SOLID WASTE MANAGEMENT AND WILLINGNESS TO PAY AMONG URBAN HOUSEHOLDS IN KERALA:
PRACTICES AND DETERMINANTS

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Doctor of Philosophy in Economics

By

REJUNA C A

Under the supervision of

Prof. (Dr.) K X JOSEPH (Retd.)
Department of Economics
University of Calicut

DEPARTMENT OF ECONOMICS
University of Calicut
Dr. John Matthai Centre
Aranattuakara, Thrissur

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CERTIFICATE

This is to certify that this thesis entitled, **"SOLID WASTE MANAGEMENT AND WILLINGNESS TO PAY AMONG URBAN HOUSEHOLDS IN KERALA: PRACTICES AND DETERMINANTS''**, submitted by **REJUNA C A** for the award of the degree of Doctor of Philosophy**,** to the University of Calicut, is a record of bona fide research work carried out by her under our guidance and supervision. The contents of this thesis, in full or in part, had not been submitted to any other institute or University for the award of any degree or diploma. Plagiarism is checked and found within the permitted limits.

Supervising Teacher

Dr. K X JOSEPH
Professor (Retd.)
Department of Economics
Dr. John Matthai Centre
Aranattukara, Thrissur

Co-Guide

Dr. SHYJAN D
Assistant Professor
Head, Department of Economics
Dr. John Matthai Centre
Aranattukara, Thrissur.

Place: Thrissur
Date:

DECLARATION

I, REJUNA C A, affirm that this thesis titled **" SOLID WASTE MANAGEMENT AND WILLINGNESS TO PAY AMONG URBAN HOUSEHOLDS IN KERALA: PRACTICES AND DETERMINANTS"** is a bona fide record of research done by me under the guidance of Dr. K X JOSEPH, Retired Professor of Economics, University of Calicut and Dr. Shyjan D, Assistant Professor and Head, Department of Economics, University of Calicut. I declare that this thesis had not been submitted by me earlier for the award of any degree, diploma, fellowship or any other similar title.

Place: Thrissur

Date: **REJUNA C A**

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LIST OF ABBREVIATIONS

ABBREVIATIONS	**DESCRIPTION**
ADB	Asian Development Bank
ANOVA	Analysis of Variance
CBA	Cost-Benefit Analysis
CBO	Community-Based Organisation
CDEP	Centre for Development and Environment Policy
CKM	Clean Kerala Mission
CPCB	Central Pollution Control Board
CPR	Common Pool Resources
CSO	Central Statistical Organization
CV	Coefficient Variation
CVM	Contingent Valuation Method
DUV	Direct Use Value
EBTC	European Business and Technology Centre
ENVIS	Environmental Information System
EPA	Environment Protection Act
EPR	Extended Producer Responsibility
FGD	Focus Group Discussion
IIM	Indian Institute of Management
ISWA	Integrated Solid Waste Association
ISWM	Integrated Solid Waste Management
IUV	Indirect Use Value
KSIDC	Kerala State Industrial Development Corporation
KSPCB	Kerala State Pollution Control Board
KSUDP	Kerala Sustainable Urban Development Project
KTSHM	Kerala Total Sanitation and Health Mission
LSGAs	Local Self Government Areas

ABBREVIATIONS	DESCRIPTION
LSGIs	Local Self Government Institutions
MNRE	Ministry of New and Renewable Energy
MoEFCC	Ministry of Environment, Forest and Climate Change
MoEP	The Ministry of Environmental Protection
MoUD	The Ministry of Urban Development
MSB	Marginal Social Benefit
MSC	Marginal Social Cost
MSW	Municipal Solid Waste
MSW (M&H)	Municipal Solid Waste Management and Handling
MSWM	Municipal Solid Waste Management
MSWR	Municipal Solid Waste Rules
MT	Million Tonnes
MW	Mega Watt
NEERI	National Environmental Engineering Research Institute
NEMA	National Environmental Management Authority
NGO	Non-Governmental Organisation
NSWA	National Solid Waste Association
NUV	Non-Use Value
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Square
OV	Option Value
OWM	Overflow Waste Management
PCA	Principal Component Analysis
PP	Probability –Probability
QQ	Quantile-Quantile
RDF	Refuse Derived Fuel
SD	Standard Deviation
SM	Suchitwa Mission
SPCB	State Pollution Control Board

ABBREVIATIONS	**DESCRIPTION**
TERI	Tata Energy Resources Institute
TEV	Total Economic Value
TPD	Tonne Per Day
UK	United Kingdom
ULB	Urban Local Body
UNEP	United Nations Environment Programme
USA	United States of America
USD	United States Dollar
USEPA	United States' Environmental Protection Agency
UT	Union Territory
UV	Use Value
VIF	Variance Inflation Factor
WHO	World Health Organisation
WLS	Weighted Least Square
WTA	Willingness to Accept
WTP	Willingness to Pay

ABSTRACT

Solid Waste Management and Willingness to Pay among Urban Households in Kerala: Practices and Determinants

The present research is an attempt to find out the predictive effects of socio-economic, geographical and environmental factors on solid waste generation, management and willingness to pay for the quality improvement. The analysis is expected to yield wider policy implications for sustainable solid waste management and improved environmental quality. The study uses primary data collected from 384 households in Kozhikode Corporation by using stratified random sampling. In addition to this, Focus Group Discussions (FGDs) with waste collectors and plant workers were also carried out to gather information on solid waste disposal and management. It starts with estimating the quantum on solid waste generation, management practices and determinants. The role of public and private service providers in waste management is also scrutinised in terms of service quality. The question of people's participation for improvement in environmental quality in general and waste management in particular is analysed in detail with the help of a Contingent Valuation Method – willingness to pay.

The study estimates average waste generation as 5.3 kg per week with a standard deviation 1.79. Per capita waste generation is calculated as 1.23 kg per week. It is found that increase in the monthly household expenditure, household size, homestead and availability of waste disposal services cause increase in the waste generation. However, education is found to be incentivising the households to reduce waste generation. The enormous waste generation demands efficient management mechanism, and the households follow heterogeneous management mechanisms. Moreover, there are public and private agencies involved in waste collection and management. Public service providers are found to be successful in ensuring regularity but fail in ensuring feasibility in the collection. This may imply government failure in ensuring feasibility in the collection and may explain the prevalence of private service providers.

Waste generation and management practices followed by urban households demand special policy attention of household involvement in the form of willingness to pay for improved waste management thereby environmental quality. The estimated mean willingness to pay is Rs.201 indicates that on an average, Rs.201 is the market price placed by the households for a clean environment. Households with higher monthly expenditure, quantity of waste generation, presence of the availability of waste disposal services are found willing to pay more whereas the WTP among the higher age groups of respondents and households with more members has been found lower. Interestingly, the willingness to pay as a proportion of household income is found higher among low-income groups and the households reside closer to dumping ground. Hedonic pricing approach of WTP shows that people prefer the abandon of the problem compared to alternative methods of waste disposal such as controlled landfill and waste recycling for gas production because such methods may create all the issues of waste disposal again. Compensation policy of the government in place of abating solid waste problem is also preferred less.

Estimated willingness to pay of the households for improved waste management is higher than the actual expenses that the households incur at present. Hence, it may be surmised that public policy may accommodate the contribution of households for better waste management. The contribution of society towards improved solid waste management can be considered as a reflection of the societal aspiration towards environmental quality and sustainable living.

CHAPTER 1

Introduction

- ***Introduction***
- ***Statement of the Problem***
- ***Objectives***
- ***Data Source and Methods***
- ***Limitations of the Study***
- ***Outline of the Study***

CHAPTER - 1
Introduction

1.1 Introduction

A lion share of human-made pollution is solid waste which is essentially accused of polluting natural resources and contributing to change in environmental quality thereby affecting eco-balance. UNEP (2005) reports that in developed countries, per capita waste generation increased nearly three-fold over the last two decades, reaching almost five to six times higher than that in developing countries. World Bank report (2012) on solid waste generation across the world estimates that the amount of MSW (Municipal Solid Waste) will rise from the current 1.3 billion tonnes per year to 2.2 billion tonnes per year by 2025, with a major contribution from rapidly growing cities in developing countries. Okalebo (2014) reported that waste generation, both domestic and industrial, continues to increase worldwide in tandem with an increase in consumption. Thus solid waste generation is a big challenge faced by many countries around the globe, especially the urban centres.

