid waste.



For instance, food waste from a household is a non-hazardous waste which doesn't pose a risk even if not disposed of, but coal ash from a coal power plant can be a hazardous waste as it can harm humans or the environment and hence requires proper disposal. MSW is generally not hazardous, especially if the source of generation is households. Hazardous and Non-hazardous waste can be further divided into biodegradable and non-biodegradable waste. Biodegradable waste can be broken down in a natural way and can be used to make organic fertilizers, biogas, etc. For instance, food waste can be used in composting to make fertilizers. But non-biodegradable waste does not decompose or decay naturally and can harm the environment for a long period of time. An example of this is plastic waste floating in the oceans for decades causing the death of thousands of sea species. However, even organic (biodegradable / non-hazardous waste) can pose a health risk if there is inadequate disposal efforts involved. While decaying, such waste creates an environment for bacteria and pathogens to thrive. Such conditions lead to chronic and infectious diseases. This shows the criticality and seriousness of waste management.

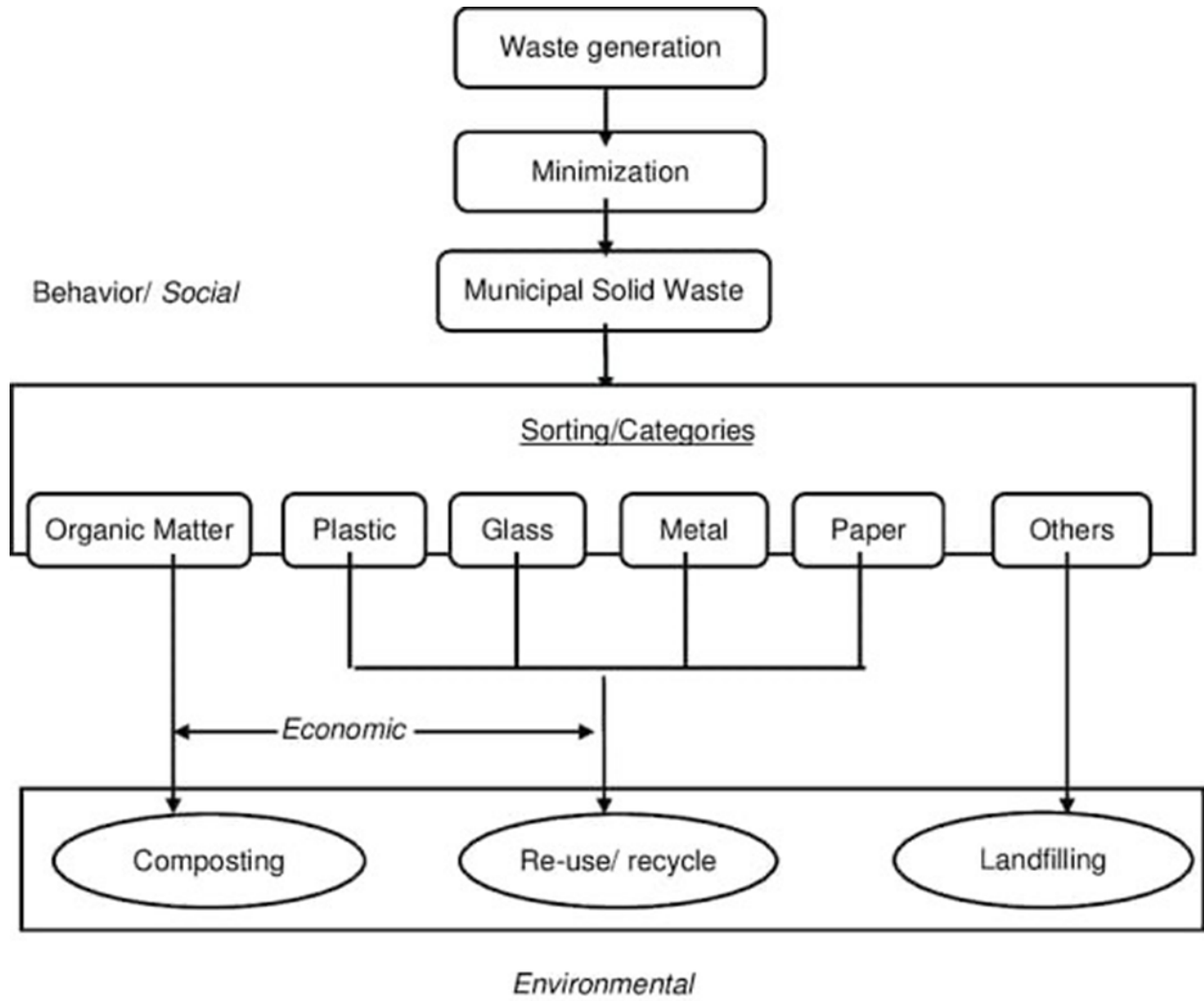
In Pakistan, there is a lack of proper waste management agencies. According to the Environmental Protection Agency (EPA), 'Pakistan generates around 20 million tonnes of solid waste annually and this figure grows by 2.4 per cent each year'. However, only about half of this waste is collected due to the lack of efficient waste management infrastructure. The garbage collected inefficiently, is also dumped carelessly. Due to the improper garbage dumping practice, not only does it make cities smelly and create health & environment risks but in the long-term disastrous outcomes. Such dumping leads to land pollution (including soil pollution), water

