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Analysing Household Willingness and Ability to Pay for Solid Waste: A Case Study of Karachi

SHAISTA ALAM (LATE) and AMBREEN FATIMA

Karachi being the industrial and commercial hub, comprising a population belonging to multiple cultures, is facing many types of socio-economic issues with solid waste at top of the list. District Municipalities lack the financial resources and capacity to provide the needed infrastructure to ensure the timely collection and disposal of solid waste. The public's involvement and financial support therefore can assist the provincial and local governments in resolving solid waste management concerns. The aim of this study is to investigate the socioeconomic status of households to assess their willingness to pay for solid waste management. A comprehensive household survey from Karachi has been carried out to achieve the aforementioned objective. The results revealed that households' willingness to pay ranged from Rs. 50 to Rs. 5,300 per month. The average number of households paying for a particular service (our selection variable) was around 70 percent, and the average per-capita income of the surveyed households was around Rs. 19,000. Interestingly, the results predict that households' Ability to pay was substantially greater than their Willingness to Pay, implying the need for motivating measures to persuade families to pay more to manage solid waste.

GEL Classification: D12, D31, H1
Keywords: Willingness to Pay, Ability to Pay, Solid Waste Management, Heckman two-step

1. INTRODUCTION

Pakistan is experiencing rapid urbanisation and environmental degradation, especially in its major cities such as Karachi mainly because of the improper handling of solid waste. Though the local and municipal governments are responsible for collecting waste, 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 a population composed of 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 the mega city. The literature on solid waste management predicts a sharp increase in waste generation. For example, ESCAP/IUCN/UN HABITANT (2013) estimated that the

Shaista Alam (Late) was Associate Professor/Senior Research Economist, Applied Economic Research Centre, University of Karachi. Ambreen Fatima <amber_aerc@yahoo.com> is Senior Research Economist/Associate Professor, Applied Economic Research Centre, University of Karachi.

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average household solid waste generation in Karachi is around 0.44 kg/cap/day, ranging from 0.19 to 0.84 kg/cap/day. Fruit and vegetable market generates 1.795 kg/shop/day and 11.77 kg/shop/day, respectively. On a daily basis nearly 12,000 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. (2020) estimated that Karachi generates around 0.57kg/cap/day. Studies also estimate 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 districts' municipal councils (DMCs). The municipal authorities face many constraints in managing solid waste in cities, and the provision of better services has become a nightmare. The megacity Karachi is now managing solid waste through private contractors' cooperation, both international (China and Spain) and local. Despite expanding collaboration between public and private sectors towards managing solid waste the city still manages to collect only 60 percent of the generation of which only 50 percent reached the designated site. Therefore, the unattended waste ranged from 435 tons per day to 960 tons per day. According to the EPMC estimates (1996), the waste collection was around 51 percent to 69 percent.

Inadequate waste disposal procedures generate a slew of issues. By the end of the day, open rubbish dumps induce waterborne diseases because leachate contaminates groundwater and causes breathing difficulties. To solve this pressing issue, the government and other stakeholders must make every effort to investigate the possibility of cost-sharing among households and examine the demand side to better manage solid waste. This research is also designed to provide demand-side knowledge that will be useful during the planning phase. The specific objective of this research is to measure and identify factors that influence households' willingness to pay for solid waste management. In addition, the study also assesses the collection charges households are already paying to avail some sort of services. A contingent valuation method/approach (CVM) was applied to determine households' willingness to pay. According to Carson, et al. (1996, 1998), the CVM is the standard methodology that includes both the use and non-use value of a product. As the households' decision to demand any service is based on both use and non-use values, in this study it was assumed that the amount households were willing to pay (WTP) for the more improved system was based on its use and non-use values. Furthermore, following Fujita, et al. *(*2005), matching WTP with the ability to pay (ATP) was also considered important. The ATP was derived from the income and expenditure patterns of the households. The compression of the two (WTP and ATP) adds another dimension to our research. For example, the WTP less than the ATP means that a household is reluctant to spend money on SWM. It means that a policy framework is needed to motivate households to invest in the service. But if the ATP is low, it reflects the inability of a household to pay for the service regardless of WTP. This further means that public investment is needed. In sum, if the ATP is less than the WTP it means that public/government support is needed. On the contrary, if the WTP is less than the ATP, it implies that motivational support is needed.

The rest of the paper is structured as follows. The next part goes through the literature review. Section three discusses the methodology for the study, followed by Sections four and five, which explain the empirical findings and conclusion.

