Evaluating Solid Waste Management System in Pakistan: A Regional Analysis

By

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Solid Waste…..?

- Solid waste can be defined as material that no longer has any value to the person who is responsible for it, and is not intended to be discharged through a pipe

- Solid waste is inextricably linked to urbanization and economic development. As countries urbanize, their economic wealth increases. As standards of living and disposable incomes increase, consumption of goods and services increases, which results in a corresponding increase in the amount of waste generated.

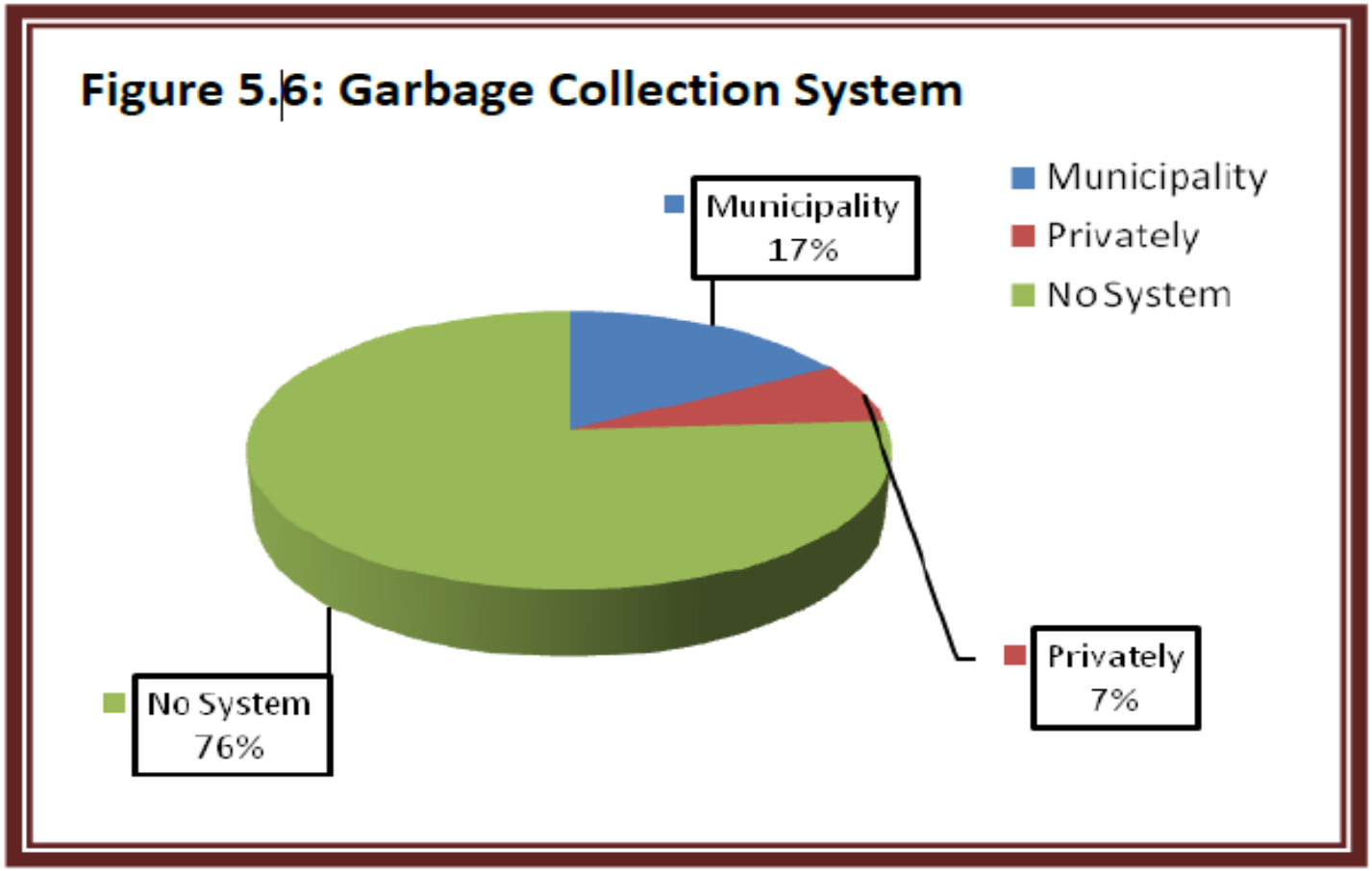
Introduction

- According to World Bank, around 1.2 kg/capita/day of solid waste(SW) are generated world wide. The actual per capita rates, however, are highly variable, for instance, in Middle East Per capita waste generated is 0.16 to 5.7 kg, whereas in Central Asia, the waste generated ranges from 0.29 to 2.1kg/capita/day

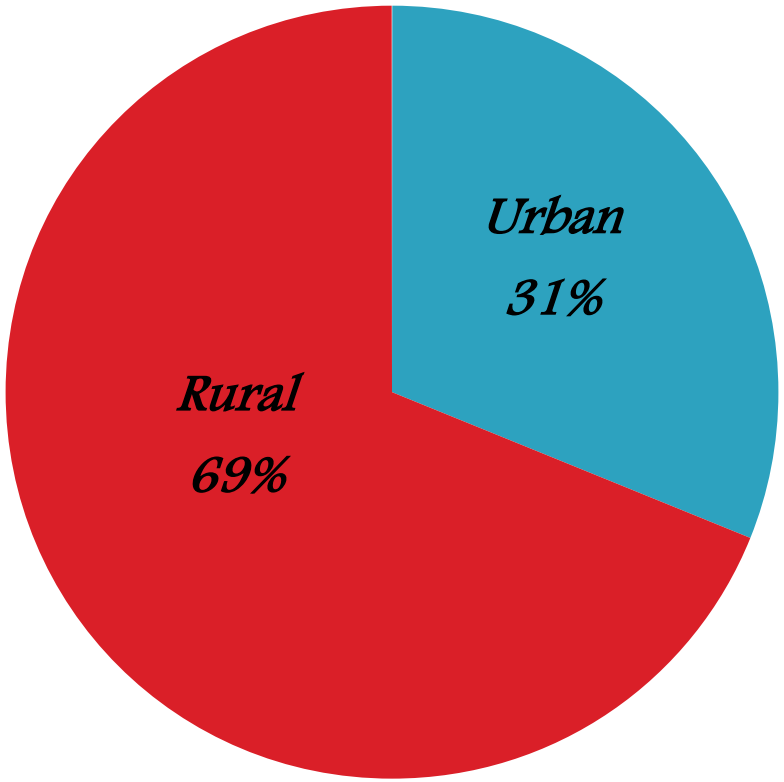
Solid Waste Generated in Pakistan

- The estimated quantity of solid waste generation in Pakistan ranges between 0.283 to 0.612 kg /capita / day
- Its growth is 2.4%t per year
- Increase in the solid waste is due to increase in urban population, industrialization, changing consumption pattern and also effluent life style
- Currently, 50% of solid waste quantities generated are collected by government

Overall Solid Waste Collection in Pakistan



Regional Comparison of no SW Collection system



Objectives

