PROSPECTS FOR THE DEVELOPMENT OF SOLID WASTE MANAGEMENT SYSTEM: A CASE STUDY OF METROPOLITAN CITY KARACHI

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PREFACE

Solid waste management in Karachi is becoming a serious concern given the population growth and uncontrolled migration. This increase in the population has been generating a huge amount of waste daily. KCCI (2018) reported that daily, about 12,000 tons of solid waste is generated in Karachi and by 2020 the Solid Waste Generation will reach 18,000 to 20,000 tons per day [Maswood M. A. (2020)]. Currently, the arrangements made by both public and private sector entities in disposing of these wastes are improper and the leakages in the system have led to the mushroom growth of the informal sector substantially. The growth in informality has now become uncontrollable. Immense literature though available on the topic but after experiencing urban flooding and the establishment of Sindh Solid Waste Management Board (SSWMB) - a creation of a parallel system instead of removing inefficiencies and strengthening the old system -has diverted the attention of scholars towards exploring the inefficiencies prevailing in the system. This study is also an attempt to explore the inefficiencies present in the prevailing system, the scope of public-private partnership in managing the solid waste and household willingness to improve the solid waste condition in Karachi city.

ABSTRACT

The study aims to explore the public and private institutional structure, its weaknesses and obstacles it faces in managing the solid waste system in Karachi. Specifically, the study aims to make (1) capacity assessment of the public sector in providing the service, (2) assessment of the role of the private sector and workers managing Solid Waste formally or informally and (3) estimation of households' Willingness to Pay and Ability to Pay for the better management of the solid waste in Karachi. For assessment purposes, the study conducted a comprehensive household survey and interviews of key players involved in the management of solid waste. The study covers all the 6 DMCs and 18 towns of Karachi. Based on the information collected from the secondary reports shared by the SSWMB and other officials of KMC, a detailed descriptive assessment is done regarding (i) generation, (ii) collection, (iii) cost of collection, and (iv) human and physical input involved. In order to explore the role of private contractors and informal players, separate interviews (KIIs) are conducted. Information collected from the private contractors not only helps us to understand the system hierarchy in managing the solid waste but also the cost and profit involved in each step – a kind of value chain analysis. The study also developed a detailed Household questionnaire to evaluate (i) the current practices in handling solid waste by household, (ii) the perception regarding the clean environment, and (iii) household willingness and ability to pay in managing the solid waste in Karachi. The study summarizes all the findings by conducting a SWOT analysis.

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LIST OF ABBREVIATIONS

SWM   Solid Waste Management

SSWMB   Sindh Solid Waste Management Board

KMC   Karachi Municipal Corporation

DMC   District's Municipal Councils

SWOT   Strength Weakness Opportunities Threat

WTP   Willingness to Pay

ATP   Ability to Pay

KII   Key information Interview

KPI   Key performance indicators

INTRODUCTION

Currently, Pakistan is experiencing rapid urbanization and environmental degradation, especially in its major cities like Karachi mainly because of the improper handling of solid waste. Though the local and municipal governments are responsible for collecting waste but only about 60-70 percent of solid waste in the cities gets collected. Karachi being the industrial and commercial hub and having a large residential area - comprising of the population belonging to multiple cultures, is facing many types of socio-economic issues with solid waste at top of the list. The population is touching around 20 million and waste generation is causing a serious problem for the social and economic development of mega city. The literature on solid waste management is predicting a sharp increase in waste generation. For example, ESCAP/IUCN/UN HABITANT (2013) estimated that the average household solid waste generation for the city of Karachi is around 0.44 kg/cap/day ranging from 0.19 to 0.84 kg/cap/day. Fruit and vegetable market has generated 1.795 kg/shop/day and 11.77 kg/shop/day respectively. In 2016 Sabir et al highlighted that on daily basis near about 12000 tons of Solid Waste was generated in six districts of the city [Sabir et al (2016)]. KCCI Research & Development Department (2018) reported that Solid waste generation in Karachi hovers between 12,000 to 15,000 tons per day of which only up to 10,000 tons per day gets collected. More recently, Korai et al (2019) estimated that Karachi has generated around 0.57kg/cap/day. Studies also estimated that around 55 thousand tons of waste is generated per day in urban areas of Pakistan and almost 60 percent of it is transported by the district's municipal councils (DMCs). The municipal authorities facing many constraints in managing solid waste in the city and the provision of better services has become a nightmare. The city is now managing solid waste through private contractors' cooperation – both internationals (Like China and Spain) and locals.

The issue is not new and has remained under debate for since long. For example, Ali & Hasan, (2001) reported that most of the solid waste was dumped at kuchra kundis, which was supposedly collected and transported to landfill sites by the District Municipal Councils (DMCs) of Karachi. But in practice, a part of that waste (about 1400 tons) was picked by scavengers daily from the kuchra kundis – with no records available. In real terms, the role of the private/ informal sector in managing the wastes has not been highlighted in-depth. Keeping in view the economic development, population growth, greater urbanization and the higher average income of the households, the production of wastes is projected to increase further. In this situation, the magnitude of the wastes produced, the formal and informal employment, and the possibilities of recycling would also increase in certain proportions.

Solid waste management is hence become one of the most debatable issues specifically for developing urban areas because of the rising consumption pattern (Abas & Wee, 2014; Marshall & Farah bakhsh, 2013). Shahid & Nargis (2014) found that most developing countries face problems to manage solid waste material which is rapidly growing due to the increase in population and the rate of development. The municipal solid waste is generated from various activities of daily life and usually increases with the growth of population and income (Tseng, 2011).

Mahar (2014) reviewed the practice of solid waste management in urban areas of Pakistan. The study found that not a single city showed a proper solid waste management system. Haider et al. (2013) studied a household-level analysis of SW generation rates across different income groups

in Rawalpindi, Pakistan. The results revealed that the SW generation is greater in higher-income groups than in lower-income group households. Altaf & Deshazo (1996) study surveyed a solid waste disposal area in Gujranwala city and the results revealed that households were willing to pay for improved SWM service.

Sabir et al., (2016) inspected the situation of solid waste management procedures employed in Karachi and the challenges faced by the responsible authorities. This study found that the citizens are disappointed with the performance of the solid waste system in Karachi. The study also found that municipalities, faced a lack of financing and appropriate instruments to ensure their effectiveness. The citizens of Karachi are also a contributing factor in the growing garbage by means of their participation in unlawful disposal. With increasing solid waste per day in the city, there is a need to implement an adequate system of dumping or recycling the solid waste on day to day basis.

Immense literature though available on the topic (see annex-A1) but after experiencing urban flooding and the establishment of Sindh Solid Waste Management Board - the creation of a parallel system instead of removing inefficiencies and strengthening the old system - has diverted the literature towards exploring the inefficiencies prevailing in the system. The available literature remains focused on exploring generation, collection and recycling issues. Literature also provides evidence of environmental hazards as well. Literature, exploring the institutional structure, its weaknesses and obstacles it faces in managing the system is very limited.

AIMS AND OBJECTIVES

Given the scenario above, the study aims to firstly provide a comprehensive review of the existing system and practices in managing solid waste. Secondly, it provides an in-depth assessment of the role of private contractors and the informal sector in SWM. Based on the information gathered through the interviews of key officials, private contractors, players working informally and households, the study aims to suggest an efficient waste disposal policy. Specifically, the objectives of the study are to:

- understand the current process/practice of solid waste management (SWM) in the city of Karachi by categorizing the type of wastes generated and the process of managing the different types of wastes.
- evaluate the capacity of the public sector in managing solid waste i.e. the assessment of the public sector to highlight the major problems faced by the public authorities in managing solid waste and point out the inefficiencies within the system.
    - identify the incapacity/gap in the provision of services delivered by the public sector.
- evaluate the role of the private sector (contractors directly hired by the public authorities or informally) in managing solid waste, highlighting their motives and the interest in entering the business. The type of activities performed by the private sector is also examined.
- estimate the extent of informality in managing the SW.
- evaluating prospects of collected waste for recycling and reuse,
- estimated households' WTP for managing SW
- by assessing the roles of public, private and informal sectors in managing Solid Waste, the proposed study aims to provide policy options for efficient management of solid waste using SWOT analysis.

METHODOLOGY – SCOPE OF STUDY

The above-stated objectives are assessed by conducting a comprehensive analysis of all the stakeholders involved at different levels starting from wastes produced, collected, transported and disposed-off/ recycled or reuse. The study is based on a survey of 18 towns in Karachi. This help in evaluating the role of District Municipal Committees (DMC's) in managing solid waste in localities across all 6 districts. The study collected primary information through key informant interviews and household surveys – study interviewed almost all the key stakeholders - households, officials of DMCs, private contractors and informal players in the system. In addition, small scrap dealers (Kabariya - operating both at large and small scale) and small scale industries involved in recycling are also contacted for value chain assessment. To assess the objectives, the study performed:

- Capacity Assessment Analysis: Given the information collected through KII's of public officials, the capacity of the public sector in providing the service is assessed
- Assessment of Role of Private and Informal Sector: Both Qualitative and quantitative analyses are performed to evaluate the role of the private sector and informal workers in managing SW
- Value Chain Analysis: To evaluate the prospects of recycling and reuse value chain analysis is performed – exploring profit margin of private/informal players involved in SWM, given that the SSWMB is not involved in recycling/reuse.
- WTP analysis: Socio-economic condition of the households' surveyed is assessed in-depth for the estimation of households' WTP. Detailed methodology is discussed in section 4.4
- Assessment of Linkages vs. Leakages: To understand the current practices/process of solid waste management a comprehensive framework is developed. The framework explores linkages and leakages at each level. The leakages identified are based on the qualitative and quantitative assessment performed.
- SWOT Analysis: In the final stages, the study identifies the strength, weaknesses, opportunities and threats involved in managing solid waste in Karachi based on the assessment

3.1 Data Collection, Designing of survey Instruments and Field Visits

As the study mainly aims to collect information through Key Informant Interviews of Public officials and private contractors and surveys of informal players and Households, the methodological design of the study put the comprehensive effort in highlighting the issues to be probed during KII's and household and informal players surveys. The step followed includes:

- Finalization of all the survey instruments, see attachments: A3.1 to A3.3 (Private contractors), (Informal Players) and (Household)
- Pre-testing of the instruments to iron out field-level problems if any and finalization
- Identifying the sample household using the appropriate randomization process
- Developing a field plan for efficient coverage of the sample
- Actual face-to-face information collection using a set of issues from Public officials and Private Contractor – by employing thoroughly trained interviewers
- Data entry and data cleaning is in Process

3.2   Finalization of the Survey Instruments

Public officials

As the first step officials from both KMC Solid waste and SSWMB are selected for interviews. In order to cover the hierarchy Director SSWMB and Deputy Director KMC (list of interviews conducted with name, designation are annexed A3-) were interviewed before conducting interviews of officials at each DMCs of Karachi. The information collected is related to the following issues:

- Assessment of capacity
  - Generation by District
  - Collection by District
  - The magnitude of Unattended waste by District
  - Cost of collection by District
- Assessment of management inefficiencies
- Identifying Gaps in SWM planning
- Public-private partnership models with informal system reforms
- Process for recycling and reuse of SW – if any

Table 0.1: Selected Interviews – Public Officials

Selected Interviews	Conducted
1. SSWMB Department - Director and Deputy Director	2
2. KMC Solid Waste Department -Senior Director and Director	2
3. Cantonment Board	1
4. SITE – Industrial Area	1
5. District Municipal Corporation - Director/ Deputy Director /Director Operation	6

Private Contractor and Informal Players/Workers

The information gathered is related to:

a.   Motives and Incentives
b.   Type of Agreement with Public sector
c.   Type of waste collected per day
d.   Management process
- Hiring of workers- Number of workers
- Hiring of vehicles - Number of vehicles, Transportation cost
- Subcontracting to individuals working informally
- Process of hiring an informal subcontractor
- Process of collecting waste

- Disposal process by type of waste
- Cost of service provided

f. Process of and prospects for managing reusable Solid Waste

g. Profit and Expenditure pattern

Table 0.2: Survey of Contractors and Informal Players

Selected Interviews	Conducted
1. Private Contractors from 18 towns	36
2. Informal Worker under each Contractor	50

Household Survey

a. Profile (covering occupation, sources of income and educational attainment)

b. Type of waste usually generated

c. Process of the collection – the cost of collection

d. Major concerns related to solid waste management

e. Awareness regarding the current process of dumping and recycling

f. Existing system – satisfaction with the current system

g. Amount willing to pay for the improved system

3.3 Sampling

Table 3.3 provides detail of the sample of households selected from each town. In order to reach an appropriate household sample different combinations of confidence interval and specification error are considered in order that it remains statistically valid and representative. In view of the above, it is considered appropriate to determine the sample size with 95 percent confidence and less than 10% specification error. The following formula is used which yielded an optimal sample size of 445 households:

Optimal Sample Size = $Z^2 [p (1-p)]/e^2$ (for known population)

Where, Z = Specification of confidence coefficient

p = Estimated Proportions

e = Specification error

Table 0.3: Household Sample

Town Name	Total	Proportion	Sample (proposed)	Sample (Materialized)
Baldia	616,721	0.043	20	21
Bin Qasim	480,855	0.034	15	15
Gadap	439,675	0.031	14	14
Gulberg	688,581	0.048	22	21
Gulshan-e-Iqbal	949,351	0.067	29	30
Jamshed	1,114,138	0.078	34	39
Kaemari	583,641	0.041	19	19
Korangi	829,813	0.058	26	28
Landhi	1,012,393	0.071	31	32
Liaqatabad	985,576	0.069	30	34
Lyari	923,177	0.065	29	29
Malir	604,766	0.042	19	18
New Karachi	1,038,863	0.073	32	34
North Nazimabad	753,423	0.053	24	23
Orangi	1,098,858	0.077	34	35
Saddar	935,565	0.066	29	28
SITE	709,944	0.050	22	23
Shah Faisal	509,916	0.036	16	17
City Total	14,275,256		445	460

Source: Data was extracted from the website of pbs.gov.pk

FINDINGS

Given the objectives of the study, the result section is divided into 6 parts.; first part assesses the capacity of the public sector, SSWMB and KMC, in managing Solid Waste; the second part assesses the role of the private or informal sector in managing SW – their role and motive is assessed by estimating the income or profit generated during the process starting from the collection, segregation/sorting, selling of recyclable, transporting and dumping of waste. The third part aims to perform a value chain analysis to assess the value of recyclable waste in Karachi by type as well. The fourth part of the report explores the socio-economic condition of the household to evaluate their willingness to pay for managing solid waste. The last part develops a comprehensive framework to understand the linkages and leakages within the system. Based on linkages and leakages the report summarizes the findings by performing a SWOT analysis.

4.1   Capacity Assessment Analysis

Historical Understanding of SWM in Karachi

The local government institution has been acknowledged across the civilized world as an essential democratic and administrative unit. The municipal body is selected by residents to effectively manage public affairs, as well as to satisfy the needs of local inhabitants and to promote efficient delivery of services at the community level in order to ensure people long term quality of life. The municipal government of Karachi has a long history [see annexe table A4.1 for reference].

More recently, the KMC re-emerged in place of the City District Government Karachi in 2013, following the enactment of the Sindh Local Government Act 2013. Many critical duties have been removed from the scope of KMC by the Sindh government. According to the Sindh Local Government Act 2013, all development schemes/works must be carried out by the concerned councils, i.e. Karachi Metropolitan Corporation.

The Sindh Solid Waste Management Board (SSWMB) is established in 2014 under the Sindh Solid Waste Management Act. Before the formation of the Solid Waste Management Board districts are the responsibility of the KMC, town councils, and union councils (DMC). The principal collecting agencies are town councils that manage and operate the primary collection system either with their own equipment or by contracting private sector operators. The CDGK is in-charge of the two "official" open dumping sites – one at Jam Chakro and the other at Gond Pass. After the establishment of the SSWMB, the distribution of power and responsibilities remain shuffled between the two. Currently, KMC is responsible mainly for managing medical wastes.

Organizational Structure and Functions - SSWMB

The SSWMB is responsible for collecting and disposing of Waste throughout Sindh, including Municipal Solid Waste, Industrial Solid Waste, and Medical/Hospital Waste. However, the Board is expected to gradually take charge of the solid waste management function from the Councils and other bodies and until that time DMC's are allowed to handle solid waste in their respective areas.

Solid Waste Management in Karachi has three operational segments; (i) front-end collection, (ii) middle-end services and (iii) back-end services. There are ten Garbage Transfer Sites located all around the city. The capacity of the existing infrastructure is insufficient. The institutional

structure of the sector is fragmented with the uncoordinated division of functions. Key institutions managing SW are (i) SSWMB as the primary service delivery agency and (ii) DMCs which have a more limited role.

Front-end collection services, collection from primary collection points (bins or kuchra kundis) and moving it to designated GTS, is divided between the SSWMB, and DMCs. Both are using different operational mechanisms. DMCs provide these services using sanitary staff who are regular employees of the DMC, and equipment that is owned and operated by DMC. In contrast, the SSWMB uses a private sector-led model through proper contracts.

Table 0.1: Existing Structure

No. of KMC	01
No of DMCs	06
Cantonment Boards	05
Karachi Port Trust	01
Pakistan Steel Mills	01
Port Qasim	01
Sindh Industrial Trading Estate	01
Export Processing Zone	01

Source: Based on KII's

The SSWMB is also responsible for the remaining segments of the transportation of waste till disposal to the sanitary sites. The Board also performed operational and maintenance (O&M) infrastructure of GTS and the disposal sites. Board manages its functions through contracting out functions to the private sector as well. On the contrary, DMC's does not currently have the technical capacity, in terms of facilities to handle waste scientifically. Capacity building is the need of the day. DMC's also lack the financial capacity to handle wastes properly.

Overall, the institutional capacity of the public sector needs to be assessed. Legal and regulatory framework with policies though exists, implementation levels are improper this may be due to heavy involvement of informal private contractors. Institutions are also generally directed by politicians or public sector workers who do not have enough skill to manage waste. There is little knowledge about the environmental hazards generated by untreated or dumped waste among the workers as well. The assessment helps identify weaknesses or strengths of the existing system in a structured way and hence highlights the factors that need attention leading to proper management of SW. The literature identified many assessment tools designed to assess capacity for institutional, organizational, technical, and financial aspects. However, this study remains focused on organizational, technical, and financial aspects only.

Generation

As the responsibilities are shared by two institutions it is essential to have some estimate of the amount of waste generated by districts reported by the two. This will help in estimating the manpower, vehicles and equipment needs for primary collection, transportation, and disposal of waste in each district. Municipal Solid Waste generation per capita per day as estimated by Kawai and Tasaki (2016) for Pakistan is 0.65 while EPMC estimates (1996) indicates solid waste generation as 0.61 per capita per day for Karachi. As the two factors don't have much variation

the study has employed EPMC estimates given for Karachi. Using the EPMC statistics and population census (2017) study has estimated the waste generation per ton per day for districts of Karachi. The estimated generation is not much different to what KMC has estimated (from the document provided by KMC officials during KIIs).

Table 0.2: KMC Estimates

Total Garbage (Town wise)	12000 tons/day
Estimated Garbage 2020	17000-19000 tons/day
KMC Area	80% Area (only 40% capacity)
DHA, CD, SITE.	20% Area
Vehicles (KMC)	168
Vehicle (DMC)	567

Source: Provided by KMC during KIIs

Table 0.3: Waste Generation Estimates using EPMC Waste Generation Rate

District	Population		Rate of Waste generation per capita / per day	Waste generated (Tons per day)		KMC Estimates (tons/day)
	1998	2017	EPMC(1996)	1998	2017	-
South	1468579	1769230	0.614	901.7	1086.3	1700
East	1447529	2875315	0.614	888.7	1765.4	1600
West	2127765	3907065	0.614	1306.4	2398.9	2100
Central	2289071	2971382	0.614	1405.5	1824.4	2000
Malir	914765	1924346	0.614	561.6	1181.5	900
Korangi	1608609	2577556	0.614	987.7	1582.6	1500
Total	9858316	16026911	-	8049.6	11856.1	9800

Source: Authors' estimation otherwise mentioned

Collection

The information provided in the below tables is extracted from the Bidding Document of SSWMB highlighting the minimum requirement a bidder need to fulfil in order to win the contract. The information presented in the below tables on collection and vehicle requirements is extracted from the bidding documents of SSWMB for different districts[1]. Considering that minimum waste collection requirements requested in biding documents are actually lifted up by the contractors (100% lifting), still results in waste unattended ranging from 85 tons per day to around 482 tons per day. Further, as reported by KMC that actual lifting is only 60% of the generation of which only 50% reaches the designated site, the unattended waste ranges from 435 tons per day to 960 tons per day. EPMC estimates; (1996) also reported a rate of waste collection around 51% to 69%.