2. REVIEW OF LITERATURE

Solid waste management has, become one of the most debated issues, especially in developing urban areas because of rising consumption (Abas des & Wee, 2014; Marshall & 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. Municipal solid waste is generated from various activities of daily life and usually increases with the growth of population and income (Tseng, 2011). Mahar (2010) 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 was 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 were 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 to the growing waste through their participation in unlawful disposal. With the increasing solid waste per day in the city, there is a need to implement an adequate system of dumping or recycling solid waste on daily basis.

Anjum (2013) examined the processes of waste generation, collection, and disposal along with estimating the willingness to pay for SW using a survey of Islamabad. According to the findings, 65.4 percent of households are probably willing to pay for solid waste management. Moreover, a monthly mean willingness to pay of the households is reported as Rs. 289.15. The findings are consistent with the notion that willingness to pay is influenced by age, income, education, and environmental concern. Sumukwo et al. (2012) used the contingent valuation method (CVM) and multiple regression techniques to determine willingness to pay in Kenya. Age, educational attainment, household income, and the amount of readily available discretionary funds are among the variables that affect willingness to pay. The findings indicated that most people are willing to pay Kshs 363 a month for solid waste management.

3. DATA & EMPIRICAL METHODOLOGY

3.1. Data Source

A thorough household survey was done to gather information for the estimation of households' willingness to pay for managing solid waste in Karachi, and it included questions regarding socio-economic characteristics of the household as well as, major concerns related to solid waste management, awareness, and satisfaction regarding the current process and amount that households are willing to pay for the improved system. Table 1 provides details of the sample of households selected from each town. To reach an appropriate household sample, different combinations of confidence interval and

specification error were considered so it remains statistically valid and representative. Given the above, it was considered appropriate to determine the sample size with 95 percent confidence and less than 10 percent specification error. The following formula was 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 = the specification of the confidence coefficient
p = estimated proportions
e = Specification error

Table 1

Household Sample

Town Name	Total	Proportion	Sample (Proposed)	Sample (Materialised)
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
Kemari	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

3.2. 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 a service is an assessment of the preferences held by people.

If a service is not available in an area, the willingness to pay for the services cannot be properly inferred from the expenditures that are supposed to occur. This issue further pushed us to use the "stated preference" approach, i.e., the contingent valuation approach

(CVM) as many surveyed households currently were not paying for solid waste management in their area. Under the CVM, the households were directly asked exactly what they would be willing to pay to avail the SWM service.

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

$$Wtp = \beta' X + \varepsilon \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

Where X is the vector of independent variables hypothesised to be influencing the willingness to pay for the service. The independent variables used in the estimation of the above-stated model are presented in Table 2 below with the expected signs. The demand for the solid waste management system is hypothesised to be a function of the households' socio-economic conditions (per-capita income, occupancy status, and congestion), demographic factors (gender of the household head, dependency ratio, age, and the education of the primary contributors), satisfaction with the current service, awareness, and the knowledge of solid waste management, use and non-use values (bequest—leaving a better environment for the future generation), and the environmental impact of waste. The choice of variables and the effect hypothesised were based on the descriptive analysis presented in Section 4.

Table 2

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 Current System	+ve
Index- Awareness/Knowledge Regarding SW	+ve

We computed the age and education of the individuals contributing to the household income, i.e., the primary contributor's age and education. Primary contributors are those

who are assumed to have more say in the family's decisions since they are the earning members of the family. After identifying the primary contributors, the mean age and average education of the primary contributors to the household were estimated. We assumed that the higher the age and education of the primary contributors in a house the higher the amount the households are willing to pay.