Solid waste has become an important local environmental issue in recent years and one of the impacts of human exploitation of the environment. High population, rapid economic growth and change in living standard accelerates the generation of municipal solid waste in Indian cities (CPCB, 2004; Sharholy et al., 2006). Ministry of Environment and Forest, Government of India (2016), pointed out that the Indian State of Kerala is considered to have a developed modern society. All types of wastes including solid, hazardous and biomedical waste generation in the State are high. Increasing urbanisation, changing lifestyle, rapid economic development, consumption pattern and rise in tourism are the main reasons for the rise in waste generation in the State (Kerala State Urban Development Corporation, 2006; Varma, 2007 and Koshy, 2010). About half of the solid waste in Kerala (49 per cent) is generated from the households (Koshy, 2010) and the collection of waste from residences is not handled properly. A major part of the domestic waste ends up in the streets or barren lands in the city premises. The quantity and quality of wastes generated from households vary, according to income, food habits, age, lifestyle, educational and occupational status. The average waste generation from a household is found to be 0.289 kg per person per day (Ashalakshmi & Arunachalam 2010). Malinya Muktha Kerala Action Plan (2007) pointed out that the per capita waste generation is relatively high in Kerala due to the peculiar consumption pattern in the State. It has the potential to pollute all the vital component of the living environment, i.e., air, land and water at local and global levels (Patil, 2013). Hence, quantities of waste generation and its determinants in the State are at the forefront of discussion not only among policymakers but also a major concern among academicians and researchers.

Kerala, one among the major densely populated States, has been severely suffering from the issue of waste disposal. Koshi (2010) argues that most of the towns in Kerala do not collect the total waste generated, and only a fraction of the collected wastes receive proper disposal. A high proportion of the collected waste is disposed of unscientifically in waste disposal sites, including roadsides and other public areas. Local administration in Kerala has instituted many waste treatment plants in collaboration with the private service providers for effective waste management which includes Vilappilsala at Trivandrum, Brahmapuram at Kochi, Chelora at Kannur, Njeliyanparambu at Kozhikode, Laloor at Thrissur, Vadavathur at Kottayam, Kureeppuzha at Kollam, etc. However, a substantial part of the households does not benefit regular waste collection services from the authorities. Besides, inefficient collection and disposal of solid waste pollute water, land and air, and pose risks to human health and environmental quality. It adversely affects the health and environmental quality of nearby people. People’s agitation against waste treatment plant had lead to closing down of some plants like Vilappilsala at Trivandrum and Laloor at Thrissur. At present waste processing facility is available[1]

[1] Kerala Suchitwa Mission Report (2007) revealed that only 17 municipalities have land and treatment facilities available in Kerala. Out of 999 Village Panchayats, only 126 Village Panchayats have land for waste treatment. All facilities for waste treatment is available only in 7 Panchayats, while partial facilities are available in 105 Village Panchayats in the form of biogas plants and vermin compost units. 35 Village Panchayats have recently set up resource recovery centers for collection of recyclable materials especially plastics.

only in two Corporations in Kerala- Cochi and Kozhikode. The other Corporations use the land for waste dumping without proper facilities for processing. Hence, waste management practices followed by urban Kerala are to be addressed in a wider perspective.

The burden of municipal solid waste necessitates huge expenditure for its management (Ministry of Environment and Forest and Climate Change, Government of India, 2016). Adequate budgeting, cost accounting and financial evaluation are essential for the effective management of solid waste. The responsibility of planning, functioning and investment programme in solid waste management remains with the local government. So, the role of State and local governments in waste management is imperative. Moreover, public-private participation has emerged as a promising alternative to improve waste management in different parts of the State. Hence, the service quality dimensions of both public and private service providers in waste management are also important for empirical scrutiny.

Three main options for financing the substantial recurrent cost of MSWM (Municipal Solid Waste Management) are user charges, local taxes and intergovernmental transfers. It is usually preferred to finance recurrent MSWM costs through user charges. However, community willingness and participation are the operational challenges faced by the authorities in collecting user charges. Therefore, quantification of the willingness of the community and its determinants are pertinent issues at the implementation stage to arrive at a measure of the user charge. It is in this context that the present study gains its relevance.

1.2 Statement of the Problem

Environmental quality is generally considered as a public good which is non-rival and non-excludable in consumption and under the absence of price signal, it leads to market failure. In such cases, government interventions through public policy and control measures might be necessary. Government interventions are normally through taxation, regulations, private incentives, public projects, macroeconomic management and institutional reforms. However, all government interventions may not be socially desirable because of policy failure. That is to say; government interventions may distort a well- functioning market or may fail to establish the foundations for the market to function efficiently and effectively. Thus market and government failure demand the need for a technique that can evaluate non-market goods in general and environmental quality in particular.

Stated preference techniques are the primary means of valuing non-market benefit, and the commonly used non-market valuation technique is the CVM (Contingent Valuation Method) (Callen & Thomas, 2015). Generally, households are willing to pay for environmental quality in general and improved waste management in specific. However, how much they are willing to pay for improved environmental quality and the various factors that influence has not adequately attempted in the literature. Hence, the present study tries to understand the society's participation for improved environmental quality with the help of WTP[2] (Willingness to Pay) for a hypothetical project and its various socio-economic determinants. As a corollary to this, it is also imperative to empirically verify generation of solid waste, its determinants, management practices and the relative role of public and private service providers.

1.3 Objectives

- To estimate the quantity of waste generation and the factors that determine solid waste generation among urban households.

This involves an exploration of the types and quantity of waste generated among urban households in Kerala. It solicits households waste generation with socio-economic and location factors such as education, income level, age, gender, occupational status, household size and proximity to waste treatment plant. It relates

[2] The stated price that an individual would accept to pay for avoiding the loss or the diminution of an environmental service (OECD, World Bank, 2005).

the quantity of waste generation with other enabling variables such as the practice of segregation of waste and availability of waste disposal service.

- To examine the present practice of solid waste management mechanism carried out by the urban households in Kerala.

Specifically, this involves an analysis of the heterogeneous practices of waste management followed by urban households in Kerala. It involves an analysis of the perception and practices of waste disposal, practice of storage and segregation followed and current issues and challenges pertaining to waste disposal. It also examines service quality dimensions of both public and private service providers in waste collection.

- To estimate households willingness to pay (WTP) towards improved solid waste management among urban households in Kerala.

It aims at estimating the value that households attach to a clean environment. It involves estimation of WTP of households towards different features of the project like ensuring a clean environment, provision of safe drinking water, control of rodents and mosquitoes, waste recycling for gas production and construction of a controlled landfill with large life span. It examines the WTP of the households towards organic and inorganic waste and WTP towards private and public owned waste management project.

- To estimate the factors that determine the households' willingness to pay for a clean environment.

It solicits households' willingness to pay and relates WTP with socio-economic factors such as education, income level, age, gender, household size and size of the homestead. It relates WTP with some enabling factors like quantity of waste generation, availability of waste disposal service and proximity to the dumping site. Thereby the study aims to make the people aware about the benefit of an improved way of solid waste management for a sustainable society.

1.4 Data and Methods

The present study is conducted in Kozhikode Corporation. The study uses both primary and secondary data. Primary data are collected from 384 sample households residing in the Kozhikode Corporation. Along with this, focus group discussion with waste collectors (Kudumbasree units[3], Corporation sanitary workers and Niravu workers[4]) and waste treatment plant workers were carried out to gather information about the solid waste collection, disposal and management. These are supplemented by information from secondary sources such as different published sources of various government departments. A detailed description of the sample design is given in Chapter 3.

