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Perception and Willingness to Pay of Households towards Solid Waste Management in Hubballi-Dharwadand Bengaluru, India

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A B S T R A C T

In the solid waste management, people's participation is the key component. The active participation of the people either financially or physically and cooperation is the key to success of urban development and civic services management. Towards the scientific solid waste management, the lack of financial resources was one of the major impediments which corporations suffered. Therefore, it necessitates to know the willingness to pay off households for waste management service. For the study primary data was collected from city dwellers both from Hubballi-Dharwad and Bengaluru. In Hubballi-Dharwad, 71.67 per cent of respondents were willing to pay and in Bengaluru, about 85.00 per cent of the respondents were ready to pay the money. The major determinant of willingness to pay was income (0.144) where it was expected to have positive influence on willingness to pay and another was level of satisfaction (0.133) with the current solid waste management practices. The other variables like quantity of households solid waste generated per day (0.165) and the study hypothesized that the willingness to pay to be positively related with the quantity of solid waste generated, since higher the generation, the more would be the problem faced by households. In respect of the level of satisfaction with the solid waste management services provided by corporations, it is assumed that the respondents who were satisfied were willing to pay.

Introduction

Solid waste problem surpasses traditional environmental boundaries and augment air, water as well as land pollution. It is the most visible form of environmental problem in many urban regions. The increased generation in solid waste and diversification in solid waste generation is attributed to many factors such as rising population, changing income, consumption pattern, economic development, urbanization and industrialization. Solid waste describes non-liquid materials accumulated from domestic, trade, commercial, agricultural and intensive industrial activities including from public services.

With rapid population expansion and constant economic development, waste generation both in residential as well as commercial/industrial

areas continues to grow rapidly, putting pressure on society's ability to process and dispose of this material. Also, unscientifically managed solid waste streams can pose a significant risk to health and environmental concerns. Improper waste handling in conjunction with uncontrolled waste dumping can cause a broad range of problems, including polluting water, attracting rodents and insects, as well as increasing floods due to blockage in drains. As well, it may bring about safety hazards from explosions and fires. Improper solid waste management can also increase greenhouse gas emissions, thus contributing to climate change.

Having a comprehensive waste management system for efficient waste collection, transportation, and systematic waste disposal together with activities to reduce waste generation and increase waste recycling can significantly reduce all these problems. While nothing new, an ISWM approach provides the opportunity to create a suitable combination of existing waste management practices to manage waste most efficiently.

Integrated Solid Waste Management (ISWM) represents a contemporary and systematic approach to solid waste management. The U.S. Environmental Protection Agency (EPA) defined ISWM as a complete waste reduction, collection, composting, recycling, and disposal system. An efficient ISWM system considers how to reduce, reuse, recycle, and manage waste to protect human health and the natural environment. It involves evaluating local conditions and needs. Then choosing, mixing and applying the most suitable solid waste management activities according to the condition.

The solid waste management problems can be resolved by the participation of all stakeholders involved in solid waste management as better solid waste management programmes required cooperation among the government, local residents and non-governmental organizations which can play a vital role and also provide a good results in the field of city waste management. People's participation and perception is the most important criterion for successful programme planning, policy making and its management.

Materials and Methods

The present study was taken up in two selected municipal corporations (HDMC and BBMP) of Karnataka. The study was based on both primary and secondary data. For evaluating the objectives of the study, the required primary data were collected from120 randomly selected households belonging to different occupational and income categories. The secondary data on population and solid waste generation was collected from reports of HDMC and BBMP. The primary data was collected through personal interview method with the help of pre-tested and well-structured schedule. The data collected pertained to the year 2016-17. The primary data was collected on education, family type, housing type, occupation, income, per capita generation of solid waste and perception and willingness to pay off respondents. To accomplish the specific objectives of the study the following analytical tools and techniques have been employed to draw meaningful interpretation and inferences.

Analytical tools

Tabular presentation technique

The descriptive statistics like averages, percentages, *etc* were used and tabulated to compile the data on perception and willingness to pay for better solid waste management and households were also asked to indicate their willingness to pay.