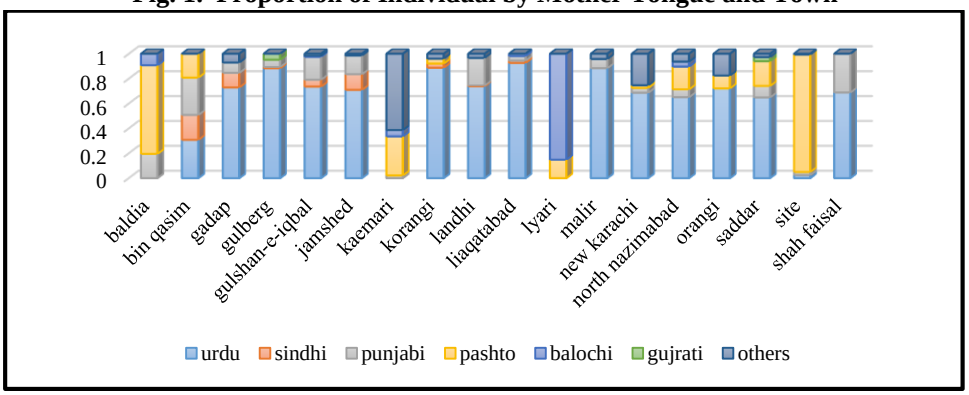
However, the key issue in estimating the above WTP model for the solid waste management services was that we did not observe the whole surveyed household. Since many of the surveyed households were currently not paying for solid waste management, their stated preference could lead to a problem of sample selection bias. However, in our study, we applied Heckman's two-step selection procedure to correct the sample selection bias. Heckman (1979) approached 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's two-step procedure was used to control the selection bias of the sample. The selection equation was estimated using the maximum likelihood approach as an independent probit model. The variables' inverse Mills ratios were generated from the parameter estimates. The willingness to pay (amount) can be s observed only when the selection model equals 1, which is then regressed on the explanatory variables and inverse Mills ratios using ordinary least squares (OLS). The lambda is introduced in the second stage as an additional variable. If the coefficient of lambda is significant, we reject the null hypothesis of no selection bias.

4. EMPIRICAL RESULT

4.1. Household Socio-economic and Demographic Profile

Being the nation's economic hub, Karachi attracts a diverse population from all around the country for a variety of reasons. The city hence comprises multi-linguistic households. The following figure shows that the commonly spoken languages are Urdu (58 percent), Pashto (15 percent), and Punjabi (8 percent). The variation based on languages was examined to show the multicultural environment of Karachi. The variation can also be analysed in terms of ownership. Since the migrants in Karachi are not natives of the city, their interest in the development of the city can be considered limited.

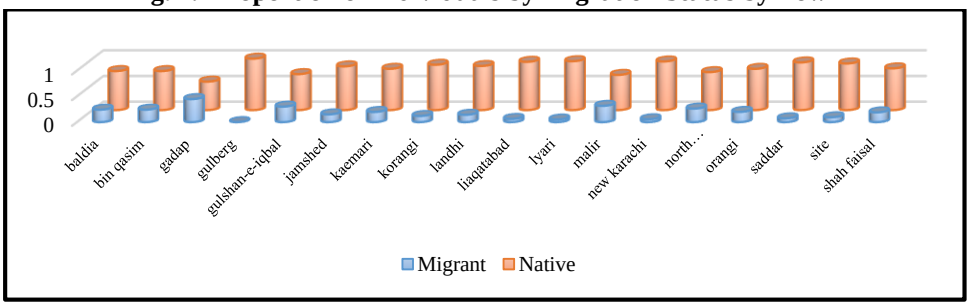
Fig. 1. Proportion of Individual by Mother Tongue and Town



Source: Author's estimations.

Figure 2 depicts the migration status of the surveyed population. Overall out of surveyed population 16 percent were migrants and 84 percent were natives. Gadap town has highest migrant share among all towns followed by Malir, Gulshan-e-Iqbal, North Nazimabad, and so on.

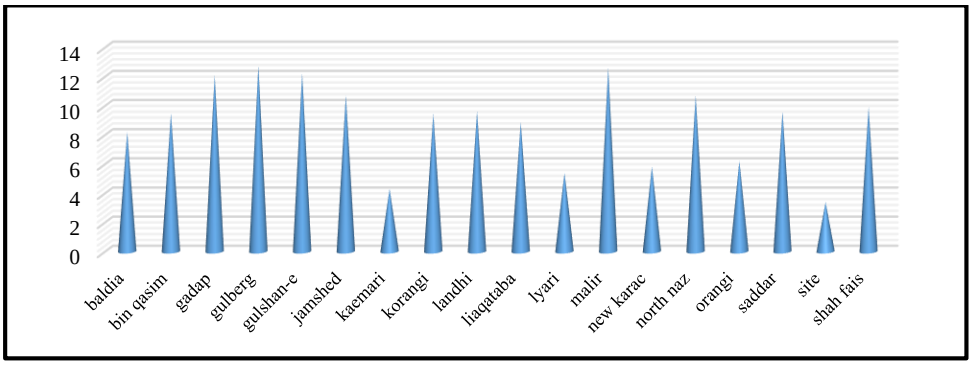
Fig. 2. Proportion of Individuals by Migration Status by Town



Source: Author Estimation.