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[1] The information placed here is as per direction of officials of SSWMB given during the KII's. The documents are available on the official website of SSWMB as well.

Table 0.4: SSWMB's Estimated Minimum Waste Collection

District	Waste generated	Waste Collected	Waste Unattended
South	1086.3	1000	86.3
East	1765.4	1465	300.4
West*	2398.9	2000	398.9
Central**	1824.4	1600	224.4
Malir	1181.5	700	481.5
Korangi***	1582.6	1500	82.6
Total	9839.1	8265	1574.1

Source: From the bidding documents of SSWMB.
* District West comprises of only Orangi, Baldia, Kemari and SITE town
** District Central Include Gulberg, Liaquatabad, New Karachi & North Nazimabad
*** District Korangi include Model Colony, Shah Faisal, Landhi and Korangi.

Table 0.5: KMC Estimates of Collection and Disposal

District	Waste generated	Collection – KMC @ 60% of Generation	Disposal – Landfill Site @ 50% of total Collected	Waste Unattended
South	1086.3	651.78	325.89	434.52
East	1765.4	1059.24	529.62	706.16
West	2398.9	1439.34	719.67	959.56
Central	1824.4	1094.64	547.32	729.76
Malir	1181.5	708.9	354.45	472.6
Korangi	1582.6	949.56	474.78	633.04

Source: Rates provided by KMC during KIIs

Resources

As far as human and physical resources required for operation is concerned, KMC has reported the number of employees and vehicles in possession in each DMCs of Karachi. KMC also claimed that of the total vehicles in possession only 25% is functional.

Table 0.6: KMC Estimate of DMC's Human and Physical Resource

District	Human Resource (#)	Different types of vehicles (#)
South	2083	124
East	1531	116
West	1741	88
Central	3157	118
Malir	336	27
Korangi	1544	59

Source: Information provided by KMC officials during KIIs

SSWMB again has provided minimum requirement of vehicles in each district by type enough to cater for the estimated waste need to be collected. Table 4.7 and table 4.8 below is based on the information provided however the district wise information are also gathered during interviews with DMC's to confirm the availability of resources.

Table 0.7: SSWMB's Estimated Vehicle Requirement for Managing SW by Vehicle Type

Vehicle	Requirement
Loading Machinery (Small & Large)	10 to 12
Dump Trucks (Small and Large)	15 to 20
Three Wheeler	40 to 50
Wheel Excavator	1
Tractor with trolley	10 to 12

Source: SSWMB tender documents

Further to this, based on the KII's of the officials of DMC's, the study re-assessed the physical resource available and the collection estimate provided by the DMC's. Considering the information provided by the DMC's waste unattended ranges around 43% (for the Districts Malir and West) 80% (for district Central). District East is the only district where DMC East has reported no left-over. Further, if we consider that the DMC's are operating with full resources available then it means that the resource needs to be increased from 40 to 80 percent.

Table 0.8: Resources Reported by DMC's and SSWMB in Respective District

| | East | | Malir | West | | Central | South* | Korangi |
	CK-Eng.	DMC/SSWMB		Kemari	West (Rest)			
Labour	1147	654	450	950	666	-		200
Mini Dumper/ Compactor	32	4	34	18	26	16		60
Side Compactor	45	0	0	25 (Bin /Tray Compactor)	0	0		0
Arm Hook	19	16	0	9	0	0		0
Dumper	10	29	10	22	18	16	15-25	12
Loader/Mini Loader	11	5	4	11	10	8	3-5	3
Tractor Shawwal	0	0	0	0	0	7		
Tractor Trolley	0	0	0	0	0	28	1	
Tractor/Tract or Blade	0	3	3	2	1	4	1	1
Mini Tippers	0	0	0	5	0	0		0
Bobkit	0	4	0	0	0	0		0
Mechanical Sweeping Machine	5	0	0	4	0	0		0
Water Bowser	3	0	0	0	0	0		0
3-Wheeler (Chingchi)	237	0	0	172	129	0		33
UC Covered (Collection/da y/ tons)	31 (1600)	7 (200)	NA (670)	23 (1000)	18 (378)	N/A	N/A	13 (300)
Waste Generation	1765.4		1181.5	2398.9		1824.4	1086.3	1582.6
Waste Unattended	-		511.5	1020.9		-	-	1282.6

Source: Based on KIIs. For District South, we have taken the information from tendering document.

Funds, Grants and Collection Cost – Financial Resources

Funds, grants, Aid etc. all diverted to manage the SW in Sindh particularly in its main hub Karachi. Sindh is also receiving International funding's as well. For example, the Asian Development Bank's (ADB) Infrastructure and Service Delivery Reform Program has provided $400 million to the Sindh Cities Improvement Investment Program (SCIP), which aims to improve solid waste management services in its 20 secondary cities as well. Total receipt/Income of SSWMB is Rs. 8,042.69 Million. Of the total receipt, the Salary and non-salary Expenses of the board are Rs. 1070 million and Rs. 5348 million respectively. The operating expense of the board is budgeted around Rs. 5058.65 million while the board has also incurred expenses on acquiring physical assets - Rs. 26 million. However, as far as the cost of collection or total operational cost is concerned no comprehensive information is available at the district level. As SSWMB has outsourced the task

to Chinese contractors in four districts, the cost of collection bids by the Chinese firms is available for these districts only. The cost estimates are taken from the agreement copy available on the website of SSWMB.

Table 0.9: Front End Collection, Sweeping and Transportation

District	Contractor	Amount US Million $
WEST	M/S Hangzhou Jinjiang Group of Sanitation Services Co. Ltd	22.35
EAST	M/S Changyikangjie Sanitation Engineering Co. Ltd	9.651
SOUTH	M/S Changyikangjie Sanitation Engineering Co. Ltd	14.254
MALIR	M/S Hangzhou Jinjiang Group of Sanitation Services Co. Ltd	6.134

Source: SSWMB tender documents

The agreement also provides a Bill of quantity/price list of different activities related to managing solid waste. From the agreement per unit cost of collection and Sweeping is projected to come up with the cost of collection in other districts of Karachi, assuming that per-unit price of the collection remains unaffected by the district.

Table 0.10: Cost as per bid by M/S Hangzhou Jinjiang Group for Malir

Item	Unit	US $	Pak Rs.
Cost of Collection	Tons	18	2,906
Manual Sweeping of Roads and Street	Per Km	12	2,006
Manual Sweeping of Footpath, open spaces, green Belts, roundabouts etc.	Per Sq. Km	6188	1.016,645
Mechanical Sweeping of Roads	Per Km	36	5,894
Mechanical washing of main Roads	Per Km	208	34,103

Source: SSWMB agreement documents

Table 0.11: Estimated Cost @ Rs. 2,906 Tons Per Day

District	Waste generated	Waste Collected	Waste Unattended	Cost by Generation	Cost of Collected	Cost of Unattended
South	1086.3	1000	86.3	3,156,788	2,906,000	250,788
East	1765.4	1465	300.4	5,130,252	4,257,290	872,962
West	2398.9	2000	398.9	6,971,203	5,812,000	1,159,203
Central	1824.4	1600	224.4	5,301,706	4,649,600	652,106
Malir	1181.5	700	481.5	3,433,439	2,034,200	1,399,239
Korangi	1582.6	1500	82.6	4,599,036	4,359,000	240,036

Source: Authors' estimates based on the unit rate of collection extracted from the agreement of Malir. Overall from the assessment above (section 4.1), the waste unattended ranges around 43% to 80% and to manage this unattended waste the resource needs to be increased from 40 to 80 percent.

Evaluating the Role of Private Contractors and Informal Players

This section explores the role of private contractors and informal players in managing the solid waste of Karachi. Their point of entry, contracting mechanism if any, the motive of involvement and profit or income they make from the waste are detail assessed here. This section starts by exploring the point of entry of the contractor. The purpose is to understand the system that manages solid waste in Karachi.

a. System Hierarchy Followed

Currently, the system that exists in Karachi can be grouped into 3 different models. The one that is properly handled by the public sector through formal subcontracting – model 1; second that operate through town/UC contracting out informally to private contractors either on personal relation basis or on political grounds while model 3 is completely informal in nature and operate in Orangi town mainly - among the lowest income areas of Karachi.

Table 0.12: Process of Collection

	ALL	Central	East	South	West	Korangi	Malir
Contractor							
Private (%)	91.7	100	75	100	80	100	100
Public (%)	8.3	-	25	-	20	-	-
Hiring Process (%)							
Tender	19.4	87.5	25	50	40	-	16.67
Informal	69.4	-	25	50	50	100	83.33
Personal Relation	8.3	-	50	-	10	-	-
Experience	2.8	12.5	-	-	-	-	-
Agreement Period (%)							
yes	25	12.5	50	50	40	-	16.67
No	75	87.5	50	50	60	100	83.33
Agreement Period							
Average # Years	1 to 2	.25	2	3.5	2.8	.66	1.2

Source: Based on KIIs and Primary Survey

Based on the survey of the contractor and informal players (employees hired by the contractor) study confirmed that solid waste in Karachi is still managed by private contractors (around 92%). While 8 percent public sector managing solid waste comes under the SSWMB contractual agreement made with the Chinese firms (Kangjie and Hangzhou). However, the door to door collection through outsourcing to a Chinese firm is very little evident – door to door collection by a Chinese firm (SSWMB) is evident in some areas of Korangi and East only. Further, hiring of the contractors, are around 69 percent informal, 19 percent formal, 8 percent on the basis of personal relationships while only around 3 percent is on the basis of experience – contractors are hired on the basis of having experience of the work.

Once the contractor is hired he again either sub-contracts to other or operate through informally hired workers. The hired workers of informally hired contractors are usually responsible for door to door collection. The collected wastes are usually dumped at the undesignated side – left for the KMC or SSWMB to pick. The formally designated points are either very limited in number or far reach. The contractor earns through a fee charged to the household while informal players if hired earn wages otherwise share the income generated through the fee charged. The collected waste is usually sorted by the informal players on spot, the remaining wastes are sorted at the designated or undesignated sites. Contractors, informal players and rag pickers all are involved in sorting.

Model 1

Town/UC
- Contract out Door to Door Collection
- Hired through proper channel - mainly KMC eployees
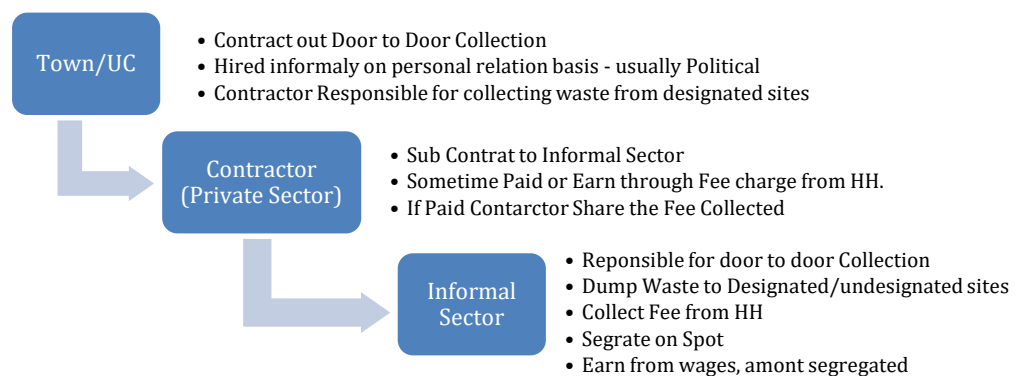- Contractor Responsible for collecting waste from designated sites

Contractor (Public Sector)
- Sub Contrat to Informal Sector
- Sometime Paid or Earn through Fee charge from HH.
- If Paid Contarctor Share the Fee Collected

Informal Sector
- Reponsible for door to door Collection
- Dump Waste to Designated/undesignated sites
- Collect Fee from HH
- Segrate on Spot
- Earn from wages, amont segregated

Model 2

Town/UC
- Contract out Door to Door Collection
- Hired informaly on personal relation basis - usually Political
- Contractor Responsible for collecting waste from designated sites

Contractor (Private Sector)
- Sub Contrat to Informal Sector
- Sometime Paid or Earn through Fee charge from HH.
- If Paid Contarctor Share the Fee Collected

Informal Sector
- Reponsible for door to door Collection
- Dump Waste to Designated/undesignated sites
- Collect Fee from HH
- Segrate on Spot
- Earn from wages, amont segregated

Model-3

| Informal Sector | Responsible for door to door & collect fee from | Segregate waste on spot | Dump Waste to Designated site | Earn from wages, amount segregated |

As said earlier, Model 3 reported above is at work in Orangi Town mainly where in some areas (UCs) households themselves have hired a contractor responsible to collect waste door to door. The system is operating through Mohalla committees. UC's have also hired contractors but the contractors are collecting waste 2 to 3 times a week only. In some UC's, NGO's are also working to manage solid waste. Orangi Town is a unique example where the system is completely in the hands of informal channels.

b. *Income and Expenditure pattern*

This sub-section discusses the cost of collection reported by the contractors. The study has only explored the variable cost (fuel cost and wage cost). The fixed cost is not enquired at the time of interview as the fixed cost of the public sector (KMC and SSWMB) will be much higher than the small private contractor – operating mainly through a horse and a cart or 4-wheeler – Chingchi. The cost of the public sector is higher as they are mainly involved in collecting waste from designated/undesignated sites and moving to landfill sites – not involved in door to door collection. For which they required heavy machinery. Hence, the comparison will not remain valid. Further to this, informally hired workers collecting waste received wages and fuel cost – if operating using Chingchi, from the contractor hence their cost estimates are not available as well. According to table 4.13 on average one contractor is responsible for the collection of waste from around 2000 households. They mainly operate through hiring 1 to 2 vehicles and employing 3 to 4 employees. The average cost per house on fuel is very minimum; less than Rs. 1 while the average wage per household is around Rs. 15.6 resulting in an average total cost per household born by a contractor is Rs. 16 only.

Table 0.13: Cost of Collection

	ALL [Cost/HH]	Central	East	South	West	Korangi	Malir
# Household Per UC	1983.6	3618.75	550	800	2790	983.3	810
# Vehicle	1 – 2	1	3-4	1	1	2	1-2
# Employee	3 – 4	2	10	1	2	3	4
# UC Covered	5 - 6	3	9-10	23	6-7	1	3
Fuel Cost [per Month/ UC]	Rs. 426.67 [Rs. 0.45/HH]	393.75	400	475	446	441.66	425
Wage [Monthly]	Rs. 14,133 [Rs. 15.6/HH]	7,725	16,375	16,500	16,600	8,166.6	22,250
Total Cost	Rs. 14,560 [Rs. 16/HH]	8,118.8	16,775	16,975	17,046	8,608.3	22,675

Source: Based on KIIs and Primary Survey

Table 4.14 reports income from fee collections only, for simplicity this sub-section avoid incorporating income generated from the sale of recyclable segregated. The income generated by segregating the recyclable waste is detailed discuss in value chain analysis – next section. The income generated as reported by the contractor is almost 65 percent higher than the amount collected through fees, the revenue estimated is also very high. To further, probe the issue study explores if the income is shared with the hired worker or UC hiring Contractor?

Table 0.14: Income from Collection - Contractor

	All	Central	East	South	West	Korangi	Malir
Fee per Household	179.7	227	325	125	90	200	166.7
Income Reported	1,28,472	2,34,375	75,000	60,000	99,000	1,38,333	85,000
Income Generated (# Household*Fee)	3,58,583	7,98,750	1,73,750	100,000	3,71,000	1,96,667	1,22,333
Revenue [Fee Collected – total Cost]	3,44,023	7,90,631	1,56,975	83,025	3,53,954	1,88,058	99,658
Revenue Per Household	163.7	221	293	104	73	191	144

Source: Based on KIIs and Primary Survey.

On probing the issue from both contractors and hired employees, they both agree that they share the income generated from fee collection. The fee collected is shared with the hired employee (75%), shared by UC around 19% while 6% is kept by the contractor.

Figure 0.1: Who Take the Fee
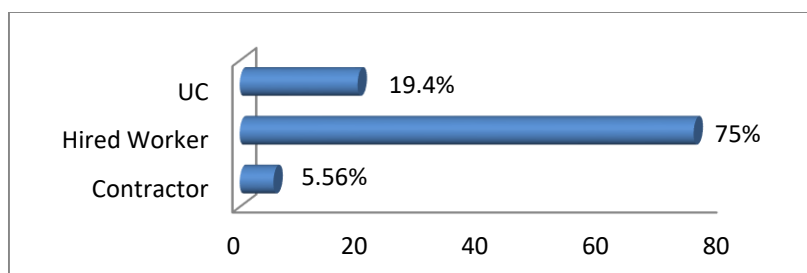
Similar issues are also probed by the hired worker, informally hired workers; the below tables provide some interesting facts related to income generated and waste collected per kg per household per day.

Table 0.15: Income from Collection – Hired Workers

|	All	Central	East	South	West	Korangi	Malir
# Household Covered	1056	1592	483	750	1137	939	811
Fee per Household – Rs.	217	262.5	317	50	97	211	350
Income Generated (# Household*Fee) – Rs.	22,6018	4,56,667	145,000	35,000	99,000	200,556	273,333
Wages if Hired – Rs.	11,678	8,383	11,167	15,667	16,733	8,444	9,889
Total Amount of waste Collected (per day/worker)Kg	1910	3017	915	1290	1890	1797	1452
Amount of waste Collected (per HH/day)Kg	1.76	1.96	1.8	1.7	1.6	1.8	1.7

It is evident from the table that, informally hired workers usually covers around 1000 households per day and waste collected per worker per day is around 1900 Kg while the waste collected per day per household by a contractor is around 1.76Kg.

4.2 Value Chain Analysis

The above sub-section has helped in developing an insight into the mechanism followed in-term of waste collection in Karachi. Given the understanding developed above the study move to analyze the opportunities available within the system which if utilized efficiently will help in improving the solid waste management process in Karachi – i.e. development of the recycling industry.

As evident from the finding above solid waste management in Karachi is heavily dependent on the informal sector for the collection as well as disposal of waste. Informal waste pickers have a noteworthy contribution in the collection, sorting, disposing and recycling of waste material. Contractors hiring these workers are sometimes also involved in segregating waste and in recycling, however, the public sector is not involved in reselling recyclable material for the obvious reason – a non-profit organization. The below figure provides a flow of waste from collection to segregation of recyclable material.

Figure 0.16: Generation, Collection, Segregation and Income from the sale of Recyclable
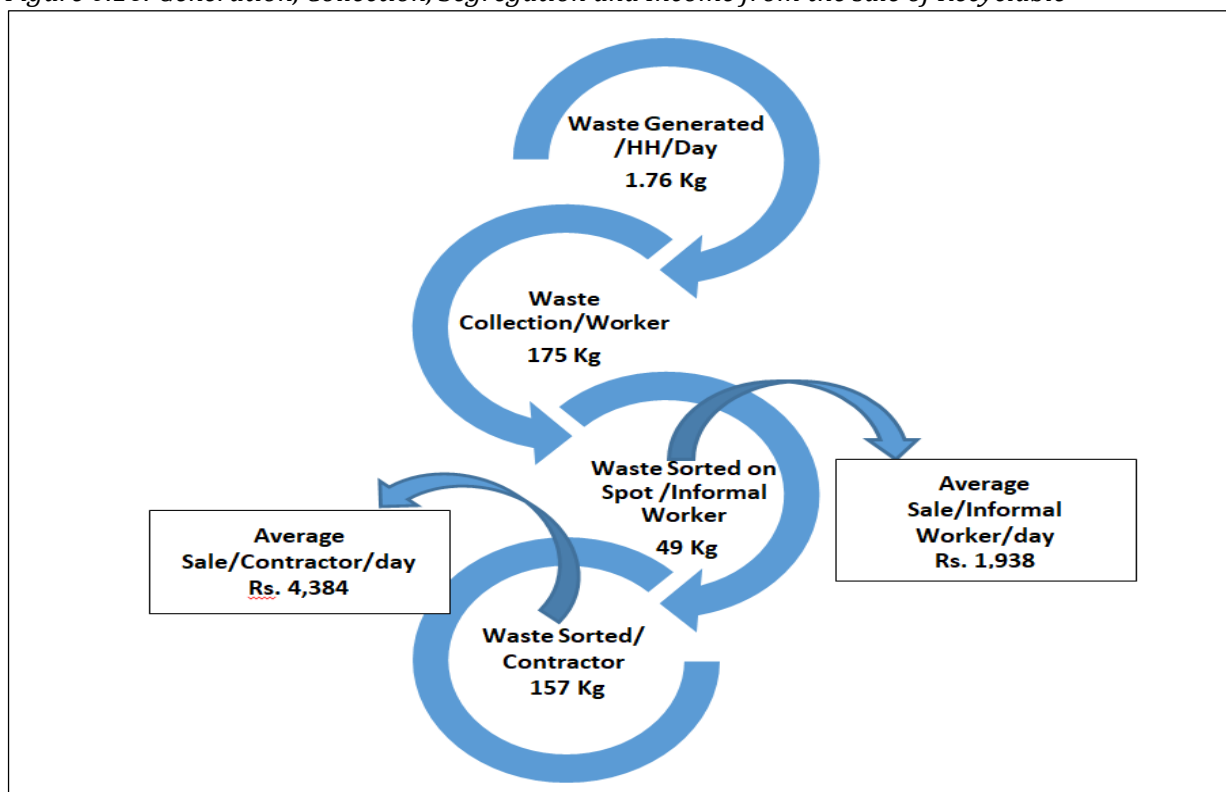
Source: Based on Survey of Private Contractors and Informally Hired Workers.