Statistical test of significance t-test

A t-test's statistical significance indicates whether or not the difference between two groups' averages most likely to reflects a "real" difference in the population from which the groups were sampled. A statistically significant t-test result is one in which a difference between two groups is unlikely to have occurred because the sample happened to be atypical. Statistical significance is determined by the size of the difference between the group averages, the sample size, and the standard deviations of the groups. For practical purposes statistical significance suggests that the two larger populations from which the sample drawn are "actually" different.

The t statistic to test whether the means are different can be calculated as follows:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{Sx_1x_2\sqrt{1/n_1+1/n_2}} \quad (1)$$

$$Sx_1x_2 = \sqrt{\frac{S_1^2 (n_1-1) + S_2^2 (n_2-1)}{n_1 + n_2 - 2}}$$

Where,

Sx_1x_2 is the grand standard deviation (or pooled standard deviation),

1 = group one, 2 = group two.

For significance testing, the degrees of freedom for this test is $n_1 + n_2 - 2$ where n is the number of participants in each group.

The test of significance was employed to test differences in the willingness to pay of respondents for solid waste management.

Logit model

In the present study logistic regression was employed to know the factors influencing the willingness to pay of respondents for better solid waste management. Since logit model is used in the present study an elaboration on this model is required before specifying the model. The influence of socio economic factors on adoption, willingness to pay for something, participation in activities *etc.* were analysed by several studies (Shakya and Flinn, 1985 and Thomas *et al.*, 1990). The answer to the particular question put to the respondents was dichotomous which will not allow variation within these limits. The linear probability model specification of the dichotomous choice is

$$Y_i = X_i \beta + \mu_i \quad ----------(2)$$

The dependent variable Y_i takes the value of one if the decision maker selects the first option, zero otherwise. X_i is a matrix of regressors with N observations and K estimable coefficients, β is a Kx1 vector of parameters; and μ_i is the i^{th} identically and independently distributed random disturbance term with zero mean (Polson and Spensor, 1991). While the linear probability model is computationally and conceptually easier than the other two, its specification creates estimation problems with the application of Ordinary Least Squares (OLS) and many times violates the basic tenants of probability (Mingche, 1977). An inherent deficiency of the model is the heteroscedastic disturbance term. Though the heteroscedastic problem can be overcome through monotonic transformation, its efficiency by weighted least squares also depends on conditions applied. These deficiencies could be overcome through the use of monotonic transformation estimated through likelihood approach (logit and probit specification), which guarantees that prediction lies between the intervals 0 and

1(Capps and Krammer, 1985). While probit model assumes the standard cumulative distribution function, the logit follows logistic distribution function for the probability.

In the present study, the dependent variable is a dichotomous one and the logit model was employed. The logit model specified was as

$$T_i = f(Z_i) = \frac{e^{Z_i}}{1+e^{2i}} \text{ for } -\infty < Z < \infty \text{ and } Z_i = X_i' \quad \text{----------(3)}$$

Where, $f(Z_i)$ is the logistic density function for logit model. Let Pi be the probability that the respondents were willingness to pay.

As per the above logistic function,

P(C/X) = The probability of an respondents willingness to pay

$$= \frac{e^{Z_i}}{1+e^{-2i}} \quad \text{---------- (4)}$$

$$1\text{-}P(C/X) = 1 - \frac{e^{Z_i}}{1+e^{2i}} \quad \text{----------(5)}$$

= the probability of an respondents not-willingness to pay

The Odd's ratio =

$$[\{P(C/X)\} /\{1\text{-}P(C/X)\}] = e^{+Z_i} \quad \text{---------- (6)}$$

Take logarithm on both sides,

$$\ln [\{P(C/X)\} /\{1\text{-}P(C/X)\}] = Z_i = X_i^I\beta + E \quad \text{----------(7)}$$

Where, β= vector of response coefficients
E= vector of random disturbance

The specific logit model estimated to predict the 'odds' of a respondents in favour of willingness to pay is given by

$$[\{P(C/X)\} /\{1\text{-}P(C/X)\}] = \alpha + \sum^{8}_{i=1}\beta_1 X_1 + \sum^{4}_{j=1}\gamma_j D_j + \mu \quad \text{---------- (8)}$$

