Methodology

CHAPTER - III

METHODOLOGY

The methodology adopted in the current study is discussed under the following heads:-

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3.1 Locale of the Study

Coimbatore also known as Kovai is the second largest city in Tamil Nadu, after Chennai and the sixteenth largest urban agglomeration. It is one of the fastest growing tier-II cities in India and a major textile, industrial, commercial, educational, information technology, healthcare and manufacturing hub of Tamil Nadu. It was the capital city of the historical Kongu Nadu and is often referred to as the Manchester of South India. The city is located on the banks of the Noyyal River surrounded by the Western Ghats and is administered by the Coimbatore City Municipal Corporation. Coimbatore is the 4th largest metropolis in South India and the administrative capital of Coimbatore district. Coimbatore has been ranked 4th among Indian cities in investment climate by Confederation of Indian Industries (CII) and ranked 17th among the top global outsourcing cities by Tholons.

Coimbatore is situated in the west of Tamil Nadu, bordering Palakkad district of the state of Kerala. It is surrounded by the Western Ghats mountain range on the West and the North, with reserve forests and the (Nilgiri Biosphere Reserve) on the northern

side. The Noyyal River runs through Coimbatore and forms the southern boundary of the corporation. The city sits amidst Noyyal's basin area and has an extensive tank system fed by the river and rainwater.

The eastern side of the Coimbatore district, which includes the city, is predominantly dry. The western and northern parts of the district border the Western Ghats of Nilgiri biosphere, the Anaimalai range and the Munnar range. A western pass to Kerala, popularly referred to as the Palghat Gap is the western boundary. Because of its close proximity to the Western Ghats, the district is rich in fauna.

Coimbatore has a pleasant, salubrious climate due to its proximity to thickly forested mountain ranges and the cool breeze blowing through the Palghat gap which makes the consistently hot temperatures pleasant. Under the Koppen climate classification, the city has a tropical wet and dry climate, with the wet season being from October to December due to the northeast monsoon. Coimbatore is located at an elevation of about 411 meters. The mean maximum and minimum temperatures varies between 35 °C (95 °F) and 18 °C (64 °F). Due to the presence of the mountain pass, more elevated parts of the district benefit from the south-west monsoon in the months from June to August.

According to 2011 census, Coimbatore had a population of 1,050,721 with a sex-ratio of 997 females for every 1,000 males, much above the national average of 929. A total of 102,069 were under the age of six, constituting 52,275 males and 49,794 females.Scheduled Castes and Scheduled Tribes accounted for 10.27 percent and .07percent of the population respectively. The average literacy of the city was 82.43 percent, compared to the national average of 72.99 percent.

With more than 25,000 small, medium and large industries, the city's primary industries are engineering and textiles. Coimbatore is called the "Manchester of South India" due to its extensive textile industry, fed by the surrounding cotton fields. The district also houses the country's largest amount of hosiery and poultry industries. The city has two special economic zones (SEZ), the Coimbatore Hi-Tech Infrastructure (CHIL) SEZ at Saravanampatti and the TIDEL Park near Peelamedu, and at least five

more SEZs are in the pipeline. As of 2005, when Tirupur was a part of Coimbatore district, Coimbatore was the highest revenue earning district in Tamil Nadu. In 2010, Coimbatore ranked 15th in the list of most competitive (by business environment) Indian cities.

3.1.1 Solid Waste Management in Coimbatore Municipality

With physical expansion, rapidly increasing population and growing industrialisation comes the challenge of garbage generated in the city. If not properly managed and safely disposed, solid waste can play havoc with the health of city residents. The Government of India had notified the Municipal Solid Waste (Management and Handling) Rules in 2000, thereby making it mandatory for all urban local bodies in the country to engage in collection, segregation, secondary storage in covered bins, transportation in covered vehicles, processing through composting or waste-to-energy technologies and disposal of rejects in engineered/sanitary landfills. Even after many years, though most cities have confined themselves to collection and transportation of solid waste, processing and safe disposal is being attempted only in few cases.

The city of Coimbatore presently generates around 815 TPD (in 2012) of municipal solid waste (MSW) having an average generation rate of 600 gms/capita/day. The CCMC Coimbatore City Municipal Corporation (CCMC) is in charge of the waste management in its 100 wards. CCMC collects around 775 TPD of MSW which accounts for almost 95 percent of collection efficiency.

Until 2003, garbage was dumped at Kavundampalayam dumpsite (33.4 acres). Over the years it had collected 30,000 cubic metres of garbage, and the waste collected reached a height of over two metres. The waste was shifted, bulldozed and re-formed within this area in the process of capping, using thick gas drainage layers, geo-textile lining, vegetative layers and gas vents using perforated HDPE pipes. In capping this dumpsite, the CCMC has reclaimed 20 acres of land besides increasing the land value of the surrounding areas.