The next figure shows the average years of education (highest education level at the time of interview). According to survey estimates, the average years of education is around 12 years, in the towns of Gulberg, Gadap, Malir, and Gulshan-e-Iqbal. In contrast to SITE and Kemari Town, where the average years of education are only about four years.

Fig. 3. Average Years of Education

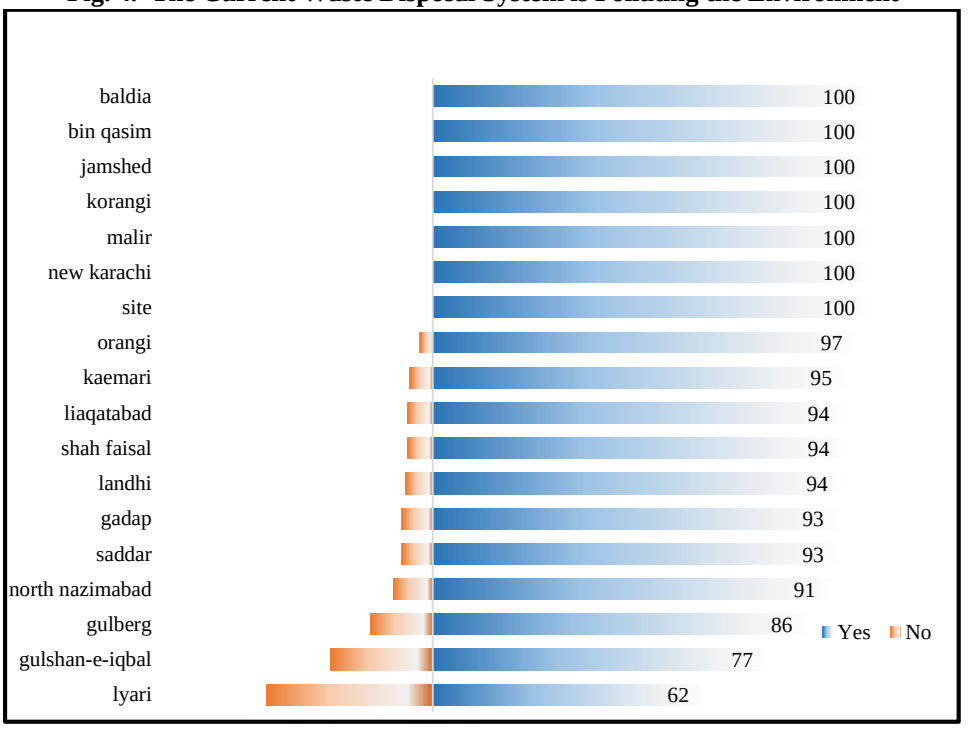


Source: Author Estimation.

4.2. Perception and Behaviour Regarding Solid Waste Management

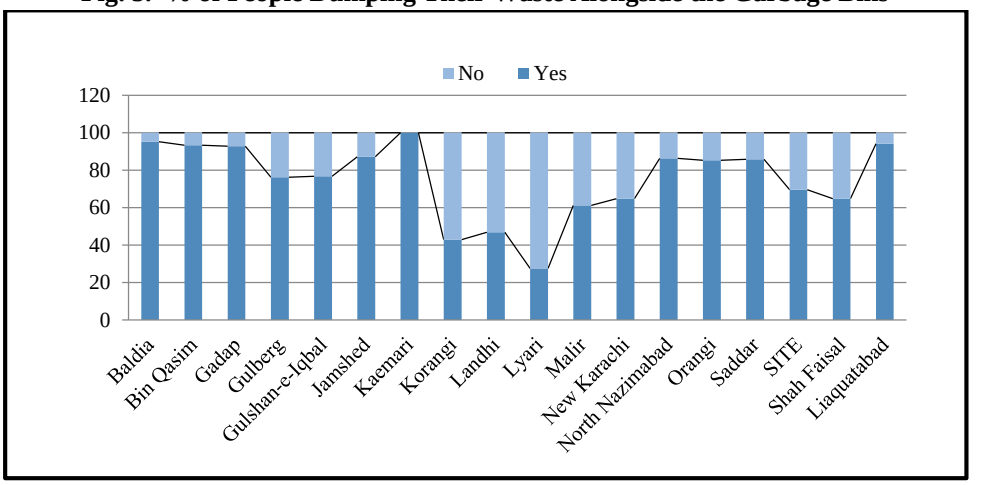
Public officials claimed that the main hurdle in handling solid waste was individual behaviour, we explored the perception, behaviour, and awareness of the surveyed households regarding solid waste management. The figures below show the results. The majority of the surveyed households said that they were aware of the environmental consequences of waste. We also enquired whether they dumped the waste alongside the bin (not in the bin). The majority responded with yes. We further asked the households if they were aware of the environmental consequences of the waste, and why they did not use a bin.