Where,
X_1=Gender
X_2= Age (Years)
X_3= Family size
X_4= Education (Years of schooling)
X_5= Family type
X_6= Income
X_7= Waste generation
X_8= Satisfaction of solid waste management

Results and Discussion

Perceptions of city dwellers about solid waste management in Hubballi-Dharwad and Bengaluru cities

In both the cities the sample respondents were interviewed for the purpose of assessing personal and household characteristics, socio-economic conditions, participation and perception in regard to solid waste management. The results are presented in Table 1. The results indicated that in Hubballi-Dharwad, average quantity of solid waste generated by households was 1.21 kg/day, of which the wet waste was highest at 0.60 kg/day (53.57 %) and dry waste was 0.52 kg/day (46.43 %). Majority of the households (78.33 %) had knowledge about wet waste and dry waste. It is important to know the difference between wet waste and dry waste as it would help in segregation of waste at the source. Of the total respondents, only 11 respondents (18.33 %) segregated their household waste and large number of respondents (81.67 %) did not segregate their household waste. This unsegregated waste at households' level would eventually increase the financial burden of municipal corporations to segregate solid waste at municipal level. The segregation of wet and dry waste required

separate dustbins in the houses to classify however, in majority of the households did not have separate dustbins was a limitation. The average number of dustbins in the households was 1.8. The plastic was the major constituent of the solid waste and increased proportion was due to use of the plastic bags for waste disposal by the households.

The waste was being collected by different agencies in study areas. In most of the areas, the waste was collected by municipal sweepers/workers through door to door collection system and in few areas the private sweepers collected the waste from households (36.67 %). It was clear from the result that the average money paid for waste collection by households was ₹ 35.08 per month. The average distance of waste receptacles will determine the method and frequency of the waste disposal in any area. Of the total respondents, 32 households indicated that the common waste bin was located within the 100 to 200 m and 46.67 per cent households opined that common garbage bin was allocated far away from the home (more than 200 m). Further, the study attempted to know the awareness about consequences of poor solid waste management. It was clear from the result that highest 78.33 per cent of households knew the ill-effects of poor solid waste management at the household level and the remaining 46.67 per cent of households didn't knew about the consequences of poor solid waste management.

Similarly in Bengaluru, perceptions of households about the solid waste management were studied and results are presented in the same table. The average quantity of waste generated at households level was 1.54 kg/day and the proportion of wet and dry waste was 66.67 per cent and 33.33 per cent, respectively. As large as 81.67 per cent of the households had knowledge of wet and dry waste together generated but the extent of segregation of waste at households in to wet and dry waste was only 40.00 per cent. It was clear from table that though the respondents had the knowledge of wet and dry waste but they were not willing to segregate the waste and the remaining 60.00 per cent of the respondents didn't segregate the waste. The average number of dust bins at households level was 2.1 and percentage of respondents who used plastic bags for waste disposal was more (86.67 %). The agencies involved in the collection of waste from households were Municipal Corporation Department (MCD) sweepers, private sweepers and Non-Governmental Organizations (NGOs). About 46.67 per cent of the households handed over their waste to private sweepers and private sweepers and NGOs collected waste from 35.00 per cent and 18.33 per cent of the households, respectively. The average money paid by the households towards solid waste collection was ₹ 49.67 per month and was relatively more than at Hubballi-Dharwad. Out of the total respondents, 73.33 per cent of households indicated that the common waste bin was located within the 100 to 200 m and 26.67 per cent of households opined that common garbage bin was allocated far away from the home (more than 200 m). Further, it was clear from the results implied that maximum of about 86.67 per cent of households knew the negative consequences of poor solid waste management and only 13.33 per cent of households didn't know about the consequences or unaware of poor solid waste management.