pollution and air pollution. An example of a disastrous outcome of inadequate waste dumping is urban flooding experienced across big Pakistani cities such as Karachi and Lahore. The waste ends up clogging the drainage lines hence the phenomena of flash floods. Further, the puddles (water pollution) caused by clogged drainage lines can lead to breeding grounds for infectious bacteria and insects such as mosquitos. Such polluted bodies of water are common in Pakistan and have led to dengue mosquitoes causing many people to lose lives by dengue fever. While there exists landfill sites such as Jam chakro for waste disposal, there are no creative solutions to ensure the waste is disposed of or recycled properly. The waste is either left as it is, or it is burnt creating severe air pollution.

The issue of proper disposal also lies with the lack of segregation of waste at the start. Most of the residential, commercial and institutional areas are rarely segregated, which leads to increasing the effort needed to recycle. The lack of segregation also leads to contamination across different types of waste which can reduce the quality of it. This can be seen from the example of Green Earth Recycling, a company in Lahore specializing in recycling and manufacturing of waste, where it was observed 'that lack of segregation of waste at the start made recyclable materials such as paper and plastic become contaminated with bacteria which reduced their quality and usefulness'. This shows how important segregation at the source of garbage generation is.

Furthermore, the company heavily relies on scavengers for recyclable materials. Scavengers, or garbage pickers, play an important role in the garbage collection and recycling domain. While there are no official recycling facilities, there is still recycling going on though the informal sector. This includes the scavengers (garbage-pickers) just as shown in above examples who collect garbage and sell scrap / recyclables to local scrap dealers or stores. Syed Ayub Qutub, executive director of Pakistan Institute for Environment-Development Action Research (Piedar), quotes that these 'scavengers collect almost 100% of the metal and glass, 95% of paper and 60% of plastic waste which is undocumented even though the benefit is huge to the environment'. However, many of these scavengers are children and the lack of necessary equipment for garbage collection poses a health risk for them. Further, the sector also includes raddiwala who go house to house and buy scrap directly to sell it later. If this informal sector was put to use for formal waste management, the potential is huge.