Fig. 4. The Current Waste Disposal System is Polluting the Environment



Source: Authors' estimations.

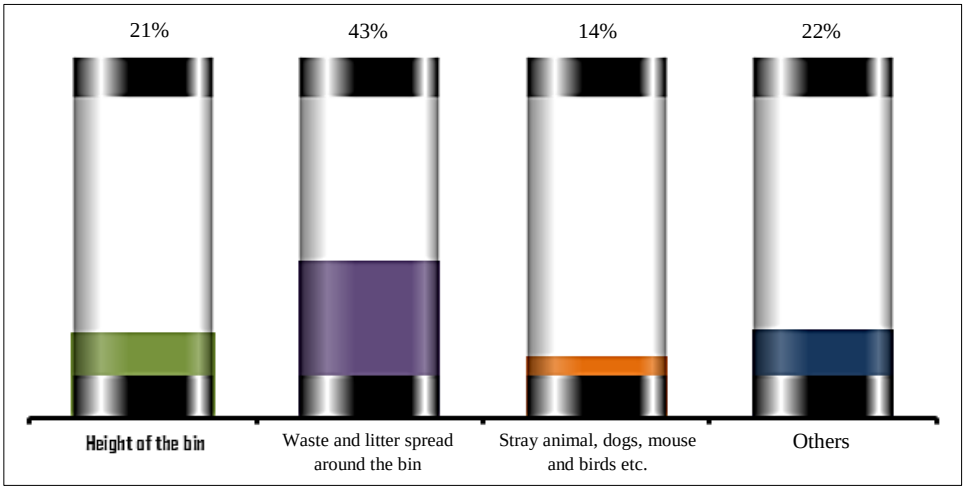
Fig. 5. % of People Dumping Their Waste Alongside the Garbage Bins



Source: Authors' estimations.

Around 43 percent of households replied that they threw the waste alongside the bin, (not in the bin) because the place where the bin was placed was too smelly. Around 21 percent said the bin was too high, and 14 percent said that they did not go near the bin because of the animals around the bins.

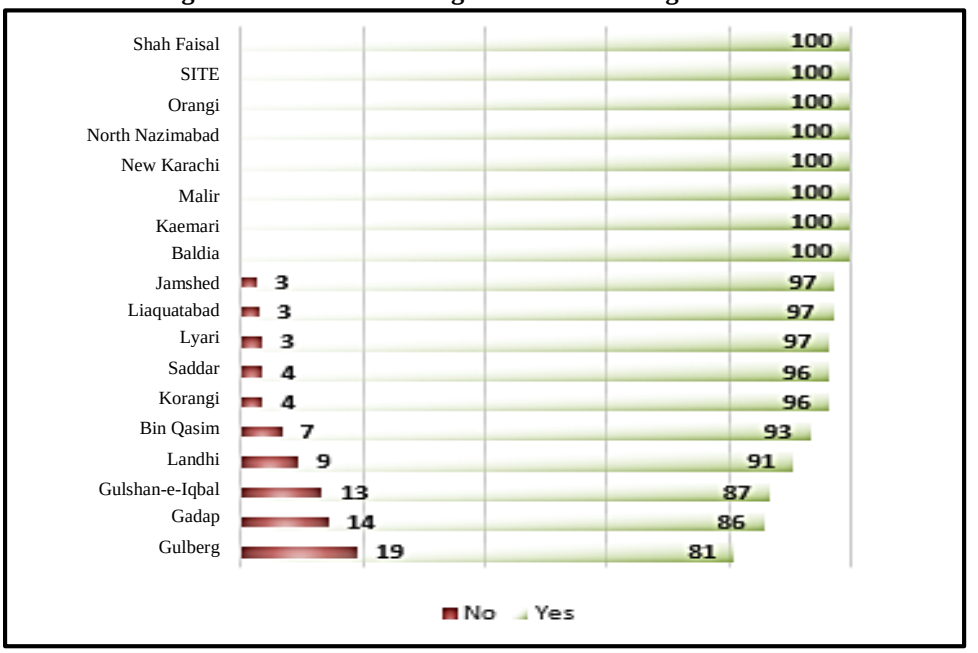
Fig. 6. Particular Reason for Dumping Outside Bin



Source: Authors' estimations.

