

# Solid Waste Management in Nagaon Town of Assam- An Application of Contingent Valuation Method



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**Abstract:** Solid Waste in urban areas, popularly known as Municipal Solid Waste (MSW) refers to materials discarded in urban areas which municipalities are responsible for collection, transportation and final disposal. The Ministry of Environment and Forest (MoEF) Govt. of India defines Municipal Solid Waste (MSW) as commercial and residential waste generated in municipal or notified areas in either solid or semisolid form excluding industrial hazardous waste but including treated biomedical waste (MoEF, 2000). The paper was based on both primary and secondary sources of data. For collection of primary data, the study used stratified sampling technique. Firstly, Nagaon Municipality Board (NMB) was the universe of the study which included 26 wards. Secondly, NMB was divided into different zones in order to cover different groups of population. Finally, the households were selected by using random sampling technique. In order to fulfill the objectives of study, the contingent valuation method was used. Finally, a logit regression model was applied in order to determine the household's willingness to pay for an improved solid waste management among the surveyed households.

**Keywords:** Solid Waste, Stratified Sampling Techniques, Contingent Valuation Method, Logit Regression Model

## I. INTRODUCTION

Solid wastes can be defined as non liquid waste materials arising from domestic, trade, commercial, agriculture and industrial activities and from public services. Solid waste is a combination of various heterogeneous waste materials, it is known as garbage, refuse, sludge from a waste treatment plant or air pollution control facility and other discarded materials, including solid, liquid, semi-liquid etc. Solid Waste in urban areas, popularly known as Municipal Solid Waste (MSW) refers to materials discarded in urban areas which municipalities are responsible for collection, transportation and final disposal. The Ministry of Environment and Forest (MoEF) Govt. of India defines Municipal Solid Waste (MSW) as commercial and residential waste generated in municipal or notified areas in either solid or semisolid form excluding industrial hazardous waste but including treated biomedical waste (MoEF, 2000)[1]. Solid wastes are unwanted materials disposed of by man, which can neither flow into streams nor escape immediately into the atmosphere.

These non-gaseous and non-liquid residues result from various human activities. These cause pollution in water, soil and air [2].

Municipal solid waste (MSW) is one of the major areas of concern all over the world today. In developing country like India, there is rapid increase in municipal solid waste due to various problems like rapid urbanization and population growth, changing life styles etc. It can be defined as the materials that no longer have any value to the person. SWM is a term that is used to refer to the process of collecting and treating solid waste. According to Ramachandra 2006, SWM includes all financial, legal, administrative, planning and engineering function [3].

Managing waste is a major problem all over the world. Currently, 1.3 billion metric tons of MSW are generated annually in the world [4] and this amount is expected to rise about 2.2 billion tons by 2025. Asian countries generated more than 3 million tons solid wastes in 2000, which may go up to nearly 9 billion tons by 2050. According to Press Information Bureau (PIB), India generates 62 million tons of wastes every year (PIB, 2016). The waste generation from Indian cities has increased by 50 percent in the past decades and continues to grow at an ever increasing rate. The total MSW generated in urban India is 68.8 million tons per day. The MSW generation in North-East region is increasing at the rate of 3% annually (Ministry of New and Renewable Energy Government of India 2017-18). The MSW generates about 1124 tons per day in Assam (Assam Urban Solid Waste Management Policy Report, 2018)[5]. In case of our study area, the total solid waste generation in Nagaon district is 48 metric tons per day (Assam Urban Solid Waste Management Policy Report, 2018). Although, the figure is (413gm per head) quite alarming the local authorities, the policy makers and general people should be aware of this problem and hence there is extreme need for proper SWM in Nagaon town.

## II. RELATED REVIEW OF LITERATURE

There are many studies on SWM around the world. However there are very few studies on the problem of solid waste accumulation, management and disposal in urban centre of India. Some of the important studies are as follows:

J. Khan et. al. (2009), in their article 'An Analysis of Willingness to Pay for Better Solid Waste Management Services in Urban Areas of District Peshawar' explained that the government in the developing countries alone cannot rectify the problems of increasing solid waste due to scarcity of resources. Hence, there was an urgent need of community participation to mitigate these problems.

