Community Participation for Urban Solid Waste Management: A Study on Tinsukia Municipality of Assam

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Abstract:
Generation of Municipal Solid Waste (MSW) and its poor management is one of the major environmental issues of Indian cities. Poor management and improper regular dumping of solid waste degrades the urban environment quality and that creates environmental pollution which has an adverse impact on the quality of life of the inhabitants in the society. This study explores the possibility of community participation approach as an alternative approach to municipal own waste management to tackle the MSW problem in Tinsukia Municipality of the State Assam. This approach will be sustainable if there is proper demand for solid waste management (SWM). This paper also attempts to assess the demand for better SWM. People's demand is reflected by their willingness to pay through Contingent Valuation Method. This paper shows that municipal service of SWM is not sufficient. Due to this insufficient service people are ready to pay for getting better service. The people have a significant demand for better waste management. The willingness to pay is significantly affected by income and volume of waste.

JEL Classification: Q 51, Q53

Key words: Waste generation, Garbage disposal, Contingent Valuation Method, Willingness to Pay, Logit model

1. Introduction

Waste is an unavoidable by-product of human activities. Volumes of wastes are increasing day by day due to increase in population, increase in income, rapid urbanization, technology and improper throwaway culture of the people. Urbanization is now becoming a global phenomenon. The increased pace of urbanization and a migratory population pressure in urban area has been posing a challenge to urban environment management especially in the developing countries. The rapid urbanization has a multiple effect on quality degradation of environment. To avoid this problem, a solid waste management (SWM) service and a proper policy regarding the waste management is required.

Problems associated with SWM service provision in developing countries are reaching an ever increasing magnitude, leading to considerable adverse impacts on the environment and quality of life of the inhabitants. Such problems are usually associated with limited managerial, technical and financial capabilities of municipal authorities (Abrabo, 2007). Pearce and Turner (1994) suggested that as much as 60 and 45 million tons of waste yearly remain uncollected in low-income and middle income countries.

Indian cities generate an estimated 0.115 million metric tonnes of waste per day and 42 million metric tonnes annually (3iNetwork, 2006). The per capita waste generation ranges between 0.2 and 0.6 kg per day in the Indian cities that is lower than that in developed countries. However, lifestyle changes due to economic growth and fast rates of urbanization have resulted in per capita waste generation increasing by about 1.3 per cent per year. The Energy Resources Institute (TERI) has estimated that waste generation will exceed 260 million tons per year by the year 2047—more than five times the present level (3i Network, 2006).

Indian cities are often characterized by poorly rendered services including waste management - the most ignored of all basic services, on account of various reasons. The situation worsens with increasing population pressure in urban centres like Kanpur, one of the important metropolitan cities of North India, having an inefficient, outdated and unscientific waste management system (Zia and Devadas, 2008). Increasing population levels, rapid economic growth and rise in community standard accelerates the generated rate of Municipal Solid Waste (MSW) in India (Sarholy et. al., 2007).

The government of India has issued MSW (management and handling) rules in the year 2000 for scientific municipal solid waste management (MSWM), ensuring proper collection, segregation, transportation, processing and disposal of MSW and upgrade of the existing facilities to arrest contamination of soil and ground water. These rules are applicable to every municipal authority in India (Sarholy et. al., 2008). They have focussed on a comprehensive review of MSWM for Indian cities to evaluate the current status and identify the problems of MSWM. They have concluded that the lack of resources such as financing infrastructure, suitable planning and data and the leadership are the main barriers in MSWM.

MSW disposal has usually been directly or indirectly subsidised by local governments and in that case waste generators face zero marginal costs (Strathman et. al., 1995). But the waste generators have no positive marginal cost, then generally they have no more credibility, responsibility due to lack of awareness particularly in developing countries. So, the volume of garbage increases with improper dumping by waste generators.

The main problem for MSWM is high operating cost viz; cost of collection of waste, cost of waste segregation, transportation cost for dumping etc. In most of the cases, the municipalities are not able to handle the increasing quantity of solid waste and not able to maintain high operational cost. There is a need to involve private sector and community participation in waste management (Rathi 2007).

