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The Current Practices, Concerns and Willingness to Pay for Domestic Solid Waste Management Services in Urban Areas of Mardan, Pakistan

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ABSTRACT

The paper examines the current practices, concerns household willingness to pay (WTP) for Solid Waste Management (SWM) Services in urban areas of District Mardan, Pakistan. A sample size of 384 was allocated to 15 urban union councils proportionally. Contingent Valuation (CV) survey method was used for eliciting willingness to pay for target beneficiaries. The findings of the study show that household generates 53% biodegradable, 38% non-biodegradable, and 11% non-putrescible solid waste and majority households use Polythene bags for indoor SWM. The households mostly disposed the solid waste near to their resident at vehicle collection points, communal containers, canals/perennial nullahs and in many places, incineration was also practicing. Most households (85%) remained un satisfied with SWM services and willing to pay for improvement. Bid wise logistic regression analysis shows that majority of households' (280) are odd in favor of bid1 and mean WTP is PKR 125/month. This paper posits stress on the public utility company that for sustainable planning toward better services, CV survey is an appropriate tool for acquiring information on the existing practices and concerns for household WTP for proposed services. Service provider and practitioner may take in to consideration these results to improve waste management in the locality.

KEYWORDS: Willingness to Pay, Urban Area, Solid Waste Management, Logistic Model, Contingent Valuation Method.

INTRODUCTION

Solid waste means any material of no value for the person responsible for its creation. It is created by agricultural, domestic, healthcare, commercial, mineral and industrial activities and collects in various places. The words "trash," "garbage"and "rubbish" are used interchangeably and used for solid waste. "Solid Waste Management (SWM) is the generation, separation, collection, transfer, transportation and disposal of waste in a way that takes into account public health, economics, conservation, aesthetics, and the environment, and is responsive to public demands" [1]. The rapid pace of urbanization in developing countries have resulted from many environmental problems like provision of safe drinking water, air and noise pollution and proper solid waste management in the region [2]. This not only damages to public health, economic, environmental and biological losses but also rendering a daunting task to the service providers in these countries [3]. Consequently, provision of better SWM services as a challenge in most developing countries [4]. The use of contingent valuation method (CVM) has been the most frequently used method for non-market valuation and estimating the benefits of environmental improvement. A hypothetical market can be created through bids game method and to elicit household's willingness to pay (WTP) for environmental improvement, and in so doing, can be used to establish the benefits [5, 6, 7]. Globally, the CVM is used in various fields of economics such as in health economics [8; 9], transportation economics[10], culture economics[11] and environmental economics[12,13,14]. Recently, the application of CVM has been observed in extensively in both developed and developing countries especially for SWM services [15]. Thus CVM has the most straightforward and direct technique for assessing of public perception and WTP to make the SWM services more sustainable and further expand to the deprived population in the area. The demerits of the method are that responses are based on hypothetical situation rather than actual behavior.

The present study was an attempt to use CVM and estimate households WTP for better services to make sustainable the waste collection services in Mardan, Pakistan.

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Background of the study

Pakistan spread over an area of 796,095 sq. km, with total population 207,774,000 and per-capita GDP of $ 1,629 [16]. Urban population in the district Mardan constitutes 19 percent and the major portion of generating solid waste. Table-1 shows proportion of mega cities waste generation and collection in Pakistan.

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Table-1: Solid Waste Generation and Collection in Major Cities of Pakistan			
City name	**Waste Generation Tons/day**	**Waste Collection Tons/day**	**Collection rate(%)**
Karachi	6632	3515	53
Faisalabad	902	487	54
Hyderabad	756	386	51
Gujranwala	615	320	52
Peshawar	564	344	61

Source: (Mahar *et al*., 2007)

It is evident from the above Table-1 that solid waste collection rate ranges from 51 to 69 percent by respective municipalities in the area. The waste which was not collected mostly observed in street, vacant plots and open spaces which is the main reason of environmental degradation.