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They found 49 percent of the households were willing to pay for better solid waste management in their study area Peshawar.[6] J.

Dutta (2009), in her Dissertation entitled, 'Municipal Waste Management in Guwahati City' has found that like other cities, Guwahati is also facing a serious threat from growing generation of municipal waste. Her study has also conducted to find out the preference of the people for both the Integrated Solid Waste Management (ISWM) service and the private waste collection and disposal service. She has suggested introducing the Public Private Partnership (PPP) for disposal service through NGO's and community organization.[7] D. Das and R. Mahanta (2011), in their research paper entitled 'Municipal Solid Waste Management in Guwahati –A Case study' has found that the management of municipal solid waste is a very crucial issue in the city. By applying the Logit regression model they found that the people of the city are willing to pay around Rs.60.22 for better waste management services. They also suggested that a PPP method can solve the current problem in the Guwahati City.[8] N.Ejaz and N. S. Janjua (2012), in their research paper 'Solid Waste Management Issues in Small Town of Developing world: A case Study of Taxila city' has found that open dumping and irregular collection of solid wastes create serious problem in Taxila city, Pakistan. They have also found that faulty solid waste system, rapid urbanization, industrialist insufficient funds are creating negative environmental impacts i.e. land and water pollution, infectious diseases, blockage drain and small canals and loss of bio-diversity in study area. Joel et al. (2012), in their research paper entitled 'Economic Valuation of Improved Solid Waste management in Eldoret Municipality' has found that due to increase in population growth and rapid economic expansion Eldoret city, Kenya is facing increasing generation of waste and waste collection and disposal problem. They analyse the economic value of improved Solid waste Management (SWM) with 199 sample household respondents in study area. A. T. Roy, U. Deb and R. Mazumder (2013), in their research paper namely 'Sustainable Urban Waste Management in Silchar Municipal Area: An Application of Contingent Valuation Method in Cachar District of Assam' has found that the Willingness to Pay (WTP) for sustainable Solid Waste Management (SWM) scheme in Silchar. By using probit regression model, they determine the various socio-economic characteristics affect the decision regarding WTP for waste management. They used primary data to analyze the WTP for SWM scheme. They have suggested that municipal authority should focus on responsiveness campaigns about consequences of waste mishandling and benefits of payment for proper SWM in Silchar[9]. A. Debnath and A. Mitra (2017), in their research paper entitled 'Urban Solid Waste Management in Itanagar Municipal Area of Arunachal Pradesh-An Application of Contingent Valuation Method' has estimated that the willingness to pay among the respondents of Itanagar municipality area based on primary data. By using Contingent Valuation Method (CVM) they identified the determinants of Willingness to Pay (WTP) and showed that the educational attainment of respondents, income of households and environmental awareness were positively and significantly affects the maximum WTP for improving solid waste management in Itanagar town[10]

### III. OBJECTIVES OF THE STUDY

The objectives of the present study are as follows:

1. To examine the quantity of solid waste accumulation in Nagaon Town of Assam.
2. To study the existing management scenario of solid waste in Nagaon Town of Assam.
3. To identify the Willingness to Pay (WTP) of the people of Nagaon town for local private services to collect and dispose the waste.