In a solid waste system, the weakest link with respect to marginal cost pricing is usually the price paid by the residential waste generators (Savas et. al. 1977). But in developing countries, the local administration does not generally impose additional payment

forcefully for waste management due to apprehension of losing vote bank and because of many people are belonging to middle income group and lower income group. Even though those city dwellers have ability to pay but they are not willing to pay because they expect that it is the responsibility of the local administration.

It is noticeably observed that wastes are not thrown and dumped properly, not collected regularly and not managed properly may be due to lower consciousness of the people or may be due to lesser number of supporting staff and materials in the municipalities regarding its regular management. Therefore, it is better to judge whether they have consciousness and demand for getting better service of waste management or not.

The public-community participation (PCP) system is the most frequently suggested method in managing households' solid waste problems in India owing to the gradual decline in the municipal services provided by the public authorities both in terms of quality and quantity. In this system, operational efficiency may be achieved by involving the private sectors on a larger scale along with community people and by including the provision for payment of incentives / subsidies to them in exchange of services rendered (Chakraborti et.al. 2009).

This paper attempts to explore the possibility of community participation approach as an alternative approach to the existing municipal waste management which is poorly managed by Tinsukia Municipal authority of Assam to tackle the SWM in better way. This paper also estimates the determining factor of the demand for the betterment of the MSWM service.

2. Methodology

2.1 Data collection methodology

In this study, the primary data has been collected by using three stage stratified random sampling technique. There are 15 wards in Tinsukia municipality. These fifteen wards have been classified into 5 strata, each stratum containing 3 wards based on geographical set up, viz; north, south, east, west and central zone. In the first stage, 2 wards have been selected randomly from each stratum. Thus a total of 10 wards have been selected. In the second stage, by using random number table, 5 lanes have been picked up from the wards selected in the first stage. So, from the total 10 wards, 50 lanes have been selected in this stage. In the final stage, from each of the selected lanes, 3 households have been selected randomly. One household have been selected from the beginning of each selected lane and one is from the middle and one from the end of lane. The justification of this selection is that the throwing pattern or dumping of household garbage by the households is expected to be same within a lane. The nature of throwing and dumping garbage depends on whether there are vat or not in that lane. So, a total of 150 households have been selected for this study. A questionnaire has been framed and a door-to-door survey has been conducted personally for collection of primary data. The required secondary information has been collected from the review of published and unpublished document on waste and waste management in India and from the Tinsukia municipality.

2.2 Methodology for data analysis

To analyze the data, statistical, mathematical and econometric tools have been used. For showing the demand for better management of solid waste, contingent valuation technique have been used in this study. The primary use of contingent valuation method (CVM) is to elicit people's willingness to pay (WTP) or participation for changes in quantities goods and services. This approach have been used to check whether the people are interested to participate or not for the better management of solid waste disposal and to get the better environment. Here, participation is in terms of financial participation, not in physical participation for collection. Generally, urban people in India are not interested in physical participation. During the survey a question was asked regarding financial participation that: If the municipality wants to employ additional persons (may be casual labour) to keep the area clean, then are you willing to share financially? The response option was binary either yes or no. So, the population is divided into two groups. For estimating the probability of the community participation (CP), bi-nomial logit model can be specified by Eq. (1).

$$P\{CP = 1 \text{ for yes}, 0 \text{ elsewhere}\} = \frac{1}{1 + e^{-(\alpha + \sum \beta_i x_i)}} \quad \text{.....Eq. (1)}$$

Where; x_i' s, i = 1 to 3, stand for the three explanatory variables Y, HE and W.

$$\mathbf{L_i = \alpha + \beta_1 Y_i + \beta_2 HE_i + \beta_3 W_i + u_i} \quad \text{.....Eq. (2)} \quad ; L_i = \text{Log}\,[P_i / (1 - P_i)]$$

