The purpose of this study is to determine whether household in Silchar are willing to pay for improved waste collection and disposal facility. The survey is in the quest of finding out the monetary value that households are able and willing to attach for an improved waste management service. The study determines the coping mechanisms adopted by households in Silchar to alleviate the impacts of unreliable waste collection and poor or unsafe disposal facility, and the related costs incurred.

Poor solid waste handling is threatening the lives of Silchar residents. To improve this pressing problem the government and other stake holders have to put maximum effort. The problem is usually inadequate management compared to solid waste generation in Silchar town. In line with this, it is very important and timely to look for the possibility of cost sharing by households, and for this we need to analyze the demand side for improved solid waste management. This study is designed to generate demand side information, which is vital for the planning process. The study therefore examines the willingness to pay of households for sustainable solid waste management scheme in Silchar municipal area.

Environmental valuation methods are ultimately relying upon individual preferences. These are divided into two approaches- direct methods and indirect methods. Direct methods are based upon expressed preferences elicited through questionnaire surveys. For the present study a direct method of valuation, namely the Contingent Valuation Method (CVM) under Discrete Choice (DC) framework is adopted to estimate the households
willingness to pay (WTP) along with its determinants for a sustainable urban waste management service in Silchar municipal area.

In this chapter Contingent Valuation Method (CVM) is discussed in detail and also discuss about the rationale behind the selection of CVM. Selection of tools, processing of data, survey design and sampling procedure of the present study is also explained in this chapter along with application of various methods on Willingness to Pay (WTP).

4.1 Rationale behind Selection of Contingent Valuation Method (CVM)

Economic valuation is about “measuring the preferences” of people for an environmental good or against an environmental bad. The economic value of something is measured by a summation of many individuals’ willingness to pay (WTP) for it. The WTP reflects individuals’ preferences for the good in question. Valuation is in money terms because of the way in which preference revelation is sought. i.e., by asking people how much they are willing to pay. Many of environmental goods and services are provided freely. Therefore, they have zero prices because no market place exists in which their true values can be revealed through acts of buying and selling. Projects and program appraisal cannot be sufficient or adequate without valuation. National priorities for environmental policies are better informed if economic values are known with a degree of certainty (Pearce, 1993). Economic valuation of environmental goods has found vast application in determining compensatory payments for environmental damage (Willis and Corkindale, 1995). Valuation techniques are also applied to the more immediate human environment, such as water supply, waste management and sanitation. This study employs the Contingent Valuation Method (CVM) to determine the willingness to pay for improved waste collection and disposal system in Silchar. The CVM is a survey-based technique of monetary valuation used to elicit people’s preferences expressed in terms of WTP. The CVM utilizes an appropriately designed questionnaire (or experiment) to elicit the
valuations or bids of households about a decrease or increase in the amount of an environmental good, and how much they are willing to pay or to accept compensation in order to avoid an environmental damage. The assumption is that a market for environmental goods and services exist (Pearce and Turner, 1990). It makes use of bidding games for approximating the willingness of households to pay for an environmental service. The CVM can be carried out by several ways such as the use of (1) direct questionnaires, (2) face-to-face interviews, (3) mail surveys, and (4) telephone. Single bid games, also known as the single open-ended, is also used in this study. This is where the respondent is asked to mention the amount he or she is willing to pay for a service described by the interviewee. A CV study needs three basic things. First, the respondent should be given detailed information about the service to be valued and the hypothetical scenario under which it is made available. For example, the structure under which the service is provided, the range of available substitutes and the method of payment. Second, a method which elicits respondent’s willingness to pay (WTP) is required. The respondents are asked for their maximum WTP (e.g., per month). Third, demographic information (such as age, gender, income, education) is needed to estimate the valuation function for the environmental service. The data obtained are used in regression analysis to estimate how the values are related to the respective demographic variables based on theory.

A CVM exercise basically involves informing the respondent about the prevailing situation (prices, environmental conditions, etc), and then informs him/her about a change. The individual is asked to value a particular change in environmental conditions in a future hypothetical scenario. Contingent Valuation evolved as a method to quantify the benefits of non-market environmental goods and attributes in order to allow them to be entered directly into cost-benefit calculations. CVM have the advantages over the other methods of environmental valuation such as the travel-cost and hedonic pricing techniques. The
method is able to quantify some types of benefits, such as non-use or passive use benefits, which lie outside the scope of travel-cost and hedonic pricing studies. CVM is able to measure passive use values and this has led to many applied environmental economists choosing it (Hanemann, 1991).

However, critics of CVM are critical of the reliability and validity of answers to hypothetical WTP questions. They argue that the method is prone to a number of difficulties (or biases). First, there is always the possibility of strategic behavior. Respondents may understate their willingness to pay if they feel that they can free-ride or they may overstate their willingness to pay. This can arise if they feel that the provision of the superior situation is not conditional on their actual payments. Therefore, a careful design of the questionnaire and description of the service is needed to minimize this kind of bias. Second, the respondents may answer only to please the interviewer. Third, there exist the hypothetical nature of the process calling for careful structuring of questions to inform respondents about the relevant points, and not overloading them with unnecessary description. It is therefore argued that precise assessments of the environmental change need appropriate information provision. Fourth, a range of other problems that are coupled with contingent valuation incorporate responses bias and starting point biases (Mitchell and Carson, 1989). Moreover, the cross-sectional Contingent Valuation studies have tended to have low R-squared, though; R-squared is used to demonstrate that WTP amounts are not random responses. Mitchell and Carson (1989) have indicated that the reliability of a CV study which fails to show an R² of at least 0.15, using only a few key variables, is open to question. These biases are a result of difficulties for households in perceiving the hypothetical or contingent market or from choice of starting point of bids (Pearce and Turner, 1990; Jimson, 2001). Even with all these biases, accurate estimates of WTP can be made. Generally, the CVM has found vast applications in case of developing
countries. It has surpassed other environmental resources valuation techniques. Contingent Valuation can specifically estimate WTP for an environmental good or service.