At another dumpsite (1.89 acres) in Ondipudur that was functional until 2006, garbage had been dumped to reach a height of over two metres, and this again has been capped and converted into a green hillock. In the third dumpsite at Vellalore (a large area of 250 acres), garbage of 12,50,000 cubic metres was piled up to the height of two metres and it is currently being capped scientifically.

The CCMC is following an integrated approach to solid waste management. With door-to-door collection, building awareness for segregation at the household level, and transporting the rubbish to the dumpsites has been the practice in many cities, the CCMC, added to this has chosen to first take care of the backlog in processing and disposal.

Prior to 2007, Coimbatore was no different from most other cities of India in its neglect of the garbage generated in the city. Heaps of garbage were poorly collected and carelessly transported from transfer stations in uncovered trucks to dumpsites, which could be described as land-hills. As the city expanded over the years, the dumpsites got closer and closer to town and became a major public health hazard.

In 2007, Jawaharlal Nehru National Urban Renewal Mission (JNNURM) offered urban local bodies a vision to clean up the city and solid waste management and disposal was an activity, attracting substantial funding under JNNURM. The CMCC was quick on the uptake and was the first municipal corporation to get approval for an integrated solid waste management project in February, 2007. It is the first public-private partnership (PPP) project under JNNURM.

The total cost of the solid waste management project was Rs 96.5 crore, with 50 per cent contribution from the Central government, 20 per cent from the Government of Tamil Nadu and the remaining 30 per cent to be contributed by the CMCC. Of the total cost, Rs 26.3 crore was for collection and transportation of segregated waste up to the transfer stations in the city. This was to be implemented by the CMCC itself. The larger part of the project was for setting up a compost plant (a waste processing facility), an engineered landfill (a waste disposal facility), capping off the three old and abandoned dumpsites, building four new transfer stations with mechanical handling facilities and

transporting waste to the processing and disposal site is being carried out. This task was implemented by entering into a PPP.

The private partner was selected through a process of competitive bidding and the CMCC's share of financing was managed through the PPP. Land (180 acres, including 25 acres for the engineered landfill) was given to the private concessionaire by the CMCC on annual lease at Rs 1 per square meter for a period of 20 years. The contract was on DBOOT (Design, Build, Own, Operate and Transfer) basis. A minimum quantity of 700 tonnes per day of waste was to be provided by the CMCC and a tipping fee was agreed on the basis of the cost calculations for transportation, processing and disposal (up to 25 percent of the waste). The average tipping fee per metric ton worked out to Rs 668 in 2008, Rs 947 in 2012, Rs 1036 in 2013, rising to Rs 3710 in the terminal year of the contract, that is, 2027.

An engineered sanitary landfill has been built by the private operator at Vellalore over the years. At the waste processing facility, once the waste is received from the transfer stations, all recyclable materials are segregated. Combustible bulk materials are segregated and shredded for making Refuse Derived Fuel. The biodegradable waste is taken through aerobic digestion process to make compost, while the inert material is sent to the landfill.

The Peelamedu transfer stations are equipped with an electronic weighbridge and garbage is unloaded from collection vehicles and reloaded onto larger bulk refuse carriers for transportation to the treatment and disposal facility. The CCMC has introduced an online waste truck monitoring system using radio frequency identification (RFID), which is linked to the weigh bridges commissioned at the waste transfer stations, as well as at the waste processing and disposal facility at Vellalore. All the trucks deployed for waste transport are fitted with radio frequency tags, which are electronically programmed. As the truck halts at the weigh bridge, it automatically records the truck number, the wards from which the waste has come, the name of the driver, the time of entry of the truck, weight of the waste, etc. This enables the corporation to monitor the exact number of trips made by each truck and the quantity of waste handed over at the transfer station. The secondary transportation of the waste to

the waste processing facility and the engineered landfill is carried out by the private company in covered trucks.

While the PPP part of solid waste management has done well, the CCMC has been wanting in its efforts to achieve door-to-door collection and spread awareness about segregation. Many new initiative are being undertaken to minimize the waste and to recycle the collected once for use in other sectors.

3.2 Selection of the Sample

Multi stage random sampling design was adopted for selecting the sample. The study was confined to Coimbatore city and the entire process of solid waste management were analysed. Solid waste management includes management of generation, storage, collection, transportation, processing and disposal of solid waste. Coimbatore city has four major transfer stations situated in Peelamedu, Ondiputhur, Ukadam and Sathy Road. Sathy Road is the highest waste collecting transfer station. Hence the households residing near Sathy Road were selected as sample.