The main recyclable component identified by both contractors and the workers includes Plastic, Paper, Cardboard and Scrap (mainly steel and iron). Our household survey also confirms that households are also mainly interested in the sale of these goods as well. As there is vast variation in the quality of the recyclable material segregated, the rate at which the material is sold also show much variation. The below table provides information on the rate per Kg (sample average) as reported by the surveyed contractors. For authenticating the rate reported, the price per kg is also verified by the team from the market during the survey. The market rate is not much different from what surveyed contractors have reported except in the case of Plastic and Steel/Iron. The variation is maybe because of the variation in quality.

Table 0.16: Rate Per Kg

Item	Reported by Contractor (Rs.)	Market Survey (Rs.)
Plastic	34	15 - 40
Paper	18.4	15 – 25
Cardboard	23	25
Glass	20.8	12 - 20
Steel/Iron	68	80
Wood	12	10 – 12

As said earlier the main recyclable items are Plastic, Paper, Cardboard and Scrap - Steel and Iron, the study further conducted a detailed assessment of these three items – amount collected, amount segregated by the contractors and Informal workers and the income generate through the sale of these products.

Table 0.17: Amount Collected, Segregated & Income Generated - for Selected Items

	Plastic	Paper	Cardboard	Steel & Iron
Collection (Kg/Worker)				
Central	95	32	38	24
East	25	20	29	12
South	60	23	25	25
West	63	33	30	15
Korangi	60	21	23	33
Malir	63	21	22	21
Average- Collection (Kg)	65	27	29	21
Segregated -Per Contractor (Kg)				
Central	0	0	0	0
East	53	57	30	10
South	0	0	0	0
West	90	250	133	6
Korangi	0	0	0	0
Malir	3	8	8	13
Average - Contractor (kg/Cont.)	35	69	37	7
Segregated on Spot- per Hired Worker (Kg)				
Central	5	7	4	1
East	19	19	19	18
South	0	0	0	0
West	20	27	18	7
Korangi	1	0	0	0
Malir	2	4	4	2
Average Hired Worker (Kg /worker)	8	10	8	4
Income Contractor (Rs)				
Central	0	0	0	0
East	1125	965	675	375
South	0	0	0	0
West	2700	2500	1988	510
Korangi	0	0	0	0
Malir	138	200	200	875
Total Cont. Income (Rs/day)	925	842	643	388
Income Hired Worker (Rs.)				
Central	90	82	73	73
East	60	328	40	700
South	0	0	0	0
West	443	307	301	514
Korangi	0	0	0	0
Malir	120	109	109	119
Average Worker Income (Rs/day)	134	139	100	221

Table 4.17 provide information regarding plastic, paper, cardboard and steel and Iron, the amount collected, sorted and sold in the local market. The average income generated by the contractors from the sale of these products is much higher than the income generated by the

informally hired workers per day. Further, in some cases, both contractor and hired worker reported that they do not sell the sorted item daily they usually sell the items in local marker after every two days.

Figure 0.2: Flow of Recyclable Material
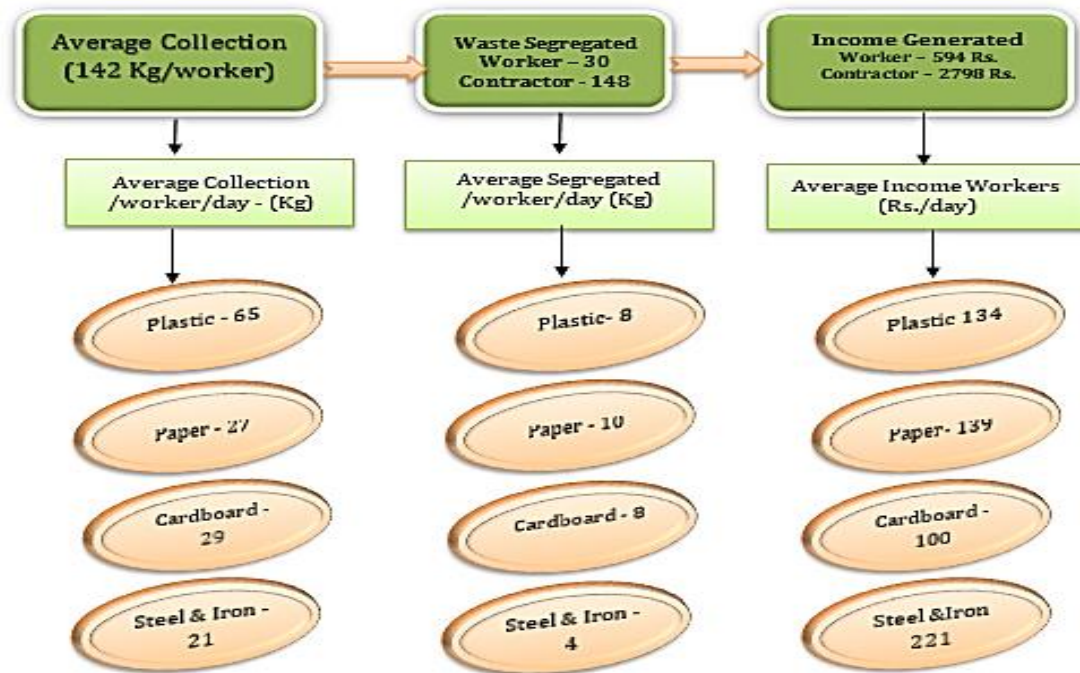
Both, contractors and waste pickers (hired workers) sell these items to small dealers (chota kabadiya). Small dealers purchase these items from a large number of waste pickers and again sort the recyclable material. They make bundles of the selected items and sell them to large dealers (bara kabriya). The large dealers just work as a bridge between small dealers and small scale industry usually operated within the premises of household or under the small unit. Though the detailed surveys of small and large dealers, small and medium scale industry and large recycling industry are beyond the scope of the study we did collect some information on small unit making "Danna" from the collected plastic and paper and cardboard industry making boxes from the recycled paper and cardboard. Figure 4.4 and 4.5 provides the value chain analysis for plastic and paper/cardboard. it can be concluded from the two flows that the income generated by each stakeholder involved steeply increases making the two recyclable items highly profitable.

Figure 0.3: Value Chain for Plastic

Small Dealer Rs 15-20 per Kg

PLASTIC WASTE MANAGEMENT

Large Dealer 50-80 per Kg

Small Units (Dana) Rs 100-120per Kg

Figure 0.4: Value Chain for Paper/Cardboard

Small Dealer Rs 15-25 per Kg

Large Dealer 30-35 per Kg

Small Units Rs 45-50 per Kg

Figure 0.5: Value Chain for SWM
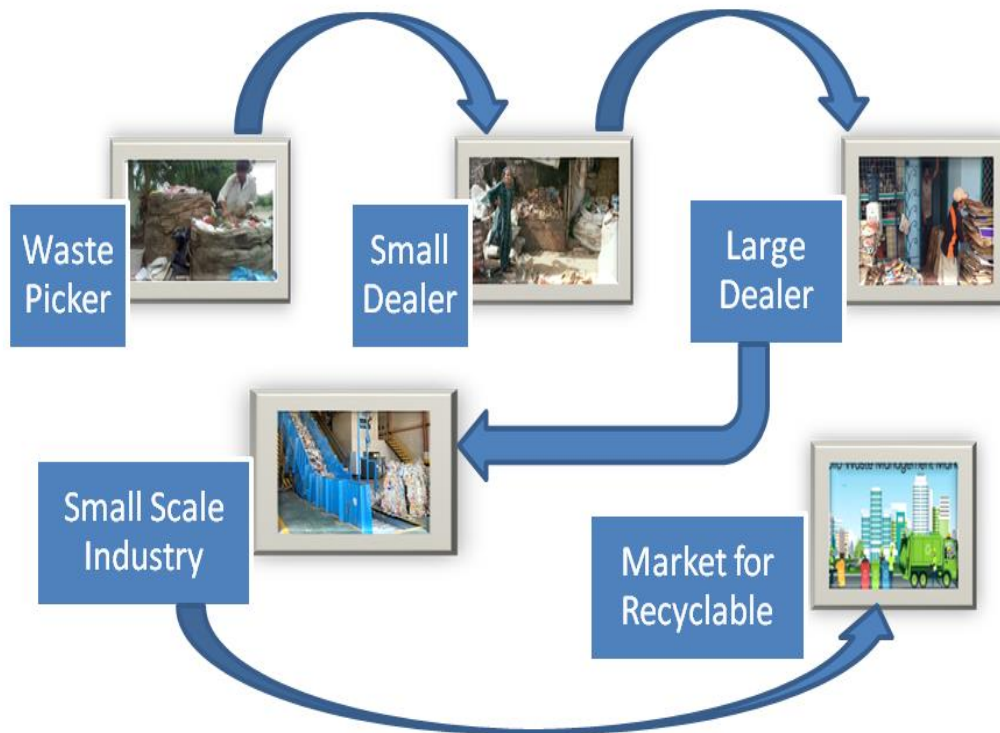
Source: Author illustration.

The above assessment shows that if solid waste is properly segregated and managed it will result in a profitable industry.

4.3   Household Socioeconomic and Demographic Conditions

This section outlines basic information gather during the household survey. The section starts by highlighting the socioeconomic profile and then move to discuss the solid waste management practices followed by household. Household perception, behaviour and awareness come under discussion during KIIs as an obstacle in handling solid waste in Karachi therefore household survey is designed to explore such issues in depth. Recycling and reuse activity if performed is also probed for assessing its prospect at house level. Finally, what a household is spending and what it is willing to spend on solid waste management are discussed as well.

4.4   Household Socio-economic and Demographic Profile

Figure 4.7 shows the gender distribution of the surveyed population. The distribution is almost equivalent in ratio.

Figure 0.6: Survey Proportion by Gender across Towns
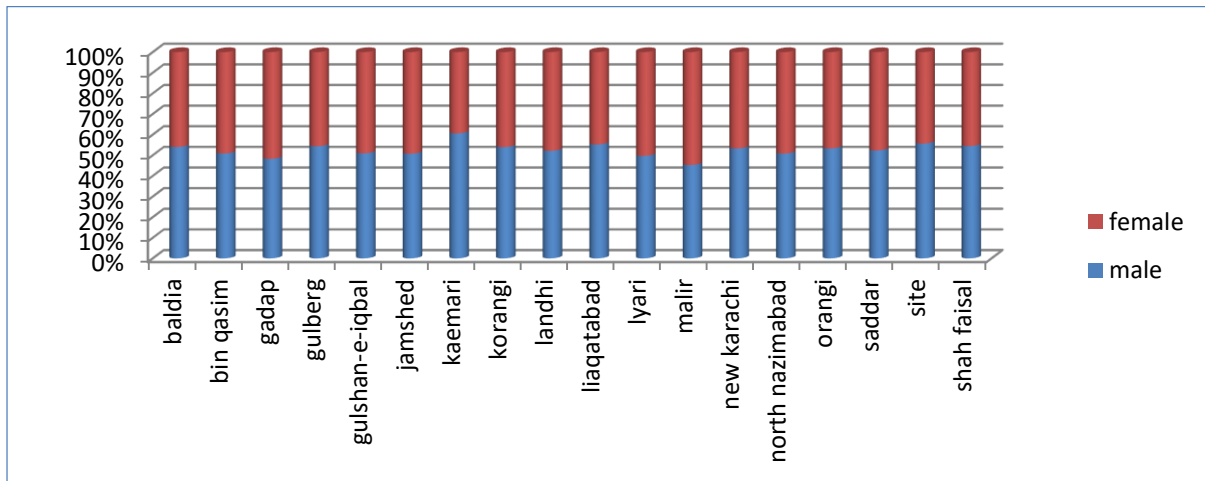
Source: Author Estimation

Figure 4.8 shows that the commonly spoken languages are Urdu (58%), Pashto (15%) and Punjabi (8%). The variation on the basis of language is examined here to show the presence of the multicultural environment of Karachi. The variation can also be analyzed in the light of ownership. People with other areas of origin are mainly migrants, hence their interest in the development of the city environment can be considered limited.

Figure 0.7: Proportion of Individual by Mother Tongue and Town
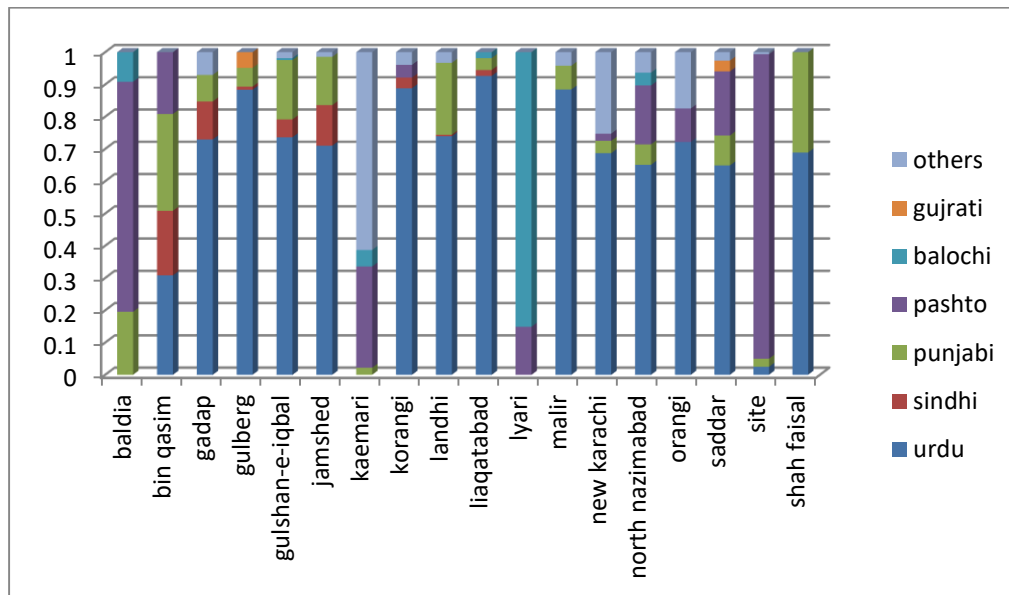
Source: Author Estimation

Figure 4.9 specifically explored the migration status of the surveyed population. Overall out of surveyed population 16% are migrants and 84% are natives.

Figure 0.8: Proportion of Individual by Migration Status by Town
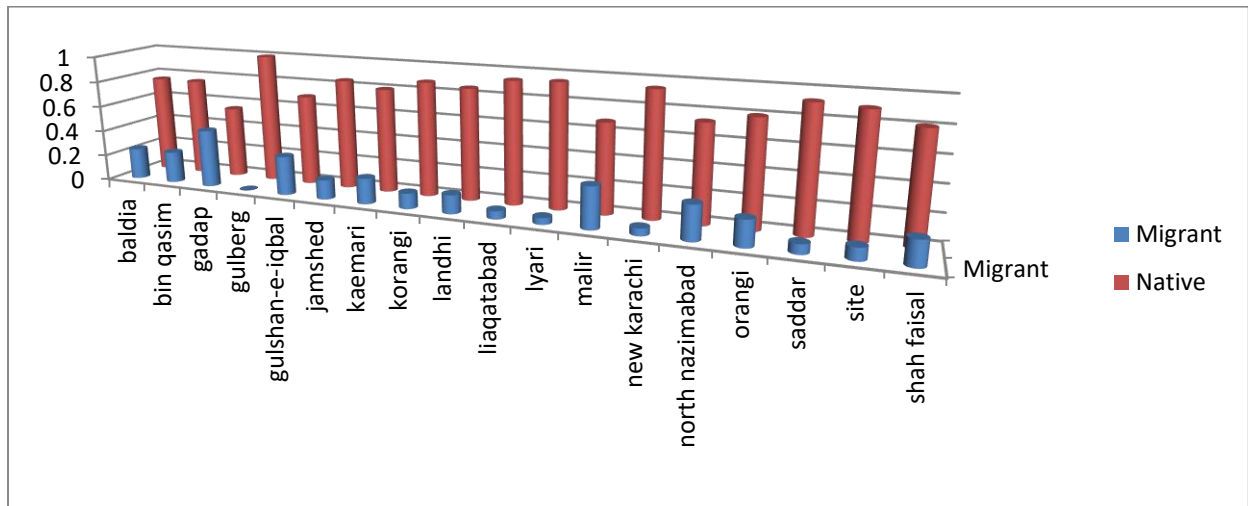
Source: Author Estimation

Figure 4.10 highlights average years of education (highest education level at the time of interview).

Figure 0.9: Education Profile of Individual
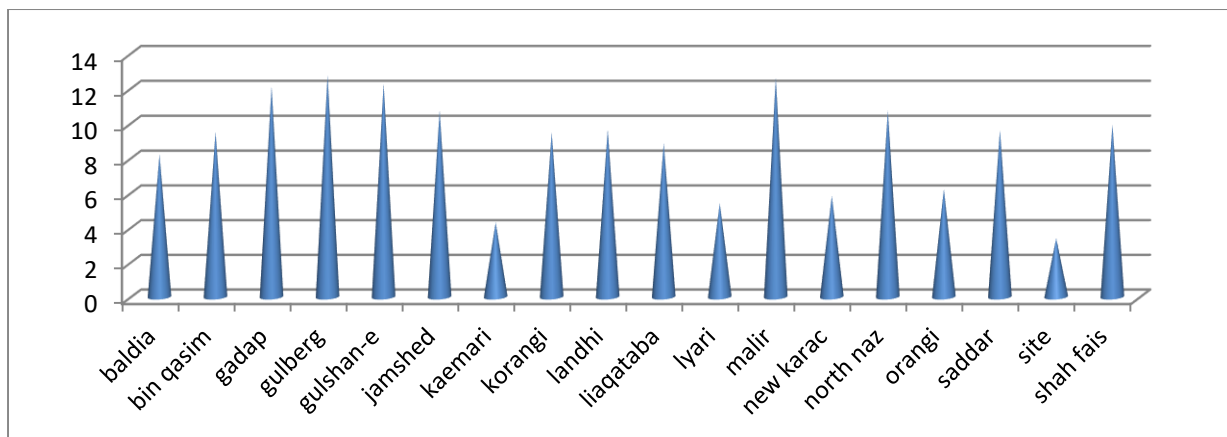
Source: Author Estimation

4.5   Household Assessment of Waste Collection

The below figure provides information regarding the waste collection mechanism. It is clearly evident that solid waste management in Karachi is in the hand of private contractors. The second-largest waste collector is informal (mainly Afghani), here mentioned as other. Some part of the city is also managed by the city municipal system – DMC. The proportion is highest for Lyari, the town is mainly managed by DMC. The towns operated under complete informality are Baldia, Orangi, SITE and Kemari. This further endorses our findings in sections 4.1 and 4.2.