**Operational Model**



**Source:** Author



With the rapid increase in urbanization, the solid waste generated on a daily basis outstrips the environmental capacity to manage and dispose of the produced waste. Cities are currently absorbing two-thirds of the total population increase throughout the developing world (UNCHS, 1993). Pakistan lacks little to no subsidized budget for solid waste management. Under these circumstances, the way solid waste is managed is far from efficient. The Sindh Solid Waste Management Board Act 2014 was passed for the collection and disposal of all solid waste. The Board has the power to grant permission to individuals, industries etc for compost making and power generation from solid waste. However, the Court clearly states that the existence of this Board will be a liability for the Sindh government. According to a study, approximately 12000 tonnes of solid waste is generated in Karachi alone. Out of this, 40% of the solid waste is found on the streets rather than in proper disposal sites. However, these statistics tend to vary according to the scale of the studies/research conducted. While Karachi as a whole might be an expansive city to investigate, the operational model focuses on Gulshan e Iqbal, a residential and commercial neighbourhood in Karachi.

The process of collecting and disposing solid waste is divided into 3 shift arrangements. The first shift lasts from 6AM to 2PM whereby the communal containers/ waste bins are collected. The compactors pick up the waste that might be found on the road or in front of shops. The door to door collection is carried out through Suzuki mini dumpers/ pickups. Garbage bags are distributed all over the zone to ensure that household waste is sorted. The map above identifies the locations of the garbage bins in Gulshan e Iqbal zone. The consumer will be required to pay a penalty for not sorting the garbage. Similarly, the distribution of garbage bins will be based on solid waste segregation to enable efficient disposal and management of waste. Each household will receive three garbage bins for three different categories of waste – organic waste, plastic/paper waste, other waste like batteries. The second and third shifts continue from 2PM to 10PM and from 10PM to 6AM respectively. These consecutive, round-the-clock shifts ensure that the waste has been collected from both residential and commercial areas. The division of



garbage bins is based on the following statistics: As per SSWMB draft report on waste amount characterization in Karachi districts (May 2021), 'the major fraction of MSW in Gulshan zone was organic waste at 44.39% (including kitchen waste, food and fruits etc.), followed by plastic waste (including wrapper, baggies, Styrofoam, etc.) at 19.67%, Pamper / Diapers / Sanitary Pads waste at 10.04%, textile waste at 8.50%, paper waste at 5.50%, Grass and Wood at 4.24% and residue material remaining on sheet at 2.22%'. According to the population census of 2017, the total number of housing units in the Gulshan zone are 154,136 (145,984 Pacca, 2367 Semi-Pacca, 5785 Kaccha). The census data also suggests the average household size to be 5.33.

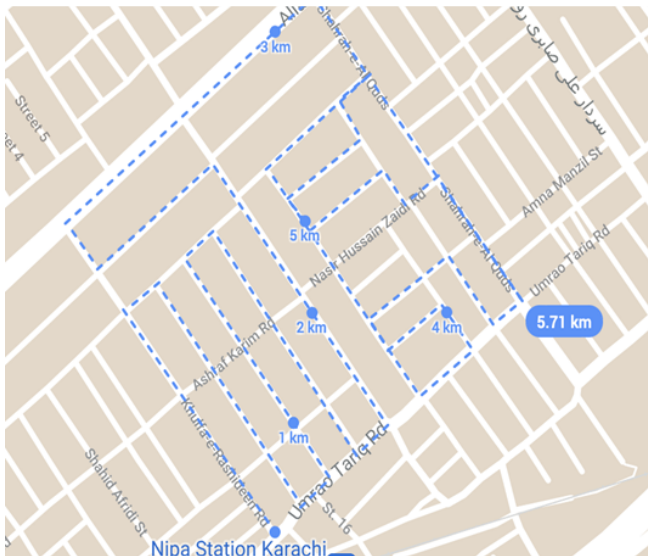
By providing separate garbage bins to the consumers, the recyclable waste can be sorted at source and can be later sold to SEPA certified waste contractors. A total of 12 vehicles are used for waste collection and transportation to transfer stations which are leashed on government land. In addition to that, there are various landfill sites at Jam Chakro and Gond Pass which are located at a distance of 35kms from the city centre. The non hazardous and non recyclable waste is often dumped at these landfills managed by municipal administration. The hazardous waste is stored in designated areas with restricted access and proper marking. The collection and management of waste in Sindh areas like Gulshan zone is carried out by the Sindh Solid Waste Management Board and the DMCs. The town councils and agencies responsible for collection of waste either use their own equipment or collaborate with private sector agencies that provide the necessary services.