#### A Brief Introduction of the Study Area

Nagaon is located in the central district of Assam. Nagaon district is situated in heartland of Assam and it is a center of whole Northeastern province of India, and lying along with South bank of Brahmaputra River. The Nagaon district is bounded by Brahmaputra river and Sonitpur district in north, North Cachar hills or Dima Hasao district and Hojai west Karbi Anglong in south, East Karbi Anglong and Golaghat district in the East and Morigaon district in West side. The Nagaon district lies at a distance of approx 123 kilometers by road from Guwahati, capital of Assam. Nagaon is well connected by National Highways mostly NH36 and NH37 and other state roads. Nagaon is also connected by Indian Railway network with two important junctions- Chaparmukh and Lumding and other important stations that is Nagaon, Haiborgaon, Dhing, Silghat, Kampur. Nagaon town is the Administrative Headquarter of the Nagaon District in Assam, India. It is a town with an area of 9.22 square kilometer. Nagaon is a non industrial town with an area extending from 26°20'14" North to 26°22'05" North latitude and from 92°40'02" East to 92°42'56" East longitude. Nagaon town has 26 wards having 14,686 households with population of 1, 17,722.

#### A Brief Introduction of Nagaon Municipality Board (NMB)

Nagaon Municipality Board (NMB) was established in the year 1893 in the district of Nagaon, Assam. The total area under NMB is 9.22 square kilometer and the numbers of wards are 26. According to 2011 census, the ward wise population is 1, 17,722 and the total number of households of Nagaon Municipality Board (NMB) is 14,686. The total number of workers (daily wages) are 164 and the total sweepers are 91 (total Brooms are also 91 as per worker), they work for 1 hour daily and get rupees 2000 per month of Nagaon Municipality Board (NMB). The Nagaon Municipality Board (NMB) transported the Municipal Solid Waste by two tipper trucks, three tractors with trailer, the total number of Handcars are eighteen and there is one compactor, all vehicles are covered by tripal during working time. The total numbers of dustbins are 104, which are providing by government. The total volume of Solid Waste generated in Nagaon town per day is 59 metric tons. There is a door to door garbage collection facility in this locality provided by Nagaon Municipality Board (NMB) only for 7 wards. From each households within seven wards, rupees 50 is collected for this service by NGOs and SHGs. The proposed site for processing waste and disposal facility is located at Sensuwa, which is 8 kilometers from town area, this area is taken as rent by NMB temporarily. This is depicted in table 1.



**Table 1: Basic Data of NMB**

NMB total area	9.22 square kms
Number of Wards	26
Total population (census 2011)	1,17,722
Total Employees	265
Total workers (daily wages)	164
Total sweepers	101
Total Waste generation (per day)	59.1 metric tones

Source: Nagaon Municipal Board, Nagaon

There are various numbers of equipments and vehicles available in NMB for proper or suitable management of MSW. These are shown in following table 2.

**Table 2 List of Numbers of Equipments and Vehicles**

Equipment/Vehicle	Number
Excavator	1
Excavator (Phoak lane)	2
Hand cart	26
Skid loader	2
Compactor	2
Tipper Truck (5cm capacity)	1
Tipper Truck (3cm capacity)	10
Tipper Truck (1.5cm capacity)	2
Tractor	3
Tractor Trolley	6
Try-Cycles Rickshaw	52
Hydraulic Tricycle	6
MS Container	30
PVC Container	25
Total Dustbins	104
Total Brooms (as per sweeper)	91

Source: Nagaon Municipal Board, Nagaon.

#### IV. METHODOLOGY OF THE STUDY

The study was empirical in nature, which is mainly based on primary data. For collection of primary data, the study used stratified sampling technique. And the study used both primary and secondary data. The study was basically based on multistage sampling technique. The different stages are as follows:

In the first stage, Nagaon town was purposively selected. Nagaon Municipality Board (NMB) was the universe of the study which included 26 wards. In the second stage, the NMB was stratified into three different zones to cover different groups of people in Nagaon town:

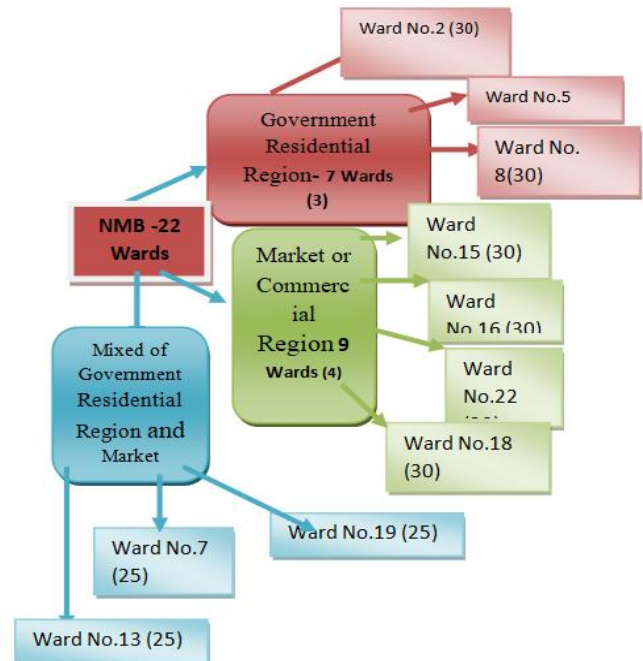
- Government Residential Region
- Market or Commercial Region
- Mixed of Government Residential Region and Market or Commercial Region

Finally, an attempt was made to include the sample from the three regions of the town and household was selected randomly for each group. For this purpose the questionnaire

was prepared and an attempt was made to include the following information in the questionnaire:

- Quantity of total waste generated.
  - Type of waste problems, type of collection services etc.
  - Household perception towards garbage problems of the town.
  - Level of Education, income level, years of living and other socio-economic characteristics of the respondents.
- The details were given in following block diagram 1.1.

**Block Diagram 1.1  
Design of Sample Survey**



Note: Figures in bracket indicate the number of sampled wards and number of sampled households.

The total sample size was almost 200 households which consisted of around 2 percent households Nagaon town as per 2011 census. In order to conduct survey, a questionnaire was prepared. The questionnaire was divided into three major sections and all together 37 questions which are as follows:

- The first section was dealt with the socio-economic profile of the households.
- The second section dealt with the environmental attitudes and perception.
- The third section provided the existing situation regarding waste facing by the respondents followed by willingness to pay for the improved environmental services.

The door to door sample household survey was carried out for the collection primary data. In order to gather proper information, first the market for the product was introduced in front of the households along with a brief idea on the present situation of solid waste management and problems so that if any household was not familiar to the solid waste management procedures, they might have an idea and inspiration about the reality and the fact.



With the discussion and conversation, their responses were recorded in the required columns of the designed questionnaire.

## Model Specification

To know the Willingness to pay for surveyed household in Nagaon town, the Logit regression model is used. Logit Model or logit regression or logistic regression model can be defined as a uni and multivariate technique that permits for estimating the probability that an event occur or not through the prediction of a binary dependent outcome from a set of independent variables [11] and it was developed for the first time by David Cox in 1958.[12] It is used to analysis the relationship between a dichotomous dependent variable and metric or dichotomous independent variables. Logistic Regression combines the independent variables to estimate the probability that a particular event will occur or not, it is a non linear regression model that forces the output (predicted values) to be either zero or one. With this background it was found that our analysis consisted of two groups of respondents. Whereas one group were willing to pay for 'Improved Solid Waste Management Scheme' and another group did not. The surveyed respondents expressed their decisions about willingness to pay by replying 'Yes' or 'No' responses. Hence, the dependent variable in our analysis was a dummy variable. The analysis of this type of models is generally done by using Logit or Probit regression model due to their ability to deal with a dichotomous dependent variable. Besides, out of these two models, which model gives better result is determined by the distribution of the error term. When the error term of regression model follows logistic distribution then logit model is applied. But if the error term follows normal distribution then probit model is used (Mazumder, 2013, p. 28). This study used dichotomous logit regression model with a view to determine the effect of various socio-economic characteristics of willingness to pay for improved solid waste management in Nagaon town.