The study is of a mixed approach; both quantitative and qualitative. Both descriptive and inferential statistics are used for analysing the data so as to reach valid and generalised conclusions. Analysis of the service quality dimensions of both public and private service providers are empirically verified through discriminant analysis in the routine of principle component under varimax rotation with software support from SPSS, 22. The study employs one way ANOVA to determine whether there are any statistically significant differences between the mean willingness to pay towards different features of the project like ensuring a clean environment, provision of safe drinking water, control of rodents and mosquitoes, waste recycling for gas production and construction of a controlled landfill with large life span. The study employs a multiple regression model to examine the factors that determine waste generation among urban households and to examine the factors that determine willingness to pay of the urban households for improved waste management. The magnitude of overlaps in WTP towards organic and inorganic waste disposal and WTP towards public and private service providers are elicited through Venn

3 Kudumbasree is the poverty eradication and women empowerment programme implemented by the Kerala State Poverty Eradication Mission of the Government of Kerala, launched on 1998. In Kozhikode Corporation, Kudumbasree actively involved in the household waste management as a self-employment programme with the support of government.

4 Niravu started as a community based organization collectively engaged in promoting organic farming and zero waste management in Vengeri, Kozhikode in 2006. Now, it extent its service as a private service provider in the collection of inorganic waste from different parts of the Corporation.

diagram. A detailed description of the econometric techniques is given in section 3.3 of Chapter 3.

1.5 Limitation of the Study

After all, the study is dealing with the concern of solid waste management and willingness to pay for environmental quality as a public good. The specificities of the SWM are rather too stringent. The distinguishing characteristics of the SWM and environmental quality as a commodity are valid for the analysis of waste management. One has to be cautious even in the use of terminologies like households, willingness to pay, service provider, quality, access, etc. when applied to environmental economics. A direct translation of the concepts of economics, or, for that matter, of other disciplines, to the field of environmental economics may often lead to misconceptions. Moreover, to keep the story tight, we have not attempted to examine the health impact of SWM is not subjected to detailed inquiry. Besides, economic theories argue that whole waste generated by the households will not be an economic bad. Economic bad is happens in the case of those waste whose disposal is a difficult task. Here, the study could not be able to categorise waste as economic bad or not. Issues of categorisation would get complicated in such situations. Moreover, keeping given time, resources and manpower, the study has taken a sample of 384 households from Kozhikode Corporation as a representation of urban households in Kerala. By using appropriate standardised tools and techniques and employing adequate tools for analysis, it is hoped that the results obtained from the study are valid and generalised

1.6 Outline of the Study

The study is organised in eight chapters including the introduction. Chapter 2 presents theoretical developments on environmental issues and literature on the CVM (Contingent Valuation Method) and the dichotomous choice method are reviewed to aid in formulating an analytical framework for the study. It also involves a review of the existing studies on the solid waste generation and management practices including willingness to pay (WTP) of the households for improved waste management. Chapter 3 presents a detailed description of the research design in three sub sections. Section 3.1 includes data source, sample design, data collection procedure, statistical methodology for data collection and pilot study. Section 3.2 gives a detailed description of analytical framework followed by empirical methods in section 3.3. Chapter 4 examines the extent of solid waste management, policy initiatives and practices in Indian and Kerala context generally and Kozhikode Corporation in specific. Chapter 5 deals with the estimation of waste generation and examines factors that determine waste generation on the basis of theory and empirics. Chapter 6 examines the heterogeneous waste management praxis followed by urban households. More specifically, the study looks at service quality dimensions of both public and private service providers in waste management by using discriminant analysis. Chapter 7 is an estimation of household willingness to pay for improved waste management and examines the determinants of WTP of households towards improved waste management thereby environmental quality. It also involves an estimation of WTP of the people towards different features of the project. Summary of the findings and policy implications are presented in Chapter 8.

CHAPTER 2

Developments in the Literature: Theory and Empirics

- ***Introduction***
- ***Theoretical Developments on Environmental Issues***
- ***Empirical Literature on Solid Waste Management***
- ***Summing UP***
- ***Gaps in the Existing Literature***

CHAPTER - 2

Developments in the Literature: Theory and Empirics

2.1 Introduction

The present research problem takes its theoretical derivatives and conceptual frame from the nascent discipline environmental economics. The study examines the relationship between environment and development, a focal area of environmental economics by posing the issue of solid waste on environmental quality. All the development process: production, consumption and distribution generate enormous solid waste in the economy. The study tries to examine whether this solid waste is an environmental problem or public bad in specific. It will not be an environmental problem if we could able to manage all the waste from production and consumption without affecting environmental quality. However, in reality, it is a public bad because the generation of solid waste degrades the environmental quality and make a change in environmental quality. Through this study, the quality change is valued by using a valid technique. This part of the study focuses on the theoretical aspects of the environmental problem as well as reveals empirical studies on the changing issues of environmental quality related to the issue of solid waste. It also involves a reflection of the previous researches on the valuation of quality change by using contingent valuation technique.

In understanding the theoretical framework of the study, the following questions become relevant.

1. How do we characterise environmental problems?
2. What are the modelling solutions to an environmental problem?
3. What are the alternative techniques for valuing environmental goods?
4. How effectively can we use contingent valuation method as a theoretical construct in valuing environmental goods?

In understanding the empirical literature on MSWM (Municipal Solid Waste Management), the following questions become relevant.

1. How is the environment related to the economy?
2. What is the magnitude of waste generation and what are the factors that determining waste generation?
3. What are the issues and challenges of waste management?
4. What are the alternative approaches followed by the household to manage domestic waste and how effective it is?
5. How effectively can WTP approach adopt for improved waste management and what are the factors that influence the WTP of the households towards improved waste management?

The literature review attempted in this chapter is organized in the following sequence. An examination of theoretical developments on environmental issues is given in section 2.2. It involves the economist's view on environmental problem as market failure and externality by using the theory of public good. Modelling environmental problems run in two streams; one follows internalizing externality through the application of market instruments. Valuing change in environmental quality is another way of modelling environmental problem. Revealed preference approach and stated preference method including contingent valuation techniques for valuing environmental goods are given in brief. Section 2.3 reviews the empirical literature on different dimensions of solid waste like extent of waste generation and determinants, issues and challenges of waste management and waste management practices of households. A brief discussion on the studies on WTP approach for improved waste management and factors that influencing WTP of the households also incorporated in this section.

2.2 Theoretical Developments on Environmental Issues

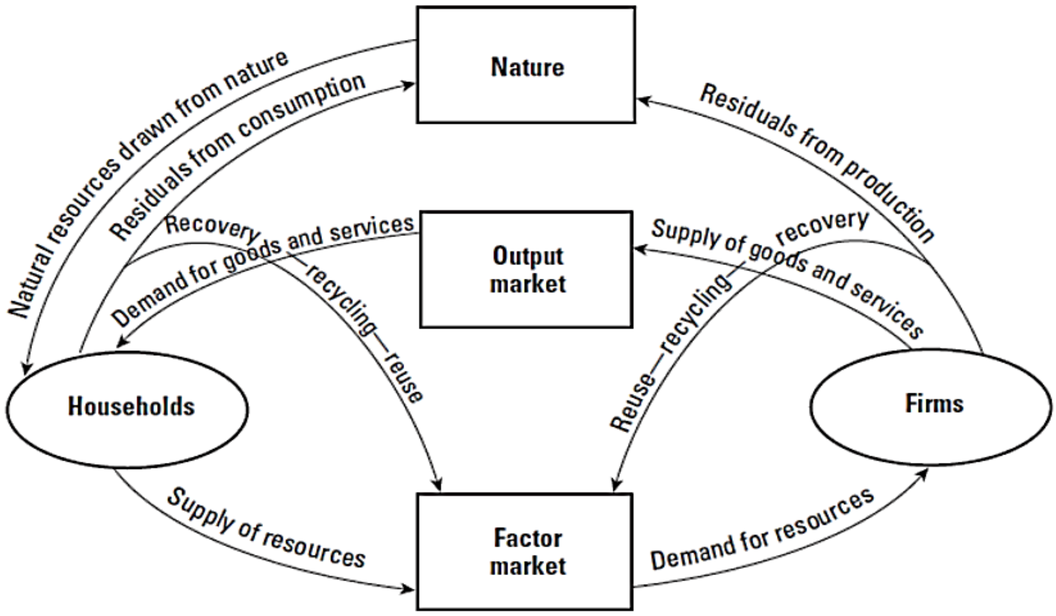
The fundamental presumption of environmental economics is that the environment and economy are interlinked and interdependent entities and therefore, changes in one affect the other. Environmental goods are often public goods or collective goods for which either no market exists, or the markets are imperfect. In many cases, consumption and production of these goods create unintended side effects or externalities. Consumption decision of some environmental goods may be irreversible and may have a profound impact on the well-being of future generation. This means that the fundamental decision that comprises economic activity is directly connected to an environmental problem.