### **Financial Model**

Sindh Solid Waste Management Board (SSWMB) is already operational in different areas of Karachi which shows that the logistics part of the model is done. However, the entire model needs to incorporate the operational model presented. The importance of the model lies with the fact that segregation occurs at the very start, hence reducing efforts to sort the waste after. To create a more realistic financial and operational model and to base it on concrete data available, a single neighbourhood was selected as the base. After evaluation, it was found many areas of the Gulshan-e-Iqbal in Karachi East are not being catered by the SSWMB and the services, where operational, are below par. Further, the Gulshan-e-Iqbal encompasses entities like the residential sector, shopping malls, parks, hospitals and educational institutes, which makes it representative of solid waste that is usually found at the landfill locations.



The distance needed by the Solid Waste Management Company to collect the waste was computed through google maps. To simplify the process, Gulshan-e-Iqbal was taken as the base case and the distance for collection vehicles was measured. Next this region was overlaid to the entire Gulshan zone to get the approximate distance needed to be covered.





Each block in our map covered 5.7 km, therefore the cumulative distance needed to be covered for solid waste collection will be 182 km. The area was further divided into north and south zones depending on the distance from the center of Gulshan-e-Iqbal. This data led to the estimation that approximately 12 loading vehicles will be needed to cover all the blocks, which cost PKR 0.3 Mn each and have a loading capacity of 2 tons. These vehicles will be specifically used for their fuel optimization as compared to bigger trucks with lower mileage running on diesel and creating more air pollution.



The average waste generation, according to the UN Habitat report, for middle income households (mostly in Gulshan-e-Iqbal) is 0.29 kg per person per day leading to a total waste of approximately 238.2 tons. Every vehicle would need 10 runs to ensure all areas in the zone are covered. The cost table would include:

Component	Assumption	Cost (PKR)
Vehicles	<ul style="list-style-type: none"> <li>2 tons each vehicle and total 239 tons, hence 12 vehicles</li> <li>Every vehicle cost PKR 0.3 Mn</li> <li><b>One time cost</b></li> </ul>	$12 \times 300,000 = 3,600,000$
Transfer Stations	<ul style="list-style-type: none"> <li>2 transfer stations will be built, one for organic waste and one for other recyclable waste such as paper, plastic, textile, etc.</li> <li><b>One time cost</b></li> </ul>	$2 \times 1,000,000 = 2,000,000$
Fuel cost	<ul style="list-style-type: none"> <li>Total area is 182 km, so around 15km will be covered by each vehicle in each run and there will be 10 runs</li> <li>Petrol per litre is PKR 150 and the vehicle runs around 15km per litre</li> <li>Per month cost (30 days)</li> </ul>	$150 \times 10 \times 12 \times 30 = 540,000$
Wages	<ul style="list-style-type: none"> <li>Every vehicle will have 1 driver and 1 loader &amp; every transfer station will have 2 people for management, assuming minimum wage</li> <li>Per month cost (30 days)</li> </ul>	$((2 \times 12) + 4) \times 17,500 = 490,000$
Safety gear for workers	<ul style="list-style-type: none"> <li>Assuming PKR 1000 equipment per worker per week (4 weeks)</li> <li>Per month cost (30 days)</li> </ul>	$((2 \times 12) + 4) \times 4 \times 1,000 = 112,000$
Repair & maintenance	<ul style="list-style-type: none"> <li>Assuming PKR 10,000 per truck per month</li> <li>Per month cost (30 days)</li> </ul>	$12 \times 10,000 = 120,000$
Utilities for transfer stations	<ul style="list-style-type: none"> <li>Assuming PKR 10,000 per station per month</li> <li>Per month cost (30 days)</li> </ul>	$2 \times 10,000 = 20,000$
<b>Operational cost per month (excluding one-time costs)</b>		<b>1,282,000</b>
<b>Total cost for first month</b>		<b>6,882,000</b>

The above table comprises common costs for a waste management service such as labor, fuel cost, maintenance and repair costs etc. However, there may be other costs associated with this service too which include but not limited to the cost of planning & feasibility study (sunk cost), preparation of tenders / contracts, management & monitoring and quality control, marketing campaigns for awareness, insurance cost and so on.