- The objective of this paper is to evaluate the present solid waste management system of Pakistan both descriptively and empirically.

  Specifically we have evaluated the WTP for Collection and Disposal of waste from

  1) Household
  2) Neighborhood

- To evaluate study has estimated the Household willingness to pay for SWM using Heckman's two-step procedure.

Review of Literature

- Joel et at, (2012) estimated WTP by using contingent valuation method (CVM) and multiple regression technique in case of Kenya. The determinants of WTP includes income, age, education and disposable method available to the household's. Results highlighted that residents are willing to pay on average Kshs 363 per month for solid waste management.

Cont…

- Giatu et al, (2012), highlighted the generation, collection and disposable of solid waste in Public institutes in Kenya. The solid waste is mainly composed of vegetables and food in Kenya, generating almost 23tons of waste per week. The cost of planning and managing the waste ranged from Ksh 0.13 to 0.59 /week/student while per capita waste generation ranged from0.28kg/week/student to 0.71kg/week/student. However, in Kenya, collection system is inefficient and disposal systems are not environmentally friendly. 30 to 40 percent of all solid waste generated in urban areas remained uncollected and less than 50 percent of the population is served [Otieno, 2010)]. He argued that if the issue of sustainable solid waste management in Kenya is not considered urgently, all the towns in Kenya will be gulfed in waste.