By reviewing various literature of solid waste management, it was found that willingness to pay of the respondents for better solid waste management mainly depends on the factors like Level of Educational Attainment (Years), Size of Family, Households' Income, Respondents' age, gender, civil status, Years of living in Nagaon town, number of the income earners in the family, marital status, knowledge of the respondents about the ill effects of waste on environment etc. [13], [14]. These factors are the primary determinants of the willingness to pay. Hence, a WTP function for solid waste management services in the present study can be formulated as follows:

$$WTP = f(Y_h, EDU, Fs, YL, AGE, Es)$$

Where,

WTP = Willingness to Pay for an Improved System of Solid Waste Management. (Households willing to pay are given a score of 1; others are given zero in binary model)

$Y_h$  = Households' Income

EDU = Level of Educational Attainment (Years)

$F_s$  = Size of Family

YL = Years of living in Nagaon town

AGE = Respondents' age

Es = Environmental awareness

The mathematical form of the model can be formulated as follow:

$$\ln(WTP) = \frac{1}{1 + e^{\beta_0 + \beta_1 Y_i + \beta_2 E_i + \beta_3 F_i + \beta_4 L_i + \beta_5 A_i + \beta_6 E S_i + \epsilon_i}}$$

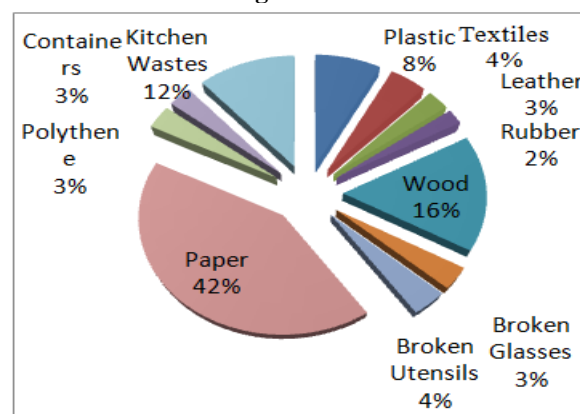
The study was also taken the help of secondary data collected from various published and unpublished sources like the Census of India Publications, Basic Statistics of North Eastern Region published by North Eastern Council, and other published and unpublished data available with Census Authorities, the Directorate of Economics and Statistics, Human Development Report, Nagaon Municipal Board (NMB), Websites of Central Pollution Control Board (CPCB), Draft of 'Assam Urban Solid Waste Management Policy, 2018', Press Information Bureau [15], Ministry of New and Renewable Energy Government of India, 2017-18, etc.

## V. RESULTS AND DISCUSSION

### Composition of Solid Waste in Nagaon Town

It is necessary to estimate the per capita waste generated as well as composition of waste products from household sample survey. However, our sample survey in 2019 shows that Nagaon town produced 68.63 tons solid waste produced per day. This survey also shows the composition of different types of waste product generated by household in Nagaon town, which is furnished in figure 1

**Figure 1 Percentage Composition of Solid Waste in Nagaon Town**



Source: Field Survey, 2019.

Figure 1 shows that paper wastes are consist of the highest portion around 42.15 percent followed by kitchen waste 11.62 percent. In our survey, plastic and broken glasses are consists of only 7.68 percent and 3.30 percent respectively out of total wastes generated by households.

### Result of Logit Regression Model

The estimation of logit regression model shows the relationship between WTP of the respondents of waste collection and disposal service and selected socio- economic characteristics of the respondents.

The estimated results of the logit regression model were put in following table 3.

**Table 3 Result of Logit Regression Model**

Independent Variable	Coefficient( $\beta$ )	S.E.	Wald
Age of Respondent	-.106	.309	.118
Education	-.337	.209	2.598
Family Size	.057	.150	.144
Household Income	-.591	.198	8.903***
Year of Living	.017	.392	.012**
Environmental Awareness	8.945	1.018	7.201***
Constant	-5.260	2.032	2.156***

**Hosmer and Lemeshow Test:** Degree of freedom= 8

Significance=0.59

Chi-square= 11.723

*Note: \*\* and \*\*\* indicate 0.05 and 0.01 level of significance respectively.*

*Source: Authors' Calculation from Field Survey, 2019.*

The result of logit regression model which is showed in table 3 that year of living and environmental awareness has positively determined the willingness to pay for improve solid waste management system in Nagaon town. From the result it is found that year of living positively influenced the willingness to pay for improved solid waste management and it is statistically significant at 0.05 levels. This indicates that local people of Nagaon town are more concern regarding environmental sanitation of the locality.