Economic growth implies an increased per capita availability of goods and services. Production of goods and services require many inputs or resources from nature, or the biosphere such as land, water, air, trees, animals, metals, minerals and so on. Besides, in the process of production of goods and services, many wastes: solid, liquid, and gaseous are produced. These wastes are dumped into the biosphere which adversely affects the quality of the environment. As production and consumption increases, the more will be the impact on the environment. There are many interpretations on the issue of development and quality of the environment.

The explicit relationship between economic activity and the environment is interpreted through different models. Material balance model of Knees et al., (1969-70) positions the circular flow within a large schematic to show the connections between economic decision making and the natural environment. The model shows that an economic system linked to nature through natural resources that run from the environment to the economy. This flow describes how economic activity draws on the earth's stock of natural resources, such as soil, minerals, and water.

The second set of linkages runs in the opposite direction, from the economy to environment which shows how raw materials enter the system eventually are released back to nature as a byproduct or residuals. Most residuals are in the form of gases released into the atmosphere, and in the short run, most are not harmful. Some are absorbed naturally through the assimilative capacity of nature. There are also liquid residuals, such as industrial waste waters and solid residuals like municipal trash and certain hazardous wastes all of which are a potential threat to health and ecology.

Figure 2.1: Relationship between Environment and Economy



Source: Callen and Thomas (2013)

The model shows that inner flows are running from the two residual outflows back to factor market that is the flow of residuals back to nature through recovery, recycling and reuse. The material balance model shows that all resources are drawn from the environment ultimately return to nature in the form of residuals. Some arise in the short run, such as waste materials created during the production. Other resources are first transformed into commodities and do not enter the residual flow until the goods are used up. Even if recovery does take place, the conversion of residuals into recycled or reused goods is only temporary. In the long run, these two end up as wastes which create negative externality thereby environmental problems.

2.2.1 Environmental Problems: A Market Failure

Classical microeconomic theory predicts an efficient outcome under certain assumptions about pricing, product definition, cost conditions and entry barriers. If any of these assumptions fail to hold, market forces cannot operate freely. Depending on which assumption is violated, the result will be any of some inefficient market conditions, collectively termed market failures. These include imperfect competition, imperfect information, public goods and externalities.

Economists model environmental problems as market failure using either the theory of public goods or the theory of externalities.

- If the market is defined as "environmental quality", then the source of market failure is that environmental quality as a public good.
- If the market is defined as a good whose production and consumption generate environmental damage, then the market failure is due to an externality.

Environmental quality is generally considered as a public good which is non-rivalry and non-excludable in consumption, and when it is valued at market price, it leads to market failure. It is non-excludable if it is consumed by anyone and non-rivalry if no one has an exclusive right over its consumption.

The Paretian condition for a public good stated that MSB (Marginal Social Benefit) should equal it's MSC (Marginal Social Cost). However, a characteristic of a public good is such that the economy will not reach the point of Pareto optimality in a perfectly competitive market. Public goods create externalities which violate the Pareto welfare maximisation criterion of equating marginal social cost and marginal social benefits. A public bad is any product on condition that it decreases the welfare of others in a non-exhaustive manner. These are social marginal costs which are higher due to negative externalities.

In the real world, we cannot see the attainment of Pareto optimality due to some constraints in the working of perfect competition. An important cause of environmental degradation is a market failure which means poor functioning of markets for environmental goods and services. Market failure happens due to many factors like incomplete markets, common property resources, imperfect markets, externalities, asymmetric information, public goods and public bad. Market failure is a necessary but not a sufficient condition for government intervention. Government intervention must outperform the market or improve its functions. Besides, the benefits from such intervention must exceed the cost of planning, implementation, and enforcement, as well as indirect and unintended costs of distortions introduced to other sectors of the economy by such intervention.

2.2.2 Environmental Problems: Externalities

The economic theory defines waste as a negative externality. Production and consumption activities produce waste which has a negative impact on the environment and welfare, which is not taken into account by competitive markets. Economic activity that harms the environment creates present and future losses to humans in the form of damaged health, lower productivity, depleted natural resources and reduced enjoyment of nature. Environmental economics seeks to quantify these losses and determine the most efficient way to reduce them.

Externalities arise when certain actions of producers or consumers have an external (indirect) effect on other producers or consumers, and it is an unintended and uncompensated side effect of human activity. An externality could be positive and negative. If an activity of a person causes some unintended benefits to some other person or persons or external benefit to the third party, but he cannot claim by any compensation from the beneficiary, then the externality is positive. Conversely when an act of a person causes some unintended harm/loss to some other person or persons or external cost to the third party, and he does not compensate the person affected, then the externality is negative.

The theory of negative externality is the foundation of environmental economics. All gaseous, liquid and solid waste, which usually called ‘emission’, is the inescapable and unfortunate consequences of human activities. If these wastes are not properly dealt with, they can cause tremendous damage to consumers, firms and the nation at large since most wastes have externality effect.

Negative externality decreases the utility or production of another economic agent like disposing solid waste on the street or into a river. Cropper et.al., (1992) characterise pollution as a public “bad” but results from “waste discharges” associated with the production and consumption of various goods and services.

Neoclassical economist, who made an important contribution to environmental theories during 1950, recognises the common property nature of many environmental resources as the root cause of many economic externalities. The property rights of the environmental goods are undefined, as a result, the market for these goods are virtually nonexistent. Property rights play an important role in determining the attitude and behaviour of people towards the environment, its use and management. It has well established that the absence or the lack of well-defined property rights in environmental resources has led to their over exploitation, degradation, depletion and pollution. Air pollution, pollution of rivers, lakes and other water bodies and the degradation of common grazing lands etc. are the problems raised out of the absence or the lack of well-defined property rights. In the absence of well-defined property rights, a large proportion of environmental resources and amenities fall in the categories of Common Pool Resources[5] (CPR) and open access[6]

In India, most of the environmental resources are de facto open access resources or CPRs and hence are prone to degradation, pollution and misappropriation. In a nutshell, most of the CPRs and all open access resources in India are subject to what Garret Hardin (1968) called 'the Tragedy of Commons'. In the case of a CPR, an individual can appropriate all the benefits resulting from his increased use of the resource, he bears only a small fraction of the incremental costs associated with increased use, and all the members of the community share the incremental costs. It shows that the common pool problem is one of the reasons for the existence of externality.

2.2.3 Modeling Environmental Problems

From an economic perspective, the general solution to externalities, including those affecting the environment is to internalise the externality, that is, to force the market participants to absorb the external costs or benefit. One way this can be done is through the assignment of property rights. Other approaches to internalising

5 Resources those are held and used in common by an identifiable group of people.

6 Resources those are accessible to anybody and everybody without any restriction.

environmental externalities are policies that change the effective product price by the amount of the associated external cost or benefit.

The underlying causes of many environmental problems are not directly related to the specific projects but from policy and market failures. In these cases, government action is required to correct these failures through intervention, which may include changes in property rights and other institution governing resource use, policy instruments such as tax/subsidies, market-based incentives and regularity measures and direct public investments. Coasian property rights approach and Pigouvian tax subsidy approach are two alternative approaches to abatement of externalities.

Coase theorem (Coase, 1960) examined how the assignment of property rights can be used to overcome the problem of pollution. Proper assignment of property rights to any goods, even if externalities are present, will allow bargaining between the affected parties such that an efficient solution can be obtained, no matter which party holds the rights. Assignment of a property right can be used to internalise an externality, and it does not matter, regarding economic efficiency, which party (the polluter or persons suffering from the pollution) is assigned the right. The theorem is used to show that a solution to the problem of externalities is the allocation of property rights.