Cont…

- Sharholy and trivedi, (2008) highlighted that in case of India, the improper management of SW is creating problems to public health and the environment, 90 percent of solid waste in India is dispose unscientifically in open places.

Cont..

- Bel and Fageda (2009) highlighted those factors that determine solid waste service cost by using sample data in Galician municipalities. Their findings showed that Public delivery is cheaper than private delivery in case of SWM. Moreover the higher the size of economies the lower will be the cost of Service management.
- Hagoes et al (___), using limited dependent variable model, analyzed the factors that improves WTP for SWM in Ethopia. They concluded that low income and less awareness of environmental hazards are the main factors that influence WTP for solid waste management although, existing fee in Ethopia for SWM is below the WTP of the residents.

Methodology:

– Introduction to Heckman Approach

- In open ended questions, there could be a problem of sample selection biasness due to the reason that higher population respond zero for WTP for SWM.
- therefore earlier researchers have intensively used logit/probit or tobit model in order to mitigate zero responses.
- However, in our study we have applied Heckman's two-step selection procedure to correct the sample selection bias

- Heckman two-step procedure is used to control the selection bias of the sample. The selection equation is estimated by 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.

Heckman Model

Starting with the WTP equation:

$$W_i = \beta X_i + \varepsilon_i$$

Here W is the amount in Rs. That households are paying for the SWM.

W (amount actually paid) is observed only for those household who are willing to pay

Household willingness to pay is derived as :

$$E_i = \gamma Z_i + u_i$$

E_i is the willingness to pay, equal 1 if household is willing to pay zero otherwise.

Heckman Model

The expected value conditional upon the WTP can be written as:

$$E(W_i \mid E_i=1, X_i) = E(W_i \mid X_i\ Z_i\ u_i)$$
$$= \beta X_i + E(\varepsilon_i \mid X_i\ Z_i\ u_i)$$

Hence:

$$E(W_i \mid E_i=1, X_i) = \beta X_i + E(\varepsilon_i \mid E_i=1) = \beta X_i + E(\varepsilon_i \mid u_i > -Z_i\gamma)$$

this becomes a problem because the error terms are highly correlated.

Heckman Model

The Heckman model also uses the following assumptions:

$$(\varepsilon, u) \sim N(0, 0, \sigma^2_{\varepsilon}, \sigma^2_{u}, \rho_{\varepsilon u})$$

That is both error terms are normally distributed with mean 0, variances as indicated and the error terms are correlated.

where $\rho_{\varepsilon u}$ indicates the correlation coefficient.

(ε, u) is independent of X and Z

The error terms are independent of both sets of explanatory variables.

Heckman Model

Heckman approached the problem as an omitted variables problem.

An estimate of the omitted variable would solve this problem.

Specifically:

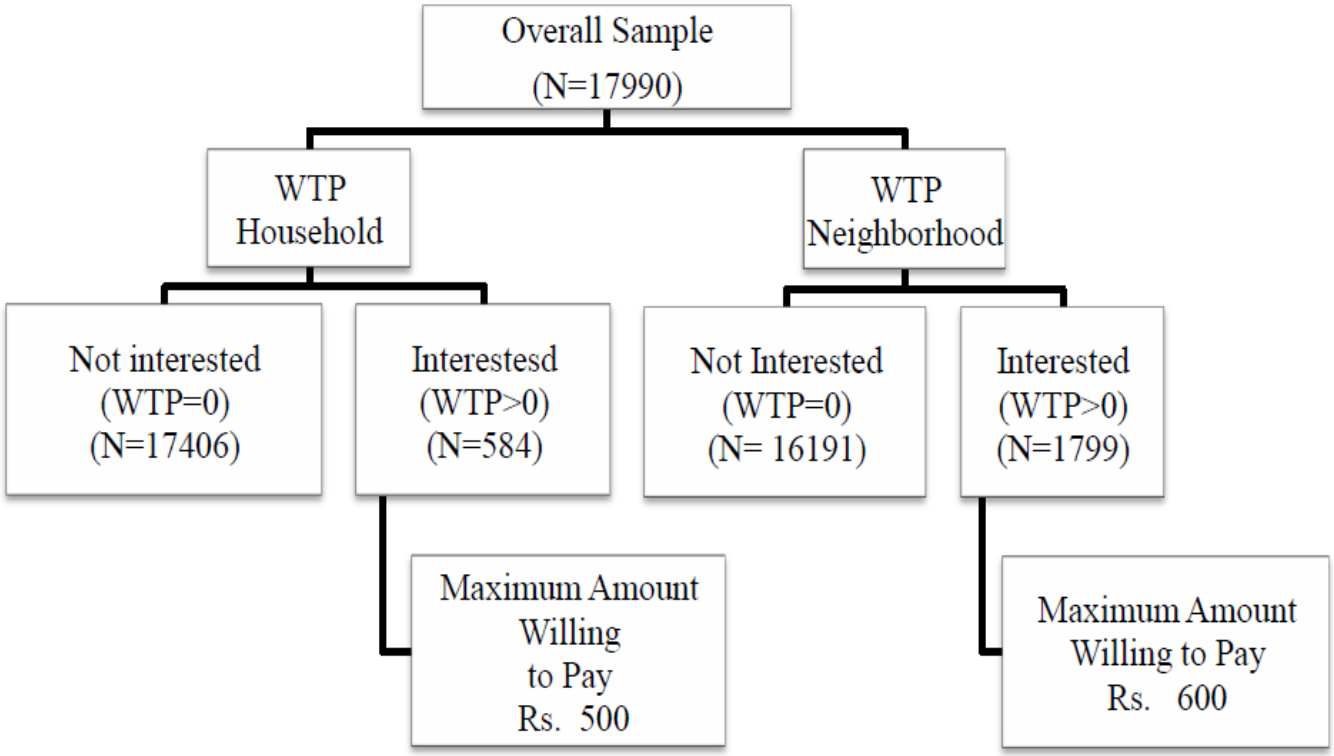
$$E[(\varepsilon_i | u_i > - Z_i\boldsymbol{\gamma})] = \rho_{\varepsilon u}\sigma_\varepsilon \lambda_i(-Z_i\boldsymbol{\gamma}) = \beta_\lambda \lambda_i(-Z_i\boldsymbol{\gamma})$$

where $\lambda_i(-Z_i\boldsymbol{\gamma})$ is 'just' the inverse Mill's ratio evaluated at the indicated value and β_λ is an unknown parameter.

Named after John P. Mills, it is the ratio of the probability density function over the cumulative distribution function of a distribution. Use of the inverse Mills ratio is often motivated by the property of the truncated normal distribution.

Assessment of SWM System in Pakistan

Chart 1: Break Down of Sample Size



Regional comparison of WTP for SWM- Collection from Household

Characteristics	Average Amount Willing to Pay (Rs.)	
	Urban Areas	Rural Areas
Ages of Primary contributors:		
Up to 14 Years	38	0
15 years to 64years	79	92
65 years and above	55	100
Education of Primary contributors:		
No Education	75	89
Matriculation	77	84
Graduate	108	200
Post Graduate	100	300
Total Income (Annual):		
0 – 150000	80	91
150000 – 230000	44	105
230000 – 370000	63	45
above 370000	93	115
Service provider:		
Municipality	68	131
Private	87	91
No formal	62	24

Regional comparison of WTP for SWM- Collection from Neighborhood

Characteristics	Amount Willing to Pay (Rs.)	
	Urban Areas	Rural Areas
Ages of Primary contributors:		
Up to 14 Years	0	105
15 years to 64 years	95	86
65 years and above	73	79
Education of the Primary contributors:		
No Education	82	87
Matriculation	85	89
Graduate	125	128
Post Graduate	158	300
Total Income (Annual):		
0 – 150000	91	84
150000 – 230000	72	62
230000 – 370000	84	74
above 370000	140	115
Service provider:		
Municipality	74	123
Private	95	92
No formal	92	28