First phase of the study deals with those who generate the waste. Households, institutions, industries, markets, hospitals etc are the major waste generators. Among them households were selected for the current study. Some of the areas which generate highest amount of waste under Sathy transfer stations are Gandhi Park, Sathy Road and Avinashi Road. A total of 279 households were randomly selected. The households selected were as follows- Gandhi Park (97), Avinashi Road (94) and Sathy Road (88). To accomplish the task of collecting information on existing household solid waste management practices and their perception on the effectiveness of the current system, willingness to pay for solid waste etc is gathered with the help of a pre - tested questionnaire.

The second phase of the study aimed at collecting details from those who collect the waste. In Coimbatore city, NGOs, contract workers and government sanitary workers are engaged in the solid waste collection. An important objective of the study is to understand the socio economic status, health problems and insurance facility of

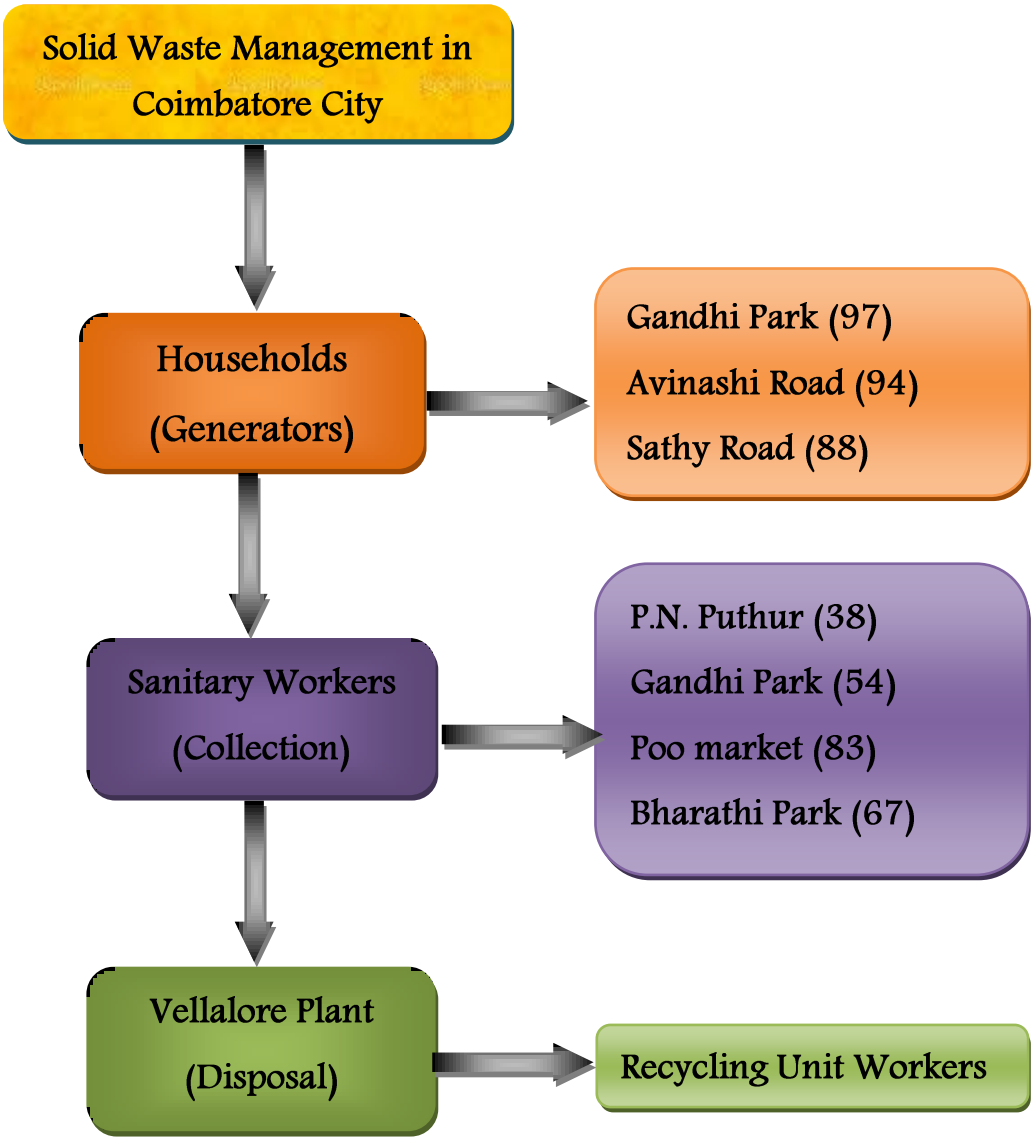
sanitary workers. A total of 242 sanitary workers working in different areas were randomly selected as follows: P.N.Puthur (38), Gandhi Park (54), Poo Market (83), Bharathi Park (67). All these areas come under Sathi Road Transfer Station. These sanitary workers were the ones who transported the waste from Roads and houses to the collecting points.