Furthermore, the surveyed households also showed their concern for environmental degradation caused by waste.

Fig. 7. Environmental Degradation has a Negative Effect



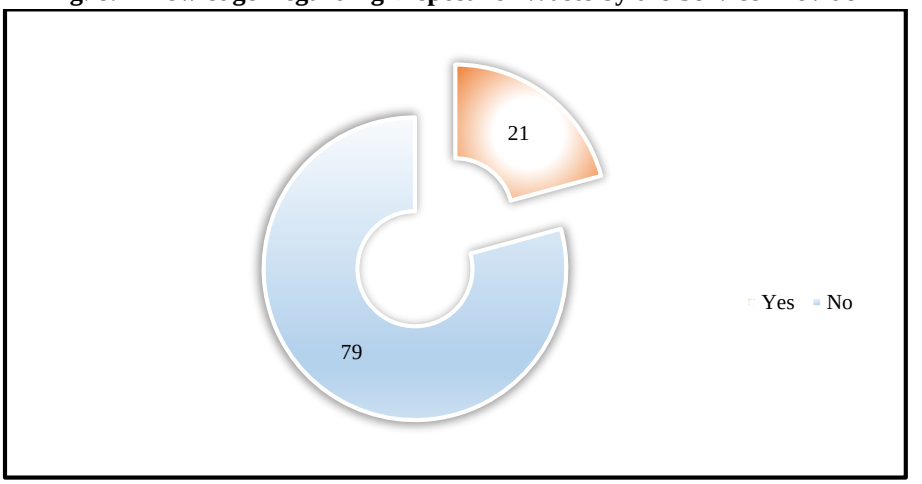
Source: Authors' estimations.

4.3. Knowledge and Awareness regarding the Current System

The two figures below show how many households took interest in the management of solid waste. This gives an idea of how serious a household is in managing the solid waste

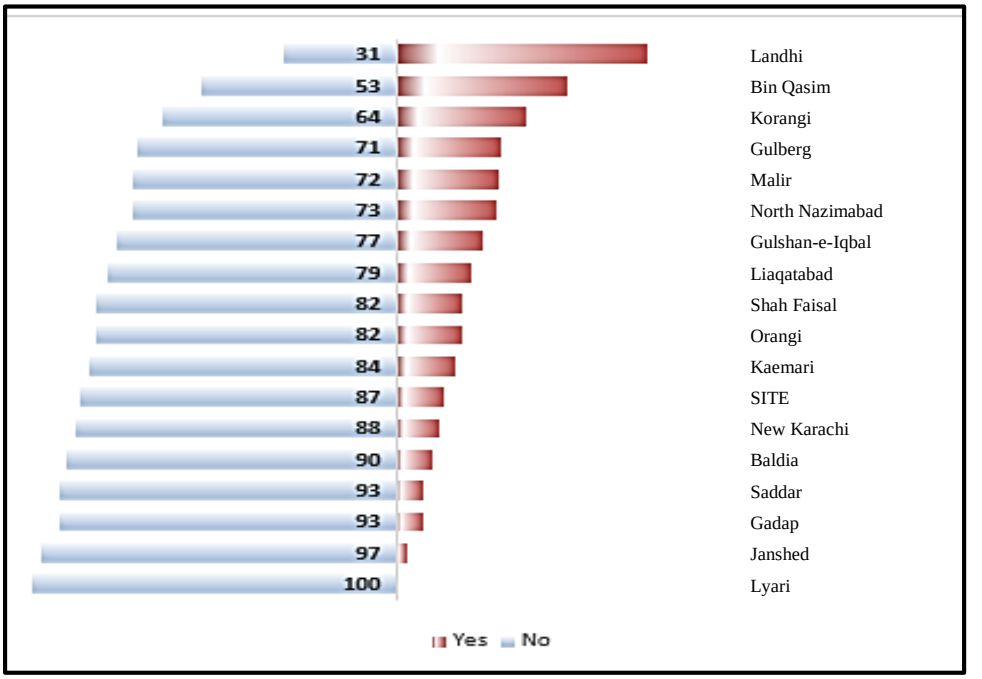
problem. Though Figure 8 highlights that around 79 percent of households were aware of their service providers, it is evident from the next figure that the majority of the households were unaware of how waste was disposed of by their service providers. This further highlights that their interest or concerns were limited.