In Mardan, Pakistan (Central Khyber Pakhtunkhwa), the high rate of industrialization, unplanned urbanization has put enormous impact on health, local and local environment, and economy. Poor, non-scientific management of waste and public participation in the planning process, the retarded rate of awareness/education in masses generally caused an increase in pollution of air, water and soil. Like any other cities in the country, most of the households in Mardan dump domestic waste in nearby rivers, sewage, putting in other illegal sites near to their homes. Mismanagement of municipal solid has created serious issues like air and water pollution. Besides, it also disturb the eco system and resulting fruits and vegetables un-hygienic. In Mardan, the average rate of waste generation was approximately 0.55 KG per day and total waste on the basis of population was 217 tons/day. Out of total 65-70 tons,/day Waste Transported to Landfill Site and the remaining are not properly managed [17]. Against this background, Planning for sustainable SWM services to take a more informed decision to identify the WTP needed to showcase a best practice example of in urban Mardan, which could be replicated all over Pakistan.

MATERIALS AND METHODS

i. **Study area and Sampling**

ii. Mardan, the second populous city of Khyber-Pakhtunkhwa, is a dynamic and fast-growing city. It is famous for its agro-based industries and historical Buddhist culture located at Jamal Garhi, Takht Bhai and Sawal Dher. Administratively, district Mardan comprised of 46 (15 urban and 31 rural) union councils. Geographically, the city lies at 34°12'0 N 72°1'60 E and an altitude of 283 metres (928 ft), and borders district Nowshera in the East by Buner and Swabi in the North by Malakand and Buner districts, west by Malakand and Charsada districts and on the on the south by district Nowshera. Demographically, total population was 1460100 persons out of which 255128 persons (17.47%) live in urban area. The total housing unit was 173088 and population growth rate was 3.01% and average household size was 8.4 persons [26]. The study was limited to all the 15 Urban union councils of District Mardan.

iii. The random sampling method was used and the sample size was allocated to 15 urban union councils through proportion allocated method. The using simple random sampling method-a method which is more representative of the sampled group as compared to non-random sampling techniques (Gravetter and Forzano, 2011). With the help of sample calculator, the sample size was estimated using the formula:

$$SS = \frac{Z^2 * (p) * (1-p)}{C^2} \quad \text{.....Eq. 1}$$

Where:

SS= Sample size

p = probability of rejecting the null hypothesis at 5 percent level of significance

Z = shows critical value, following the Z table Z 0.05 =1.96 (TTT)

C = stands for confidence co efficient

The population of urban Mardan has projected 1,694,936 persons for the year 2017 and the sample size, thus, calculated was 284 households. The sample size was allocated to 15 urban union councils through proportional allocation method

iv. Survey design and Data collection

The application of CV survey is the most widely used method for household preference collecting informations for betterment of public goods and services [18]. The various application such as [27] in Nigeria, [28] in India, [29] in Uganda; [30] in Cameroon; [18] in Ghana are the famous example of CV studies in developing countries. All of these studies provide evidence that household is provide a significant amount of improvement of solid waste improvement. This survey was conducted in January 2017 and direct face to face interview was conducted in this study. Many studies report face to face interview is a reliable approach in CVM studies [20]. As a second largest city of Khyber-Pakhtunkhwa and widened area, the study was confined to Mardan city. In Mardan, only 29 percent of solid waste was properly collected and transported to the landfill area and remaining 70 percent are littered along roads, canals and footpaths [17]. This improper solid waste management is the human impact on the environment cause serious health implication on the quality of life of the citizens. Previously the municipal services were provided but the municipal corporation Mardan but the present government have incepted a public utility company with the name of Water and Sanitation Service Company in Mardan (WSSM). Now the whole services of drinking water, sanitation and solid waste management was shoulder to WSSM.

Another consideration before conducting this CVM survey that weather data should be collected from the individual as reported by [23; 24] in his studies or household as suggested by[21; 22]. It primarily depends on type of vehicle used for the services in the locality whether such payment is made by an individual or household basis [25]. In the present study, payment is usually made on the household basis and are paid by the head of the household according to the prevailing culture and tradition. Therefore individual income may be considered as household income. We have selected 15 urban union councils from the whole Mardan district. The sample size was calculated through sample estimator given in (Eq. 1) and proportionally allocated to every union council.

v. Questionnaire Design

The Primary data was collected using Contingent Valuation Survey (CVM) method through well-designed questionnaires. The first section of the questionnaire includes the socio-economic characteristics and attributes of the households; while second part includes questions relating to the current practices of SWM, household concerns and WTP for improved solid waste management services.