Where P_i is the probability that community are willing to participate; $(1 - P_i)$ is the probability that community are not willing to participate; Y_i is monthly family income of the i^{th} family; HE_i is monthly health expenditure of the i^{th} family; W_i is the volume of waste generated in the i^{th} family; α is intercept parameter; β's are coefficients of quantitative variables and u_i is the random error that follows normal distribution with mean zero and constant variance σ^2. The justification for the explanatory variables used in the logit model can be explained. Household's willingness to pay is a function of income, because willingness to pay depends on household's ability to pay and that ultimately depends on income. Health expenditure is one of the influencing factors for willingness to pay because health expenditure may increase due to poor environment. Improper disposal and irregular collection of garbage is one of the important causes of poor environment. So, it should have positive impact on household's willingness to pay. Volume of garbage is another determining factor of household's willingness to pay. Volume of household garbage depends on the family size. Larger family generates larger volume of garbage. So, volume of garbage should have a positive influence on willingness to pay. Though these variables are included as most important determining factor of willingness to pay but there are other qualitative variables like sewerage problem, municipal failure in waste management, water logging problem etc. that may have an influence on the dependent variable. Here, the dependent variable is a binary variable, so inclusion of too many dummy explanatory variables has been avoided technically, though these are included in the following multiple regression exercise (Eq. A3) where willingness to pay is treated as quantitative variable. This model can be estimated by using ordinary least square or maximum likelihood estimation method.

From this approach, significant determinants in favour of community participation can be obtained. To find the absolute value of willingness to pay (WTP) the CVM can be used. There are some cases where people are not willing to participate. Regarding this another question was asked to the respondent: If yes, how much do you want to pay per month? Those people who are not in favour of participation or sharing bidding has started from lowest range of Rs.5 and who are in favour, bidding has started from highest range of Rs.60. Finally, the population is divided into two groups. The number of household increases in favour of willingness to pay group because those who are not willing to pay earlier, some of them are now agree to pay the lowest bidding.

The demand for better environment can be represented by the absolute value of WTP of the household. The possible determinants of this demand are income, health expenditure, volume of waste, sewerage problem, water logging problem and municipal failure in waste management. The justifications of first three quantitative variables are stated earlier. Sewerage problem and water logging problem are the cause of improper throwing of garbage into road side or into drain which ultimately degrades the environment. Municipal failure in waste management also degrades the environment. These later three variables are treated as dummy explanatory variables which can be the indicator of the household's consciousness and awareness. So, demand can be influenced by the awareness and consciousness of the household. For the determination of the responsible factors of demand a multiple regression exercise have been done in the following:

$WTP_i = \alpha + \beta_1 Y_i + \beta_2 HE_i + \beta_3 W_i + \gamma_1 SPi + \gamma_2 FW_i + \gamma_3 WL_i + u_i$ .....Eq. (3)

Where**,** SPi = {1, if people thinks there is sewerage problem,

0 otherwise}

FW_i = {1 for the family that thinks municipality has failed in waste management

0 otherwise}

WL_i = {1 for those family who face water logging problem

0 otherwise}

γ's = coefficient of dummy variables.

Y_i, HE_i, W_i, u_i, α and β's are defined earlier.

Case study

2.3 Study area description

The study area Tinsukia Municipality is located in the state Assam of the north-eastern India. It is one of the largest municipalities in Assam both in geographical area and also in demographic size consisting with 15 wards and 131 lanes. Regularly, about 16 tons of household garbage and 4 tons of commercial waste are generated.[1] There are different types of waste coming from different waste generators which is mentioned in Table 1. Source – separated collection is considered to be one of the key elements to successfully practice integrated SWM. But, in the Tinsukia Municipal area storage and segregation of municipal solid waste at source is substantially lacking due to common bins for both decomposable and non-decomposable waste. Though there are some bins on the road side

[1] Das and Gogoi (2010)

for disposal of waste but it is not more frequent and most of these bins are in damaged condition. Due to lack of more frequent bins people use a portion of street as a waste disposal place which creates an unhygienic condition around it. The Municipality is unable to provide waste collection services to all parts of the city due to lack of manpower and infrastructure. Only 87 sweepers are working daily and 2 mini truck, 10 wheel barrow and 4 tractors are there for collecting this huge amount of garbage regularly[2]. The problem is compounded by resident's apathy on their role in waste management. Throwing of waste on the streets and outside home, shops etc. are a common practice (Das and Gogoi 2010). Municipality collects non-segregated mixed wastes are disposed with the help of mini truck for the land filling at Tingrai Trenching ground which is about 10 km away from the city.