Fig. 8. Knowledge Regarding Disposal of Waste by the Service Provider



Source: Authors' estimations.

Fig. 9. Do You Know How Your Service Provider Disposes of Your Collected Waste?



Source: Authors' estimations.

4.4. Household Willingness to Pay for Solid Waste

The table below provides the descriptive statistics of the variables of interest. According to the table, the households' willingness to pay varied from Rs. 50 to Rs. 5,300 per month. The average numbers of households currently paying for availing some sort of service (our selection variable) were around 70 percent (323 out of 459), and the average per-capita income of the surveyed household was around Rs. 19,000. Table 2 also reports the indices developed. It shows an average score of 0.66 for the environmental knowledge index (ranges between 0 to 1, where 1 means perfect knowledge), a score of around 1.9 for the satisfaction index (ranges between 0 to 3, where 3 means complete satisfaction), and a score of 0.67 for current solid waste management process.

Table 3

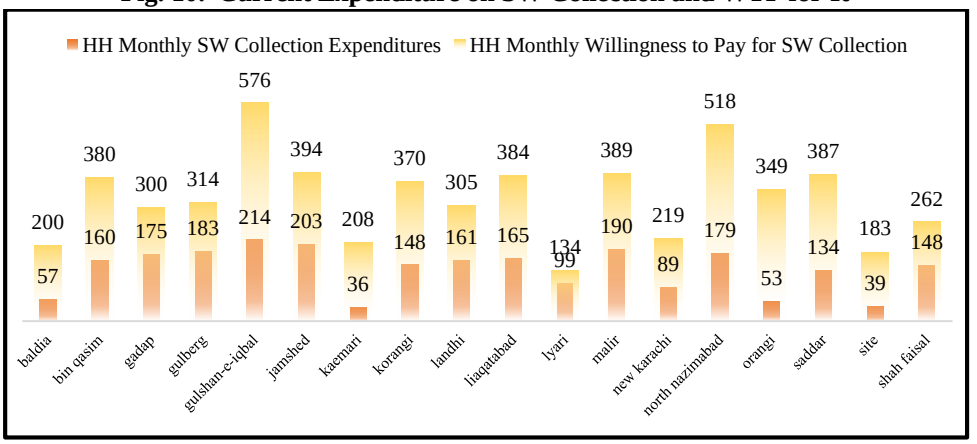
Descriptive Assessment of Factors Influencing WTP

	# Obs.	Mean	S.D	Minimum	Maximum
Household Willingness to Pay	459	467	452	50	5300
Participating in MSW Equals 1 Otherwise 0	459	0.7	0.46	0	1
Household Per Capita Income	459	19085	21867	1429	340000
Male Headed Household	459	0.9	0.3	0	1
Dependency Rate	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	39.4	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 Worth- Managing SW for Better Future	459	0.98	0.14	0	1
Index- Satisfaction Score with Current System	459	1.93	0.8	0	3.3
Index- Awareness/Knowledge Regarding SW	459	0.67	0.16	0	1

Source: Authors' estimations.

The following figure shows the current expenditure household made on SWM and what households were willing to pay for further improving the system. The numbers are disaggregated by town.

Fig. 10. Current Expenditure on SW Collection and WTP for It



Source: Authors' estimations.

In general, households would be willing to pay more than they do in order to receive the service. Residents in Gulshan-e-Iqbal and north Nazimabad towns are the most eager to spend money overall on services whereas those in Liyari are least willing in this regard.

4.4.1. *WTP Regression Results*

Table 4 reports the factors influencing the maximum amount households were willing to pay for making improvements in the current solid waste management condition and their decision to pay for the services (under the current state), which equals 1 if yes and 0 otherwise.

Table 4

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 Observations	459		
Censored Observations	136		
Uncensored Observations	323		
Wald $chi^2(8)$	26.14		
Prob > chi2	0.001		

Source: Authors' estimation.
Significance level: 1 percent (***), 5 percent (**), 10 percent (*).