Before presenting the CVM questionnaire, households were oriented the proposed service improvement plan, characteristics of services, its implication on environment and the reason of payment for solid waste management services. The WTP questions were not asked from the households who opted for the proposed improved SWM services. Those households who were in odd favour of proposed SWM service plan were asked to show their willingness to pay for improved SWM service plan. The proposed improved SWM service plan consisted of the following improved services plan:

- Door to door and daily regular solid waste collection (Sweeping of roads, Clearance of the dump bins, open space clearance from garbage)
- Covered or compactor trucks for transportation
- Controlling sanitary landfill through change in disposal method
- Proper recycling of this waste.
- And addressing complaints

The households were asked if they are willingness to pay for improved solid waste management services it will be like other utility charges e.g. electricity, gas and telephone bills. Ranges of five (03) bids in PKR from higher to lower order were offered and a double-bounded dichotomous choice question was asked and household responses were recorded against each bid. The number of first stage bid1 is PKR (251-300), if they answer no then PKR (201-250) up to lower range bid5 PKR (50-100) till the positive response of household. It is important to note that how responses to household changes to the offered bids.

Analytical Procedure

For the analysis of the data, descriptive statistics mainly averages, percentages and regression analysis were used. The Socio-Economic characteristics and existing state of solid waste management services were assessed through descriptive statistics. Household willingness to pay for improved SWM services model was used by Englin and Mendelsohn (1991) and Brown and Mendelsohn (1984) used hedonic travel cost method and revealed preference approach by [32]; [33] and contingent valuation method by [31] and [5]. As this research tries to quantify the

households WTP for non-market goods, so CVM is the appropriate method to take into account the variation in willingness to pay for solid waste management service improvement in urban Mardan.
For assessing the factors of WTP for solid waste management services improvement literature suggest the various model, like Logit models, symmetrically trimmed least squares and ordinary least square. However, the use of logistic model was the most commonly used model and suggested by many studies like [3;18; 19]. So in this study separate Linear Logit Model was used for each bid separately.

Theoretical Framework

Generally, household maximizes their utility subject to income constrained and choose the option which gives him/her the highest level of satisfaction. In this context, WTP shows the upper ceiling of the amount households are willing and ready to pay for the environmental improvement and it varies from person to person. The WTP variation among the target population offers interesting market information and clue for policy maker ad planner for better planning. Following the recent work of [18] and [34], the WTP of an inquired household for offered service improvement at a particular price (offered bids) have certain probability distribution function. SWM services have estimating problems because of its non- market characteristic nature. It causes negative externality to environment and public health in area. Therefore, to estimate household willingness to pay, CVM was used as discussed in the previous section. In economics perspective, the consumer have inclinations beyond goods and services from non-market and market places and showed by their respective utility functions. Households always maximize their utility from given commodities within their budget constraints. So, the utility function can be as follows:

U (n,m)… … … … … … … (i)

n=non marketed commodities/ improved SWM services

m = marketed commodities (composite of goods and services)

and the expenditure function

e (p, n, u) … … … … … … (ii)

Where

u = goods utility

p = goods prices and

Eq-2 shows the amount of money spent by consumer for attainment of maximum satisfaction from his limited resources. This expenditure function is the cumulative function of n and p while for n it is diminishing one. Furthermore, for households spend minimum remains on identical utility functions as follows:

Min(n+pn)……..(iii)

Subject to $U = U(n, m)$

In this case (Pm=1) means that composite goods price is 1.

The problem of minimization can be resolved through lagrangian multiplier method and will derive through Hicksian demand function and assumed as follow:

$hi = hi(pn, u^*)$ … … … … … ……. (iv)

The least expenditure function can be obtained through substituting Hicksian matching values in lowest expenditure function:

$e^* = e(p, n, u^*)$ … … … … … ……. (v)

Where e shows the minimal spending for the achievement of desired utility u usig SWM service. n shows prices of substitutes and complimentary goods. Expenditure function derivative with respect to prices shows the following form.

$\partial e/\partial pi = hi(pn, u^*)$ … … … … … …..(vi)

The integration of marginal WTP for better waste management can be achieved through WTP for improved SWM services from "n" to "n*"

$$WTP = -\int_{n}^{n^*} \partial e(n, u^*/\partial n.dn) \text{ … … … …} \quad \text{(vii)}$$

Willingness to Pay is the total money the consumer is willing to pay for better life due to solid waste management services. For improved solid waste management the function is:

$WTP = e(p, n, u) - e(p, n^*, u)$ … … … … (viii)

Here, "n" shows maximum level of waste management and "n*" shows best form of solid waste management.