2.4 Description and observation of the field survey

From the field survey of 150 households, it is observed that different people are dumping their waste regularly in different ways. Most of the people (43.33 per cent out of total sample) dumped their waste by roadside and 26.67 per cent people out of total sample dumped in vat provided by the municipal authority (Table 2). 10.67 per cent people of the sample try to compost the organic part of the waste, 10.67 per cent people of the sample incinerates their waste and 8.67 per cent people throw their waste into drain. Regarding the waste collection by municipal authority, different people responded differently. 32.66 per cent of sample households responded that the garbage collection is not regular and 42 per cent respond that municipality collects garbage once in a week which implies these areas are neglected regarding the garbage collection service (Table 3). For this irregularity, 46.67 per cent sample households inform the municipality for taking the action of garbage clearance, 22.67 per cent sample households manage by making their private arrangement and 24.67 per cent sample households do not take any steps (Table 4).

3. Analysis on Demand for better Waste Management

Open dumping of solid wastes generates various environmental and health hazards. The decomposition of organic materials produces methane, which can cause fire and explosions and contributes to global warming. The biological and chemical processes that occur in open dumps pollute surface and ground water and that ultimately affects the human health. From the primary survey it is observed that 22 per cent of the population suffered from malaria and 25 per cent of the population suffered from various types of water born disease. Throwaway culture of garbage into drain creates the water blocked situation which is a favourable situation for mosquito breeding. Mosquito breeding occurs in water containing heavy vegetation. Society can be affected by several diseases like malaria, filariasis, encephalitis etc. due to this excessive mosquito breeding in water.

The willingness to participate for the better management service is an important aspect of efficient urban SWM. It is observed that majority of the households are willing to

[2] Das and Gogoi (2010)

participate financially if household's waste could be removed regularly, additional services are provided by the municipality such as engaging in each ward to clean the garbage and keep the locality clean and pollution free. The primary survey reveals that 67.33 per cent of the population is willing to participate financially and out of these populations, 68 per cent household respond that they are willing to participate for clearance of garbage by the municipality on volumetric basis. Those (32.67 per cent) who do not support the community participation idea stated that already they pay taxes to municipal authority for their services. For this study, we have started our bidding from lowest range of Rs.5 monthly for those people who are not in favour of community participation. Table 5 shows the WTP-wise frequency of the households of different income groups. Peoples are grouped under five income groups and for bidding WTP are grouped into twelve groups. Nobody is interested to pay Rs.60. Higher income group has willing to pay more than the lower income groups. The WTP ranges up to Rs.25 for the income category under Rs.1000-5000 income groups. The WTP ranges between Rs.10 to Rs.50 for the next income group Rs.5000-10000. There are few cases where the WTP is zero and it is mainly under lower income earning people. Though there are exceptional cases, but this table reveals a clear and compact picture, where a positive association seems to exist between income and WTP.

Table 6 shows the average income, expenditure, WTP, health expenditure (HE), family members and per-capita income of the people. People under this category of low income, their average willingness to pay for better waste management, health expenditure and per-capita income is very low. The difference between the average income and expenditure of these people is very less compared to the people belonging to higher income category. Though these people want to share cost for additional services from the municipality for better waste management but their WTP is low because of their low income. Table 8 clearly shows that as the average income increases, the average WTP also increases. Thus WTP clearly depends on income. Moreover, Table 6 also shows that as the average income increases, the average family health expenditure also increases. This may be due to the reason that the poor families generally go to the government hospital where they have to pay a very less amount of money for the treatment of every disease and the rich families generally go to the private hospitals and nursing homes.