4.2 Contingent Valuation Method (CVM)

The Contingent Valuation Method (CVM) was first used by Davis (1963) in a study of hunters in Maine for the valuation of environmental goods. Since mid-1970s, the method has become the most widely used and most controversial of all environmental valuation techniques. Carson (1991) describes six main components to a successful CVM study:

A. Defining the Hypothetical Market Scenario

In the first stage, a hypothetical or contingent market is set in which individuals are simply asked how much they are either willingness to pay (WTP) or willingness to accept (WTA) in respect of the proposed change in provision of the good under investigation. The market scenario is the information to be conveyed to a respondent, to place the respondent in the right frame of mine to give meaningful responses to questions. One of the decisions to make is how to define the good to be valued. If a town has been harmed by poor waste management system, then what environmental service should be valued which may be a door to door collection of waste or providing bins in the locality.

It is also important to describe the context within which the service is supplied. If it is a door to door collection, how payment would be made and it may be a tax fee or a charge.

It is also vital that the description of the market in a realistic manner to the respondent and at the same true to the eventual economic model which will be used to analyze the collected data. If the market scenario is not understandable and believable to the respondent, the data will give robust results.

The payment mechanism is also an important issue in constructing the market scenario. The market scenario must be rooted in real-world experiences, including the payment
vehicle. Thus if the service is avoiding poor waste management, then a believable payment vehicle might be a tax on collecting and disposing waste. It is also important to avoid a scenario that irritates respondent’s notion of right and wrong.

It is also important to provide a right context for the survey. For example, in valuing safe and hygienic waste management, most people know a little about safe waste management. So that to get meaningful responses to questions on this topic, some information will probably needs to be provided to respondents. Obviously, tie and other constraints allow very little education of respondents in the course of administering a survey. This raises the question of bias introduced by incompletely or inaccurately “educating” the respondent.

The NOAA (The U.S. National Oceanic and Atmospheric Administration) Panel makes several recommendations regarding the market scenario. One point they make is that respondents should be reminded that substitutes exist. For instance, in ascertaining the value of a waste management service in city unhygienic by growing human settlement in the city’s geographical area, the respondent should be reminded that there are many sources of pollution in city. The Panel suggests that the survey should be designed to avoid generating spurious emotions, such as a dislike of “big business”. The Panel also urges that there be checks within the questionnaire to be sure that the respondent understands and accepts the information in the survey.

B. Choosing Elicitation Method

After properly defining the market scenario, the next step is to decide how best to obtain the valuation response. This is obviously a very important part of the survey and one of the most difficult to administer effectively. There are four primary ways of eliciting value: (i) open-ended (OE), in which the respondent is asked ‘how much are you willing to pay?’ for preservation or conservation of environmental resources, (ii) dichotomous choice (DC),
where respondents are asked ‘are you willing to pay Rs. X?’, the amount X being systematically varied across the sample to test individuals’ responses to different bid levels. This approach produces a discrete bid response variable and may be iterated using higher or lower bid amounts depending upon the respondents’ replies to previous amounts; (iii) iterative bidding (IB), in which a series of DC-type questions are followed by a final OE; (iv) payment card (PC), in which respondents select their maximum WTP amount from a list of possible sums presented on a card to them.

The dichotomous choice (DC) or referendum approach is recommended by the NOAA Panel because they thought it minimizes possible bias and is also familiar to the respondents who often vote yes/no on public decision making process. One problem with referenda is that more data are needed to obtain statistically significant results and this raise the cost of the survey.

C. Design Market Administration

Having design the survey, it must be administered, i.e. complete the survey and respondents responses are assembled. There are basic approaches to survey administration: mail, telephone and in-person.

Mail survey is the cheapest to administer, although they have problems. One problem is no response. A mail survey is considered a success if only if 30 per cent of the surveys are not returned. Another problem with mail surveys is that the respondent needs to understand the survey instrument. Therefore the survey must be relatively simple.

Telephonic surveys are also relatively inexpensive to administer. However, telephone must be widely available within the population being surveyed. There may also be bias in terms of who answers the telephone call. For example, unemployed people may be more likely to be available. Another problem with telephone surveys is that visual cues cannot be used
(e.g., photograph). This may lead to problems in eliciting values regarding changes in environmental quality, since photos are often used to express the nature of the changed quality.

In-person surveys are the most expensive to administer but can be the most reliable. The NOAA Panel recommends the in-person surveys to collect the data in a CV type study. One problem with an in-person survey is interviewer bias. It is difficult for an interviewer to always appear neutral when conducting an interview. Furthermore, since environmental goods are often perceived as desirable and socially “correct”, respondents may be reluctant to reveal their unwillingness to pay if in fact they do not view the environment as very important (in the words of the NOAA Panel, “social desirability bias”).

Another issue in market administration is pre-testing of the survey. The NOAA Panel emphasizes the importance of exhaustive pre-testing of the survey instrument before the actual survey is conducted. This would include very careful analysis of the wording of each question and the organization of the survey. The survey can then be administered to test groups and adjusted based on feedback.

D. Sample Design

There are two issues in choosing the people to answer the CV questionnaire. The first is to choose the group or population from which the sample is to be drawn and second is to draw the random sample.

E. Experimental Design

The goal of a CV survey is to develop statistically significant estimates of willingness to pay for a particular environmental good or to test a hypothesis about the willingness to pay for the hypothetical good. Considering the cost of data collection, it is important to
construct the survey carefully so that appropriate information is collected in an efficient manner without unintentional biases. This is the process of experimental design.

F. Estimation of WTP Function

The last step is to take the survey results and correctly estimate the WTP function. This is obviously an important step. Sometimes this step is neglected until after the survey has been conducted, only to find that some vital piece of information is needed but was not collected on the survey. This outcome would suggest a defective experimental design.