The spending change is either corresponds surplus or reward excess if it close to initial utility situation, it reimburse and it corresponds surplus if it is final level of utility, Now keeping the model findings we can predict willingness to

Pay HH's , which includes income, other factors, education level, wealth and reserve's. So, to estimate willingness to pay major determinants, following model is specified:

Model Specification

On the basis of above theoretical framework, the household willingness to pay for solid waste management services was constructed as and taking value 1 if consumer is willing to pay for solid waste management improvement and 0 in vice versa case. The dependent variable is dichotomous (1,0) form, so probabilistic model was used in this study and is given by:

$$Probibility\ (event) = \frac{1}{e^{-Z}}$$

Where combinations of variables like X_1, X_2…… Xn is shown by Z

$$Probibility\ (event) = \frac{1}{e^{-(\beta 0+\beta iXi)}}$$

The probability equation given above is determining the event log odds as:

ln (event probabaility/1-event probabaility) =Z

In this model

$Z= \beta_0 + \beta_1 INC + \beta_2 EDU + +\beta_3 HHs + \beta_4 HOC + HAWR + U_i$.....(ix)

The definition, measurements units and economic expectations presented inTable-2 used in Logit model:

Table 2: Definition, Units and Priori Expectation of the Variables used in the Logistic Model

Variable	Definition	Units	A priori expectation
INC	Definition	PKR	+
EDU	Main earner of the household average income	0= hardly literate , 1=primary level, 2=middle level, 3 = Secondary level, 4=B.A/B.Sc, 5= M.A/M.Sc, 6=M.Phil/PhD	+
HHS	Household level of education.	Number	+
HOCP	Household total population	1 = = not Employed 2=Employed in public sector 3= Employed in Private sector 4= Entrepreneur.	+
HAWR	Employment status of household	Dichotomous, , Yes=1, No=0	+
WTP	Household health awareness	Dichotomous, 1=Yes, 0=No	+

RESULTS AND DISCUSSION

Existing Solid Waste Management Practices

A survey was conducted in three urban union councils of district Mardan in the year 2017. It was found that major proportion of household solid waste generation was bio-degradable organic waste (53%) including food, paperboard, leaves, grass, straw, wood, animals dung, sludge's etc. While inorganic or non-biodegradable waste (38%) includes bones, rags, polyethene bags, plastic, rubber, glass, metals, stone, bricks, gravels, tetra packs etc. And other non-putrescible have the ratio of (10%). Most households collect their wastes in polythene bags (55%), open drum (25%) and wheelbarrow (15%) before disposal. Majority of household (41%) have solid waste collection point or picker at the doorstep and no distance from their home. While 34% dispose at a distance of (31-60) meters 16% (61-90) meters.

Regarding households solid waste disposal practices, the analysis shows that most of the respondents (52%) were served by WSSM and collected by pic point. 24% uses a communal container for solid waste disposal and remaining kept waste outside their homes in open air because they were lacking storage containers and incineration as shows in Table-3.

Table 3: Current Practices of Solid Waste management in Urban Area of Distric Mardan

Variable	Frequency (N=384)	Percentage
Major categories created of solid waste		
Orgaini waste[1] or Biodegradable	204	53.1%
Inorgaini waste[2] or Non-biodegradable	146	38.0%
Non-putrescible	34	8.9%
Indoor Solid Waste Management Practices		
Use of Polythene Bag	**211**	55%
Throughing in Open Drum	**96**	25%
Collect in Wheel barrow	**58**	15%
Other	**19**	5%
Distance from Solid Waste Collection points(In Meters)		
0-30	**159**	41.4%
31-60	**132**	34.4%
61-90	**62**	16.2%
91 and above	**31**	8.0%
Solid Waste Diposal practices in Urban Mardan		
Collection vehicle at a pickup point	**201**	52.3%
Throwing in a communal container	**105**	27.4%
Throwing in backyard/street/canals	**56**	14.6%
Throwing in open field (illegal pile)	**18**	4.7%
Incineration	**4**	1.0%
Satisfaction regarding the SWM services		
Satisfied	31	8.0%
Not satisfied	342	89.3%
Do not know	11	3.2%

The analysis further shows that majority of household (89.3%) respondents claimed that they were not satisfied from the existing solid waste management service like sweeping of roads, clearin dump bins, addressing complaints and garbage clearance from open spaces. It was found that garbage bins were not cleaned properly, roads were sweeping un-regularly and local municipalities di not collect wastes from all houses timely and in this scenario the households themselves dump their waste in vehicles. Furthermore, some of the waste collectors dump waste unsystematically which creates further problems of waste management. Even in special occasion, collectors often escape and avoid collecting waste from urban sectors, in this case only 8 percent of households were satisfied from their services.