Some Important Variables

- Primary contributors(PC) are those who assumed to have more say in the family's decisions, in our case, they are earners in the family.
  - Specifically we have used median age and years of education of the primary contributors in a house as explanatory variables.
- Proportion of male and female earners in the household is computed by aggregating the number of female contributors and male contributors and then dividing the aggregated numbers with the total number of earners in the house(higher female contributor higher WTP)
- Further Housing conditions is represented through occupancy of household, dwelling type of house and access to piped water.

Empirical Results (Household)

Willing to pay for solid waste management	Coefficients	P-Value
Region		
Urban	0.173	0.000***
Education of primary contributors (years)	0.009	0.000***
Occupancy status		
Tenants	0.061	0.000***
Subsidize\Rent free	0.023	0.174
Dwelling type		
Apartment	-0.023	0.013**
Age of primary contributors (years)	0.013	0.000***
Amount Willing to pay for waste management (Rs)		
Age of primary contributor	-0.017	0.026**
Service provider		
Private	0.919	0.000***
No formal system	-1.37	0.000***
Dwelling type		
Apartment	-0.04	0.195
Total income of primary contributor	1.04E-07	0.002***
Female Earning Ratio (primary contributor)	-0.027	0.046**
Occupancy status		
Tenants	0.182	0.000***
Subsidize\Rent free	-0.125	0.015**
Housing Condition - Source of water		
Outside the house	-0.101	0.000***
Education of primary contributors (years)	-0.009	0.037**
Constant	-1.650	0.000***
Mills		
Lambda	0.187	0.000***
wald chi2	28.540	
Prob>chi2	0.000***	
Number of observation	17990	

Empirical results (Neighborhood)

Willing to pay for solid waste management	Coefficients	P-Value
Region		
Urban	0.219	0.004***
Education of primary contributors (years)	0.008	0.000***
Occupancy status		
Tenants	0.072	0.005***
Subsidize\Rent free	0.018	0.010***
Dwelling type		
Apartment	0.032	0.005***
Age of primary contributor (years)	0.014	0.000***
Amount Willing to pay for waste management (Rs)		
Age of primary contributors	0.005	0.000***
Service provider		
Private	0.102	0.016**
No formal system	-2.424	0.022**
Dwelling type		
Apartment	0.179	0.021**
Total income	6.65E-08	0.000***
Female Earning Ratio (primary contributor)	-0.178	0.011**
Occupancy status		
Tenants	0.209	0.019**
Subsidize\Rent free	-0.239	0.038**
Housing Condition - Source of water		
Outside the house	-0.101	0.000***
Education of primary contributors (years)	-0.009	0.037**
Constant	-0.400	0.031**
Mills		
Lambda	0.236	0.003**
wald chi2(6)	34457.770	
Prob>chi2	0.000***	
Number of observation	17990	

Conclusions

- Due to the significant regional discrimination and modest disparities in income, people in urban areas are more aware and concerned about their waste disposal and environmental quality
- Household Owner prefers for household services and more willing to pay for that whereas resident of apartments prefers neighborhood services and more willing to pay for that services

- People with higher ages showed negative relationship with WTP for household and showed positive relationship if services are provided for the neighborhood.
- Primary contributors with urban settlements are more willing to pay for services of SWM for both household and neighborhood. Also, WTP is higher for privately held system for both household and neighborhood services.

Policy Implications

- Around 70% Rural areas and 32% Urban areas have no SWM' system, however 0nly in 17% areas government(Municipality) collects SW, there is a need to increase waste Collection through third tier of government.
- Government may collect the amount of SW through municipalities bills etc on monthly basis, but government should improved their performance

- In rural areas government should take initiative for creating awareness about waste management through NGOs and media
- Through proper disposable of SW government can control basic health problem as well
- SW, may used for recycling process for instance energy generation etc.