4.2.1 CVM Guidelines from the NOAA Panel

In 1992, the U.S. Government decided that contingent valuation (CV) had become so important to its management of environmental resources that a high-level review was needed on the validity of the CV method. The U.S. National Oceanic and Atmospheric Administration (NOAA) got the responsibility of writing regulations under the 1990 Oil Pollution Act, convened a panel of six distinguished economists (Robert Solow, Kenneth Arrow, Edward Learner, Paul Portney, Roy Radnor and Howard Schuman) and survey researchers to evaluate the CV method. The NOAA Panel concluded that CV could be useful, but certain practices would seem to be necessary to generate reliable estimates of WTP. These recommendations had a significant influence on the results of a CV survey. The principal recommendations are as follows:

1. A dichotomous choice format should be used.
2. A minimum response rate from the target sample of 70 per cent should be achieved.
3. in-person interviews should be employed (not mail shots), with some rule for telephone interviews in the piloting stages.
4. WTP, not WTAC, measures should be sought.
5. After excluding protest bids, a test should be made of whether WTP is sensitive to the level of environmental damage.

6. CVM results should be calibrated against experimental findings; otherwise a 50 per cent discount should be applied to CVM results.

7. Respondents should be reminded of their budget constraints.

4.3 Selection of Tools

Collection of data is one of the most important parts of a research work. The data serves as the base or raw materials for analysis. Without an analysis of factual data, no specific inferences can be drawn on the question under study. The relevance, adequacy and reliability of data determine the quality of the findings of a study. Thus, the scientific process of measurement, analysis, testing and inferences depends on the availability of relevant data and their accuracy. So, in a research work, it is very much necessary to select reliable and valid tools of data carefully to getting valid and reliable data.

To achieve the main objectives of the present study, primary data are essential. The primary data are those which are collected afresh and for the first time, and thus happen to be original in character. The necessary secondary data for the present study are collected from the Silchar Municipal Board. In the present study, a face to face interview is carried out through a structured schedule to collect the necessary primary data, which are essential to attain the objectives of the present study from the households of Silchar municipal area. The interview or survey schedule is divided into nine different sections, which are as follows:

A. Section I: Particulars about the Respondent

Selected members of the sample households of Silchar municipal area are the respondents of the present study. This section encloses information regarding location, level of
education, age, sex, occupation, income, mother tongue, length of residing in the location, type of dwelling unit and monthly expenditure of the family.

B. Section II: Present Status of Drainage System in the Locality

This section includes information on water logging problem, sewerage system, clearance of drain, steps against irregular clearance and mosquito problem in the locality.

C. Section III: Households’ Attitude regarding Waste Disposal Practices

This section includes mere information on households’ disposal habits regarding daily waste generated which include food waste, environmentally hazardous waste and electronic waste. It also focuses on frequency of collecting garbage from the para by municipality. If the service from municipality is not available what are the alternatives households used to take is also quested. Cost of private arrangements is also traced for disposing waste.

D. Section IV: Household’s Observations Regarding Visible Solid Waste in Public Places

In this section observation of households’ regarding solid waste in public places is examined which is important for analyzing the current waste management scenario in the ton.

E. Section V: Household’s Awareness Regarding Solid Waste Management

It is also core part of the schedule and this part of the interview schedule is designed to have an idea of households’ awareness regarding current waste management scenario in the locality.

F. Section VI: Household’s Outlook on Solid Waste Management

This section analyses the approach of the residents of Silchar towards the problem of waste management and also information regarding possible alternatives to solve the problem of
mismanagement. This section also collects information regarding some measures that are useful for increasing the level of awareness among the households on solid waste management.

G. Section VII: Household’s Opinion on Drainage and Waste Disposal System in Silchar

This section catches the opinion of the residents of Silchar Municipal Area regarding drainage and waste disposal system and the reason behind bottlenecks of these systems. It also examines the commitment level to keep the town clean and safe.

H. Section VIII: Willingness to pay for an improved Waste Collection and Disposal System.

This is the main part of the schedule and it is designed to elicit households’ willingness to pay (WTP) for improved waste collection and disposal system in Silchar municipal area. For that at first the present waste management scenario is presented including expenditure, manpower and equipments regarding waste management. After that hypothetical market scenario is constructed and in this hypothetical respondents are asked to state their WTP for improved waste management. The voluntary payment vehicle has been adopted as the mode of payment.

I. Section IX: Information about Household’s Socio-Economic Status

This section includes information regarding socio-economic ground of all the family members of the sample households. This includes relationship with respondents, age, sex, educational qualification, occupation and income per month which are essential for regression analysis in CVM.

4.4 Processing of Data

The data, after collection, has to be processed in order to analyze and to draw conclusions. This is essential for scientific study and for making contemplated comparisons and
analysis. Processing of data implies editing, coding and tabulation of collected data so that they are amenable to analysis.

(A) Editing

Editing of data is a process of examining the collected raw data to detect errors and omissions and to correct these when possible. It involves a careful examination of the completed questionnaire and/or schedules. Editing is done to assure that the data are accurate, consistent with uniformly entered, as completed as possible and have been well arranged to facilitate coding and tabulation. In the present study, all 378 schedules are completely filled up during interview in Silchar and during the survey period all the completed schedules are also scrutinized one by one carefully.

(B) Coding

Coding refers to the process of assigning numerals or other symbols to put the responses into a limited number of categories or classes. In the present study, both quantitative and qualitative data are collected on the basis of extensive literature review and to measure the qualitative data in quantitative form, some numbers are assigned by using the process of coding.

(C) Tabulation

In a research work when a large number of raw data has been assembled, it is necessary to arrange the same in some kind of concise and logical order. This procedure is referred to as tabulation. Thus, tabulation is the process of summarizing raw data and displaying the same in compact form (i.e., in the form of statistical tables) for further analysis.

In the present study, socio-economic characteristics of the households are described and interpreted in tabular forms. The objectives of the study are also analyzed and interpreted using numbers of tables.
4.5 Sampling, Design of Survey Questionnaire and Elicitation Format

In the present study, primary data are used to estimate the willingness to pay (WTP) for sustainable urban waste management scheme in Silchar municipal area. Silchar Municipal Area, an area with a high concentration of the working population was purposively selected. It is implicitly assumed that Contingent Valuation would be appropriate to apply in this area, as the population is relatively more educated. This is mainly because Contingent Valuation works effectively if it is applied to a more educated and informed population. Silchar Municipality has 28 wards under it. The ward wise household list is first collected from the Silchar Municipality Office. There are a total of 19652 households under Silchar Municipality. Of the total number of households, 2 per cent of households from each ward was selected the total of which is approximately 378 households for an interview. In order to conduct the dichotomous choice type of CVM, the 378 selected households were randomly arranged into six subgroups of equal size (63 households in each subgroup). This randomness was ensured through random selection with the help of MS Excel worksheet. This sampling was done without replacement as a result of which the population size declines with every sampling drawing. In step one 63 households were randomly selected from the entire list of 378. In step two a fresh sample of 63 households were selected from the remaining list of 378-63=315 households and so on. In this method, declining population size with every selection is inevitable. Before the CVM survey was conducted these random subgroups of 63 each was first prepared and the bid levels were assigned to each of these six subgroups starting with Rs. 50 and ending at Rs. 300.