Concerns and Attitude Towards Solid Waste Management

Inadequate SWM practices to public health cause environmental pollution. Undesirable practices and crude tipping pollute water, air, land, increasing disease vectors which affects public health [40]. For mitigating the public adverse impact on human and environment and protect the public health of the community the household concern were evaluated in urban Mardan. All these must be thoroughly considered to grabble the issues of SWM in the area. Household were of the opinion that solid waste causing health problems and if they are participating in waste collection themselves, it can cause infectious diseases.

Mosquitoes and other flies are the major caused by solid waste (90%) and (83%) were the opinion that disposal of waste and improper use caused various diseases. while, the concern of reduction in natural resources was minimum (50.3%) and (65.8%) respondents that solid waste was present in their neighborhood.

[1] Food, Paper Board, Leaves, Grass, Straw, Wood, Animals Dung, Sludges etc.
[2] Bones, Rags, polyethylene bags, Plastic, Rubber, Glass, Metals, stone, Bricks, Grvels, Tetra packs etc.

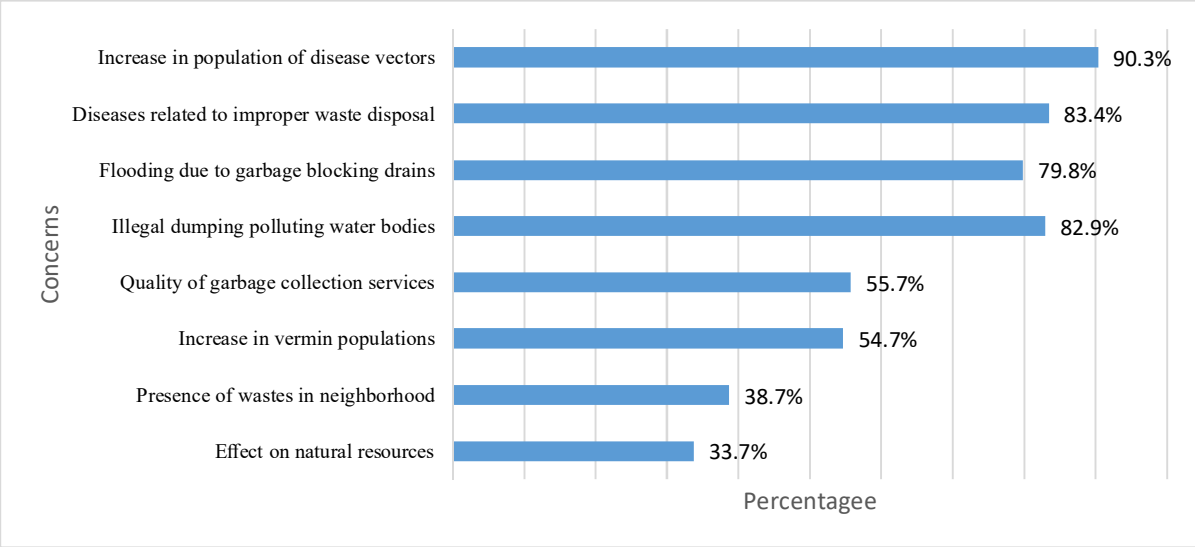

Figure 5: Concerns Expressed by Urban Slum Dwellors about SWM

Solid waste management improvement received positive move from majority of respondents in their localities. About 90.3 percent said that existing SWM had played an extensive role in managing solid waste in their localities. There is an urgent need to develop a well balanced approach by the SWM compatible with the conservation of resources, ecology, health and economic policies.

Willingness to pay for improved SWM Service

Bitwise linear logistic model was used for the dichotomous choice question in present paper. The basic statistics and double bounded logit analysis used for independent variables are showed in Table-4.