Figure 0.10: Who Collects Waste from Household?
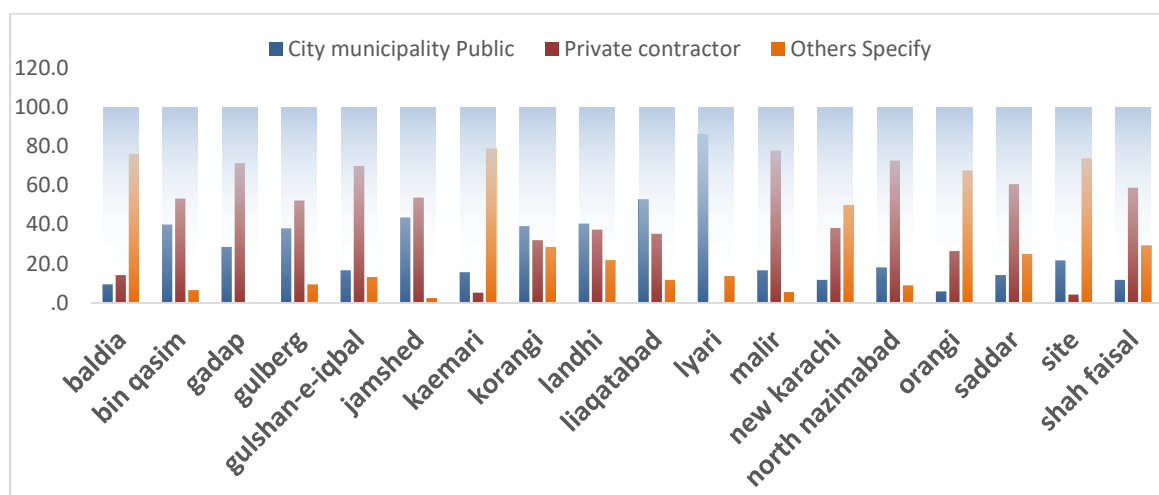
Source: Author estimation

Table 4.18 highlights the time preferred by households to collect waste. Households mainly preferred their waste to be picked in the morning. Individuals do not prefer their waste to remain at home for long – showing their willingness to have a clean environment.

Table 0.18: Waste Collection Frequency

Towns	Morning	Noon	Afternoon	Evening
Baldia	81.0	9.5	4.8	4.8
Bin Qasim	93.3	6.7	0	0
Gadap	85.7	14.3	0	0
Gulberg	85.7	4.8	9.5	0
Gulshan-e-Iqbal	93.3	3.3	0	3.3
Jamshed	48.7	41.0	7.7	2.6
Kaemari	78.9	15.8	5.3	0
Korangi	50.0	32.1	3.6	14.3
Landhi	87.5	9.4	0	3.1
Liaqatabad	35.3	61.8	0	2.9
Lyari	58.6	10.3	6.9	24.1
Malir	77.8	0	0	22.2
New Karachi	82.4	8.8	8.8	0
North Nazimabad	77.3	13.6	4.5	4.5
Orangi	70.6	8.8	17.6	2.9
Saddar	96.4	3.6	0	0
SITE	60.9	17.4	13.0	8.7
Shah Faisal	100.0	0	0	0

Source: Author Estimation

Household perception regarding the solid waste collection mechanism is mainly not good, except for the households in Lyari, almost all the household's surveyed, rate the service provided to them either as not good or fair.

Figure 0.11: Evaluation of the State of Solid Waste Collection
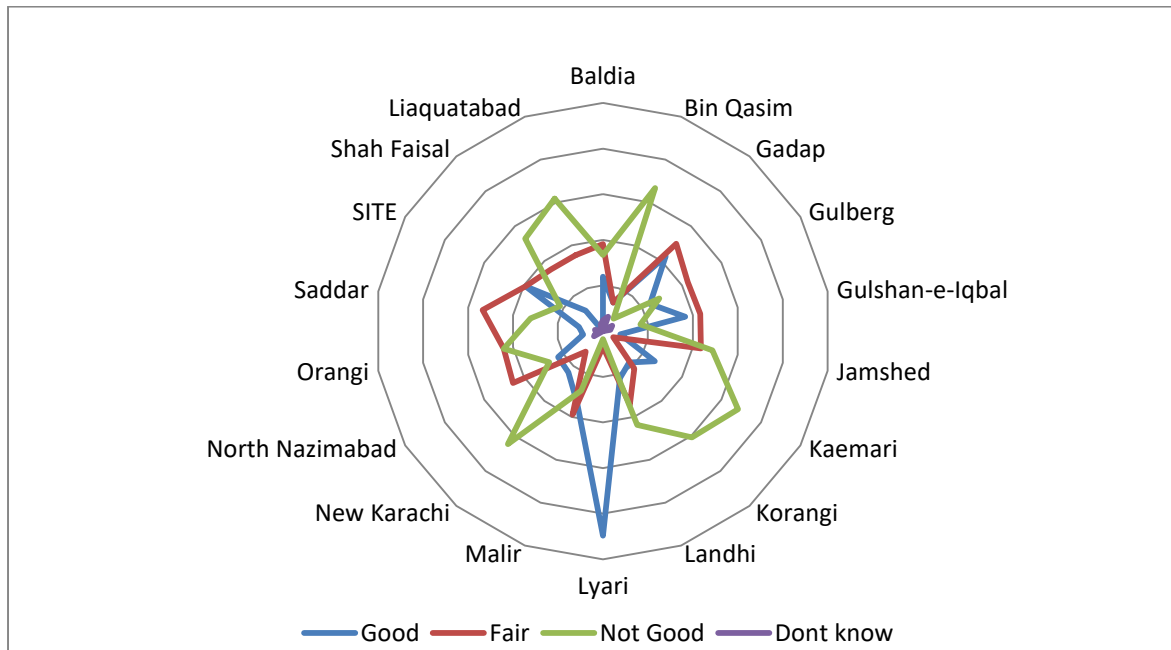
Source: Author Estimation

Recycling and Reuse Activity

In order to evaluate the knowledge of the household regarding recycling three interrelated questions are probed. Is the household aware of recycling, if yes are they agreeing to be involved in recycling and if they agree are they ever earning income from recycling? Figures 4.13 to Figure 4.15 shows that households in Karachi are not only aware of recycling but also generate income through recycling. Households in Karachi, generating on average around Rs. 400 monthly from the sale of recyclable material while the main recyclable materials are Paper/cardboard, plastic and Metal.

Figure 0.12: Awareness Regarding Recycling
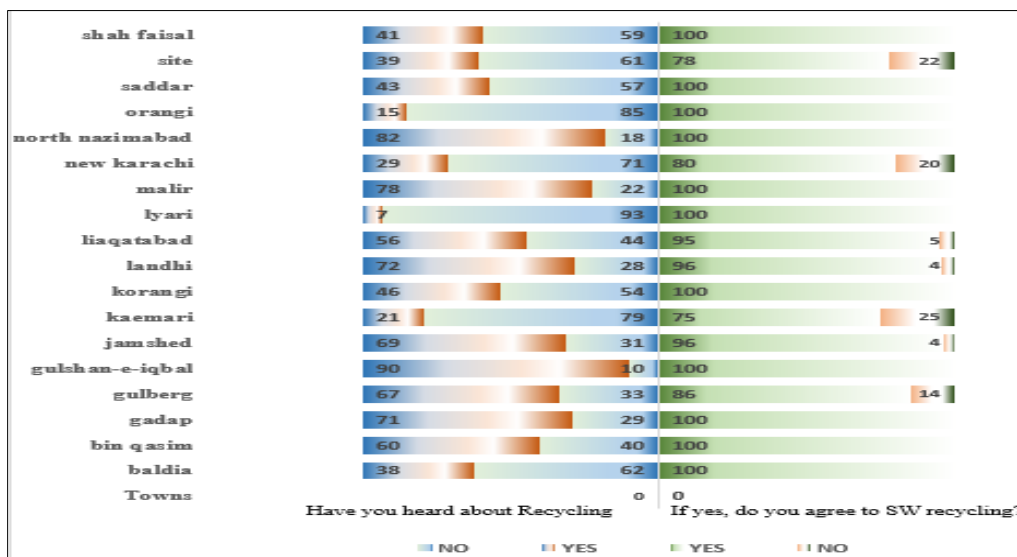
Source: Author Estimation

Figure 0.13: Did the Household Generate any Income from Selling of Waste?
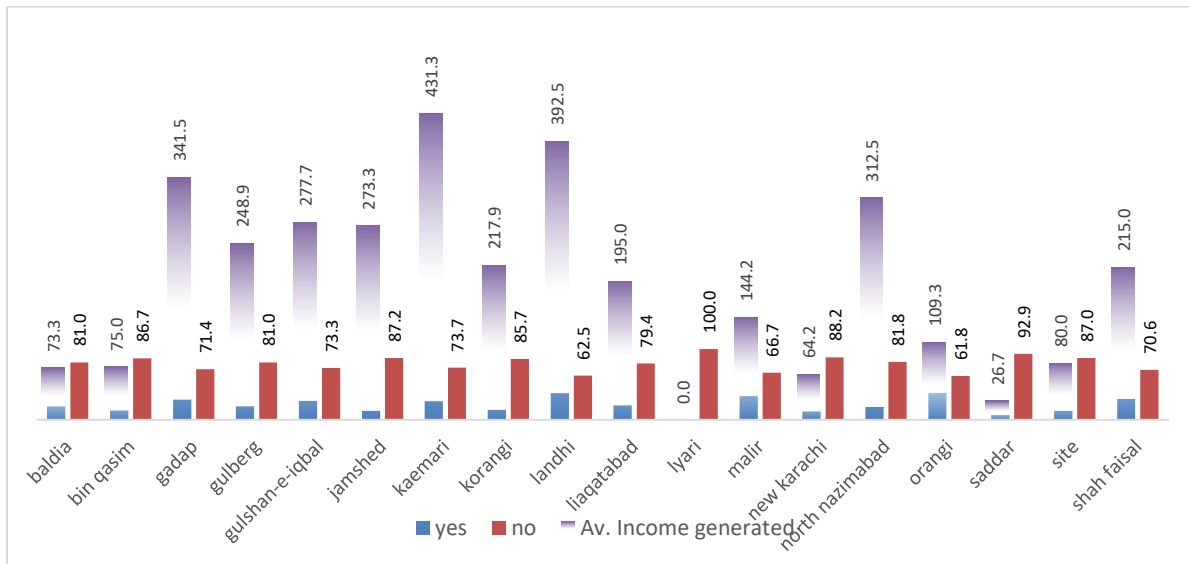
Source: Author Estimation

Figure 0.14: Average Income generated by Waste Type
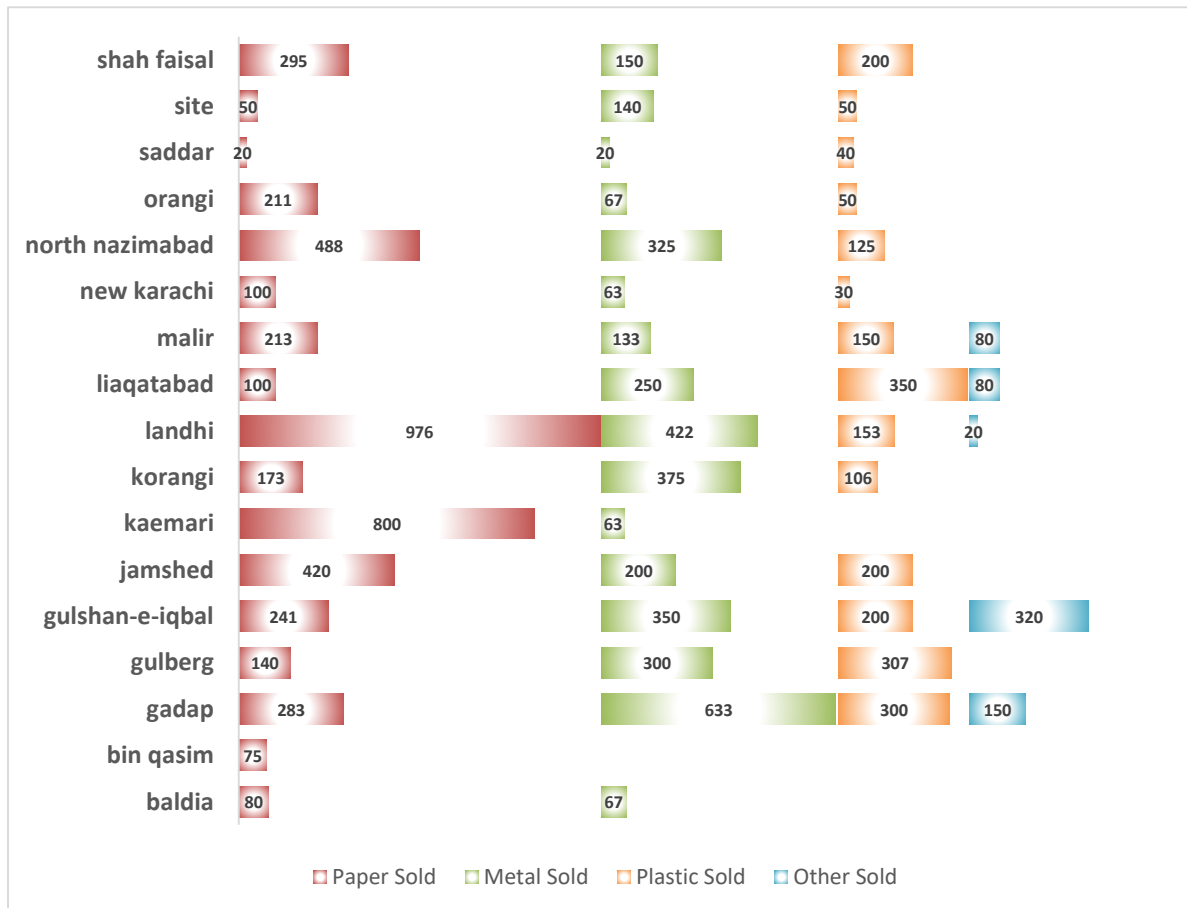
Source: Author Estimation

Perception and Behaviour Regarding solid waste management

As claimed by the public officials that the main hurdle in handling solid waste is individual behaviour, the below figures explore the Perception, Behaviour and Awareness of surveyed households regarding solid waste management. Though the people surveyed majorly responded that they are aware of the environmental consequences of waste as expected. Given the 100 percent response, the study then enquire how many dumped the waste alongside the bin – the main response is Yes they do - Households though, aware of the environmental consequences of the waste but, they still through their waste alongside the bin. This led to asking another question why do they do so?

Figure 0.15: The Current Waste Disposal System Is Polluting the Environment
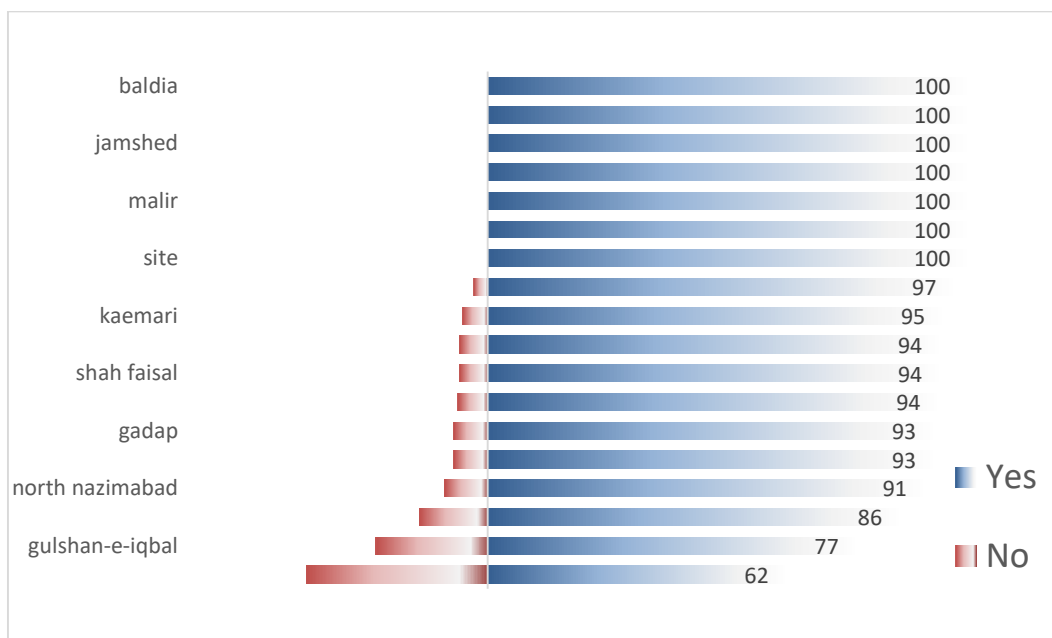
Source: Author Estimation

Figure 0.16: % of People Dumping Their Waste alongside the Garbage Bins

Source: Author Estimation

30
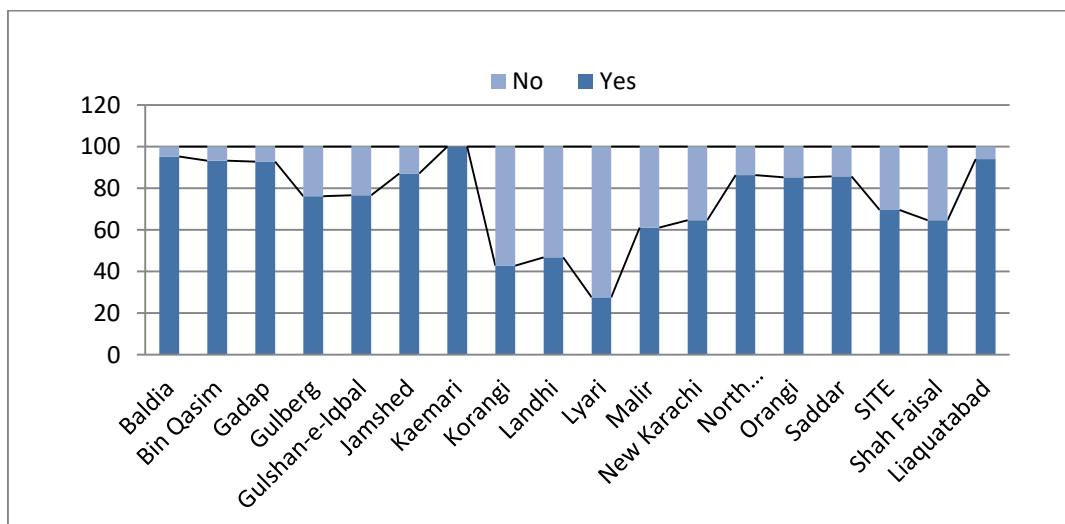
Around 43% of households replied that they throw the waste alongside the bin as the waste litter spread around the bin and the place is too smelly. Around 21% claim that the bin is too high while 14% claim that they do not go near because of the animals around the bins.

Figure 0.17: Particular Reason for Dumping Outside Bin
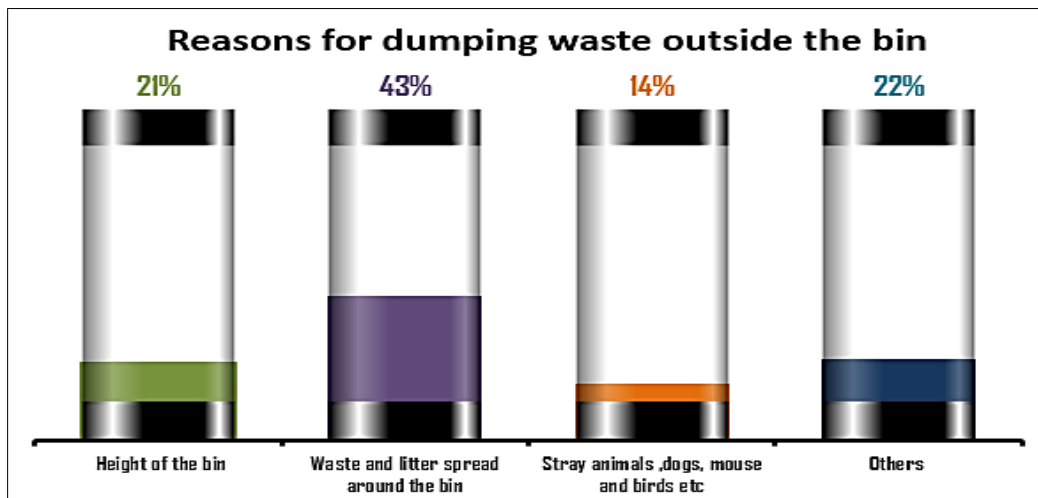
Source: Author Estimation

Further, surveyed households have also shown their concerns regarding environmental degradation caused by the waste.