The structured questionnaire, pretested in a pilot study was used. The questions were designed to get the most precise data for econometric analysis of willingness of pay. A pilot survey is carried out in the month of December, 2010 to pre-test the interview schedule of this study. It is done by questioning 60 households in Silchar with the intention
of see how well it serves the rationale of obtaining necessary data for attaining of this study. Accordingly, minor necessary changes were made in the schedule like-minor changes in CV queries to formulate them in a comprehensible form, exclude the extreme bid amounts in dichotomous choice of CV questions, etc.

4.6 Dealing with Survey Biases

Contingent valuation method (CVM) is basically based on a hypothetical market situation and so there exists some biases. It is very much essential to reduce these biases to a minimum level, otherwise it gives robust results. The survey instrument of the present study is very much carefully and consciously designed and administered to control these sources of bias.

‘Hypothetical biases’ arise in CV survey because respondents are replying to the CV questions in a hypothetical market situation. In the present study, the date of collection of willingness to pay (WTP) amount is also mentioned in the survey instrument to reduce these biases or to make the situation more real one.

‘Interviewer biases’ may exist if telephone or in-person survey is used to collect the necessary data for a particular study. This bias arises because the respondents try to shape their answers to upgrade their status in the eyes of the interviewer. However, it is possible that this issue could remain considerable in some context. So the respondents of the present study are randomly selected to collect the necessary information.

The choice of the payment or bid vehicle can also affect the WTP results. The ‘payment vehicle biases’ ‘arises because the respondents may have preference for a particular bid vehicle. The vehicles most frequently used in CVM studies, such as utility bills, entrance fees, taxes and higher prices are likely to be familiar to most respondents. To avoid these biases in the present study simple donation or contribution type of voluntary payment
vehicle is set to keep away from the complicacies of other involuntary payment vehicle like income tax. It is familiar that respondents have positive feelings and preferences towards voluntary payment vehicles.

‘Starting point bias’ arises in the iterative bidding game when the initial bid influences respondent final bids. In theory, the starting bid is merely a tool for initiating the bidding process and should not affect respondent final bids. The starting point bias might arise when the item being valued is poorly defined or not distinctly perceived by the respondent. In the present study, very carefully a pilot survey is carried out and the extreme bid amounts are removed in the final survey to reduce these biases. The respondents also get only one particular randomly assigned bid amount in CV survey of the present study, not a range of bid amounts like Rs. 10 to Rs. 20, to minimize the starting point bias.

‘Information bias’ or ‘embedding bias’ arises due to the lack of appropriate or relevant information to the respondents for stating his/her value judgment correctly. The hypothetical market scenario in the CV survey is constructed according to the recommendations of the NOAA Panel to reduce these types of biases in this study and as well as certain important information is also provided to the respondents while conducting interviews.

1. Income of the respondent is limited and it has various other essential uses in their daily life.

2. There are many other environmental issues like clean drinking water, proper sanitation, and noise and air pollution apart from waste management in Silchar.

3. Silchar is an important town in respect of social, cultural and commercial ground. So a clean and hygienic environment is required for residence.

4. These matters which are mentioned here are only a few among many others environmental evils that Silchar faces.
All these not only deal with respondents’ budget limit and helped in reducing hypothetical bias but also it is help to overcome the embedding effects.

### 4.7 The Hypothetical Market Scenario

Willingness to pay for improved waste management is estimated in this study by two types of contingent valuation methods (CVM) – dichotomous choice and open ended of CV methods. The dichotomous choice (DC) or referendum approach is recommended by the NOAA (U.S. National Oceanic and Atmospheric Administration) Panel for CV type study; because they thought it minimizes possible bias and is also familiar to the respondents who often vote yes/no on public decision making process. In this study, both the DC CVM and open ended CVM are used to estimate the WTP for improved waste management in Silchar Municipal Area. The hypothetical market scenario of the present study is constructed according to the recommendations of the U.S. National Oceanic and Atmospheric Administration (NOAA). This method is worded in this study as follows:

*The present system of waste collection and disposal and expenditure incurred by the Municipality on it needs to be understood before planning for an effective and efficient alternative. During the financial year 2010–11, the total establishment cost of Silchar Municipal Board was approximately Rs. 70 lakhs. The running cost and depreciation of all vehicles used by the Municipality during the same period for the purpose of waste collection and disposal was around Rs. 26 lakhs. The wages and salaries of all waste collection and disposal workers including that of drivers stood approximately at Rs. 1.56 Crores. The sum total of these annual expenses (costs) was around Rs. 2.52 Crores during the last financial year. This is the running expense or cost incurred by the municipality per annum. This is actually the recurring cost per annum. Consequently if this sum is divided by the number of houses (number of households will be higher) in Silchar Municipal Area, which is 19,652, then the average cost of waste collection and disposal*
per house per year comes to around Rs. 1282/-. This figure divided by 12 gives the monthly average cost per household, which is around Rs. 106/-. 

I shall now show you the physical machinery strength (equipments and vehicles) and man power actually used by Silchar Municipality for the purpose of waste collection and disposal. At present there are 116 casual laborers for the purpose of waste collection and disposal. These workers are assigned with the task of collecting solid waste from all parts of the city with the assistance of the garbage collection vehicles. At present the municipal authorities use 9 vehicles in all for the entire area covered by the municipality. Presently there are 2 excavators, 2 robots, 1 lifter, tipper, truck, tractor and a garbage compactor vehicle. However it is worth mentioning that this physical machinery strength may be insufficient to effectively manage and organize the household waste collection and disposal problem of Silchar.