Table 7 shows the econometric result of binomial logit model by using maximum likelihood estimation (MLE) method. It is observed that volume of waste and income are significant variables of community participation. Income is significant at seven per cent level of significance and volume of garbage is significant at one per cent level of significance. The marginal effect is computed at the mean values of the independent variables. The marginal effect of income variable at the mean value of Rs.9130.33 is positive and significant at 6 per cent level of significance and for garbage volume at the mean value 16.861 kg.; it is also positive and highly significant at one per cent level of significance. Concerning the sign of significant variables, it is concluded that if income increases and volume of garbage increases, the probability that the people in favour of community participation increases. The people are ready to pay for cleaning the garbage. Now, this demand can be analyzed by quantifying community participation dummy

variable by WTP. Eq (3) is the demand equation. The econometric result of this multiple linear regression by using ordinary least square is shown in Table 8. From the multiple regression result, it is observed that WTP is affected by family income positively which is significant at less than one per cent level of significance. If family income increases by Rs.1000.00 monthly, then household have to spend Rs.16.00. The amount of monthly generated waste per household has also influence on peoples demand. The coefficient is also positive and significant at seven per cent level of significance. This implies that WTP depends on amount of garbage generated in the household. Peoples are willing to pay for additional volume of waste generation monthly. If monthly garbage generates by 100 kg., then household have to spend Rs.31. Similarly, WTP depends on failure of waste management (FW) by the municipality. This coefficient is negative and significant at five per cent level of significance. Negative coefficient implies that the people will not pay more if they feel that the municipality has not done their job properly. Their WTP depends on the performance of the municipality in providing their services adequately. Other variables are found to have no significant impact on demand.

Summary of observations and conclusion

A good percentage of people of the sample (43.33 per cent) are throwing their waste into the road side and drain. Only 10.67 per cent people throw into the proper place, though the number of bins is not sufficient. Storage and segregation of waste at source is substantially lacking. The bins are common for both decomposable and non-decomposable waste. Currently, all the waste is collected in a mixed state. But, the problem is that waste is not collected regularly. 42 per cent people of the sample respond municipality collected once a week, only 25.34 per cent respond waste collection is done more than once a week and 32.66 per cent respond it is not regular. So, irregularity of this service creates a lot of health hazard problem and that affects on inhabitants which is reflected in Table 6. MSWM services in Tinsukia is the responsibility of municipal authority, but always they are providing a less satisfactory service due to limited technical, limited manpower and financial sources. People have a demand for better management service; even they are ready to pay on volumetric basis for betterment of service. 67.33 per cent people of the sample have ready to participate for collecting waste. Though initially the rest 32.67 per cent people refused to participate in this process but finally most of these people are willing to pay at a lower rate. Only 4.66 per cent sample households are not in favour of WTP. From the binomial logit model, it is observed that the probability in favour of cost sharing have to increase with increase in income and volume of waste. These two variables are significant. Marginal effect of these two variables is also positive and significant. From this multinomial logit model, it is clear; there is a demand for better waste management. Now, this demand is assessed or quantified by using CVM study. The WTP bids are regressed on the above variables mentioned in logit model and in addition three dummy variables are incorporated in the multiple regression analysis. From this multiple regression result, it is concluded that if family income increases by Rs.1000.00, the people have to spend Rs.16.00 and have to pay Rs.0.31 if the volume of waste increases by one kg. Now, municipality can think for imposition of additional charge for providing better SWM service and for its viability as

already peoples are agree to participate financially due to their significant demand. So, community participation can be the alternative viable approach for better SWM.

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List of Tables

Table 1: Generators of waste and type of waste

Sl. No.	Sources	Type of waste
1.	Households and Institutions	Mostly organic with some plastics, glass, metals, inert materials & hazardous waste like batteries, point etc.
2.	Schools	Mostly papers
3.	Veg./fruit markets, restaurants etc.	Mostly organic

4.	Commercial centers	Mostly paper and plastics
5.	Health care facilities	Infectious & non-infectious waste

Source: Urban Waste Management: A Study on Tinsukia Municipal Board of Tinsukia District of Assam (2008)

Table 2: Household's garbage disposal method: Opinion poll

Disposal of garbage	Opinion poll (in number)	Opinion poll (in per cent)
Dump as compost	16	10.67
Dump by road side	65	43.33
Dump in vat	40	26.67
Incineration	16	10.67
Throw drain	13	8.67
Total	150	100.00