Figure 0.18: Environmental Degradation has a Negative Effect
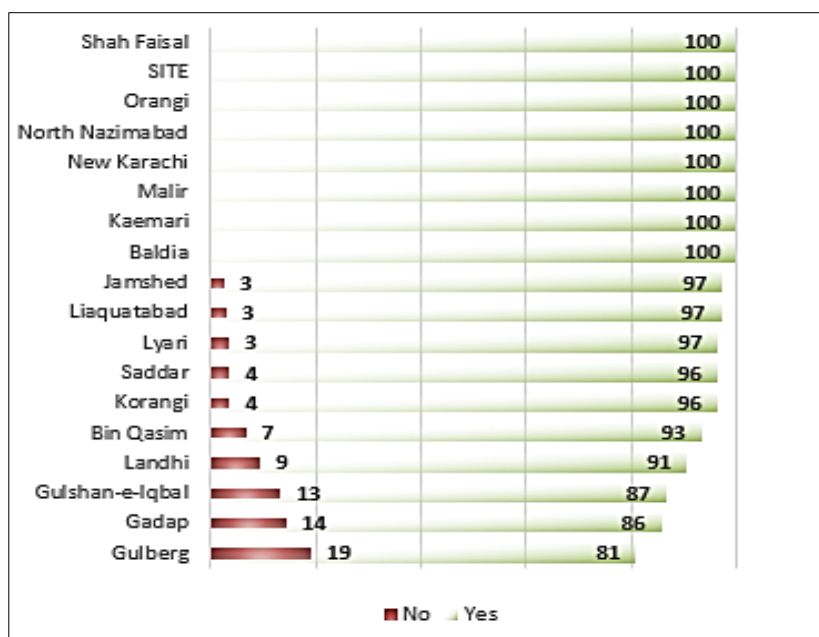
Source: Author Estimation

Knowledge and Awareness regarding Current System

The below two figures explore how many households take interest in the management of solid waste. This will give an idea of how much serious a household is in managing the solid waste problem. Though figures 4.20 highlight that around 79% of households are aware of their service providers however it is evident from the next figure that the majority of the households are unaware of how their wastes are dispose-off by their service provider. This further highlights that their interest or concerns are limited i.e their behaviour in managing the solid waste is not serious.

Figure 0.19: Knowledge regarding Disposal of Waste by the Service Provider
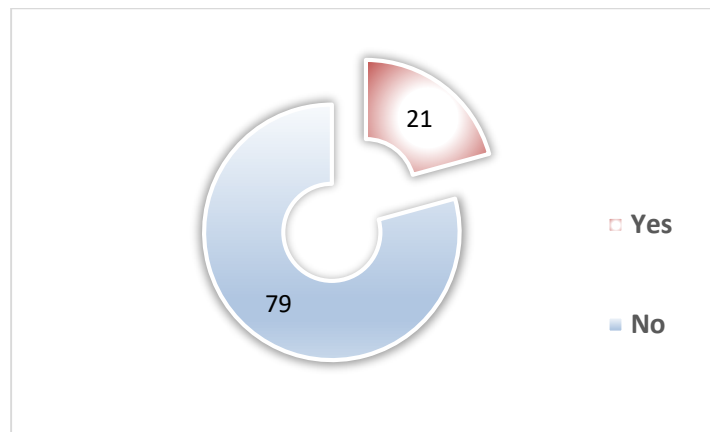
Source: Author Estimation

Figure 0.20: Do You Know How Your Service Provider Disposes of Your Collected Waste?
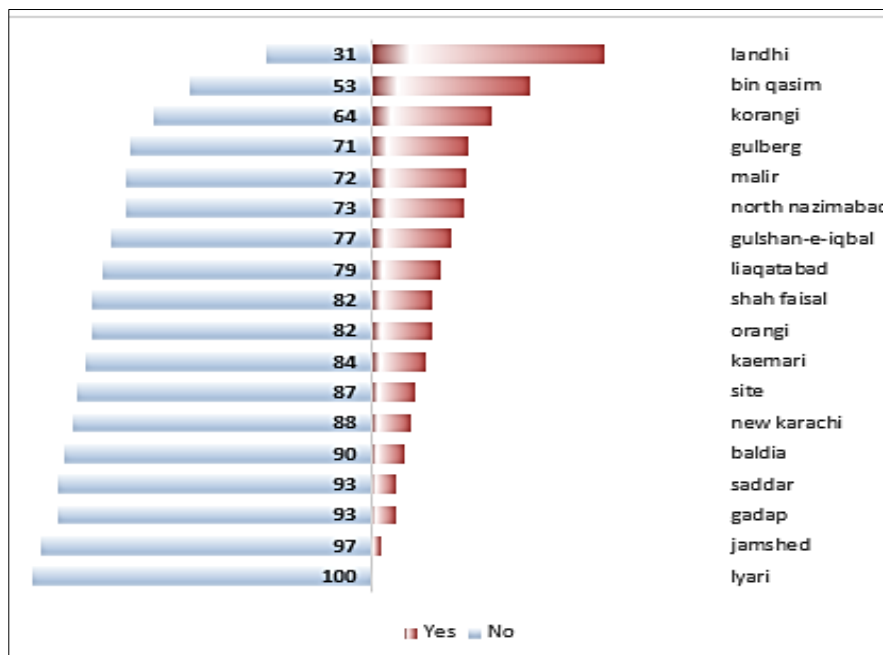
Source: Author Estimation

4.6   Household Willingness to Pay for Solid Waste

After exploring the household socio-economic characteristics their perception, behaviour, awareness and their willingness for recycling, the purpose of this section is to measure and identify factors that influence household willingness to pay for solid waste management. In addition, this part has also assessed the collection charges households already paying for availing some sort of services. Given the vast literature available on the topic, a contingent valuation method/approach (CVM) is applied to determine household willingness to pay. According to Carson et al; (1999), CVM is the standard methodology that includes both the use and non-use value of a product. As the household's decision to demand the service is based on both use and non-use value hence in this study it was assumed that the amount household willing to pay (WTP) for the more improved system is based on its use values and non-use value. Further, considering Fujita *et al. (*2005), it was also considered important to match WTP with the ability to pay (ATP). ATP is derived from the income and expenditure pattern of the households. The compression of the two (WTP and ATP) has added another dimension to our research. For example, WTP less than ATP means the household is reluctant to spend money on SWM. It means a policy framework is needed to motivate households to invest in the service. But if ATP is low, it reflects the inability of the household to pay for the service regardless of its willingness to pay. This further means public investment is needed. In sum, if ATP is less than WTP it means public/government support is needed, in the case WTP is less than ATP it implies that motivational support is needed.

The analysis of this part is based on the descriptive assessment presented in section 4.4. To analyze the association between WTP and factors influencing the household demand for the SWM, the Heckman two-step technique is employed.

Methodology

The concept of 'economic value' is usually defined as the measurement of changes in personal well-being. The theory was extended to measure the changes in the prices and quantities of marketed goods as well as non-market goods and services such as managing solid waste. The economic valuation of the service is basically an assessment of the preferences held by people.

If the service is not available in an area, willingness to pay for the services cannot be properly inferred from the expenditures that are supposed to occur. This issue further pushes us to use the "stated preference" approach i.e. contingent valuation approach (CVM) - many surveyed households currently not paying for the solid waste management in their area. Under CVM households are directly asked exactly what they would be willing to pay to avail of the SWM service.

Given the stated preference approach study included an open-ended question in the household questionnaire about how much a household is actually willing to pay. The study considered this as more reliable than a dichotomous choice question "yes" in case people are willing to pay or otherwise "no". Moreover, the advantage of using the open-ended variable is that it does not require that one should assume identical preferences across households having the same characteristics. The stated WTP can therefore directly be regressed on characteristics of the households. The following simple function is estimated to assess a household's willingness to pay:

$$wtp = \beta'X + \varepsilon \qquad (1)$$

Where X is the vector of independent variables hypothesized to be first influencing willingness to pay for the service. The independent variables used in the estimation of the above-stated model are presented in table 4.19 below with the expected signs. The demand for the solid waste management system is hypothesized to be a function of household socio-economic conditions (per-capita Income, occupancy status and Congestion), demographic factors (gender of the head, dependency ratio, age and education of the primary contributors), satisfaction with the current service, awareness and knowledge regarding the solid waste management, use and non-use values (bequest – leaving a better environment for the future generation) – environmental impact of waste. The choice of variables and the effect hypothesized are based on the descriptive analysis presented in the preceding section as stated earlier.

We have computed the age and education of the individuals contributing to the household income – the primary contributor's age and education. Primary contributors are those who are assumed to have more say in the family's decision, as they are earning members of the family. After identifying the primary contributors the mean age and average education of the primary contributors in a house are estimated. We assume that the higher the age and education of the primary contributors in a house higher will be the amount the household willing to pay.

Table 0.19: Explanatory Variable with Expected Sign

Explanatory Variables in WTP model	Expected Sign
Household Per Capita Income	+ve
Male Headed Household	+ve
Average Years of Education of Employed Household Members	+ve
Average Years of Age of Employed Household Members	+ve
Ownership of the house - Own House	+ve
congestion [room per person]	-ve
Index- Knowledge regarding SW Impacting Environment	+ve
Bequest Worth – Managing SW for better Future	+ve
Selection Model - Participating in MSW equals 1 otherwise 0	
Male Headed Household	+ve
Dependency Rate	-ve
congestion [room per person]	-ve
Average Years of Education of Employed Household Members	+ve
Average Years of Age of Employed Household Members	+ve
Index- Satisfaction Score with the current System	+ve
Index - Awareness/ Knowledge regarding SW	+ve

However, the key issue in estimating the above WTP model for the solid waste management services is that we are not observing the whole surveyed household. Because many of the surveyed households currently not paying for solid waste management hence their stated preference could lead to a problem of sample selection bias. However, in our study, we have applied Heckman's two-step selection procedure to correct the sample selection bias. Heckman (1979) approach this as an omitted variable problem, he proposed that an estimate of the omitted variable would solve this problem of the sample selection bias. Therefore, Heckman two-step procedure is used to control the selection bias of the sample. The selection equation is estimated by the maximum likelihood approach as an independent probit model. The variable inverse Mills

ratio is generated from the parameter estimates. The willingness to pay (amount) is observed only when the selection model equals 1 and is then regressed on the explanatory variables and inverse Mills ratios by ordinary least square (OLS). The lambda is introduced in the second stage as an additional variable. If the coefficient of lamda is significant then we reject the null hypothesis of no selection bias.

The table below provides the descriptive statistics of the variable of interest. According to Table 4.20 households willingness to pay vary from monthly Rs. 50 to Rs. 5,300; Average numbers of households currently paying for availing some sort of service (our selection variable) are around 70 percent (323 out of 459) and the average per-capita income of the surveyed household is around Rs. 19000, Table 4.20 also reports the indices developed; it shows, an average score of 0.66 for environmental knowledge index (ranges between 0 to 1, where 1 mean perfect knowledge), a score of around 1.9 for satisfaction index (ranges between 0 to 3, where 3 mean complete satisfaction) while a score of 0.67 for current solid waste management process. For the descriptive assessment of other variables see Table 4.20.

Table 0.20: Descriptive Assessment of Factors Influencing WTP

	# Obs.	Mean	S.D	Minimum	Maximum
Household Willingness to pay	459	467	452	50	5300
Participating in SWM equals 1 otherwise 0	459	0.70	0.46	0	1
Household Per Capita Income	459	19085	21867	1429	340000
Household Headed by Male	459	0.90	0.30	0	1
Dependency Ratio	459	3.89	2.37	1	13
Average Years of Education of Employed Household Members	459	10.43	4.51	0	19
Average Years of Age of Employed Household Members	459	39.40	9.79	17.7	86
Ownership of the house - Own House	459	0.79	0.41	0	1
Index- Knowledge Regarding SW Impacting Environment	459	0.66	0.22	0	1
Bequest - MSW for better Future	459	0.98	0.14	0	1
Index- Satisfaction Score with the current System	459	1.93	0.80	0	3.3
Index - Awareness/ Knowledge regarding SWM	459	0.67	0.16	0	1

Source: Author Estimation

Figure 4.22 shows the current expenditure household made on SWM and what households willing to pay for further improving the system by town.

Figure 0.21: Current Expenditure on SW Collection and WTP for It
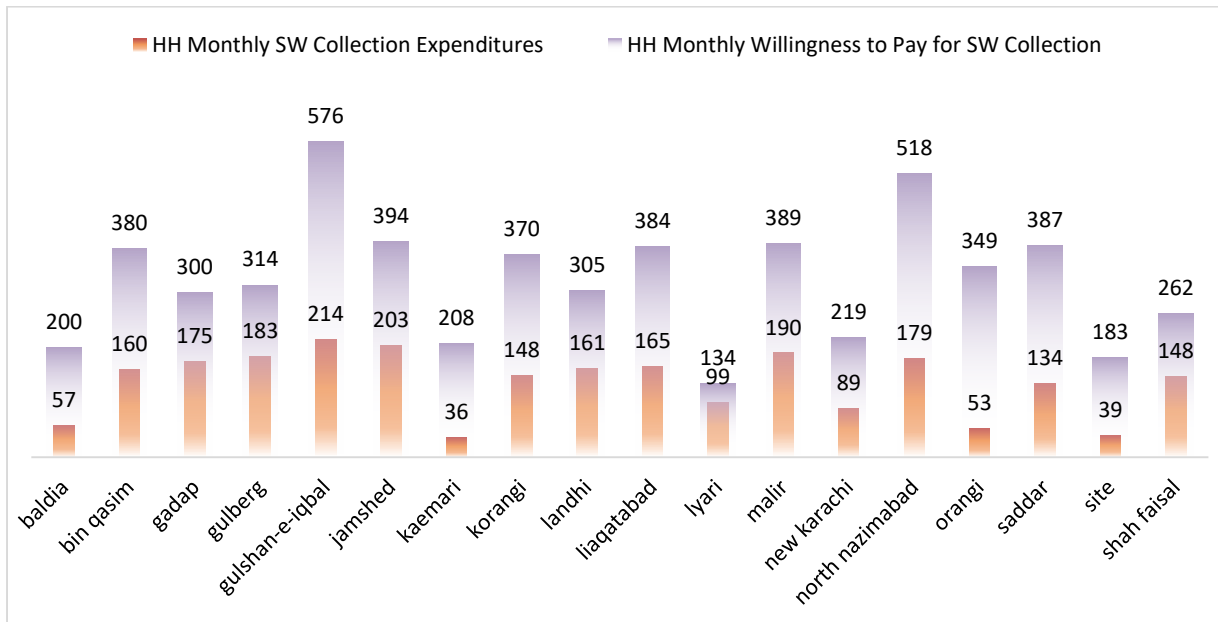
Source: Author Estimation

WTP Results

Table 4.21 reports the factors influencing the maximum amount household willing to pay for making improvements in the current solid waste management condition and their decision to pay for the services (under current state) - equal 1 if yes and 0 otherwise.

The table shows that among the explanatory variables household per-capita income, household if headed by a male, the average age of the primary contributor and Knowledge regarding SW impacting environment exhibits significant impact on household willingness to pay for the SWM. Except for the average age, the rest shows a positive and significant effect. The table shows that a 1 rupee increase in per-capita income increases the WTP slightly around Rs. 0.002, an increase in the male-headed household increases the WTP by Rs. 223 while household knowledge regarding the environmental impact of solid waste increases the WTP by Rs. 257. However, the average age of the primary contributor, hypothesized to have a positive impact, was found to be influencing WTP negatively, this may be because as the age of the primary contributor increase their approach towards personal saving increase in-order to secure future after retiring from work life. Overall a one year increase in the age of primary contributors was found to be decreasing the WTP by around Rs. 5.6.

The first stage probit estimates show that an increase in the age and education of the primary contributor increases the probability that the household will pay for SWM. In terms of coefficient (The probit coefficients give the change in the z-score for a one-unit change in the predictor), with a one-unit increase in the age and years of education of the primary contributor, the z-score increases by 0.02 and 0.09 respectively] The satisfaction index also found encouraging household to pay for the SWM, with a one-unit increase in the satisfaction index, the z-score increases by 0.40. In addition congestion (room per person) also shows a significant impact [with a one-unit increase in the congestion, the z-score increases by 0.44]. Furthermore, lambda measuring the

presence of selectivity bias is also significant implying that selectivity bias is present in the model hence Heckman Two-Step approach is justified.

Table 0.21: Factors influencing WTP

Variables	Coefficients	t-stats	p-value
Household Willingness to pay – Rs.			
Household Per Capita Income	0.002	1.97	0.049**
Male Headed Household	223	2.51	0.012*
Average Years of Education of Employed Members	8.5	0.8	0.426
Average Years of Age of Employed Members	-5.6	-1.79	0.073***
Ownership of the house - Own House	-77	-1.24	0.216
congestion [room per person]	2.8	0.06	0.951
Index- Knowledge regarding SW Impacting Environment	257	2.05	0.04**
Bequest Worth - MSW for better Future	62	0.35	0.727
Constant	397	1.3	0.195
Participating in MSW equals 1 otherwise 0			
Male Headed Household	-0.18	-0.7	0.485
Dependency Rate	-0.02	-0.67	0.502
congestion [room per person]	0.44	1.93	0.054**
Average Years of Education of Employed Members	0.09	5.7	0.00*
Average Years of Age of Employed Members	0.02	2.5	0.012*
Index- Satisfaction Score with the current System	0.40	4.72	0.00*
Index - Awareness/ Knowledge regarding SW	0.44	1	0.318
Constant	-2.22	-4.48	0.00*
Mills Ratio – Lambda	-311	-1.88	0.06**
Number of observation	459		
Censored observation	136		
Uncensored observation	323		
Wald chi2(8)	26.14		
Prob > chi2	0.001		

Significance level: 1% (***), 5% (**), 10% (*)
 Source: Author Estimation

Ability to Pay (ATP) vs. Willingness to Pay (WTP)

WTP refers to the maximum amount households are willing to pay for the improvement in solid waste management condition, while ATP is the amount households actually can pay. Capturing a household's ATP means checking household affordability. The SWM should be available at a cost affordable to all. The information is hence viable for policy designing. Policies formed without considering who will pay and how much ability they have to pay result in policy failure.

ATP is usually calculated on the basis of household disposable income or household expenditure composition. Researchers have followed various techniques to compute ATP and s suggested,

ATP for SWM as 1 to 2 percent of the household income for low and middle-income countries. In this study, we have computed the ATP as 1% of household income [see Wilson et al (2012) – "Comparative analysis of solid waste management in 20 cities" Waste Management & Research 30(3) 237–254 for more detail]. Specifically, ATP is computed as one percent of the household income. Table 4.22 compares the household's willingness to pay with the household's ability to pay. The results predict that in all cases ATP is much higher than the WTP suggesting the need for motivational arrangements needed to convince households to pay more to manage solid waste.

Table 0.22: Comparing ATP and WTP

Town	ATP	WTP	Difference
Baldia	705	257	ATP>WTP
Bin Qasim	731	540	ATP>WTP
Gadap	1374	475	ATP>WTP
Gulberg	1097	498	ATP>WTP
Gulshan-E- Iqbal	1738	790	ATP>WTP
Jamshed Town	1164	597	ATP>WTP
Kaemari	801	244	ATP>WTP
Korangi	720	518	ATP>WTP
Landhi	637	466	ATP>WTP
Liaqatabad	850	549	ATP>WTP
Lyari	683	234	ATP>WTP
Malir	1367	579	ATP>WTP
New Karachi	623	308	ATP>WTP
North Nazimabad	1709	705	ATP>WTP
Orangi	748	403	ATP>WTP
Saddar	1581	521	ATP>WTP
SITE	679	222	ATP>WTP
Shah Faisal	718	409	ATP>WTP
Total	987	467	ATP>WTP

Source: Author Estimation

SWOT Analysis

This section first develops a framework to understand the role and linkages of various stakeholders at each step of the management process. Identification of the weak and no connectivity at all help in understanding the leakages in the system.

Beginning from Household, generally, in the context of waste generation household is regarded as one of the most central units of analysis along with industries and medical units. A larger proportion of waste is generated by the household therefore households can be earmarked a distinct position within the analysis of waste generation. A strong negative association is found between per capita waste generation and the size of the household (Parizeau et al; 2006 & Ojeda Benitez et al; 2008). The financial position, consumption behaviour and the lifestyle of

households influence the waste generation and composition of the waste (Yusof et al; 2002&Tadesse et al 2008). The per capita waste generation decreases as income increases because of the change in lifestyle and the type of food consumed (Solomon; 2011). In the technical aspect, waste segregation is not common at the household level. In Karachi, households consider themselves as the receiver of service and they pay to avail the services but they usually don't bother about where the waste goes and how it disposes of. This opens rooms for leakages in disposing and recycling/reuse of waste generated.