The present system of waste disposal in Silchar Municipal area is largely inefficient, ineffective and environmentally unsafe and health wise unhygienic. I now present my alternative method for environmentally safe and hygienic household solid waste disposal system that aims to collect and dispose the daily household solid waste. I present my method in a point wise manner for the sake of lucidity and clarity.

- **Separation of waste at the household level:** 3 separate closed containers to be provided (by municipality) to each household for separate disposal of food related waste, paper, plastic and polythene etc. and metal and glass etc.

- **The waste disposal containers are to be collected by waste collection workers every morning during a fixed hour (say 6.30 AM), emptied and returned to the household. This process is to be repeated every day.**
➤ Each ward is to have a medium sized vehicle (provided by municipality) fitted with a closed waste dumping containers/chambers dedicated for the purpose of waste collection of that ward only. The collected waste is to be transported to Meherpur dumping ground every day.

➤ There are 28 wards. So 30 such vehicles (taking big wards into consideration) would be required. Around 30 drivers (permanent staff) would be required for all the ward vehicles taken together. Estimated cost of petroleum for all vehicles (assuming 5 liters of petrol would be required by each vehicle on an average per day) is Rs. 315000/-. If assuming Rs. 2000 is the depreciation per vehicle per month, then monthly depreciation for all vehicles comes to around Rs. 60000/-. Total running cost of all vehicles per month comes to around Rs. 375000/-. 

➤ Daily waste is to be collected from homes. For this purpose waste collection workers are required. For efficient collection and disposal around 20 workers are required per 500 households. That is a Ward having 1000 households would require around 40 workers and so on. Around 422 workers would be required for the entire town. These workers are mostly casual staff getting a lump sum salary of Rs. 4500/- per month.

➤ The casual workers would be carrying the waste to the ward vehicle by means of rickshaw van. One rickshaw van (provided by municipality) per 100 houses would be minimum necessity. Two casual workers would be required per van.

➤ The total monthly salary bill of all workers comes to around Rs. 2259000/-. The total monthly cost (running cost) of waste collection and disposal including all running costs comes to around Rs. 2634000 per month. **Per house cost (there are 19652 houses under Silchar Municipality) per month comes to around Rs. 135/- which is just Rs. 29 more than the current per house cost.** The actual municipal quarterly tax varies across houses on account of house types/specifications.
Road side vats are to be used by shops and other business establishments. Household waste is not to be dumped in road side dust bins out in the open. Open solid waste dumped by the road side raises chances of contamination, spread of infection and epidemic especially during monsoon when germs are more likely to be water borne. Moreover it is environmentally unethical and hazardous.

We must remember that the road side vats overflow with foul-smelling rotten and decomposed household solid waste primarily because at present the waste generated by the households is not directly collected from them to be dumped in Meherpur dumping ground. Direct waste collection from households and dumping in Meherpur dumping ground is the key to avoiding the problem of waste accumulation in road side dustbins.

Back yard dumping, roadside dumping and dumping in drains can be entirely avoided by the proposed system.

The above mentioned system has the potential of converting Silchar into a cleaner and environmentally safer city.

Suppose at this moment Silchar Municipal Board (SMB), a private agency or NGO comes forward to clean the town and provides its services efficiently and asks you the following questions on willingness to pay (WTP). It is also mentioned that these amounts will be collected in the next quarter from the respondents. Remembering that your income is limited and you have to incur all essential personal monthly expenditures with this income:

a. Are you willing to join such an environmentally safe waste management scheme?

  .................................................................................................................. yes/no

b. In consideration of your budgetary limitations, would you want to contribute any amount for environmentally safe solid waste management in your city?
c. If yes, will you voluntarily contribute Rs. X per month for the safe solid waste management in your city?

………………………………………………………………………………… yes/no

d. What is your maximum willingness to pay for safe waste management? Rs……….

4.8 Dichotomous Choice Method of Contingent Valuation

In the Dichotomous choice of CV method, households receive randomly assigned prices for improvement in solid waste collection and disposal system. Each household receives one randomly-drawn price. There are six different offer prices, which starts from 50 and ends at 300 with an equal interval of 50. These prices are fixed with the help of a pilot survey. In this study, the total sample size is 378. So at first all the 378 samples are equally divided into six different sets such that, member in a set have a common bid amount, but the bid amount varies across sets. With the help of this method the mean willingness to pay is found by estimating a statistical model for predicting the probability that an individual with specific characteristics will accept an offer of given size. Logit model is used to determine the mean willingness to pay of households for improved waste management service and the factors influencing their willingness to pay. The logit model was adopted since the Ordinary Least Square (OLS) procedure was not appropriate particularly when the dependent variable is dichotomous. The problem with the OLS estimate however is the on-fulfillment of $0=E(Y_i/X)$ since $E(Y_i/X)$ in the linear probability model measures the conditional probability of the event Y occurring given X, and its value must necessarily lie between 0 and 1.
A. Mean Willingness to Pay of the households

To obtain the mean WTP of the households for an improvement in their solid waste management, the responses of the households to the willingness to pay question were regressed on the prices they were asked to pay for the improved service. The coefficient estimates obtained were then used to calculate the mean willingness to pay of the households. The logit regression model is specified as

$$ Y = \frac{1}{1 + \exp^{-[\beta_0 + \beta_1 X]}} $$

(4.8.1)

where, $Y$ is the response of household to the willingness to pay question which is either 1 if yes or 0 if no, $\beta_0$ is a constant, $\beta_1$ is the coefficient of the price that the household is asked to pay, and $X$ is the price (Rs.) that the respondent in the household was asked to pay for the improved service.

The mean willingness to pay of the households for improved solid waste service is then calculated using the formula derived by Hanemann (1989). The formula is given as

$$ \text{Mean WTP} = \frac{1}{|\beta_1|} \ln (1 + \exp^{\beta_0}) $$

(4.8.2)

Where $\beta_1$ and $\beta_0$ are coefficient estimates obtained from the logistic regression and mean WTP is the mean willingness to pay of households for improved waste management.