Willingness to pay of respondents for better solid waste management

The response from the households, towards the willingness to pay for solid waste management service is recorded in Table 2. The results pertaining to whether households are willing to pay some amount to get a better solid waste management service revealed that

in Hubballi-Dharwad, 80.00 per cent of respondents were willing to contribute and while, only 20.00 per cent of respondents were not ready to pay any amount as service cost for the better management of solid waste. In Bengaluru, majority (91.62 %) of the respondents were ready to pay money and the additional 8.33 per cent of the households unwilling to make payment for better solid waste management. The respondents stated various reasons for their unwillingness to pay for solid waste management. Among those who were not willing to pay, most of them reported that people with higher incomes required to contribute as they have ability to pay should pay and few of them were of the opinion that it is not necessary to contribute and considered as the responsibility of Municipal Corporations.

The willingness to pay towards solid waste management was shown in terms of the cost or the payment which households were ready to make and presented in Table 3. When the respondents were asked to indicate their willingness to pay and they expressed the amount of contribution they were willing and it varied between households. Amount that the households were willing to pay revealed that majority (43.75 %) were willing to bear the cost between ₹ 25 to 50 per month followed by 39.58 per cent who were willing to pay above ₹ 50 and only 16.67 per cent of respondents were willing to pay less than ₹ 25 for managing solid waste in Hubballi-Dharwad. While, in Bengaluru, 49.09 per cent of the households were ready to pay above ₹ 50 and the remaining 41.18 per cent and 11.76 per cent of the households were willing to make payment between ₹ 25 to ₹50 and less than ₹ 25, respectively. The Sujatha and Janardhanam (2012) found that majority of the respondents were not willingness to pay and only 9.2 per cent were willing to pay less than ₹ 10 per month and 0.7 per cent were willing to pay more than ₹ 25 per month.

Willingness to pay among the respondents in Hubballi-Dharwad and Bengaluru

In this study, t-test was used to test the variation in willingness to pay by households for solid waste management between selected municipal corporations. For this purpose, the following hypotheses were tested.

H_0: There is no significant variation in willingness to pay among the respondents of selected corporations

H_1: The willingness to pay differs significantly among the respondents

The results on t-test revealed that (Table 4) t-test (2.55) was found to be significant at one per cent level. The variance between the respondents of both cities was significant, it was noticed that willingness to pay differed significantly among the respondents between corporations. The results of the t-test allowed to reject the null hypothesis (H_0) and accept the alternate hypothesis (H_1). Further it was noticed that willingness to pay by respondents in Bengaluru was more (₹49.67) compared to the respondents of Hubballi-Dharwad (₹35.08).

Determinants of households' willingness to pay

The factors that influenced willingness to pay for solid waste management by respondents were analyzed using binary logistic model. It was observed during survey that willingness to pay by households was influenced by many factors like gender (male/female), age of the respondents, family size, education, type of the family, income, quantity of waste generation and satisfaction with the present arrangement of solid waste management practices. The logit regression results on factors influencing willingness to pay for improved waste management are presented in Table 5.

Table.1 Perceptions of city dwellers about solid waste management in Hubballi-Dharwad and Bengaluru cities

Sl. No.	Particulars	Unit	Hubballi-Dharwad twin cities		Bengaluru cities	
			Average	Percentage	Average	Percentage
1	Waste generated per households	kg/day	1.35		1.55	
	a. Wet waste		0.60	53.57	1.04	66.67
	b. Dry waste		0.52	46.43	0.51	33.33
2	Knowledge about segregation	No.				
	a. Yes		47	78.33	49	81.67
	b. No		13	21.67	11	18.33
3	Segregation of wet and dry waste	No.				
	a. Yes		11	18.33	24	40.00
	b. No		49	81.67	36	60.00
4.	Average No. of dustbins	No.	1.80		2.10	
5	Use of plastic bags for waste disposal	No.	46	76.67	52	86.67
6	Agency that collects waste	No.				
	a. MCD sweepers/workers	No.	38	63.33	31	51.67
	b. Private sweepers/workers	No.	22	36.67	29	48.33
7	Money paid for waste collection	₹	35.08		49.67	
8	Distance to common garbage bin	No.				
	a. Close to home (100-200 m)		32	53.33	44	73.33
	b. Faraway from the home (> 200 m)		28	46.67	16	26.67
9	Awareness about consequences of poor solid waste management	No.				
	a. Yes		47	78.33	52	86.67
	b. No		13	21.67	08	13.33
10	Satisfaction with the current municipal corporation services	No.				
	a. Yes		24	40.00	27	45.00
	b. No		36	60.00	33	55.00