The table shows that among the explanatory variables, household per-capita income, households headed by a male, the average age of the primary contributor, and knowledge regarding SW impacting environment had a significant impact on the households' willingness to pay for the SWM. Except for the average age, the rest showed a positive and significant effect. The table shows that a 1 rupee increase in per-capita income increased the WTP by Rs. 0.002. Similarly, if the household was male-headed, the WTP increased by Rs. 223, and the household's knowledge regarding the environmental impact of solid waste increased the WTP by Rs. 257. However, the average age of the primary contributor, hypothesised to have a positive impact, was found to influence the WTP negatively. The reason could be that as the age of the primary contributor increases, the tendency to save more increases to secure the future after retirement. Overall, an increase in the age of the primary contributor by a year decreased the WTP by Rs. 5.6.

The first stage probit estimates show that an increase in the age and education of the primary contributor increased the probability that the household would pay for the SWM. In terms of the coefficient (the probit coefficients give the change in the z-score for a one-unit change in the predictor), a one-unit increase in the age and the years of education of the primary contributor, increased z-scores by 0.02 and 0.09, respectively. Similarly, a one-unit increase in the satisfaction index increased the z-score by 0.40. In addition, the congestion (rooms per person) also showed a significant impact [with a one-unit increase in the congestion, the z-score increased by 0.44]. Furthermore, the lambda, which measured the presence of selectivity bias, is also significant implying that selectivity bias was present in the model. Therefore, Heckman's two-step approach is justified.

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

The WTP refers to the maximum amount that the households are willing to pay for improvement in solid waste management conditions, while the ATP is the amount households actually can pay. Capturing a household's ATP means checking household affordability. The information is, therefore, useful for policy design. Policies formed without considering who will pay and how much ability they have to pay result in policy failure.

The ATP is usually calculated using the household disposable income or the household expenditure composition. Researchers have followed various techniques to compute the ATP and the suggested ATP for SWM is 1 to 2 percent of the household's income for low and middle-income countries. In this study, we computed the ATP as 1 percent of household income (see Wilson, et al. 2012). Specifically, the ATP was computed as 1 per cent of the household's income. Table 5 compares the household's willingness to pay with the household's ability to pay. The results predict that in all the cases the ATP was much higher than the WTP, suggesting the need for motivational arrangements needed to convince households to pay more to manage solid waste.

Table 5

Comparing ATP and WTP

Town	ATP (Rs.)	WTP (Rs.)	Difference
Baldia	705	257	ATP>WTP
Bin Qasim	731	540	ATP>WTP
Gadap	1,374	475	ATP>WTP
Gulberg	1,097	498	ATP>WTP
Gulshan-E- Iqbal	1,738	790	ATP>WTP
Jamshed Town	1,164	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	1,367	579	ATP>WTP
New Karachi	623	308	ATP>WTP
North Nazimabad	1,709	705	ATP>WTP
Orangi	748	403	ATP>WTP
Saddar	1,581	521	ATP>WTP
SITE	679	222	ATP>WTP
Shah Faisal	718	409	ATP>WTP
Total	987	467	ATP>WTP

Source: Authors' estimations.

5. CONCLUSION AND POLICY RECOMMENDATIONS

The households living in Karachi confront significant environmental challenges. A serious environmental issue in the city has always been the lack of proper solid waste management. The absence of adequate financing for managing solid waste is one of the major causes of this problem. The primary purpose of this study is to look at the feasibility of service charges for collecting revenue as households are concerned with the improved solid waste system and are ready to make efforts for it because every strategy in this regard would be futile if it merely focused on revenue collection and the assumption that all users should pay without taking into account the households' capacity and readiness to pay directly for this service. Hence this study not only evaluated household willingness to pay as reported by the household themselves but also quantifies it using an empirical model based on various explanatory variables. As per the survey responses, the households are generally open to pay more for the service than they already do. The willingness of residents to pay for services is highest in Gulshan-e-Iqbal and north Nazimabad towns, while it is lowest in Liyari. The regression findings indicated that the households' willingness to pay for the SWM was significantly influenced by household per capita income, households headed by a man, the average age of the principal contributor, and awareness environmental effects of SW; therefore, any policy intended to increase willingness to pay will be ineffective until these socioeconomic characteristics are improved. To get the intended enhanced effects, policymakers should target these aspects.

As far as the ability to pay is concerned the results indicated that for all towns in Karachi, the household ability to pay for SWM is higher than the willingness to pay for it. This is, in fact, promising from a policy point of view as this could be used to generate funds for financing the public efforts for managing the SW in an accelerated manner. However, for those who are reluctant to adopt and willing to contribute to sustainable waste management strategies motivational aspects are required to induce them to do so by making them aware of its long-lasting concerns for health and the environment for the current and future generations.

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