Pigou (1962) argued that taxes and subsidies could be used to encourage economic agents to internalise externalities. In the case of negative externalities, Pigou's solution is that the producer must compensate parties who are affected by negative externalities or be taxed to the extent that the marginal private cost, including the tax, is equal to marginal social cost including the negative externality. The tax should be fixed exactly the level of marginal external cost. This either induces the one who imposes the externality to eliminate or reduce the externality to acceptable limits (depending on how and to what extent the tax is imposed) or to compensate the parties adversely affected through the tax proceeds. Conversely, a payment such as a subsidy could be made to compensate producers who cause beneficial externalities. The tax-subsidy solution is commonly used in both developing and developed countries of the world.

Most governments, including that of the United States, use some different policy tools to achieve environmental quality. The majority of these fall into two broad-based categories such as command and control approach[7] and market approach[8]. Command and control is the more conventional approach, and it dominates environmental policy in most countries. Although well-intentioned, the use of inflexible regulations and pollution limits, often imposed uniformly across all polluters, has not met with consistent success. So the United States and other industrialised countries have gradually integrated market- based solutions into their environmental policy programs.

2.2.3.1 Environmental Problem: The Market Approach

The market approach to environmental policy recommended for some time by economists has begun to be adopted by the government as part of their overall response to the risk of pollution. The market approach uses prices or other economic variables to provide incentives for polluters to reduce harmful emissions. Economists are strong proponents of the market approach because it can achieve a cost-effective solution to environmental problems. Market instruments (details of market instruments are given in Annexure 2.1) are aimed at bringing the external cost of environmental damage back into the decision making of firms and consumers. Because many policy instruments use market incentives, it is helpful to classify these instruments into major categories: pollution charges and fee, subsidies, deposit/refund systems, and pollution permit trading systems.

Nations all over the world use market-based instruments to control pollution. OECD (Organization for Economic Co-operation and Development) member nations use approximately 375 different environmental taxes as well as some 250 environmentally based fees. Although the market approach continues to be a secondary form of control, its use in national policy prescriptions speaks to its importance as part of the range of available solution to the environmental problems.

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[7] A policy that directly regulates polluters through the use of rules or standards.

[8] Approach which uses incentive-based policy tools to motivate abatement through market forces.

The theoretical premise of a pollution charge is to internalise the cost of environmental damages by pricing the pollution-generating activity. A pollution charge is a fee that varies with the quantity of pollutants released, and it can be implemented as a product charge or as an effluent or permission charge. The motivation follows what is known as the "polluter-pays principle", a position rooted in the belief that polluter should bear the cost of control measures to maintain an acceptable level of environmental quality. The categories of market-based instruments are given in Table 2.1.

Table 2.1: Categories of Market-Based Instruments

Market Instruments	Description
Pollution charge	A fee charged to the polluter that varies with the quantity of pollutants released
Subsidy	A payment or tax concession that provides financial assistance for pollution reductions or plans to abate in the future
Deposit/ refund	A system that imposes an up-front charge to pay for potential pollution damages that is returned for positive action, such as returning a product for proper disposal or recycling
Pollution permit trading system	The establishment of a market for the right to pollute, using either credits or allowances.

Source: Callen and Thomas (2013)

Apart from the economic instruments identified, other incentives that have been in practice in many countries are environmental labeling system, fiscal incentives including credit subsidies, tax rebate for energy efficiencies (waste-to-energy system), and long-term use of government lands to build solid waste management and disposal facilities , voluntary approaches like Extended Producer Responsibility (EPR) etc. In the case of the environmental or eco-labelling scheme, producers voluntarily label their products to inform consumers and to promote products determined to be more environmentally friendly than other functionally and competitively similar products. The result is the development of products with lesser environmental impacts and thus reduce pollution and waste quantities.

Although economic instruments act as one of the most effective environmental policy tools for achieving waste management goals, the introduction of any new economic instrument or combination of the instrument should be carefully done, especially in the context of developing country. Given the very different conditions prevail in countries; the developed country experience in the use of economic instruments is not readily transferable to developing countries. The selection of policy instruments should be carefully based on the nature of the solid waste problem, local conditions, willingness and ability of the people to pay, existing political and institutional context, regulatory framework etc.

2.2.3.2 Application of Economic Instruments: International Experience

Economic instrument approach tries to provide incentives to consumers, producers and other economic agents to make environmental improvements or reduce adverse environmental consequences due to their activities. Economic instruments incorporate “polluter pays principle” for environmental management. One of the main advantages of economic instruments in the case of solid waste management is that they provide continuous incentives which motivate waste generators and service providers to find out the least cost combination of disposal, recycling and re-use that is available to them. These instruments are meant to reduce waste generation; induce the practice of segregation of hazardous waste for special handling and disposal; optimize recovery, re-use and recycling of waste; support cost-effective solid waste collection, treatment and disposal system; minimize adverse environmental impacts related to solid waste collection, transportation, treatment and disposal systems and generate revenue to cover cost of waste management.

Landfill tax, waste generation charges, deposit-refund systems, product charges, recycling credits, etc. are the major economic instruments in use. The other types of instruments, which have been in practice, include eco-labelling, voluntary agreements, extended producer responsibility etc. Application of different types of economic instruments on the solid waste sector in different countries is presented in Table 2.2.

Table 2.2: Application of Economic Instruments: International Experience

Economic instruments applied to the solid waste sector	Countries where the use of economic instruments have been reported
A. Charges	
Waste Generation Charges User charges based on the volume of waste generated	Barbados, Bolivia, Brazil, Columbia, Jamaica, Mexico, Japan, United States, The Netherlands, China, Indonesia, Malaysia, Singapore, Thailand.
Waste User Charges (Flat rate charge system) Waste Tipping Charges	Belgium, Bulgaria, Croatia, Hungary, Romania, Yugoslavia, Singapore, Indonesia, USA. Canada, New Zealand, Portugal, Japan, Greece, Colombia, Canada, Switzerland, Netherlands. USA, Canada, New Zealand, Chile, Australia, Japan, France, UK, Italy, Japan, Greece, Canada.
Product Charges	Hungry, USA, Bulgaria, Jamaica, Japan, China, OECD, Thailand, Bangladesh etc.
Fee reduction for recycling	Argentina
B. Taxes	
Waste Treatment Tax	Austria, Denmark, Norway, UK, Italy, Finland
Landfill Tax	Italy, Netherlands, Sweden, UK, France, USA
Taxes to encourage recycling	British Columbia, Norway, Finland
C. Deposit- Refund system	Australia, Canada, Germany, USA, Brazil, etc.
D. Product Take-back system	Norway, Germany, British Colombia
E. Fiscal incentives	Brazil, Colombia, India, USA, Ghana, Indonesia
F. Environmental Labeling	OECD countries, India

Source: Shylajan and Bhatacharya, CDEP-IIM Culcutta (2004)

There has been a growing interest in the European Union, OECD and Latin American countries in the application of economic instruments to improve the efficiency of the waste management process. Many Central and Eastern European countries follow user charges for municipal solid waste management. Bulgaria, for instance, has a user charge system based on the value of property instead of the amount of waste generated. Many of the Asian countries also follow a flat fee system to cover the cost of waste management. Countries like Brazil, Bolivia, Chile, Mexico, Japan, and United States, The Netherlands, China, Indonesia, Malaysia, Singapore, Thailand etc. follow charges and fee system based on the volume of waste generated. Table 2.2 also reveals the truth that India is yet to follow some of the well-accepted concepts like waste generation charges and waste user charges as mechanisms to minimise municipal wastes. A cursory glance at the issues of MSW has also revealed that we do not have sound theoretical, as well as practical, know-how as for how to fix user charges or polluters pay principles for minimising solid wastes.