B. Factors Influencing Willingness to Pay of Households

To identify the factors influencing the willingness to pay of households for improved solid waste management, the household’s responses to the willingness to pay question are regressed on the prices they are asked to pay and on other selected socio-economic characteristics of the households. The logit regression model after incorporation of these factors is specified as
\[
Y = \frac{1}{1+exp^{-x}}
\] (4.8.3)

Where, \( Y \) is the response of the household to the willingness to pay question which is either 1 if Yes or 0 if No. The variable \( Z \) is defined in equation (4.5) below.

\[
Z = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8
\] (4.8.4)

\( \beta_0 \) is a pure constant, and the parameters \( \beta_1, \ldots, \beta_8 \) are the coefficients of the explanatory variable \( X_1, \ldots, X_7 \). The \( X \) variables are defined below.

\( X_1 = \) the amount that the household is asked to pay monthly for the improved service through the hypothetical scheme.

\( X_2 = \) Monthly Per capita Household Expenditure on all items (MPHE). Savings and investments are excluded.

\( X_3 = \) Household size (HSZ) in terms of number of members (individuals) residing in the household.

\( X_4 = \) Average level of education (AE) in the household measured in terms of total number of years of formal education of all members, divided by the total number of members in the household.

\( X_5 = \) Environmental awareness (EA) which is total number of desirable responses to the questions asked to the respondent on general environmental awareness divided by total number of awareness related questions asked, multiplied by 100. This variable is thus a percentage measure.

\( X_6 = \) Number of working women in the family (NWW).

\( X_7 = \) Informal Waste Disposal Arrangement dummy (IWDA), 1 for presence of such arrangements and 0 otherwise.
\( X_8 = \text{Satisfaction from Solid Waste Management (SSWM)}, \) has been captured by an absolute score out of 10.

4.9 Open Ended Contingent Valuation Method

In the open ended CVM at first a hypothetical market scenario is set up and respondents are simply asked to state their maximum willingness to pay (WTP) for the improved service that is being valued in this hypothetical market condition. To estimate the maximum WTP for the proposed SWM scheme the following model is estimated by using open ended CVM:

The specification of the equation below was primarily motivated by theory and relevant literature. In the model, WTP is endogenously determined and is a function of the following independent variables monthly average household expenditure, household size, average education, environmental awareness, number of working woman and informal waste disposal arrangement.

Thus

\[
WTP = \beta_0 + \beta_1 \text{MAHE} + \beta_2 \text{HSZ} + \beta_3 \text{AE} + \beta_4 \text{EA} + \beta_5 \text{NW} + \beta_6 \text{IWDA} + \beta_7 \text{SSWM} + \varepsilon
\]  

(4.9.1)

The expected signs of the parameters are as follows: \( \beta_1 > 0, \beta_2 < 0, \beta_3 > 0, \beta_4 > 0, \beta_5 > 0, \beta_6 < 0 \) and \( \beta_7 < 0 \). In (4.1) WTP is the maximum willingness to pay for improved waste management scheme of residents (in Rupee terms), \( \beta_0 \) is the intercept which is likely to be positive and \( \varepsilon \) is a random error term. A’ priori expectations regarding the signs of the beta’s are not difficult to explain.

**MPHE**: Expenditure is expected to be positively related to WTP. Monthly per capita household expenditure (MPHE) enters the model as a proxy of income. Environmental economic theory assumes that the demand for an improved environmental quality increases
with income. Consequently, those with a higher income are expected to be willing to pay more for an improved waste management system.

**HSZ:** Other things unchanged (especially per capita income and education and awareness) Household size (HSZ) is expected to be inversely related to WTP. It is assumed that big households will be willing to pay relatively less due to the associated high running costs (i.e. budgetary constraints). Thus, the study generally expects the sign of the coefficient of HSZ to be negative.

**AE:** Average level of education in the household (AE) is an important variable that may possibly influence WTP in a positive way. WTP for improved waste is expected to be positively related to education. The higher is the educational attainment measured in terms of number of years of formal education (Schooling, college etc.), the better would people understand the consequences of unsafe waste collection and disposal practices in town. Therefore, the more educated households may be expected to pay more compared to the less educated residents.

**EA:** It is hypothesized that the higher is the level of environmental awareness (as well as general awareness), the more would be the concern and appreciation of the respondent regarding the consequences of mishandling municipal solid waste. In other words, other things unchanged environmental awareness is expected to have a positive influence on absolute WTP.

**NWW:** Women in India and few other Asian nations are usually charged with the responsibility of maintaining cleanliness along with the health and hygiene of the home. Hence they can be viewed as the solid waste managers within the household. Number of working women or simply the presence of working women in the household is supposed to affect WTP in a positive way. A positive relationship between WTP and NWW might exist.
simply because working women have lesser time for home cleaning and home management (that includes both cooking and disposing of solid wastes) compared to non-working women or house wives. If some external agency or institution takes care of the household solid waste disposal then it may be expected that working women would be more willing to subscribe to such an arrangement. Presence of working women in the household also raises the average per capita monthly income and as such households with working women may be expected to pay more.