With the increase in economic activities and moving towards industrialization ecological damage by industrial waste could not be neglected. Unfortunately, industrial waste generation rates are unknown. Industrial waste usually comprise of chemical waste, toxic and hazardous materials along with different materials such as paper, metal, plastic, wood etc. Proper segregation is adamantly required to facilitate the efficient disposal of industrial waste. The usual practice in handling Industrial waste again comprise of both formal and informal ways. Usually, recyclable material is sorted and segregated at the spot only waste that is not of any use are dumped on land or fleet into the sea. Further, medical needs have added a considerable amount of biomedical waste to the waste stream. Empirical studies demonstrate that in Pakistan 2.0kg/per-bed/pre-hospital[2] waste is generated in which 0.5kg can be categorized as bio-medical hazardous waste. Improper handling and disposal of this kind of waste has contaminated the environment and elevated the risk of spreading contagious diseases. For the city having a population of over 20 million only two incineration units each capacity of 1 ton, are installed for the incineration of hospital, clinical and medical waste. According to the KMC officials (now responsible for handling Medical waste in Karachi after the establishment of SSWMB), two units cater only 20% of the hospital waste. The plants need to be replaced by new ones.

The whole set of activities related to the collection of solid waste is strongly linked with DMC/local government, private contractors and informal players. Collection of waste has mainly two aspects, collection from the source of generation to the large assigned collection point and from that collection site to landfill sites to dispose of. The DMC/local government is mainly accountable for providing waste management services. Due to the low precedence of concerned authorities the management of solid waste is still inefficient. Further, the lack of financial, physical and human resources, institutional inefficiencies and political interference have made the situation shoddier over time. Local political factors involved excessive political employment or the employment of untrained workers, misuse of financial resources. Further, Oteng-Ababio (2010) argued that if the public sector failed to deliver efficient service directly and it may have difficulty in monitoring private contractors as well. When waste is collected by private contractors then it is necessary to monitor that collected waste is transported to authorize landfill sites and don't dump illegally in order to save time and minimize cost. High efficiency required assurance of good working conditions in all aspects including legislation, support from competent authorities, viable contractual arrangements and effective monitoring. In private arrangements "*competition*" is a key to a successful outcome. The tendering process should maintain real competition to ensure good services as well as competitive prices. Since the advent of the SSWMB, the activity of managing SW is progressively transferred to the private sector. Initially, two Chinese companies were awarded the contract of four of the DMC's; East, West, South and Malir while outsourcing of District Central to Spanish Company is in process. The private companies though have taken the task with the proper tendering process and maintaining the requirement

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[2] https://www.env.go.jp/recycle/3r/en/asia/02_03-2/04.pdf

of monitoring process but as the companies have started the task using the KMC employees on board, complying with the old system (SSWMB largely comprise of KMC employees), hence very limited desirable result achieved. In many UC's the old process continues to exist – the system subcontracted the work on the basis of personal relations – having strong administrative or political links, which further rely on informal employment to collect waste from the houses.

As the formal sector does not have sufficient resources to provide collection as well as disposal services to all households and therefore informal waste pickers come up with a noteworthy contribution in collecting, sorting, disposing and recycling waste material. Scheinberg et al (2010) concluded that most of the informal service providers achieve net benefit while formal service providers bear the cost. The prime motivation of informal players to provide waste collection services is not only the fee that can be charged but the income that can be generated by sorting and recycling the waste. The collected waste generally comprises food waste, paper, glass, metal, plastic and silt. Recyclable and reusable waste like Paper, glass, metal, plastic etc is separated by scavengers and waste pickers from community collection points or landfill sites because this kind of waste has an economic value.

The manner in which informal recycling is performed has a significant implication. The informal sector is not well organized and workers are not capable enough of adding value to recyclable material hence are easily exploited by small and large dealers. The recycled materials are usually sold locally and a chain of intermediate traders is often found between waste pickers and end-users. The informal sector brings considerable economic benefits, they usually lack capital equipment and mostly relies on manpower therefore able to supply cheaper secondary recycled material for local industry to replace imported raw material (Wilson et al; 2006). The waste is collected typically through handcarts and donkey pull-carts for primary collection; then opens trucks, and tractors, are used for secondary collection and transport. Without the interest of the government and formal sector, segregation of waste is quite difficult therefore all the waste ends up in one container. The scavengers usually sort out the waste at undesignated sites or informal collection points.

Finally, from the assessment done and leakages identified after the thorough discussion following strength, weakness. Opportunities and threats are identified for each step, from generation to disposal.

Table 0.23: SWOT Analysis- Generation

Internal Factor	External Factor
Strength	**Opportunities**
S-1: Households show their willingness to adopt environmentally friendly consumption.	O-1: There exists a wide scope for HH to generate economic benefits from the sale of recyclable waste.
S-2: Awareness regarding the negative impact of SW mismanagement on the environment and health.	O-2: Promoting paper bags or other degradable material in daily transactions would contribute potentially to controlling SW generation.
S-3: Average earning of HH from the sale of recyclable waste is around Rs 400 per month.	O-3: Individuals are concerned regarding waste management.

Weakness

W-1: Generation of waste in the form of high micron polythene bags causes blockages in the drainage system.

W-2: Statistics for industrial waste generation are not available for evaluation and monitoring.

Threats

T-1: Growing population & uncontrolled migration influx

T-2: Increasing demand for health services especially after the emergence of the covid19 pandemic is raising bio-medical waste.

Table 0.24: SWOT Analysis - Collection

Internal Factor	External Factor
Strength	**Opportunities**
S-1: Public-Private partnerships through tendering for improving collection and controlling system informality.	O-1: under the umbrella of public-private partnership the government may utilize the informal network for efficient waste collection.
S-2: High ATP than WTP of HH in all towns in Karachi.	O-2: Fundraising opportunities are available as HHs are willing to pay additionally for improved SWM system,
S-3: Financial support for SWM nationally and internationally.	O-3: profitable recyclable waste - if collected properly
Weakness	**Threats**
W-1: Sub-contracting on the basis of personal relationship or under political influence	T-1: Lack of interest in managing SW by stakeholders.
W-2: Lack of physical resources	T-2: Political influence in managing SW.
W-3: Waste is not collected daily but rather weekly or fortnightly.	T-3: Delay in waste collection exaggerates various health and environmental concerns.
W-4: Only 25% of vehicles are functional.	T-4: Non-availability of standard procedure for collection.
W-5: Poor monitoring system.	
W-6: Emergence of informal transfer stations.	
W-7: Untrained worker for collecting waste.	

Table 0.25: SWOT Analysis – Disposal/Recycling

Internal Factor	External Factor
Strength	**Opportunities**
S-1: Individuals agreed to segregate waste by type.	O-1: Segregated waste would expedite the recycling process as it can be directly sent to relevant recyclers.
S-2: Increasing industries for recycling, especially the informal ones, is contributing towards tackling and generating revenue from solid waste.	O-2: Around 20% of plastic waste collected is resalable while only around 12% is currently sold. Further, through on spot sorting about 8kg plastic, 10 kg paper, 8 kg cardboard and 4 kg iron/steel collected daily is resalable and sold by the worker while the worker claims that around 20% of the remaining waste is still resalable.
	O-3: Boosting industries recycling food waste into animal feed could also be a potential revenue source.
Weakness	**Threats**
W-1: Lack of coordination and connections between KMCs and informal pickers	T-1: Households don't bother where and how the waste is disposed of after collection from their houses.
W-2: Informal dumping points: dumping of waste at nearby vicinity, Streets, park etc.	T-2: Lack of interest in managing SW by stakeholders.
W-3: Despite acknowledging the impact of SW on health and the environment, individuals behave reluctantly while disposing of their waste properly or in an environment-friendly manner.	T-3: Lack of implementation of environmental legislation.
W-4: About 60% of total waste is food waste which is directly disposed of because the industry for converting food waste into animal food is in its primitive stage.	T-4: Non-availability of standard procedure for disposal.
W-5: Untrained worker for collecting waste.	
W-5: Improper disposal practices deteriorate the prevailing ecology and give birth to many biological diseases.	
W-6: Low-capacity landfill sites in relation to the waste generated.	

CONCLUSIONS AND POLICY RECOMMENDATIONS

Tackling solid waste problem in a megacity like Karachi, having a population of around 16.5 million and generating a daily waste of almost 0.28 to 0.61 kg/per-capita with 2.5% growth annually, **r**equires an effective policy framework and its efficient implementation. A holistic understanding of the institutional capacities (technical, financial, human and physical resources), actors involved in managing solid waste, household socio-economic condition, and political issues along with how they are linked to the stakeholders under various phases of the SWM system given the ground realities is crucial for such policy framework. Identification of the stakeholders and their interests is important in coordinating their participation and involvement in various waste management activities. Therefore it is essential to access the role, interest, and power structure of various stakeholders in process of waste management. This report is unique in nature as it provides an in-depth assessment of all the stakeholders involved in solid waste management – from generation to disposal. Based on the assessment study draw the following conclusions and recommend policy measures:

- The assessment highlighted that issues have been exacerbated by unclear duties, overlapping functions, and inadequate coordination among the numerous institutions responsible for solid waste management. The functions are largely divided between KMC and SSWAMB, resulting in a lack of coordinated planning and integration. There is a need to resolve the issue by clearly assigning the responsibilities – there should be only one authority responsible for the SWM

- In addition, public awareness, financial needs, institutional capacity and regulations enforcement and establishment of a proper sanitary landfill are principal measures needed to ensure a sustainable solid waste management system.

- The assessment predicts high profitability from recovering recyclable material, mainly enjoyed by the private contractors and informal workers. Given the profitability, the study recommends that the problem of solid waste management (SWM) can be dealt with by adopting policies for improved municipal solid waste services characterized by regular collection, timely transportation, careful disposal (especially hazardous medical waste) and proper separation of recyclable waste in achieving sustainable development.

- Households are concerned with the improved solid waste system and are ready to make efforts for it but for those who are reluctant to adopt sustainable waste management strategies motivational aspects are needed.

- Finally, elected local governments have ineffective processes and capacities, and they lack the authority to carry out numerous municipal responsibilities. A variety of services and functions that the city perform includes, master planning, building control, water and sewerage services and solid waste management are all under the control of the provincial government. DMC's are in dire economic straits, relying almost completely on provincial government payments to satisfy their budgetary demands, the bulk of which is consumed by salaries and pensions, leaving relatively little for much-needed infrastructure management and development.

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ANNEXURE

Annex-A1.1

S.	Title	Author	Key Findings
		For Developing Nations	
1	A Literature Review on Solid Waste Management: Characteristics, Techniques, Environmental Impacts and Health Effects in Aligarh City", Uttar Pradesh, India.	Priyadarshi et al (2019)	➢ Priyadarshi et al (2019) performed scenario analysis for Aligarh city, India by conducting a door-to-door survey in the residential areas of Aligarh. ➢ The major information collected by the survey were comprises on generation and sources of solid waste, amount of waste generated, the technique with which the waste usually dispose-off and the prevailing health conditions. ➢ The finding revealed that, regardless of all struggle being made by the local officials using their inadequate resources still the situation of solid waste management is not satisfactory. Usually the waste is being dumped on open areas in the periphery of the city without considering any scientific methods. ➢ At every level from collection, transportation to disposal there were problems in the prevailing practices of solid waste management. Therefore, mismanagement of solid waste is a matter of serious concern for individual's health and sustainable environment of Aligarh city.
2	Sustainable solid waste management in developing countries: a study of institutional strengthening for solid waste management in Johannesburg, South Africa	Kubanza, N. S & M. D. Simatele (2019)	➢ The research used both primary and secondary data to analyze the impact of solid waste on environmental wellbeing and human health for Johannesburg, South Africa. ➢ It was found that the health of individuals and the urban ecology is inversely related to the extent of mismanaged solid waste in the region. This in turn becomes a barrier to economic growth by reducing productivity and wellbeing. ➢ It concludes that the ineffective SWM is the result of incapability of the institutions to enforce and implement policies/ regulations and also the reluctance of the private agents and

			community to duly recognize the issue of SW and their participation in urban development.
3	Waste Mismanagement in Developing Countries: A Review of Global Issues	Ferronato and Torretta (2019)	➢ They conclude that dumping and burning waste openly is majorly visible implemented final waste disposal treatment in developing countries. ➢ The study also evaluates the impacts on health attributable to scavenging of waste activities in informal sectors of cities especially in developing countries. The key factors influencing the environment include interacting directly with the hazardous waste collection along with contamination of water, air and gas. ➢ These multi-sourced pollution not only impacts environment and health but also endanger sustainable development of cities in particular and countries as a whole. This emphasized the need to integrate policies regarding SWM in the city and national policy frameworks so as to improve in SDGs indicators as solid waste has its impact on all three pillars of sustainability: planet, people and profit. ➢ The study suggested that future policies for municipal waste management be based on collecting and treating waste on ad hoc basis.

4	Solid waste management in India: an assessment of resource recovery and environmental impact	Ahluwalia and Patel (2018)	➢ This study investigates the environmental and financial sustainability of solid waste management in Indian cities. ➢ It performs an assessment of the rapidly increasing volume of solid waste along with its changing composition and concluded that the existing system is mainly operate to collect and transport largely mixed un-segregated waste. ➢ Resource recovery from the waste and safe disposal of the residual waste in scientifically designed landfills are grossly neglected. ➢ In the absence of segregation of waste recycling also not perform properly. Land fill Sites are used fpr open dumping and because of too much waste dumping without resource recovery generates leachate and methane gas. ➢ Although, Rules have now been introduced to achieve sustainable solid waste management but the enforcement of the rules is still a big challenge because of lack of resources and capacity to manage the system efficiently.
5	A review of solid waste management practice in Dhaka City, Bangladesh.	Yasmin&Rahman (2017)	➢ As per their results the uncollected waste produces a serious drainage predicament in a city especially in the rainy season. ➢ The open disposal and dumping of garbage is unhealthy for environment and health and therefore there is much need to adopt modern technology and equipment. They lay emphasis on the role of Public and private partnerships in this regard.
6	A comparative study of municipal solid waste management in India and Japan.	Niyati, M. (2015)	➢ Niyati performed a comparative study on the regulations and practices of SWM in Japan and India. Results revealed that Rapid urbanization and industrialization especially in low

			income countries has been recognised as the core source of rising SW generation trends creating a mass mess in urban settings.
			➤ Japan attained sustainability in managing its solid waste because of its well organised, efficiently planned and implemented SWM system. In most of the developing countries, disposal of waste is commonly associated with open dumping despite having laws in place discouraging such acts.
			➤ Furthermore, most of these legislative policy frameworks lack the push towards promoting waste management in an environmentally sound manner. Thus, widening the scope of such frameworks in this regard would aid in tackling the solid waste management effectively.
			➤ Japanese SWM model is not suited for developing countries like India because of its much different waste composition and prevailing large informal recycling sector.
			➤ Moreover, it would be relatively expensive for such economies to adopt commonly used incineration technologies practiced in Japan. Thus, it was suggested that a human rich country like India may raise its recycling rate by engaging its abundant resources in the informal sector and innovate on technological and regulatory grounds.
7	Factors Influencing Solid-W ors Influencing Solid-Waste Management in the De aste Management in the Developing eloping World	McAllister, J. (2015)	➤ This study is found as a comprehensive review regarding solid waste management practises indeveloping countries and mentioned that culture, knowledge, infrastructure, social provisions, technology, and lack of policies are found as the key constraints to influence solid waste systems.

			➢ The study suggest that to achieve sustainable solid waste management system in developing nations financial resources, physical capital along with proper public awareness and other necessities that are currently lacking are need to be provided. ➢ Furthermore, as sustainable SWM practices call for some behavioural changes therefore community participation and awareness program need to be conducted.
8	Assessment of municipal solid waste management system in a developing country	Ahsan et al (2014)	➢ For Bangladesh analyzes the current practices for managing municipal waste and indicate that concern authority is unable to manage huge generation of waste because of less economic and human resource and lack of infrastructure and technological capabilities. ➢ The support is required from all stakeholders for the door to door collection of waste along with proper campaign related to awareness and motivation of sustainable collection and disposal of solid waste. ➢ Further they highlight that efficiency of waste transportation required to be improved with the help of private sector. In view of the fact that there is no single solution they suggest integrated solid waste management technique to improve solid waste management system in Bangladesh.
9	Solid waste management in kenya: a case study of public technical training institutions	Gakungu, N. K., Gitau, A. N., Njoroge, B. N. K., &Kimani, M. W. (2012)	➢ This study examined the generation, collection and disposal of solid waste using the data of 73% of the technical training institutions in Kenya that are engaged in producing 23 tons of waste per week.

			➢ The research quantifies the solid waste generated into its different components and evaluates the attitudes of those responsible for its generation and management. ➢ It concludes that the unsafe disposal of SW by these institutions have influenced the economy negatively and cause pollution to rise substantially, thus, impact the standard of living in the regions adversely. 82% of the waste consists of vegetables and food waste along with plastics, papers, ash, metals and glass as the other waste types. ➢ The study also estimated the cost for planning and managing the SW to range from Ksh 0.13 to 0.59 /week/student while per capita waste generation ranged from 0.28kg/week/student to 0.71kg/week/student. ➢ The study suggests that Boards of Management should incorporate waste management in their institutional planning so as to ensure collection and disposal of SW in a planned manner and to allocate appropriate financial and human resources for its remedy.
10	Disposal of solid waste in Istanbul and along the Black Sea coast of Turkey	Berkun et al (2005)	➢ Istanbul are having great progress in their existing practices to manage solid waste by establishing transfer stations, sanitary landfills and methane recovery system, but in the Black Sea coast in Turkey the problems are still unmanageable. ➢ The factors that are responsible for such differences include the complex topography, feeble administrative structures and the low level of income in these local areas.
11	Integrated solid waste management: Engineering	Tchobanoglous et al (1993)	➢ Elevated growth rate of population and rising economic activities combined with the lack of training in

principles and management lssues			contemporary solid waste management practices cause difficulties in the efforts to improve the solid waste management services in the urban areas of developing countries.