2.2.4 Valuing Change in Environmental Quality

TEV (Total Economic Value) is used to find out the economic value of a change in the quality of the environment. Identifying and determining the economic values of environmental quality and measuring these values is a difficult process. The goods and services provided by the environment include recreation and tourism, plant and wildlife habitat, genetic resources, water supply, protection against natural disasters, etc. Many of these goods and services are not traded on commercial markets and therefore have no market value. The values of non-market goods and services have to be measured and expressed in monetary terms so that they can be treated as commercially traded components.

TEV is the total of the UV (Use Value) and NUV (Non-Use Value) of the environmental good.

$$TEV = UV + NUV$$

The use value refers to the values derived from the actual use of the resource and includes DUV (Direct Use Values), IUV (Indirect Use Values) and the OV (Option Values).

$$TEV = (DUV + IUV + OV) + (NUV)$$

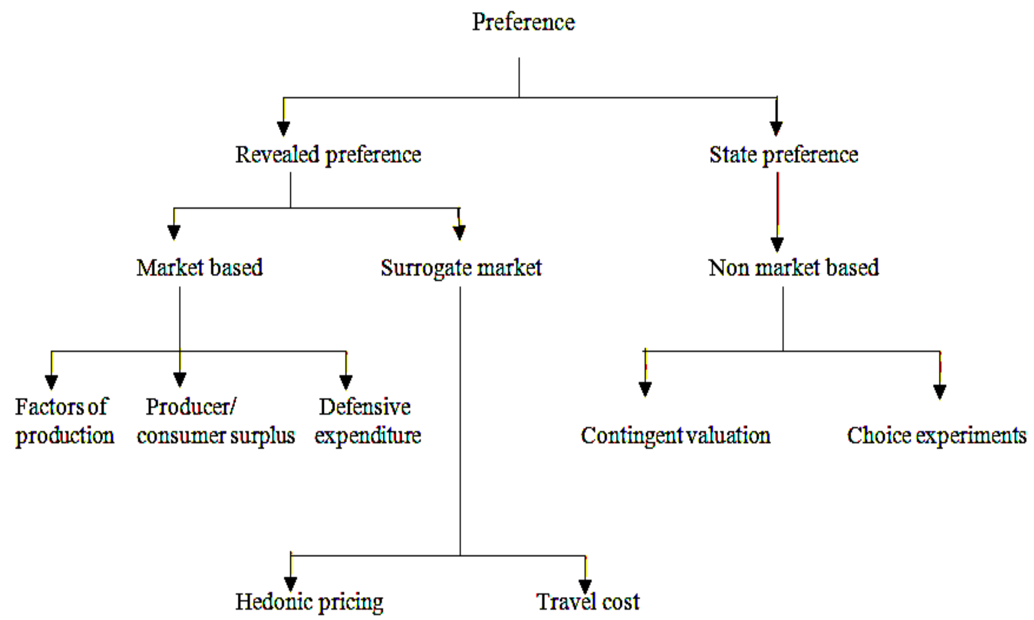
Direct use value is the direct use of a protected area, for instance, for activities such as recreation, tourism, natural resources harvesting, hunting, education and research. These activities can be commercial that is they are traded on a market or non-commercial, meaning there is no formal or regular market on which they are traded. Indirect use value is the values derived from the indirect use of a protected area and option values are values derived from using the good in the future.

Non-use value is the values that are not associated with the actual use of the resource include existence values and bequest values. The existence values are the value derived from the knowledge that good exists, and bequest values are those which are derived by the fact that others are benefiting or will benefit from the good. These existence values are certainly fuzzy values which are not related to vicarious benefit, i.e. securing pleasure because others derive a use value. Vicarious benefit belongs in the class of option values, in this case, a willingness to pay to preserve the environment for the benefit of others. Nor existence values are what the literature calls `bequest' values, a willingness to pay to preserve the environment for the benefit of our children and grandchildren.

Non-use values are particularly difficult to measure. With the emergence of environmental economics, the link between ecology and economics is more visible. Economists and ecologists have now a common interest in understanding the economic contribution of the environment. Environment valuation is mostly based on the assumption that an individual is willing to pay for environmental gains and on the other hand, are willing to accept compensation for some environmental hazards or losses. The individual demonstrates preference, which in turn put values on environmental resources. Environmental economists have developed some market and non-market based techniques to assess the environment.

Figure 2.2 presents some of these techniques and classifies them according to the basis of the monetary valuation, either market based, surrogate market or non-market-based.

Figure 2.2: Environmental valuation methods



Source: Banerjee (2003:125)

2.2.4.1 Environmental Valuation: Revealed Preference Methods

The demand for environmental goods can be revealed by examining the purchase of related goods in the previous marketplace. There may be complementary goods or other factor inputs in the household production function. Revealed preference method consists of market-based methods and surrogate market-based methods.

Market-based valuation is the principal method of valuation used in conventional national accounts. Economists could use actual or imputed or simulated market prices for valuation of those environmental goods, amenities, services and functions that are marketed. The market approach is used when environmental improvements bring an increase or decrease in real outputs or inputs. The benefits from environmental improvements are identified regarding changes in outputs or inputs such as timber, minerals, fish and crops. These output or inputs fetch market prices that reflect their scarcity value (a true market price). Thus where environmental improvement is directly associated with changes in the quantity or price of marketed output or inputs, the benefit can be measured by changes in the producer's or consumer's surplus[9].

The preventive or defensive expenditure method is a cost-based valuation method that used data on actual expenditure made to alleviate all environmental problems. For example, if drinking water is polluted, extra purification may be needed. In the preventive expenditure method, the value of the environment is inferred from what people are prepared to spend to prevent its degradation. The averting or mitigating behaviour methods infer a monetary value for an environmental externality by observing the costs people are prepared to incur in order to avoid any negative effects.

The market value approach covers only natural assets that have an economic value. They are those assets that are connected with actual or potential market transactions. Market valuation does not cover environmental assets of air, land in the wilderness, waters and species that provide environmental services, nor can market valuation capture environmental functions of 'economic' assets, which are not reflected in their market price. Surrogate (or substitute) markets can be used to derive information on values when no market exists for a good or service, and no market price is observed. Two methods based on surrogate markets approach are hedonic pricing method and travel cost method. The hedonic price technique is a method for estimating the implicit price of the attributes that differentiate closely related products in the product category. It is a fact that land values to a large extent are associated with environmental features like good quality of environment etc. for example if a price of land, fetches a very high price due to environmental quality, finds relative lower price cause of the associated odour, noise, debris, and health risks that emerges in the course of time. In this way, people are willing to pay a higher price for lands which are away from environmental pollution. This price is the price for avoiding nuisance associated with environmental decay. This is the

9 Consumer's surplus refers to any benefits that consumer may receive when purchasing goods or services at the existing market price. Consumer surplus will be higher when the market price is less than what they are willing to pay. Producer's surplus refers to any benefit the producers receive when they sell the goods and services they produce at market price, consumers and producers are used in environmental policy concern.

case of hedonic price where the value or price of environmental features is imputed by looking at the effect that its presence has on relevant market-priced goods.

The travel cost method is often used in research to assess the recreational or eco-tourism values of a recreation site such as a national park or hill station. The cost of travelling to a site is a major component of the full cost of a visit. It is assumed that the number of money people is prepared to spend to travel to a site, and the opportunity cost of the time involved can serve as a proxy for their willingness to pay for the visit. A consumer, who travels to Bangalore to enjoy the water theme park there, is willing to meet the travel cost to reach there, and therefore the price of recreation is not just the gate price, but the entire cost that is borne to enjoy this site. Along with this, environmental goods can be valued by using stated preference method which is given in the next section.

2.2.4.2 Environmental Valuation: Stated Preference Method

Individuals exhibit preferences and these preferences for many things that have no market like clean air, peace, the beauty of the song thrush, the awesome spectacle of the mass migration of the wildebeest etc. Since economic values relate to preferences and not all preferences are expressed in markets, markets cannot be necessary for economic values to exist. The demand for environmental goods can be measured by examining the individual’s stated preference for these goods relative to their demand for other goods and services. Stated preference technique asks individuals explicitly how much they value an environmental good. The valuation of environmental issues like biodiversity loss, global warming, and species extinction is highly complex. Economists have developed new ways of calculating the economic and social values of the environment. In the environmental context, it is necessary to impute a value to the environmental good or service. Economic valuation tries to measure human preferences for or against changes in the state of environments (Pearce l992). In economic valuation, the theoretical statement is that preferences are already formed, and economists try to find out the true underlying preference for environmental goods and services (Spash & Claudia, 2001).