Vellalore is the only plant in Coimbatore which recycle the solid waste and produce vermin compost from the waste. Out of 80 workers in the recycling unit, 50 workers were taken up for the current study.

The Recycling Plant helps a lot in the waste management..Hence the working of this plant was also taken up in the current study. Further the study also probed into the socio-economic profile of those working in the plant also.

The schematic representation of the sample design is presented in figure: 3.1

Figure 3.1 Sample Design



3.3 Data Base of the Study

Data pertaining to the study were collected by personal interview method. Separate interview schedules were prepared for households, sanitary workers and those working in the recycling unit. Various aspects relating to the socio economic profile of the household, the practice of solid waste management, willingness to pay, and facts on the problem of solid waste management practiced by the households were collected with the help of a questionnaire. The interview schedule for sanitary workers probed into the socio economic profile, the reason for selecting the job, the safety measures, insurance benefits, and problems faced by the workers. Relevant information with respect to workers in the recycling plant were also gathered with the help of a questionnaire These schedule were first pre-tested, and based on their responses the questionnaire were modified and used (Annexure I and II and III)

3.4 Period of Study

Data for the study were collected from the sample units during the period January 2013 to May 2013.

3.5 Concepts Used in the Study

- **Anaerobic digestion -** A controlled process involving microbial decomposition of organic matter in absence of oxygen.
- **Biodegradable substance-** A substance that can be degraded by micro-organisms.
- **Biomethanation-** A process which entails enzymatic decomposition of the organic matter by microbial action to produce methane rich biogas.
- **Buffer zone -** A zone of no-development which shall be maintained around landfills, processing and disposal facilities of municipal solid waste.
- **Collection-** Lifting and removal of municipal solid waste from collection points or any other location.

- **Composting-** A controlled process involving microbial decomposition of organic matter.

- **Disposal -** Disposal of municipal solid waste in terms of the specified measures to prevent contamination of ground-water, surface water, ambient air quality and source of bird attraction.

- **Generator of waste -** Persons or establishments producing municipal solid waste.

- **Landfilling -** The disposal of residual municipal solid waste on land in a facility designed with protective ·measures against pollution of ground water, surface water and air fugitive dust, wind-blown litter, bad odour, fire hazard, bird menace, pests or rodents, greenhouse gas emissions, slope instability and erosion.

- **Leachate -** The liquid generated from municipal solid waste that seeps through solid waste or other medium and has extracts of dissolved or suspended material from it.

- **Materials Recovery Facility (MRF) -** A facility where municipal solid waste can be segregated, baled and temporarily stored.

- **Municipal Solid Waste -** Includes the commercial and residential waste generated in a municipal or notified areas in either solid or semi-solid form excluding industrial hazardous waste, e-waste and including treated bio-medical waste.

- **Municipal Solid Waste Management -** The generation, collection, segregation, storage, transportation, processing and disposal of municipal solid waste, including reduction, re-use, recovery, recycling in a scientific and hygienic manner.

- **Operator of a facility -** A person who operates a facility for processing and disposal of municipal solid waste which also includes any other agency

appointed by the municipal authority for the management of processing and disposal facility.

- **Processing -** The process by which municipal solid waste is transformed in to new or recycled products.
- **Recycling -** The process of transforming segregated solid waste for producing new products.
- **Refuse Derived Fuel (RDF) –** It is fuel in the form of pellets or fluff produced by shredding and dehydrating combustible components of municipal solid waste.
- **Segregation -** To separate the municipal solid waste into the groups of organic, inorganic, recyclables, industrial hazardous waste and e-waste.
- **Storage -** The temporary containment of municipal solid waste in a manner so as to prevent littering, attraction to vectors, stray animals and excessive foul odour.
- **Transportation -** Conveyance of municipal solid waste from place to place hygienically through specially designed transport system so as to prevent the foul odour, littering, unsightly conditions and accessibility to vectors.
- **Treatment -** The method, technique or process, designed to modify physical, chemical or biological characteristics or composition of any waste so as to reduce its potential to cause harm.
- **Vermin composting -** Is a process of using earthworms for conversion .of bio-degradable waste into compost.
- **Waste pickers -** The individuals or groups of individuals engaged in the collection of municipal solid waste.