Table.2 Willingness to pay of city dwellers for solid waste management

Sl. No	Willingness to pay	Hubballi-Dharwad twin cities		Bengaluru city	
		Frequency	Percentage	Frequency	Percentage
1	Yes	43	71.67	51	85.00
2	No	17	28.33	9	15.00
Total		60	100.00	60	100.00

Table.3 Amount of money the city dwellers willing to pay for solid waste management

Amount (in ₹)	Hubballi-Dharwad twin cities		Bengaluru city	
	No.	Percentage	No.	Percentage
Below 25	08	16.67	06	11.76
25-50	20	43.75	21	41.18
Above 50	15	39.58	24	47.06
Total	43	100.00	51	100.00

Table.4 Willingness to pay among the city dwellers of Hubballi-Dharwad and Bengaluru cities

Particulars	Hubballi-Dharwad twin cities	Bengaluru city
Average willingness to (₹)	35.08	49.67
Variance	1,119.91	838.02
Observations	60	60
Pooled Variance	978.97	
Degrees of freedom	118	
t Stat	2.55**	

Note: ** denotes significant at 1 per cent level

Table.5 Determinants of city dwellers willingness to pay in Hubballi-Dharwad and Bengaluru cities

Particulars	Hubballi-Dharwad twin cities		Bengaluru city	
	B	Standard error	B	Standard error
Constant	23.81	8.35	21.58	5.67
Gender	-0.140*	0.071	-0.071	0.128
Age	-0.019	0.012	0.012	0.006
Family size	-0.169	0.048	-0.195*	0.143
Education	0.118**	0.088	0.175**	0.049
Family type	-0.127*	0.033	0.111	0.932
Income	0.144**	0.402	0.143**	0.003
Quantity of waste generation	0.165**	0.016	0.180*	0.015
SWM Satisfaction	0.133*	0.038	0.098	0.043
Log likelihood	-45.21		-58.13	

Note: **denotes significant at 1 per cent level, * denotes significant at 5 per cent level

The log likelihood ratio statistic was significant at one per cent, indicated that at least one of the variables has coefficient different from zero. Therefore, it can be concluded that the logit model used has integrity and was appropriate. In Hubballi-Dharwad, the estimated coefficients for the variables like education (0.118), income (0.144) and quantity of waste generated (0.165) showed positive influence towards willingness to pay and found significant at one per cent. The other variables like gender and family type had negative influence on respondents' willingness to pay indicated as family type moves from nuclear to joint family, the willingness to pay decreased by 0.127 units similarly, as we moved from female respondents to male respondents, the willingness to pay decreased. The estimated coefficient of family size showed negative influence on willingness to pay but was not found significant. In Bengaluru, the estimated parameters of variables indicated that family size (-0.195) showed negative influence on willingness to pay and found significant at five per cent while, education (0.175), income (0.143) and waste generation (0.180) indicated positive influence on willingness to pay. Estimated coefficients for education and income found significant at one per cent. The results obtained are in line with the study conducted by Khattak and Amin (2013). The researcher applied binomial logit model and study found that income of household, family disease history, education and size of the family were the major factors which affected the household's decision regarding willingness to pay.

In conclusion the people's participation is the key component in the solid waste management. The success of urban development and civic services management depends on the cooperation and the active participation of the people. The individuals can take part in solid waste management either by making financial contribution or voluntary involvement in the management practices. It was found that the major determinant of willingness to pay was income where it was expected to have positive influence on willingness to pay. The other variables like quantity of households solid waste generated per day and the study hypothesized that the willingness to pay to be positively related with the quantity of solid waste generated, since higher the generation, the more would be the problem faced by households. In respect of the level of satisfaction with the solid waste management services provided by corporations, majority of the respondents were not satisfied**.** Thus, scientific and efficient management of solid waste demands coordinated efforts of both municipal corporations and individuals.

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