Environmental economics has developed techniques whereby such values can be imputed.

In the marketplace, individuals exercise choice by comparing their WTP with the price of the product. They purchase the good when their WTP exceeds the price, and not otherwise. Imputing values involves finding a measure of WTP for environmental quality. Economic valuation involves finding a WTP measure in circumstances where markets fail to reveal that information directly. The purpose of economic valuation is to reveal the true costs of using up scarce environmental resources. Environmental valuation is thus formed an integral part in the determination of the balance between conservation and development and in the choice of environmental standards. Choice method and contingent valuation method are the two alternative approaches of non- market valuation technique. The costless choice method is a non-market valuation technique whereby people are asked to choose between several hypothetical bundles of goods to determine their implicit valuation of an environmental good or service. Since no monetary figures are evolved, this approach may be more useful in settings where barter and subsistence productions are common.

2.2.5 Contingent Valuation Method

The study adopted the contingent valuation method to elicit the willingness of the people towards improved waste management. When market data are unavailable or unreliable, economists can use an alternative estimation method that relies on hypothetical market conditions. Such methods typically use surveys to inquire about willingness to pay of the individuals for some environmental initiative. This survey approach to benefit estimation is known as the CVM because the results are dependent, or contingent on the devised hypothetical market. CVM involves directly asking people, in a survey, how much they would be willing to pay for a specific environmental service or what they are willing to accept by way of compensation to tolerate a cost. This method is more effective when the respondents are familiar with the environmental good or service and have adequate information on which to base their preference.

CVM is the only direct method that can be applied for determining both user and non-user value. Even though, it is used widely for estimating non-use values. This method involves creating a hypothetical market for a non-market good and invites the respondents to operate in that market. The CVM involves asking some individuals the maximum sum they are willing to pay to have the benefit or the minimum sum they are willing to accept to forgo the benefit. The concept willingness to pay and willingness to accept is derived from Hicksian measure of consumer surplus: compensation variation measure[10] and equivalent variation measure[11]. Empirical studies reveal that willingness to pay is at least one third to one fifth lesser than the willingness to accept.

The steps in a CVM are as follows:

1. Identification and description of the environmental quality characteristics to be evaluated.
2. Identification of respondents to be approached.
3. Design and application of a interview schedule.
4. Analysis of results and aggregation of individual response to estimate values for the group affected by the environmental change.

Designing the interview schedule so as to make people reveal the maximum willingness to pay is a crucial part of the CVM. The schedule should comprise:

1. A clear statement of the environmental features or amenity that people are asked to evaluate.
2. A set of questions that will describe the socio economic features of the respondent.
3. Questions to elicit willingness to pay of the respondents.

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[10] The compensation variation measure of consumer surplus defines consumer surplus as the maximum sum the individual is willing to pay for the privilege of buying at a lower price and retain his initial level of welfare.

[11] An equivalent variation, on the other hand, measures consumer's surplus as the minimum sum the consumer is willing to accept for forgoing the opportunity of buying at a lower price such that he gets the subsequent level of higher welfare, facilitated by the price fall.

The respondent will be provided information on when the service will be available, how the respondent will be expected to pay for it, how much others will contribute the institution that will be responsible for the delivery of the service and the quality reliability of the services. There are four broad approaches in which CVM can use to elicit the preference of the individuals, and the choice of any method depends on individual judgment (Bishop & Heberlein, 1990).

1. Bidding game technique: In a bidding game, individuals are asked to evaluate a potential change under a hypothetical situation and to express their WTP or WTA for a change in the level of provision of an environmental good or service. Two types of bidding games are used to elicit willingness like single-bid games and iterative-bid games. Single-bid games ask respondents to indicate the maximum price they would be willing to pay for an environmental good or to indicate the minimum amount of compensation they would accept for doing without that good. In the iterative or converging bid games, individuals are asked whether they would pay a given amount for the environmental good or service. The amount is then varied iteratively until a maximum WTP, or a minimum WTA is reached. The responses are then averaged and extrapolated to arrive at the aggregate WTP or an aggregate level of compensation.

2. Open-ended: In the open-ended question format the respondents are left to devise their maximum values without the aid of additional information or bidding. The respondent is free to state any amount on being asked,

3. Dichotomous choice: It offers different amounts to its respondents and asks them to say if they would be willing to pay for the amount stated in a "yes" or "no" format.

4. Payment card format: The method involves that respondents are offered a payment card which contains a list of potential willingness to pay amounts. Also included on the payment card are so-called benchmarks, giving the respondent an indication of how much money is currently being spent by each type of household on other public goods.

On the basis of information available from the interview schedule, a general willingness to pay can be derived which is likely to be of the following form:

$$WTP_i = f\{Q_i, Y_i, T_i, S_i\}$$

Where Q_i is the quantity/ quality of the attribute, Y_i is the income, T_i is an index of tastes and S_i is an index of socio economic factors.

The willingness to pay (WTP) will reflect the value of the particular environmental quality (Ciriacy-Wantrup, 1947; Walsh et al., 1984; Brookshire et al., 1981; Mitchell & Carson, 1993). This method is also known as the stated preference technique, as the people are directly asked to state their value rather than inferring values from the actual choice. The main aim of the C.V survey is to create a hypothetical market, as close to a real market, to obtain hypothetical bids 'that conform to actual bids if the actual market had existed.

It is assumed that a positive preference for something will show up in the form of a WTP for it. WTP differs from one individual to another since each one has a different set of priorities. An average of the aggregate WTP should be calculated for getting households willingness to pay towards improved waste management. The hypothetical market, the questioner, questionnaire, and the respondent must, therefore, be as close as possible to a real market. The respondent should be familiar with the good question. The questioner should provide the respondent with the proper description of the resource and its potential benefits. The respondent must be familiar with the hypothetical means of payment, say a local tax, an entry fee etc.

CVM has helped to solve a serious problem in environmental policy analysis like the need to assign a value to non-market goods and services. Surveys are used to provide analysts with the ability to ask direct questions about the economic value of environmental resources, thereby providing information that can be used as part of the cost-benefit analysis of project program alternatives or economic assessments of resource losses. CVM is now the most widely used economic survey approach (Gregory, 2000), and particularly attractive because it can estimate values where markets do not exist or where market substitutes cannot be found. CVM is widely used to measure existence values, option values, indirect use values and non-use values. It is a simple and flexible non-market valuation method, has been severely criticised on two aspects, the validity and reliability of the results and the effects of biases and errors.

The present study is mainly based on the theory of externality which leads to market failure in valuing environmental goods. Solid waste creates negative externality the valuation of which is difficult. In the absence of a price signal, it necessitates the need for government intervention. However, the government may also become failure due to policy failure. Thus market failure and government failure necessitate the need for a technique that can evaluate non-market goods. Stated preference techniques are the primary means of valuing non-market benefit, and the commonly used non-market valuation technique is the contingent valuation method. Contingent valuation method has been used to estimate the value people place on environmental commodities by creating hypothetical market scenarios to elicit their willingness to pay for them. Hence the study focuses on CVM to elicit willingness to pay by the households towards improved environmental quality specifically improved solid waste management.

2.3 Empirical Literature on Solid Waste Management

Solid waste generation and its management are crucial issues among all the countries of the world. Waste management has received the worldwide attention of academicians as improperly dumped waste can cause health, safety and economic problems. Generation of waste and its disposal has been assumed as a greater concern. Economists have given much attention to study the reasons for generation of waste and its impacts and the price that the society needs to shoulder for its disposal etc.