	Title	Author	Findings
			For Pakistan
12	Knowledge, Perception and Attitude of common People towards Solid Waste Management-A case study of Lahore, Pakistan	Haider.et.al (2015)	➢ Discussed the SWM system relate to the respondents view about perception, knowledge and attitude for the location of low middle and high-income levels by the sample of 300 household collected for the city of Lahore ➢ Finding of the result shows that SWM practices have been improved but still unsatisfactory ➢ The three income levels contributed about 564kg/day of solid waste, among which low income areas contributed171kg/day, middle income areas 194kg/day and higher income areas 199kg/day and the quantity of waste increased as the number of family members increased ➢ Composition of solid waste includes fruits and vegetables 65.2%, plastic 20.2%, paper 10.9%, glass 0.3%, textile 3.3% and others 0.1% respectively. ➢ Finding of the study also reveals the trend of reuse material and waste collection vary from high to low income
13	Impacts of solid waste management in Pakistan: a case study of Rawalpindi city	Nisar et.al (2008)	➢ Solid waste management considered as a major environmental issue especially for larger cities. ➢ Highlighted the impact of solid waste management in Rawalpindi city by increase in urbanization, horizon of industries and growing standard of living in urban areas leaving drastic impact in case of solid waste management ➢ Research finding shows, it is revealed two major problems due to poor solid waste management respectively communicable diseases and unhygienic environment

			➢ Lack of efficient management and legislation, existing solid waste management systems, high waste generation rate and high growth rate are not making the system properly grow. ➢ Because of unplanned annexation of the city, extreme weather conditions, lack of public awareness/community involvement, improper resources including improper equipment and lack of funds causing failure of SWM
14	Alternative approaches for solid waste management a case study in Faisalabad	Yasin et.al (2017)	➢ Identify the solid waste management alternative approaches of recycling, compositing and incineration for Faisalabad city that are producing 1300 to 1600 tons per day varying by the time ➢ Waste generated amount are near 54% while dispose of facility available only for 43% exist ➢ Manageable criteria for SWM reduces the problem of pollution while making the positive outcome of fertilizer and energy ➢ Recycling process applied on all the plastic and rubbers used for extra growth of running while incineration system applied to generate the energy and other part could use for the electricity generation.
15	Solid waste management practices under public and private sector in Lahore	Ashraf et al (2016)	➢ The study explored the comparison in between public private practices of solid waste management in Lahore ➢ The study indicates lacking of some key indicators, as solid waste storage capacity, administrative structure, sweeping, monitoring system and waste collection process ➢ Overall condition of SWM has not satisfied that also point out by the government of Pakistan due the irregularities in

			legislative system with poor institution performance making it worst more.
			➤ The study concludes that with public resources private system contribute by material recovery, sanitary landfills and through the informal sector support
16	Municipal solid waste management in Lahore City District, Pakistan Country report Waste Management	Batool and Ch (2009)	➤ This study analysis the determinants of total and per-capita generation of waste for Data Ganj Bakshs Town (DGBT) that is the urban area of Lahore.
			➤ Composition of those determinants consist on transportation, disposal in open dumps and storage problems, cost of current management system by making the improvement used IWM-2 model.
			➤ Finding shows that around 0.8% kg per capita /per-day of waste generating in (DGBT), mostly the non-organic waste generation of the total waste that consist of around 91% while organic waste consists of 67.02%
17	Waste Generation Rate and Composition Analysis of Solid Waste in Gujranwala City	Ilyas.et.al(2017)	➤ The aim of this study is to find out the quantity of waste producing and what the contribution in Gujranwala city of Lahore.
			➤ Sample of 776 collected through the survey by the integration of residential and commercial areas while household source divided into rural low medium and high-income levels.
			➤ Output shows for these four levels on average waste generations' rate that founded by the range of 0.3 per capita per day low to high-income areas near about 0.4 per capita per day

			➢ Finding shows more than 80% waste consist on organic waste, more over by the analysis specific gravity for waste calculated form high income is 275kg /m³ for middle accounted 285 kg/m³ while for low income is 283kg/m³ meanwhile for rural areas is 256kg/m³.
18	Comparison of MSW management practices in Pakistan and China	Korai.et al (2019)	➢ Stated the comparison of Municipal Solid waste (MSW) management in between Pakistan and China ➢ In Pakistan been observed that unsanitary disposal MSW realized the growing concern due the lack of efficient management plan ➢ Moreover, shortage of electricity and environmental issues creating more complexity and alarming situation for MSW ➢ Karachi has, total quantity of waste generation around 0.57Kg/Capita/day while total quantity rate is 4.76 MT/Y while further goes respectively. ➢ Lahore 0.75 Kg/C/D with quantity rate 2.8MT/Year. ➢ Faisalabad 0.45Kg/C/D and quantity spread 2.8MT/Y ➢ Rawalpindi 0.21Kg/C/D and quantity 0.13MT/Y ➢ Hyderabad 0.8Kg/C/D and 0.8 ➢ Islamabad it expresses around 0.5Kg/C/D and 0.1MT/Y. ➢ Comparison disclose Pakistan and China MSW collection efficiency 60% and >95% ➢ Total MSW 30mill ton and in China 203mill, dominant landfill slide >90% while in China shows 60%.
19	Hospital waste management in Pakistan	Khattak (2009)	➢ This study explores the situation in Pakistan about the health care waste management system.

			➤ Finding reveals on the daily basis around four to two thousand kg from various hospitals are generating near about 2.0kg of waste/bed /per day produce in that 0.1 to 0.5 declared high risk waste.
			➤ Moreover, also declare around 75% to 95% are coming from non-risk waste collecting by health care, household and administrative functions.
20	Framework for integration of informal waste management sector with the formal sector in Pakistan	Masood and Barlow (2013)	➤ Discussed that in developing countries for the mutual benefit informal waste management networks collaborates with formal for that a proposed an integrated frame work system for Lahore city try to identify the points of interventions among these sectors
			➤ Interventions divided into four categories that are formal SWMS, Material and value chain, society as a whole and organization and empowerment of the informal recyclers.
21	Willingness to Pay for Solid Waste Management Services: A Case Study of Islamabad	Anjum (2013)	➤ As SWM has always been a crucial problem that has to face mostly the developing countries where the larger part of budget consumes on that purpose
			➤ The study has conducted for the Islamabad SWM consist of generation collection and disposal of waste
			➤ Used contingent valuation survey approach for 100 respondents
			➤ Finding shows by the application of logistic regression that reveals 65.4 percent of the total respondents are willing to pay

			➤ However, for multiple regression reveals a monthly mean willingness to pay in Rs 289.15 shows
			➤ Results also elaborates the findings that willingness to pay affects by the age, education and income and environmental awareness
			➤ Higher the education and the income produce higher willingness to pay
22	An assessment of the current municipal solid waste management system in Lahore, Pakistan	Masood et al (2014)	➤ In that study the review of SWM regards to Lahore city has focused
			➤ Study covers the UN- Habitat city profile approach
			➤ Analyzes the current SWM system based on waste collection and transportation
			➤ Although collection coverage is near about 68%, however there is no controlled and semi controlled dispose of facility has seen in Lahore, meanwhile no official recycling process in active in the city
			➤ Although 27% recycling process under goes by the informal sector
			➤ Lahore is not making more efficient progress respect to governance features
			➤ Study suggested that more awareness should be provided by the consumer side and to make the recycling process more effective there should be integration of informal sector for financial sustainability
			➤ Lahore Waste Management has 58 officials and 10,000 field workers for waste collection and disposal by the figure LWMC(2011)

			➢ Summary of the Lahore on UN- Habit is like that public health waste collection is around 68%, environmental dispose near 8%, resource management (3R) reduce, reuse and recycle 35%, Governance strategies is too low while financial sustainability is near 68% ➢ Lack of planning and public private coordination is barriers to improving the SWM
23	A Study of Solid Waste Management in Karachi City	Sabir et al (2016)	➢ The study is qualitative in nature and mainly focused on the problem issues and challenges to cope up the SWM in Karachi. ➢ For the survey, selected 20 respondents included household and responsible municipal committee officials for the SWM. ➢ Findings shows citizens are not satisfied by the current system of SWM, municipal have responsibility to tackle down the entire situation that is not handling properly. ➢ Meanwhile it has also been observed that municipal committees are facing the problems of lack of funding and ineffectiveness for that purpose. ➢ Illegal dumping without any awareness producing largest problem in the city. ➢ Hazardous waste dumping in society creating the multiple types of diseases in the city. ➢ Machinery and equipment are too old to support the system ➢ There is a need to be required to control per day collection of SW in growing urban areas.

			➢ Management should adopt some immediate actions, strategies, planning and design to stream line the current situation to control. ➢ Study also suggested that there is also some sort of need to educate the citizens with respect to reducing the quantity of SW and further on recycling process.
24	Urban Solid Waste Management in Karachi,Pakistan	Mahmood& Khan (2019)	➢ The study evaluates the importance of Solid Waste Management system (SWM) in Urban Karachi. ➢ Multiple factors have contributed to the vast growth of garbage in Karachi. Over population and in migration are some of those factors. ➢ People living in Katchi Abadis deprived of solid waste disposal facilities; hence, they dumped solid waste in natural drains, streets or open plots. ➢ City produces various categories of solid waste which are household municipal waste, institutional waste, restaurant waste, street sweepings, landscaping waste, agricultural waste, animal slaughterhouse waste, fish market waste, vegetable market waste, sewage sludge, and tires. ➢ Landfill site to informal picker to Garbage transfer system in not enough to sustain the severity of Karachi
25	A Study of Solid Waste Management in Karachi City	Sabir et al (2016)	➢ Aim of the study is to analyze the condition of solid waste management in Karachi city. ➢ Observations show on the daily basis near about 12000 tons of SW for six districts are generating in the city.

			➢ Findings show that citizen on equal basis broken the laws and violate the restriction in the sense dump the wastages in front of house open areas and on roads. ➢ As its declared by the different statistics that 60% waste collected in the city while 40% reaming as it is on roads. ➢ There is a need to require for (3R) that are reduce, reuse and recycle process.
26	Urban Solid Waste Management in Karachi, Pakistan	Hajra et al (2019)	➢ This study evaluates the importance of solid waste management in urban city Karachi ➢ For the study of Karachi different models has adopted by different cities for the SWM. ➢ Shed the lights on different master plans since 1992 to 2020. Before 1974 around 2000 tons SW produced per day and now in 2019 it reached near about 12000 ton per day. ➢ Highly dense populated city with vast growth of garbage producing various categories of garbage like household municipal waste, commercial waste, Institutional waste, restaurant, street, hospitals, Industrial, landscaping, agriculture, animal, slaughter etc. ➢ Government made Karachi 2020 Plan although by increasing population with rising waste producing alarming situation for the city to control. ➢ Study suggested that there should be link among government and masses, people have awareness about dropdown waste

			places. Land owner, board and membership should be develops. ➤ Educational institutes can be helpful that they can motivate their students to the garbage collection and the recycling process awareness programs such as convert agriculture waste to the use of livestock food.
27	Baseline Study for Solid Waste Management - Karachi	ESCAP/IUCN/UN HABITANT (2013)	➤ The main purpose of the study is to find out waste storage methods at the household level in Karachi. ➤ The study also discusses the social and cultural habits of people with respect to hygiene and cleaning and the role they have for manage the waste and segregate the waste. ➤ The study found that the average household solid waste generation for the city of Karachi is estimated to be 0.44 kg/cap/day ranging from 0.19 to 0.84 kg/cap/day. ➤ In fruit and vegetable market 1.795 kg/shop/day and 11.77 kg/shop/day waste generated respectively. ➤ Moreover, study shows that waste generated by household, vegetable and fruit markets shows organic fraction (food waste) has the highest proportion ranging from 36.1 to 93% (weight/weight). ➤ The study also found that after plastic and paper waste the metal waste contribution remained highest. ➤ It is suggested that decentralized system should be adopted in Karachi for the SWM because centralize system creating problems.

| 28 | Exploring E-Waste Resources Recovery in Household Solid Waste Recycling | Siddiqi et al., (2020) | ➢ This paper strives to contribute to the issue of Household SW management that matters to everyone's business, specifically to developing nations.
➢ The HSW management system of the world's 12th largest city and 24th most polluted city, Karachi, was studied with the aim of generating possible economic gains by recycling HSWs.
➢ In this regard, the authors surveyed dumping sites for sample collection. The sample was segregated physically to determine the content type (organic, metals, and many others). Afterward, chemical analysis on AAS (Atomic Absorption Spectrophotometry) of debris and soil from a landfill site was performed.
➢ HSW is classified and quantified into major classes of household materials. The concentrations of e-waste [Cu], industrial development indicator [Fe], and the main component of lead-acid storage batteries [Pb] are quantified as 199.5, 428.5, and 108.5 ppm, respectively.
➢ The annual generation of the afore mentioned metals as waste recovery is articulated as 1.2 _ 106, 2.6 _ 106 and 6.5 _ 105 kg, respectively.
➢ Significantly, this study concluded that a results-based metal recovery worth 6.1 million USD is discarded every year in HSW management practices. |
| 29 | Solid Waste Management | KCCI Research & Development Department (2018) | ➢ This report attempts to shed some light on the sanitation crisis and analyze the dynamics of waste management |

	A study of : Karachi's Garbage Crises Turning the city of Light into City of Trash		system of Karachi. It also highlights the recommendations to overcome the problems related to waste management in one of the main urban agglomerations of Pakistan, 'Karachi'.
			➢ Solid waste generation in Karachi hovers between 12,000 to 15,000 TPD and is expected to be doubled by the end of 2020 of which only up to 10,000 TPD of solidwaste gets collected.
			➢ Unfortunately, Karachi has been ranked among least livable cities of the world due to improper management of civic facilities which are already inadequate where rapid urbanization has aggravated the challenges. According to EIU livability index 2017, Karachi has been ranked 136th out of 140th amongst the world's least livable cities of the world due to failing on various indicators like environment, health, livability, education and safety.
			➢ Since long waste management was the core responsibility of the Karachi and District Municipal Corporations. A few years back, a part of this responsibility was shifted to Sindh Solid Waste Management Board (SSWMB). Since then, the waste collection situation has improved to some extent but it is still much below par. To get the work done, SSWMB outsourced garbage collection system to Chinese Sanitation Companies and imported some machinery and equipment for the job.
			➢ However, this setup was ~12 times costlier for Sindh government than the spending of the municipal corporation for the work.

			➢ The unattended organic waste triggers growth of flies and other harmful pests and bacteria which cause host of diseases. Even the hazardous hospital waste does not get properly treated due to only two obsolete incineration plants. ➢ Solid waste collection in Karachi comprises of straight forward steps where garbage is initially collected from household residents through door to door service and finally dumped at allocated sites without any treatment or segregation. ➢ In order to overcome the challenges and the abysmal state of Solid Waste management in Karachi, a systematic approach is required to minimize waste generation and at the same time putting the waste to best use through recycling or converting it into energy. ➢ The study recommend that all garbage lifting authorities including KMC and DMCs can make joint efforts in promoting a clean healthy environment which we can preferably term as 'Naya Karachi' (New Karachi). ➢ It is, therefore inevitable for Karachi to not only improve the municipal solid waste management while adopting the global best practices but the citizens of Karachi should start using basic leaning technique right from their homes. ➢ A clean, healthy and safe Karachi will transform this city to a major tourist attraction and a preferred investment destination.

Annex-A3.1

Questionnaire for the Survey of Contractor (2021)
(The information collected is strictly confidential and will be used only for educational purposes)
Applied Economics Research Centre (AERC), University of Karachi

1. Name of the Contractor/Organization   _____

2. Employer - Public (UC/KMC/SSWMB) or Private   _____

3. Hiring Process/ Basis:
   (Tender/ Informal/Personal Relation/Experience)   _____

4. Formal Agreement   1. Yes   2. No
5. Agreement Period (if Formal)   _____
6. Area of work   (Town/UC)   _____
7. WARD No.   _____
8. Do you have contract of other areas/UC as well   _____
9. How many areas/UC you covered   _____

For the UC/Area under Survey

10.   Number of Household Covered   _____
11.   Number of Employees /Informal/Contractual   _____
12.   Number of (owned) Vehicles (Engage in this Ward)   _____
13.   Type of Vehicle (s) (owned)   _____
     _____
14.   Total Cost of Garbage Collection (per month)   _____
15.   Fee Collection per household/per month   _____
16.   Who Take the Fee   Himself/Hired Worker/UC/KMC
17.   Income of Contractor   _____
18.   Wages to Employee   _____
19.   Are you aware of Waste dumping Points   1. Yes   2. No
20.   Number of Waste dumping Points   Formal _____ Informal _____
21.   Who collect waste From these Points   _____
22.   Collection Times per week From these Points _____
23.   Did involve in segregation/selling/Recycling   1. Yes   2. No
24.   (If Yes) Amount segregated/Sell per day:
     Plastic: _____
     Paper: _____
     Cardboard: _____
     Glass: _____
     Steel/Iron: _____
     Wood: _____
     Other Specify: _____
     Other Specify: _____
25.   Rate at which Sell
     Plastic: _____
     Paper: _____
     Cardboard: _____
     Glass: _____
     Steel/Iron: _____
     Wood: _____
     Other Specify: _____
     Other Specify: _____
26.   Where do you sell the collected material   _____

     _____

| 27. | Garbage Leftover | 1. Yes | 2. No |
| | If Yes: Why _____ | | |

28. If Yes: What you suggest for the leftover:
Man power needed _____
Number and Type of vehicle _____
Other Suggestion _____

_____

29. Problems/Hindrances faced in operation (if any) _____

_____

30. Monitoring Mechanism adopted (if any) _____

_____

Questionnaire for the Survey of Informal Players (2021)
(The information collected is strictly confidential and will be used only for educational purposes)
Applied Economics Research Centre (AERC), University of Karachi

Informal Players/Rag Pickers/ Scavengers

1.   Name of the respondent   _____
2.   Age of the respondent   _____
3.   Gender of the respondent   _____
4.   Do you live with your Parents   1. Yes   2. No
5.   If No; to whom you live (relationship code)   _____
6.   Where do you live?   _____
7.   Permanent District of Residence (parents)   _____
8.   # Family member's   _____
9.   Do you combine Education and work   _____
10. Education (if any)   _____
11. How long you are involved in SWM/rag picking   _____
12. Name of the contractor/Employer (if any)   _____
13. Distance of Area of work from place of residence   _____
14. Areas of work (Town/UC/WARD)   _____
                                                            _____
15. Frequency of visit to the collection area (per day)   _____
16. Dumping points in your Area   (name & no.)   _____
                                                            _____

17. Type & amount of wastes collected: Plastic   _____
     (Pls. mention Units)   Paper: _____
                                          Cardboard: _____
                                          Glass: _____
                                          Steel/Iron: _____
                                          Wood: _____
                                          Other Specify: _____
                                          Other Specify: _____
18. Segregation done   1. Yes   2. No
19. Amount Sell per day   Plastic: _____
                                          Paper: _____
                                          Cardboard: _____
                                          Glass: _____
                                          Steel/Iron: _____
                                          Wood: _____
                                          Other Specify: _____
                                          Other Specify: _____
20. Rate at which Sell   Plastic: _____
                                          Paper: _____
                                          Cardboard: _____
                                          Glass: _____
                                          Steel/Iron: _____
                                          Wood: _____
                      Other Specify: _____
                      Other Specify: _____
21. Where do you sell the collected material   _____
                                                         _____
                                                         _____

22. If involved in door to door collections
     1. Number of Household Waste collected per day   _____
     2. Amount of Waste Collected per day   _____
     3. Waste Segregated   1. Yes   2. No
     4. Waste dumping Points (Formal)   _____

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5.	Waste dumping Points (in Formal)	_____	
6.	Who collect waste From these Points	_____	
7.	Collection Times per week From these Points _____		
8.	Fee Charge from Household (monthly)	_____	
9.	Total Fee collected	_____	
10.	Fee Amount Share by Contractor	_____	
11.	Fee Amount Kept by himself	_____	

23. Occupational hazard if any   1. Yes   2. No

24. Involvement in:

1.	None	1. Yes	2. No
2.	Pick pocketing	1. Yes	2. No
3.	Gambling	1. Yes	2. No
4.	Theft	1. Yes	2. No
5.	Smoking	1. Yes	2. No
6.	Drugs	1. Yes	2. No
7.	Gutka/Pan	1. Yes	2. No
8.	Others/Specify	1. Yes	2. No

25. Income (if hired)   _____

      Any other Source   _____

26. # Earner in the House   _____

27. Occupation of the earners   _____

                                  _____

                                    _____

28. Family income
1. Below 5,000
2. 5,000 – 10,000
3. 10,001 – 15,000
4. 15,001 - 20,000
5. 20,001 - higher

Annex-A3-3

Questionnaire for the Survey of Household (2021)

Prospects for the Development of Solid Waste Management System: A Case Study of Metropolitan City Karachi
RASTA ID #: 01----

QUESTIONAIRE FOR HOUSEHOLD'S INFORMATION

I.   Name of the Head of the Household (HOH)   _____

II.   Name of the respondent   _____

III.   Respondent's relationship with the HOH   _____

IV.   Town   _____

V.   Address   _____

_____

_____

_____

VIII.   Name of Enumerator   _____

IX.   Name of Supervisor   _____

X.   Date of Interview   _____

XI.   Time of Interview   _____

	SECTION-1: HOUSEHOLD COMPOSITION AND DEMOGRAPHIC INFORMATION							SECTION-2: CURRENT EDUCATION STATUS			
R.N.o.	Name of household members who usually live here. Do not list guests, visitors, etc.	What is the relationship to head of the household?	Gender	Age in Years	Mother Tongue	Current marital status?	How long has been living in this city?	Canread with understanding in any language.	Can write in any language with understanding?	Is, currently enrolled in educational institute?	What was the highest grade, completed? *(See codes below)*
		1. Head of 2. Spouse 3. 4. 5. 6. Grand 7. 8. 9. 10. 11. Others	1. 2.		1. 2. 3. 4. 5. 6. 7. 8. 9.	1. 2. 3.Widow 4. 5. Others	1. Since 2. Less 3. 1-4 4. 5-9 5. 10 years &	1=Yes 2=No	1=Yes 2=No	1=Yes 2=No	
	1.1	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**2.1**	**2.2**	**2.3**	**2.4**
1.											
2.											
3.											
4.											
5.											
6.											
7.											
8.											
9.											
10.											
11.											
12.											