**IWDA:** Informal waste disposal arrangement refers to undertaking personal waste disposal measures such as hiring the ‘thelawala’, and paying him a monthly charge of disposing off the daily solid waste. IWDA may or may not have a positive influence on the WTP. The presence of informal waste disposal arrangements may have two different and opposite impacts on WTP. Households having high levels of environmental awareness and concern over the quality of life of the residents of the town may be willing to pay for the SWM scheme irrespective of subscription of IWDA. Perhaps the WTP for such people may be more if IWDA is absent. However certain other households those who have actually subscribed to the IWDA and not too confident about the merits of the proposed scheme either due to their lack of awareness or due to their ignorance regarding the status of environmental health and hygiene of the town. Thus such households would argue that subscription of IWDA has ensured that the daily household waste is safely disposed off and is handed over to the municipal dumping vehicle, and also that, subscription to IWDA ensures environmental safety. Moreover they may argue that they are in no way responsible for an unhealthy and environmentally unsafe Silchar town. Thus at the outset it is a bit difficult to comment on the exact sign of the coefficient of IWDA. However it is still possible that the coefficient of IWDA is found to be negative.
**SSWM:** Performance of the municipal authorities with regard to the actual waste disposal services provided in the ward or the locality is a major factor that may influence the household’s WTP for the proposed SWM scheme. It may be expected that municipal wards where the municipality’s waste management services are regular (frequent) and efficient, WTP for the proposed scheme would be low. In other words, households located in cleaner wards or localities that are managed efficiently by the authorities (in terms of SWM services) would be relatively unwilling to pay for the proposed scheme, or else, their WTP would be substantially low as because they are already in a desirable environmental state. Thus WTP of the households for the proposed safe and sustainable SWM scheme is expected to be inversely related to the satisfaction from solid waste management (SSWM) services provided by the municipality in the ward or locality in which the household is located. The satisfaction of the household due to waste management services may be appropriately captured by the household’s perception about the quality of such services. This is basically an attempt to capture the evaluative assessment of the household with regard to the quality of SWM services as provided by the municipality in the ward or location. For the present study satisfaction of the household due to SWM services has been captured by an absolute score out of 10. For instance a score of 2 out of 10 reflects low levels of satisfaction while a score of 8 out of 10 implies high level of satisfaction-higher the score out of 10, higher is the satisfaction level of the household on account of SWM services in the ward. In particular a score of 5 would mean neither satisfied nor dissatisfaction.

**4.10 Methods Regarding Willingness to Pay for the Proposed Scheme**

In the present study the sample of households consists of two distinct groups of respondents – one group willing to pay for the proposed scheme and the other group unwilling to pay for the same. Respondents express their decisions regarding willingness to
pay in the form of ‘yes’ or ‘no’ responses. So the dependent variable in this analysis is a qualitative one and to analyze this type of models generally logit or probit regression models are used because of their ability to deal with a dichotomous dependent variable. A well-established theoretical background allows for estimating the probability that an event will occur or not through prediction of a binary dependent outcome from a set of independent variables. Out of these two models, distribution of the error term determines which model gives better results. If error term of the regression model follows logistic distribution then logit model is used and when error term follows normal distribution then probit model is carried out. In the present study, it is assumed that the error term follows normal distribution and probit model is used to determine how various socio economic characteristics affect the decision regarding willingness to pay for proposed waste management scheme.

The building block for this model starts with the specification of an indirect utility function for each CVM respondent (Haab and McConnell, 2002). Assuming that the representative household gain utility from the improvement in SWM and the two possible levels of environmental quality involved are: the status quo represented by $q^0$ and a specific level of improvement represented by $q^1$. Hence, her/his utility function at status quo (no improvement) will be:

\[ u_0 = u(y_i, z_i, q^0, \varepsilon_0), \]  \hfill (4.10.1)

and her/his utility function with improvement will be:

\[ u_i = u(y_i, z_i, q^1, \varepsilon_1), \]  \hfill (4.10.2)

We can rewrite equations (4.10.1) and (4.10.2) into one equation as:

\[ u_{ji} = u_j(y_i, z_i, q_i, \varepsilon_i) \]  \hfill (4.10.3)
where \( j = 0,1 \) refers to the two different states of the environment and \( i = 1,2,\ldots, n \) refers to individual \( i \) and \( u_{0i} \) and \( u_{1i} \) represent, respectively, indirect utilities at the status quo and the hypothetical improved scenario, \( y_i \) is the \( i^{th} \) utility maximizer’s (individual consumer \( i \)) discretionary income, \( z_i \) represents a vector of household socio-economic, demographic, environmental and design variables (starting prices, etc), \( q_i \) refers to the quality of the good being valued (environmental improvement), and \( \epsilon_j \) represents other variables known to the utility maximizer but not observed by the researcher or commonly the error term.

It is to be noted that when the quality of good \( q \) (environmental quality) changes from \( q_0 \) to \( q_1 \) (as a result of a policy change), the individual’s utility also changes from \( u(y_i, z_i, q_0^0, \epsilon_{0i}) \) to \( u(y_i, z_i, q_1^1, \epsilon_{1i}) \). Therefore, the condition that utility maximize \( i \) answers yes to the yes/no CVM question at offered price (bid) \( b_i \) is given by:

\[
u_1(y_i - b_i, z_i, q_1^1, \epsilon_{1i}) > u_0(y_i, z_i, q_0^0, \epsilon_{0i}) \quad (4.10.4)
\]

Equation (4.10.4) states that household \( i \) will answer yes to the yes/no CVM question at offered price (bid) \( b_i \) if his/her utility at the improved level, net of the required payment, exceeds his/her utility at the status quo. However, because we typically do not know the random part of preferences and can only make probability statements about “yes” or “no”, the probability of a utility maximizer answering yes to the valuation question is consequent upon \( U_1 > U_0 \) (i.e., the utility maximizer is better at \( q_1^1 \) even with the required payment \( b_i \)).

Hence, the probability yes for utility maximize is given by:

\[
Pr(\text{yes}) = pr[u_1(y_i - b_i, z_i, q_1^1, \epsilon_{1i}) > u_0(y_i, z_i, q_0^0, \epsilon_{0i})] \quad (4.10.5)
\]

Apparently two things turn out important for parametric estimation of the above model. First, we need to choose a functional form \( u(y_i, z_i, q^1, \epsilon_{1i}) \), and secondly, we must also specify the distribution of the error term, \( \epsilon_j \) (Haab and McConnell, 2002). Generally, most
applied empirical research work be it those employing the Random Willingness to Pay Model (Cameron and James, 1987) or the Utility Differential Model (Hanemann, 1984), begin their specification by assuming a utility function that is additively separable in systematic and stochastic components of preferences as:

$$u_i(y_i, z_i, \epsilon_{ji}) = v_i(y_i, z_i) + \epsilon_{ji} \quad (4.10.6)$$

Now, given the specification in (4.11), then, the probability of utility maximizer $i$ giving a positive response to the valuation question become:

$$Pr(\text{yes}) = pr[v_1(y_i - b_i z_i, q^1) + \epsilon_{1i} > v_0(y_i, z_i, q^0) + \epsilon_{0i}] \quad (4.10.7)$$

$$= pr[v_1(y_i - b_i z_i, q^1) - v_0(y_i, z_i, q^0) > \epsilon_{0i} - \epsilon_{1i}]$$