Source: Urban Waste Management: A Study on Tinsukia Municipal Board of Tinsukia District of Assam (2008)

Table 3: Opinion of the people regarding garbage collection

Frequency in garbage collection	Opinion poll (in number)	Opinion poll (in per cent)
More than once a week	38	25.34
Not regular	49	32.66
Regularly once a week	63	42
Total	150	100.00

Source: Urban Waste Management: A Study on Tinsukia Municipal Board of Tinsukia District of Assam (2008)

Table 4: Steps taken when clearance of garbage by municipality is not regular

Steps taken	Opinion poll (in number)	Opinion poll (in per cent)
Inform municipality	70	46.67
Meet councilors	9	6.00
None	37	24.67
Private arrangements	34	22.67
Total	150	100.00

Source: Urban Waste Management: A Study on Tinsukia Municipal Board of Tinsukia District of Assam (2008)

Table 5: Distribution of WTP by the households of different income groups

WTP/Income group (in Rs.)	1000-5000	5001-10000	10001-15000	15001 - 20000	20001 and above	Total
WTP 0	6			1		7
WTP 5	11					11
WTP 10	14	9	1			24
WTP 15	1	1	2			4
WTP 20	12	17	1	2		32
WTP 25	1	9	7			17

WTP 30		14	2	4		20
WTP 35		2	1			3
WTP 40		5	2	2		9
WTP 45		2	7			9
WTP 50		3		7	3	13
WTP 55				1		1
Total	45	62	23	17	3	150

Source: Primary survey, 2007

Table 6: Average income, expenditure and WTP of the households

Averages/income(Rs.)-groups	1000-5000	5000-10000	10000-15000	15000-20000	Above 20000
Average HH income	3845.56	8217.74	13391.3	18294.12	27666.67
Average expenditure	3374.89	7067.74	7826.09	99919.18	10733.33
Average HH WTP	11	25.81	36.3	37.94	50
Average health expenditure	76.89	183.87	321.74	252.94	300
Average family member	4.78	4.66	4.67	4.18	4.67
Average per-capita income	804.88	1762.98	2878.5	4380.28	5928.57

Source: Urban Waste Management: A Study on Tinsukia Municipal Board of Tinsukia District of Assam (2008)

Table 7: Econometric analysis of the logit model for community participation

	Maximum Likelihood Estimation (MLE) results	
Log likelihood function	-87.59637	
Restricted log likelihood	-94.03042	
Chi – squared	12.86811	
Variable	Estimated coefficients	Marginal effects♮ on Prob.(CP=1)
Intercept	-1.48992** (-2.059)	-0.314599** (-2.027)
Y (income)	0.000072 (1.810)	0.00001523 (1.826)
W (volume of waste)	0.108289* (2.853)	0.0228656 *(2.911)
HE (health expenditure)	-0.0008709 (-0.856)	-0.0001838 (-0.856)

Source: Urban Waste Management: A Study on Tinsukia Municipal Board of Tinsukia District of Assam (2008)

Note: ♮ Partial derivatives of probabilities with respect to the vector of characteristics. They are computed at the mean value of the explanatory variables.

*denotes significance at 1% level, **denotes significance at 5% level and t-values are shown in the parenthesis.

Table 8: Econometric analysis of multiple linear regression model of WTP

	OLS multiple linear regression model of WTP
R-square	0.46
Adjusted R^2	0.44
F test	20.64
Variable	
Intercepts	5.9682 (0.936)
Income (Y)	0.0016* (9.041)
Volume of garbage (W)	0.3114*** (1.781)
Health expenditure (HE)	0.0026 (0.491)
Sewerage Problem (SP)	1.7226 (0.867)
Municipality failed in waste management (FW)	-3.5314** (-1.894)
Water logging problem	-1.3623 (-0.705)

Source: Urban Waste Management: A Study on Tinsukia Municipal Board of Tinsukia District of Assam (2008)

Note: *denotes significance at 1% level, **denotes significance at 6% level, ***denotes significance at 7% level

t-values are shown in the parenthesis.