Table-4: Variables in the Model and its Description

Variables in the model	Minimum	Maximum	Mean	Std. Deviation
willing to pay	0	1	0.85	0.35
Income of the main earner.	13780	1258348	193763.57	179450.92
Total numbers of year in education.	0	6	1.37	1.24
Occupation of the respondent	1	4	2.60	1.04
Housing Occupancy	0	1	0.79	0.41
Valid N (listwise)	384			

To analyze the various influencing factors of households' willingness to pay for improvement in SWM, the marginal effects calculated for each parameters showed in Table-5:

Table-5: Result of Logistic Regression Model for Improved SWM Service in Urban Area of District Mardan

Independent variable	Dependent Variable: Willing to Pay for Improved SWM service at different Bids (Dichotomous)	
	Bid1 PKR (100-150)	Bid2 PKR (151-200)
INC	0.000*** (0.000)	0.000*** (0.000)
EDU	0.200** (0.107)	0.130*** (0.177)
HOCU	0.969*** (0.283)	0.648*** (0.248)
HOCP	0.594* (0.132)	0.307 (0.569)
Constant	-.662 (.075)***	-3.234 (0.750)
	χ^2=60.506 Pseudo R^2=0.212 No of observation, N =280	χ2=33.84 Pseudo R2=0.379 No of observation, N =39

- ***** significant at 1percent**
- ****significant at 5 percent**
- *** significant at 10 percent**
- ***Standard Error values are given in parenthesis.***

Three separate bids were developed and the probability of a households' WTP for each bid was calculated. The dependent variable was used as a function of cognitive factors (bid value) defined in Eq.-ix. The value of, R2, shows total variation in dependent variables as a result of independent variables for willingness to pay. Greater the value of R2 means that the independent variables are explaining more variation in dependent variable and vice versa. For bid-1 of 0.212 shows that correlation between dependent and independent variable is 0.79 percent, and for bid2 pseudo ' R2, the value is 0.379 means that 0.62% independent variable is explained by dependent variable.

The finding shows that almost all the variables included in the bid-1 model are positive significant in WTP model. Income of the household's had positive coefficient and significant at $p<0.01$ for bid1 and bid2. This means that richer households are more induced and willing to pay as compared to their counterpart poor ones. Increase in the income of a person, like other expenditure he/she is more ambitious for their clean ambient environment, these line resonating with [12] and [35].

Similarly, education of the respondents has another important variable in the model at $p <0.01$ for both bid1 and bid2 consecutively. Holding all other thing remaining the same, higher the level of respondent education higher will be their demand and WTP for improved SWM services and also endorsed by [14]; [36] and [37] in his studies.

Further, the occupation of the respondents also has a significant role in household WTP for both models of bid-1 and bid-2 as given in Table-5.

The household occupation is significant positively ($p <0.10$) on willingness to pay for both bid-1 and bid-2. This indicates that respondents having own house is more willing to pay for solid waste improvement service, which is in line of findings of [3] and [38].

Housing occupancy of the respondents is one of the significant factors determining their willingness to pay for improvement in management of solid waste services. Households living in their own houses are more willing to pay for improvement in waste management services compared to those living in rented houses. It shows there exist a positive correlation between ownership of houses and willingness to pay for improved solid waste management and verifying the results of [39]; [14]; [36] and [37].

CONCLUSION

The existing solid waste management services are significantly affected by unplanned growth and development in district Mardan. Majority of the households threw their waste in open plots, streets, perennials/ canals in un-hygienic ways. Unfortunately, solid waste management services are lacking to dispose waste hygienically in land or even recycle it like developed countries practices. A major vast of respondents shows their concerns over the public health and environment of the area. This study utilizes the contingent valuation method to estimate willingness of household to pay for improved solid waste management services. Results show that major portion of the households are willing to pay for improvement in existing services of solid waste management. Empirical analysis explicitly shows that respondents are mainly concerned about blocked drains, dirty streets, plastic bags which results major diseases and led to pollute the air and water. It also resulting negative externality and creating environmental degradation. Furthermore, bids wise analysis also shows that households are willing to pay for solid waste management services. Education, household awareness, income are more dominant and significant factors in willingness to pay for SWM services improvement. If the municipalities and district administration implement existing charges for solid waste collection, it will not improve collection of revenue, deadweight loss of the public utility companies will be mitigated and will lead to more sustainable services in the future.

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