Table 3 shows that environmental awareness of respondents another positive but significant determinant of willingness to pay which is statistically significant at 0.01 levels. This is showed that environmentally concerned people of study area would be willing to pay more for better management service.

However, another variable i.e., family size of respondents, which is included in the model have positive coefficient but it is not significant.

It is surprising to observe that household income was negatively related to willingness to pay but it is statistically significant at 0.01 levels.

Finally, it is found that Hosmer and Lemeshow Test in our analysis had significant value (0.59) which is greater than 0.05. If the significance value of Hosmer and Lemeshow Test is less than 0.05, it would indicate that data was poorly fitted in the model. But in this analysis it was 0.59, hence, it indicated that the model was significantly fitted the data.

When the respondents are asked whether they would willing to pay the Government prescribed money per month Rs. 40 for 'Integrated Solid Waste Management' programmed, then majority of the respondents (94.5 percent) have replied that they are ready to pay to government or any other NGOs or agencies for better solid waste management system. The study shows that Nagaon town produces 68.63 tons solid waste produced per day. The quantity of MSW generated in Nagaon town is estimated to be about 59 metric tons per day in 2018. It has been seen that the generation of MSW is increasing day by day in

Nagaon town. It is found that paper waste consisted of the highest portion around 42.15 percent followed by kitchen waste 11.62 percent, plastic and broken glasses consisted of only 7.68 percent and 3.30 percent respectively out of total wastes generated by households. The result of logit regression model which is showed that year of living and environmental awareness has positively determined the willingness to pay for improve solid waste management system in Nagaon town. From the result it is found that year of living positively influenced the willingness to pay for improved solid waste management and it is statistically significant at 0.01 levels. This indicates that local people of Nagaon town are more concern regarding environmental sanitation of the locality. From the results, it is also found that environmental awareness of respondents another positive but significant determinant of willingness to pay which is statistically significant at 0.1 levels. This is showed that environmentally concerned people of study area would be willing to pay more for better management service. However, another variable i.e., family size of respondents, which is included in the model have positive coefficient but it is not significant. It is observed that household income is positively related to willingness to pay but it is statistically significant at 0.01 levels. On the basis of these findings, the following policy recommendations are suggested for proper management of solid waste management in Nagaon town.

- It is found that majority of surveyed households (94 percent) are willing to pay for an improved solid waste management in their locality. Nagaon Municipality Board (NMB) may introduce door to door collection service daily on payment basis to make the town cleaner and hygienic.
- It is surprised to observe that most of the respondents do not know about final disposal of waste products. Hence, an awareness program among the residents is necessary so that the present system of dumping garbage in open landfill sites at Sensuwa (Nagaon) can be stopped immediately as ill effect of such open disposal dumping causes environmental problems and health hazards to the local people and the pedestrians. Hence, sanitary landfill must be accomplished as soon as possible.
- One of the important components of efficient solid waste management system is making aware of people regarding the cleanliness of neighborhood and proper solid waste management. People should be educated regarding the concept of four R's i.e. Reduce, Reuse, Recycling and Recovery for minimize the problem of disposing municipal wastes.
- Government should introduce the concept of Public Private Partnership (PPP) to solve the solid waste management problem smoothly.

## VI. CONCLUSION

Thus the study highlighted a number of important issues relating to an important emerging environmental problem of Nagaon town of Assam. However, the fact is that the issues are too broad to be captured in a single framework.

Hence, it is expected that the present study will form the basis of future research work on this less explored but economically and socially relevant field of study relating to the entire North Eastern Region.

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