There are many sources of revenue generation in waste management too. If SSWMB charges PKR 100 / per house per month, this will generate a revenue of PKR 15,413,600 per month (household units 154,136). A completely online garbage registration software can be used to ensure payment of fees. The revenue generated from just these fees not only cover all costs, but generate a huge profit which can be invested for construction of formal recycling facilities as well as composting / biogas stations. Further revenue can be generated from the sale of waste. Organic waste can be sold off to companies like TrashIt which are involved in composting. A 6kg bag of compost at TrashIt costs PKR 1000. Gulshan has around 44.39% of organic waste, which means 106 tons per day (Total waste of 238 tons per day). Assuming a stat of 15 kg of organic waste produces 1 kg of compost (assuming 1 kg is worth PKR 166), around 7 ton of compost (worth PKR 1 Mn) can be made with just 1 day's waste. Even if waste goes to Biogas, the potential is huge for the organic waste industry and revenue streams can certainly line up with proper management. Market for other recyclables such as plastic, paper, textile etc. is also huge. Unilever has its own recycling station at factories for paper and plastic, and serves as an example of a potential institutional / industrial buyer. Further, penalty fees upto PKR 200 can be charged to households for lack of proper sorting of waste. This will certainly generate waste for the first few months, until awareness is complete about the new system.

### **Risk Management:**

Scavenging is being observed as an income generating chore for particularly underprivileged individuals in less developed countries. However, waste picking by the informal sector disrupts the operations of the formal sector, for instance, waste management companies, intermediaries etc in order to glean the solid waste at the best possible price. In Pakistan, solid waste material does not even reach the dumping grounds as waste pickers used to collect it for recycling before the waste management companies or collectors of any particular private or government antibodies. On the other side of the coin, there are garbage mafias residing near the high or upper-middle income localities, in an effort to make profits through door to door trash collection. Recycling waste is also segregated by the informal collectors and being sent to their own dumping sites or used to sell to the stakeholders. The nature of their work encompasses onsite sorting, storage, handling, resource recovery and recycling. Legal firms or small-scale businesses involved in the practice of collecting waste at a stated price, have been witnessing a downfall in financial terms. Moreover, in terms of services, businesses practicing waste collection and recycling are not very fast-moving. Therefore, the scavengers get hold of the collection points before the government employed workers or legal stakeholders. Excluding that, the formal sector is not very spread out as the informal sector mainly due to the social taboo.

Consequently, as long as there is poverty, such practices would continue to take place in order to survive specifically for the street pickers.

According to a study, Karachi generates more than 16,500 tons of municipal waste on a daily basis. Nevertheless, the dearth of waste management infrastructure is the root cause of creation of environmental havoc. It has been observed that the most indispensable issue with dumping or burying waste into vacant land is that it menaces human's health. Waste pickers, in the struggle to survive financially, are risking the methane explosions. Unsorted or leftover waste lay down on the streets or being thrown into the water. Furthermore, vacant lots/landfills have been used as a source aiming to dump waste. However, disposing of plastic waste in landfills is deemed as an unendurable way as it causes threat to the environment which in turn, causes the release of greenhouse gas emissions. The garbage waste in Pakistan mostly incorporates plastic, papers and other hazardous material that has a nitty-gritty role in contributing to the environmental disorders. One vital constraint is the little knowledge or less concern among the general public on how to dispose of the perilous waste and effective waste management practices.