Codes for Section-2.4

00=Below Class 1	03=Class 3	06=Class 6	09=Class 9	12=Intermediate	15=Class 15/ M.A/ M.Sc. Part I	18=B.Ed./M.Ed.	21=Degree in Law	24=PhD.
01=Class 1	04=Class 4	07=Class 7	10=Class 10 /O-Level	13=B.A/ B.Sc./B.com Part I	16=Class 16/Masters	19=Degree in Medicine (MBBS/BDS/Pharm-D etc)	22=Degree in Accountancy	25=Others(Specify…)
02=Class 2	05=Class 5	08=Class 8	11=First Year	14=B.A/B.Sc./B.com II	17=Polytechnic diploma/Diploma	20=Degree in Agriculture	23=MS/M.Phil.	

R.No.	What were principal activities during last month?	Reasons of Unemployment *(Specify if any)*	What was employment status? *(Read all the options to the respondent)*	What was the nature of work (Occupation) thatdid?	Which industry is your primary job in?	What kind of employment?	Atmain work, what is the periodicity of payment?	How much net money didearn from the main work last month?
	1. Employed (If Employed Go 2. Unemployed 3. Not in LF (Skip Section 3-A)	After reasoning Skip Section 3A	1. Regular paid employee with fixed 2. Casual paid employee 3. Paid worker by piece rate or work 4. Employer 5. Own account worker/ Sole 6. Unpaid family worker 7. Other (Specify if Any)			1. Public 2. Private 3. Semi Govt. 4. Other (Specify)	1. Daily 2. Weekly 3. Fortnightly 4. Monthly 5. Other periodicity 6. Piece rate basis for service 7. Other (Specify)	Rs.
	3.1	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**	**3.7**	**3.8**
1.								
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16.								
17.								
18.								

SECTION-3 (A): EMPLOYMENT

SECTION-3(B): EMPLOYMENT (OTHER SOURCES)			
R. No.	Does any member of household earn income from other source?	What is that source or form of earnings or benefits?	Amount in Rs. from these sources during last month.
	1. Yes 2. No (Skip Section 3-B)	1. Rental 6. Interest Income 2. Subsidiary work 7. Profit 3. Pension 8. Shares 4. Bonus 9. Others 5. Remittances	Rs.
	3.9	**3.10**	**3.11**
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			

SECTION-4(A): HOUSING CHARACTERISTICS

1. What is your present occupancy status?

1.Owner occupied   4. Subsidized
rent

2. On rent   5. Pagri

3. Rent free   6. Other
(Specify)

2. What is the Nature of the plot?

1. Residential

2. Residential/Commercial

3. Residential/Industrial

3. What is total area of plot?

(sq.yds)

---

4. What is the dwelling type?

1. Independent house/compound

2. Apartment/Flat

3. Part of the large unit/ Portion

4. Other (Please specify)

5. What is the area of single residential unit?

(sq.yds)

6. How many rooms are there in this residential unit?

---

7. Which main material is used for Floor?

1. Ceramic tiles/Marbles/Chips

2. Cement

3. Non-Cement

4. Other (Please explain)

8. Which main material is used for roof?

1. RCC/RBC

2. Cement sheets

3. Metal/Tin/Girders/T-Iron

4. Other (Please explain)

9. Which main material is used for walls?

1. Cement

2. Raw bricks/mud

3. Plywood/Cardboard

4. Stone

5. Other (Please explain)

---

10. What is the main fuel used for cooking?

1. Gas

2. LPG

3. Kerosene Oil

4. Electricity

5. Other (Please explain)

11. What is the main fuel used for heating?

1. Solar Energy   2.Electricity

3. LPG   4. Gas

5. Bio Gas   6. Crop residue

7. Kerosene Oil   8. Charcoal\Coal

9. Dung Cake   10. No Facility

11.Other (Please explain)

12. What is main fuel used for lighting?

1. Electricity

2.Solar Energy

3. Gas

4. Kerosene Oil\Diesel\Petrol

5. Candle

6. Other(Please explain)

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SECTION-4(B): HOUSING CHARACTERISTICS		
13. What is the main source of drinking water for members of your household? 1. Piped water 2. Borehole 3. Dug well 4. Water from spring 5. Rainwater 6. Tanker truck 7. Cart with small tank 8. Bottled/R.O. Plant Water 9.Other (specify) (river/dam/lake/pond/stream/canal/irrigationchannel)	**14. Who installed the water delivery system?** 1. Government 2. Private 3. Others(specify)	**15. Is sufficient water available for drinking when needed?** 1. Yes 2. No 3. Don't Know 4. Others(specify)
16. Do you do something to make water safer to drink? 1. Yes 2. No 3. Don't, Know	**17. What you actually do to make water safer to drink?** 1. Boil 2. Add chlorine/tablet 3. Strain it through a cloth 4. Water filters 5. Solar Disinfection 6. Let it stand and settle 7. Others(specify)	**18. Do you normally pay for water used your dwelling?** 1. Yes 2. No For code 2 go to Q.20
19. How much do you normally pay for one month water supply? 1. Private (Pay) 2. Public (Pay) (Rs.)	**20. Are you willing to pay for an improved water supply system?** 1. Yes 2. No 3. Don't, Know	**21. What type of toilet is used by your household?** 1. No Toilet 2. Flush connected to public sewerage 3. Flush connected to septic tank 4. Flush connected to pit 5. Flush connected to open drain 6. Dry raised latrine 7. Dry pit latrine 8. Composting toilet 9. Others(specify)
22. Is your house connected with drainage/sewerage system?		

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1. Yes, to covered drains   2.Yes, to Under Ground drains

3. Yes, to open drain   4. No, no system

5. Other(please explain)

SECTION-5: HOUSEHOLD EXPENDITURE		
Did household members consume any of the following items?		
(Cross the None box if the item was not consumed)	Paid (in Rupees)	
	Monthly	Yearly
Food & Beverages		
Tobacco & chewing products		
Clothing & Footwear		
House Rent		
Property tax		
Electricity Charges		
Gas Charges		
Water Charges (Bill)		
Furniture, Furnishing, Floor covering, Household equipment		
Health Expenditure		
Transport		
Communication		
Recreation & Culture		
Education Expenditure		
Loan Payments		

Remittances Out		
Miscellaneous (All other)		

R No.	Does any member of your family suffer from any disease? 1. Yes 2. No (Skip Section 6)	If Yes, What type of the following disease? 1. Chikungunya 2. Malaria 3. Dengue 4. Diarrhea 5. ENT Problems 6. Allergies 7. Typhoid 8. Hepatitis 9. Covid-19 Corona 10. Others(specify)		How frequently they suffer? 1. Monthly 2. Twice in a month 3. Twice in a year 4. Others(specify)	Who did you consult first? 1. Govt. dispensary/Hospital/Doctor 2. Basic Health Unit 3. Hakeem/Herbalist 4.Homeopathic 5.Private consultant 6. Self-medication 7. Others(specify)
	6.1	**6.2**		**6.3**	**6.4**
1.					
2.					
3.					
4.					
5.					
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9.					
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12.					

SECTION-6: HEALTH

SECTION-7(A): SOLID WASTE MANAGEMENT (GENERATION & DISPOSAL)

1.Which type of waste usually generated?	**2.Can you roughly identify percentage composition**	**3. Do you usually separate out waste by category before**
1. Kitchen waste 2. Paper 3. Plastic 5. Other(Please specify)	1. Food waste ....% 2. Paper...........% 3.Plastic........% 4. Other (Please	1. Yes 2. No If Yes, Skip Q.4
4. Would you do so, if you are told by your collection service	**5. How often do you dispose of your household**	**6. Generally, when do you dispose of your waste**
1. Yes 2. No	1. Every day 2.Once every two days 3.Once every three 4. Other (Please	1. No definite time 2. Between 6am to 6pm 3. After 6pm 4. Other (Please specify)
7. What is the Location 1. Kitchen 2. Backyard 3. Outside main door/Next 4. Other Specify	**8. Is your waste bin** 1. Yes 2. No	**9. You dispose your household** 1. Polythene /plastic packet 2. Paper bags 3. Any other container
10. Do you wash your 1. Yes 2. No If No skip Q. 11	**11. How often the** 1.Daily 2.Weekly 3.Monthly	**12. Who disposes your** 1. Servant 2. Family member 3. Wastes are collected by the 4. Wastes are collected by a locally- 5. Other (please specify)
13. Does the person wash his 1. Yes 2. No	**14. Where is the** 1. In the community 2. By the side of the road as there is no 3. In an empty space 4. Inside the house 5. Don't know	**15. What are the problems you** 1. No dustbin in the area 2. Dustbin is quite far away 3. Dustbin is not in the right 4. Dustbin is not in the way 5. It is smelly near the 6.No one is at home to

SECTION-7(B): SOLID WASTE MANAGEMENT (COLLECTION, EXPENDITURE AND INCOME GENERATION)

1. Who collects waste from household?	**2. How often does the waste being collected?**	**3. When do you prefer for your waste to be collected?**
1. City municipality(Public) 2. Private contractor 3. Others Specify	1. Everyday 2. Once in two days 3. Once in three days 4. Irregularly 5. Don't know	1. Morning 2. Noon 3. Afternoon 4. Evening
4. How much are you paying monthly for the collection of waste? **(Rs.)** 1. From household	**5. How do you evaluate the state of solid waste collection in your house area?** 1. Good	**6. How much are you willing to pay monthly for the improvement of SW collection system?**

2. From neighborhood		2.Fair				
3. From community bin		3. Not Good				
4. Others Specify		4. Don't know				(Rs.)

7. Have you ever heard about the importance of recycling?	8. If yes, do you agree to SW recycling?	9. If SW recycling program setup, would you be willing to separate out material into separate bags for collection purpose?

1. Yes
 	
2. No
   If No, Skip
      Q.8
	1. Yes
	2.No
		1. Yes
		
		2. No
		
		3. Don' know

10. Did the household generate any income from selling of waste?	11. What type of waste is usually sold for income generation?	12. How much income is generated from each waste type?
1. Yes 2. No If No Skip Q. 11, Q. 12	1. Paper 2. Metal 3.Plastic 4. Other specify	1. Paper 2. Metal 3.Plastic 4. Other specify

SECTION-7(C) SOLID WASTE MANAGEMENT (ENVIRONMENT)		
1. The current waste disposal system is polluting the environment. Do you agree?	2. Which of the following problems (generated from improper waste disposal) are responsible for polluting the local environment?	Do people dump their waste alongside the garbage bins instead of putting inside those?

1. Yes
 	
2. No
 	
          If No go to Q. 3
	1. Wastes being disposed in the drain and blocking the drain.
	2. Wastes being disposed in the sewerage line and blocking the line.
	3. Wastes being disposed on the road and spreading odour.
	
	4. Uncollected waste from the drain or dustbin spreading odour.
	5. Mosquitoes/flies from the dumped wastes
	6. Deterioration of the local environment and beauty by the improper disposal ofwaste here & there.
	7. Other specify
		1. Yes
		
		2. No
		
		          If
		   No go to
		      Q. 5

4. Any particular reason……………….	5. Do you consider that environmental degradation has negative effect on your family?	6. Do you know that from kitchen and vegetable wastes, an organic fertilizer can be made which is good for the environment, does not degrade the fertility of land like other chemical fertilizers, and is very much useful for plants and lands?
1. Difficult to put waste inside the bin due to height of the bin 2. Difficult to put waste inside the bin due to waste and litter spread around the bin 3. Stray animals (dogs, mouse and birds etc. 4. Any other reason …………………....	1. Yes 2. No	1. Yes 2.No

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7. Would you like to use this organic fertilizer in your garden or in the plants' tub? 1. Yes 2. No	8. Do you have any idea about Community Based Organizations (CBO)? 84 1. Yes 2. No If No, Skip Q.9	9. Community based Organization (CBO)s can improve the local waste removal system and help to provide a better environment. Do you agree…? 1. Yes 2. No
10. Do you know how your service provider disposes your collected waste? 1. Yes 2. No	11. Are you concerned about the disposal methods of the service provider? 1. Yes 2. No	12. Do you think that leaving a better environment to future generations is something? 1. Yes 2. No

List of Selected Public Sector Official Interview Summaries

First Meeting
Public Sector Official Interview
KMC

- The function of KMC is to deal only with medical waste after the emergence of SWMB.
- They Collect 20% of the medical waste which is around 4 to 5 tons/per day only from private registered hospitals.
- The estimated generation is approximately 1.44 kg per bed in hospitals.
- There was no scientific way of disposing waste observed before 2006 while after 2006 KMC installed two insulation plants for disposing waste scientifically.
- The capacity of two insulation plants is about 220 units. Individually each insulation plant insulates 2 tons per hour with gaps on average i.e 5 tons per day.
- He highlighted some administrative issues and problems that are.
  - ✓ Limited capacity for collection
  - ✓ No record of proper generation
  - ✓ Insulation plant functioning with full capacity, but it is not enough
  - ✓ No uniform policy of hospitals has been developed for their plants and records.
  - ✓ Big hospitals do not provide access to the record
- Small private hospitals are not registered and they work informally although they hire private contractors to collect their waste but they have no record of waste disposed.

Suggestions
  - ✓ Uniform policy should be adopted
  - ✓ Every-body should be under one umbrella whether it be KMC, SWMB or EPA

Second Meeting
Public Sector Officials Interview
SSWMB

- The KII emphasized on the problems prior to 1999 and discussed the previous system of Nazim's and Mayer's performance devoted to Karachi.
- He elaborated outsource financing and disclosed its pros and cons. He informed regarding the current collaboration of SSWMB with Chinese Company and Spanish company.
- Recently SSWMB completed a survey with the collaboration World Bank and pointed out 20 key performance indicators (KPI).
- The core issues that are relevant in describing the city's condition are;
  1. Ownership and stakeholders
     (Until the city have a centralized authority that owns the city instead of decentralized ones, the process of criticizing and politicizing will continue).
  2. Behavioural response of the persons
     (Individuals are unaware about the seriousness of the issue thus they do not behave in the manner they should. There is a need to change individual mindset on an immediate basis from the grass root level).
- While mentioning about a SWM survey conducted in different districts of Karachi he mentioned that more or less similar situations were found concerning the localities and garbage dumping situation either in front of house or by nearer empty places along the roadsides.
- The Major dumping of garbage is done in to two landfill sites [Jam Chakro and Goandpass] that Sindh Solid Waste Management designated.
- Talking about the statistics in the previous studies mentioning that the generation of waste in Karachi is about 12000 tons daily, he rectified this figure to be approximately 9000 tons per day instead.
- He pointed out different collection sources like; door to door collection from households by UCs, Industrial and hospital hazardous waste etc.
- No discussion was made regarding cost of collection and cost of generation.
- He discussed about assessing the management capacities and agreed that lack of labour efficiencies, poorly equipped system, and inadequate household cooperation are the core obstacles in SWM.

- He said they are trying to enhance the efficiency of the SSWMB. To improve the system and to have a check and balance on the employees, they have developed a Command and Control System on a per-day basis in Karachi. Further, daily workers such as sweepers, collectors, trolley loaders, dumpers etc., remained on record by the time of entrance and exit. Snapshots of workers are also identified if they are involved in any causality or misshape during the workplace.

- The KII focused on the ground realities of SWM collection issues in Karachi that the SWM teams faces during the work.
- To him increasing children awareness regarding how and where to dump waste is of crucial importance in shaping the behavior of the society in general.
- The garbage bins at the collection points are inadequate at various places; garbage has been dumped in open-air alongside the streets.
- According to him the waste generation per day per person is around 0.6.
- He highlighted the lack of resources as the major institutional issue.
- He also mentioned that there are only two-land fill sites namely Jam Chakro and Goand-pass where the garbage is dumped.
- They also launched the awareness campaigns regarding proper waste handling.
- Further he highlighted that the Afghan mafia in Karachi has strong support. The mafia is circulating day night and segregating the waste. Some of them sold the segregated waste to street venders and the rest sold the wasteto the primary collectors.
- Politically influenced contracting is making SWM problematic.
- Around 1800 to 1900 tons of daily waste is generated and we collect almost all of it.
- Uncooperative behavior of restaurants / shops managers or owners is also contributing in making collection difficult as they usually remove the waste bins placed in front of their businesses.
- In general, Afghanis usually sort and segregate on spot thus the waste collected afterwards is usually of no or very low resale potential.
- According to him, they struggled relatively much more in controlling the informally working Afghan mafia in East district.
- He further mentioned that industrial waste do not appear on roads because of its relatively higher economic value and thus it is not creating much on ground problems.
- He also mentioned complains regarding Afghan ragpickers involvement in stealing vehicle batteries and other such activities.

Suggestions

Provide awareness regarding proper waste disposal from grass root level especially educating children. Spread awareness using various platforms such as mosques, social media, advertisements etc.
Mechanization is to be adopted rather than manual sweeping.
Malls should dispose their own garbage or at least limit the waste to specific points from where it can be collected easily.

- KMC is now responsible for dealing the medical waste and cleaning of Nalas in Karachi after handing over the remaining responsibilities to SSWMB. The activities in which KMC is involved are as follows
    - ✓ Transportation is provided to industry and hospitals through a private contractor (only local contractors)
    - ✓ Private contractors charge the fees from the industry and hospitals
    - ✓ The fee is divided into two parts 75% to KMC, while 25% to contractors
    - ✓ The contractor monitors Installation plants as well
    - ✓ Eid -ul-Azha waste management
- Talking about the generation issues KMC officials pointed out that
    - ✓ Population is not defined properly as migrants are not included, especially those who work daily from Karachi to Hyderabad and Hub
    - ✓ Without proper population count, the generation is around 12000 tons per day but If the population is properly documented, the generation will go on around 25000 tons per day
- The other issues that he raised regarding proper waste management include:
    - ✓ Lack of proper system to manage garbage
    - ✓ Landfill site are not enough and properly managed.

- ✓ Front end collection, if not provided by SWMB/KMC –leakages will be there, and hence there will be informalities in the system
- ✓ 40% of the waste is dumped in Nalas
- ✓ 10% remained laid down on streets
- ✓ Composition of waste not known
- ✓ Informal dumping site emerged all over the city
- ✓ Formal transfer stations are limited from where they are shifting to the landfill site

Fifth Meeting
Public Sector Official Interview
Karachi Cantonment Board **(PAF Base Faisal)**

- The area of responsibility and rubbish outsourcing seen.
- For the collection of garbage, registered known private contractors are available.
- The proper accountability is handled by Faisal base, while tender criteria entirely depend upon the competition.
- The collection of garbage charged by each household is around Rs 425, and the timing of collection in morning and evening varies as per the convienience of the household.
- Approximately 120 to 130 tons of garbage is generated daily,.
- It is the right time to avoid outsourcing because subcontracting have their leakages, and we have to pay an extra amount in form of taxes.
- There is a significant difference between KMC and the Cantonment board concerning accountability and responsibility at all levels of work. Therefore, the sound monitoring system of the cantonment board makes it different from the others shown by their outcome.

Annex-A4.1

Historical understanding of SWM in Karachi

Acts/Ordinance/System	Major Highlights
KMC Rules 1947 abandon on 1960	
Basic Democracies Act 1959 dismantled in 1971	
Granted Metropolitan Corporation status in 1976 -disbanded by the Government of Sindh on 1986	Combines Landhi Korangi Municipal Committee, Drigh Malir, Baldia Township, and North Karachi in KMC
Two-tier federated system was implemented 1986	Administrator was appointed
Sindh Local Government (Fourth Amendment) Ordinance, 1987 - abolished in 1992	Established the four Zonal Municipal Committees (district-wise), namely South, East, West and Central
Two-tier federated system was implemented in 1992 abolished in 1994	Administrator was appointed, Zonal Municipal Committees amalgamated into KMC, District Municipal office Malir was established
The unified KMC continue till mid-1996, the two-tiered federated system was restored - till 2001	Been given the authority to levy taxes and collect Fees
The Sindh Local Government Ordinance 2001 added a third tier continue till 2011	District/City District Governments, Talukas / Town Municipal Administrations, & Union Councils. Karachi Metropolitan Corporation was replaced by the City District Government Karachi under the devolution
Sindh Local Government Ordinance 1979 revived in 2011	
Enactment of the Sindh Local Government Act 2013	The KMC re-emerged in place of the City District Government Karachi in 2013
Sindh Solid Waste Management Board was established in 2014 under the Sindh Solid Waste Management Act	the Board is expected to gradually take over the solid waste management function from the Councils and other bodies