3.5 Techniques of Analysis

Besides averages, percentages and graphs, the following techniques were applied.

3.5.1 Chi-square Test

The X^2 test is one of the simplest and most widely used non-parametric tests in statistics. The quantity X^2 describes the magnitude of the discrepancy between theory and observation and is symbolized as:

$$X^2 = \frac{\sum(O - E)^2}{E}$$

Where O refers to observed frequency and E refers to expected frequency.

In the present study, Chi-square test was applied to examine the association between willingness to pay and other independent variables mainly the environmental condition, current way of handling solid waste, satisfaction towards transportation of waste, method of charging a fee and organization preferred for solid waste management.

3.5.2 Multiple Regression Analysis

Multiple regression analysis is a statistical technique which is used to analyze the relationship between a single dependent (criterion) variable and several independent (predictor) variables. Its basic formula is

$$Y_1 = b_0 + b_1X_1 + b_2X_2 + \ldots\ldots\ldots + b_nX_n + e$$

where Y_1 – dependent variable, X_1 …….X_n – independent variables, b_0 – intercepts, b_i - coefficient of the independent variable (i = 1,2,….n) and e – random component.

A linear multiple regression models were used for analyzing the nature and magnitude of the explanatory variables included in the model on the willingness to pay as monthly tariff by the households. The following model is used for the estimation of regression co-efficient.

That is

$$W = \alpha + \beta_1 SEX + \beta_2 AGE + \beta_3 EDU + \beta_4 INCO + \beta_5 OCCU + \beta_6 TYP + \beta_7 HHS$$

Where,

W = Willingness to Pay;

α = Constant term;

SEX = Sex of the Respondents;

AGE = Age of the Respondents;

EDU = Education of the Respondents;

INCO = Income of the respondents;

OCCU=Occupation;

TYP= Type of family.

HHS= Household size

$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7$ are the relevant parameters of the model.

3.5.3 ANOVA Technique

In this study ANOVA is used to test the variation of willingness to pay that exists between areas. For the purpose, the following hypotheses are tested.

Ho: There is no significant variation among respondents from different areas on the willingness to pay.

H_1: There is a significant variation in willingness to pay among the respondents.

3.5.4 Garrett's Rating Scale

To find out the strength of factors ranked by the selected sample groups in relation to the reasons for selecting healthcare services, Garrett's rating scale technique was used. From the ranks given for each factor, percent positions were calculated by using the formula.

Percent position = 100 *(R-0.5)/N

where R is the rank assigned and N is the number of items ranked. The percent position was then converted into scores using Garrett's scores table (Garrett H, 2005).

Garret ranking scale technique was used to rank the various environmental problems affected by residents in the Coimbatore city due to solid waste.

3.5.5 Factor Analysis

Factor analysis is a generic name given to a class of multivariate technique whose primary purpose is to define the underlying structure in a data matrix. BRoadly speaking, it addresses the problem of analyzing the structure of the interrelationships (correlations) among a large number of variables by defining a set of common underlying dimensions, known as factors. With factor analysis, the researcher can first identify the separate dimensions of the structure and then determine the extent to which each variable is explained by each dimension. Once these dimensions and the explanation of each variable are determined, the two primary uses for factor analysis, namely summarization and data reduction can be achieved. In summarizing the data, factor analysis derives underlying dimensions that, when interpreted and understood, describe the data in a much smaller number of concepts than the original individual variables.

Factor analysis was used in the present study to identify problems due to solid waste, problems encountered in solid waste management and factors which help to combat the problem of solid waste management. Further in the case of sanitary workers the reasons for selecting job, factors that help to improve their conditions were examined. In the case of recycling unit workers reasons for selecting job were also analyzed by using this analysis.

3.6 Limitations of the Study

The present study is based essentially on primary data. It is a known fact that primary data has its own limitations. To have accuracy in the data collected, cross checking was carried out. In this way, though inaccuracy in the given data was minimized, the data could not be considered as 100 percent correct. The present study relies only on the information gathered through surveys, observations and personal

interviews, which are subject to bias. As with most empirical studies, the sample size and spectrum of respondents is a limitation. Even though a concerted effort was made to include a range of different individual representing different social groups, the sample was limited to certain geographical area. A statistically random sample would have increased the confidence in the results. Moreover the survey is not representative of the whole city of Coimbatore. The sample was selected only from the areas coming under Sathy Road transfer station. Further, the findings and conclusion could only be applicable to similar set of situation. These limitations in no way negate the findings of the study but however offer scope for further research in future.