It is to be noted that the probability utility maximize $i$ giving a negative response, rejects the improvement, is

$$Pr(\text{no}) = 1 - pr(\text{yes}) \quad (4.10.8)$$

This equation is still too general for parametric estimation. However, when the systematic part of the preference function is assumed linear in income and other covariates, the model can be simplified as:

$$v_i(y_i) = \alpha z_i + \beta (y_i) \quad (4.10.9)$$

Where $y_i$ represents the individual consumer’s (utility maximize $i$) discretionary income, $z_i$ represents an $m$-vector of household socio-economic, demographic, and environmental and design variables and $\alpha_i$ is an $m$ dimensional vector of parameters. For the new SWM CVM scenario, in which the DC question will require a ‘yes’ or a ‘no’ response at some offered price $b_i$, the probability respondent $i$ answering yes to the valuation question is given by:
To estimate equation (4.15), we assume that the error term is normally, independently and identically distributed with mean zero and variance 1, the result is a probit model.

Let us assume that \( \eta = \epsilon_{0i} - \epsilon_{1i} \) and let \( F_\eta(\cdot) \) be the cumulative distribution function of \( \eta \) then the probability that the individual is willing to pay for the improvement is:

\[
\Pr(\text{yes}) = F_\eta(\Delta v) 
\]

\[
\Pr(\text{no}) = 1 - F_\eta(\Delta v) 
\]

Where \( \Delta v = V_1(y_i - b_i z_i q^1) - V_0(y_i z_i q^0) \)

The main purpose of the analysis is to estimate WTP and from the assumed utility function can drive a WTP function. Assuming that \( P_i \) is unobservable individual household’s actual WTP for improved SWM service, then:

\[
p_i = \alpha z_i + \beta(y_i)\alpha z_i + \beta y_i + \epsilon_{0i} = \alpha_1 z_i + \beta(y_i - b_i) + \epsilon_{1i} 
\]

\[
= \alpha z_i + \beta(y_i - \text{WTP}_i) + n_i
\]

Where \( P_i \) is unobservable individual household’s actual WTP for improved SWM service

By solving this individual i’s WTP can be:

\[
\text{WTP}_i = \frac{\alpha z_i + n_i}{\beta} 
\]

In the probit model \( F_\eta(\cdot) \) is the normal cumulative distribution function. As we define above, the unobservable individual household’s actual WTP for improved SWM service is \( P_i \) with linear relation with the initial bid, \( b_i \) and the covariates, then the actual WTP for an individual can be presented as follows:
\[ WTP_i = 1 \text{ if } P_i \geq b_i \]  \hspace{1cm} (4.10.14)

\[ WTP_i = 0 \text{ if } P_i < b_i \]

In a dichotomous choice CVM elicitation format the \( i^{th} \) respondent (utility maximizer) is asked if he/she would be willing to pay the initial bid \( (b_i) \) to get a given improvement in environmental quality or both quality and quantity in this case solid waste management improvement.

This is a random variable from the viewpoint of the researcher. The probability of yes or no response can be presented as:

\[ Pr(\text{yes to } b_i) = Pr(P_i > b_i) \] \hspace{1cm} (4.10.15)

\[ Pr(\text{no to } b_i) = Pr(P_i < b_i) \]

The specification of the equation below was primarily motivated by theory and relevant literature. In the above model, WTP for proposed scheme of waste management of households in Silchar municipal area is endogenously determined and is a function of the following independent variables: monthly average household expenditure, household size, average education, environmental awareness, number of working woman and informal waste disposal arrangement. The dependent variable is binary in nature – those willing to pay are given a score of 1, while others are given 0. Thus, the model to be estimated is,

\[ WTP = \beta_0 + \beta_1 MAHE + \beta_2 HSZ + \beta_3 AE + \beta_4 EA + \beta_5 NWW + \beta_6 IWDA + \beta_7 SSWM + \varepsilon \] \hspace{1cm} (4.10.16)

Here the expected signs of the beta’s are: \( \beta_1 > 0, \beta_2 < 0, \beta_3 > 0, \beta_4 > 0, \beta_5 > 0, \beta_6 < 0 \) and \( \beta_7 < 0 \).

In (4.10.16) WTP has a slightly different meaning. In fact here it is a binary variable. Households that are willing to pay the bid amount are given a score of 1; others are given
This gives rise the binary dependent variable regression model where both logit and probit analyses. \( \beta_0 \) is pure constant and \( \beta_i \)'s are the coefficients of the six socio-economic variables \((i= 1 \text{ to } 6)\). The six socio-economic correlates and their measurements have already been described before. The same sign sequence of the beta’s may be expected. The socio-economic factors which are used to explain the signs of the beta’s in the previously described WTP model, are applicable here as well. In section 4.8 the dichotomous choice method of CVM has been outlined in detail. Six bid values (in rupee terms) are selected and households are randomly assigned a particular bid value. 378 households are thus divided into six sub-groups. Each sub-group member is asked to pay a single amount within the group but different amounts across groups. The bid amounts are 50, 100, 150, 200, 250 and 300.

Equation (4.10.16) has been used to estimate the open ended absolute WTP model as well. In section 4.7 it has been explained in detail that the average running cost of the proposed safe and environmentally sustainable SWM scheme, per house per month, comes to around Rs. 135. From the open ended CVM exercise which is basically an absolute WTP problem (in monetary terms), the 378 respondents were simply divided into two groups, those who are voluntarily willing to pay a sum of Rs. 135 or more, and the remaining who are willing to pay less. In order to quantify the categorical binary variable WTP in (4.10.16), those households whose are willing to pay exceed Rs. 135 were given a score of ‘1’ and the others were given ‘0’. It is to be noted that in the present study the respondents were not directly asked whether they would be willing to pay a sum of Rs. 135 or not. Their open ended voluntary WTP amount has been used for the grouping of the ‘above Rs.135’ and ‘below Rs.135’ categories. This approach keeps in mind that if the voluntary payment is not Rs. 135/- or more per household per month on an average, then the hypothetical SWM scheme can never come into existence in Silchar Municipal Area.