While reviewing the available literature in the area of waste generation, disposal and management it is observed that most studies focus on municipal solid waste management. It is in this background study try to examine the various aspects of household solid waste and its management. All the leading studies prepared in the form of articles, books, research publications etc. have been reviewed to know the methodology of studies, the various tools being applied, and the conclusions drawn in order to identify the area where research vacuum is seen. In this part, different studies are reviewed on

- ❖ Environment and development
- ❖ The magnitude of waste generation
- ❖ Health and environmental issues of solid waste
- ❖ Solid waste management: Challenges
- ❖ Sustainable waste management policy
- ❖ CVM and willingness to pay towards improved waste management.

2.3.1 Environment and Development

A clean environment is crucial for human health and economic development. We need a dynamic and holistic approach to have a healthy environment for everyone for today and tomorrow (Patil, 2001). Any development effort without ensuring a healthy environment and surroundings for the citizen of the society cannot be described as a sustainable one. The real meaning of sustainable development is developments while protecting the environment. Sustainable development seems to suggest a solution to the twin problems such as depletion of resources and degradation of the environment. Environment, ecology and development must be balanced to meet the needs of society. Choudhary & Sahoo (2001) took a turn with the growing perception that environmental problems are real and pervasive and sustainability is a constraint.

The essential requirement for achieving sustainable development are the presence of a development states with an honest, impartial and efficient bureaucracy, strong judiciary and law enforcement agency and a genuine desire on the part of the developmental state to engage in a participatory system of environmental conservation and management (Roy & Tisdell, 1999). India should aim at green growth to achieve harmony between economic growth and environmental sustainability in the long run and for all-round human development. Along with rapid economic development, the Indian economy faces certain key environmental challenges like climate change, land degradation, air pollution and water security. Imposing taxes to yield positive environmental benefit and to reduce the negative impact and green growth aiming to achieve harmony between economic growth and environmental sustainability are suggested.

Barthwal (2002) emphasise that the increasing awareness of the people are crucial for the protection of the environment. The growing awareness regarding environmental issues and, therefore, a focus on sustainable development all over the world is certainly a desirable situation. The success in this direction can be achieved only through strong policy prescriptions. The pragmatic environmental policy should emphasise preventive measures instead of relying on curative approaches. A "paradigm shift" is called for to ensure a healthy environment for the well- being of present and future generations. The study also suggests that the pollution free environment is shared by all nations with an equal share of resources available on this planet earth. The study concluded that the strengthening of public awareness against environmental pollution is more important than statutory provisions. Successful implementation of all policy measures at all fronts is required for a healthy environment and sustainable development (World Bank, 1999).

So in order to achieve the objective of sustainability, it is necessary to establish systems of solid waste management, which harmonise the technical requirements with the objectives of environmental protection and the needs and interests of different stakeholders especially the urban poor **(** Jain, 2016**)**. As the city population increases and its economic profile changes, the quantity of waste and the resources requirement to manage it will increase. Given their financial limitations and competing demand for other services, the urban local bodies may find it challenging to raise and sustain additional allocations for this sector. Waste minimisation and community-based waste management seem the only sustainable way to manage waste. Management of such solid waste is one of the major environmental issues as urban population growth and economic development lead to increased generation of municipal solid waste (Waste Composition Study, 2009).

2.3.2 Magnitude of Solid Waste Generation.

A solid waste generation has become an increasing environmental and public health problem across the world, particularly in developing countries. The fast expansion of industrial activities stimulated by rapid population growth has produced vast amounts of solid and liquid wastes that pollute the environment and destroy resources (UNEP, 2004). In the developing countries, solid waste generation and it’s poor management has become a more challenging issue for the impending days. However, solid waste generation is lower in the developing county than the developed county in relation to per capita income owing to less purchasing and consumption rate (Cairncross & Feachem, 1993).

World Bank report (2012) on the state of solid waste around the world estimates that the amount of MSW (Municipal Solid Waste) will rise from the current 1.3 billion tonnes per year to 2.2 billion tonnes per year by 2025, with much of the increase coming from rapidly growing cities in developing countries. Low-income countries are also expected to generate 213 million tonnes of solid waste a day with the population rising to 676 million by 2025. Lower-middle-income ones are also projected to generate 956 million tons of solid waste per day with a population of 2.08 billion. Waste generation will hit 360 million tonnes per day by 2025 in upper-middle-income countries with an expected population of 619 million. For high-income nations, waste generation per day by 2025 will reach 686 million tonnes and the population at 912 million (UNEP, 2004).

Analyses across countries and over time reveal that the generation of municipal solid waste is positively related to variations in per capita income and that the generation of municipal solid waste per capita does not vary with population size among countries with comparable per capita income (Beede & Bloom, 1995). In developed countries, per capita waste generation increased nearly three-fold over the last two decades, reaching a level five to six times higher than that in developing countries. With the increase in population and living standards, waste generation in developing countries is also increasing rapidly and may double in volume in the current decade.

If current trends continue, the world may see a five-fold increase in waste generation by the year 2025 (Palczynski et al., 2002).

Beede et al., (1995) have examined the generation and management of municipal solid waste and estimate that the global burden of municipal solid waste amount to1.3 billion metric tonnes in 1990 or two third of a kilogram of waste per person per day. Industrial countries account for a disproportionately high share of the world’s waste relative to their share of world population while developing countries account for a disproportionately high share of the world’s waste relative to their share of world income. With increases in populations and living standards, waste generation in developing countries is also increasing rapidly and may double in volume in the current decade. If current trends continue, the world may see a five-fold increase in waste generation by the year 2025 (Okalebo, 2014).

The current status of municipal solid waste across Nigeria covered core aspects like generation, characterisation, collection, scavenging, open dumping, disposal and environmental implications of poor solid waste management. Solid waste generation rate was found to vary from 0.13 kg/capita/day in Ogbomosho area to 0.71 kg/capita/day in Ado-Ekiti city. Typically, food waste was found to constitute close to 50 per cent of overall municipal solid waste in Nigerian cities. The rate of generation of plastics, waterproof materials and diapers has assumed an upward trend (Nnaji, 2015).

The present annual quantity of solid waste generated in Indian cities has increased from 6 million tonnes in 1947 to 48 million tonnes in 1997 with an annual growth rate of 4.25 per cent, and it is expected to increase to 300 million tonnes by 2047 (CPCB, 2004; Sharholy et al., 2006)). In Gujarat, 9,277 tonnes of municipal waste was generated every day in 2014; it was 7,379 tonnes in 2010. Out of the eight municipal Corporations, in 2004, they did not have any functional compost plants, and four did not have any landfill sites. Further, three municipal Corporations out of eight (Ahmedabad, Gandhinagar, Surat, Vadodara, Rajkot, Bhavnagar, Jamnagar, and Junagadh) and 125 municipalities never filled up necessary monthly details of how much of solid waste was being generated, collected, and processed. It was suggested, the Government of India should work out a proper authority which should monitor SWM (Jadeja, 2015).

Municipal areas in the country generate 1, 33,760 metric tonnes per day (TPD) of MSW, of which only 91,152 TPD waste is collected and 25,884 TPD treated. Considering that the volume of waste is expected to increase at the rate of 5 per cent per year on account of increase in the population and change in lifestyle of the people, it is assumed that urban India will generate 2,76,342 TPD by 2021, 4,50,132 TPD by 2031 and 1,195,000 TPD by 2050. The challenge is in managing this waste which is projected to be 165 million by 2031 and 436 million by 2050. The CPCB report also reveals that only 68 per cent of the municipal solid waste generated in the country is collected of which, 28 per cent is treated by municipal authorities. Thus, merely 19 per cent of the total waste generated is currently treated. The untapped waste has a potential of generating 439 MW (Mega Watt) of power from 32,890 tonnes per day of combustible wastes including Refused Derived Fuel (RDF), 1.3 million cubic meter of biogas per day or 72 MW of electricity from biogas and 5.4 million metric tonnes of compost annually to support agriculture. (CPCB, 2012–13).

Municipal solid waste generation in Chennai, the fourth largest metropolitan city in India, has increased from 600 to 3500 tonnes per day within 20 years. The highest per capita solid waste generation rate in India is in Chennai (0.6 kg/d) (Esakku & Swaminathan, 2007)**.** The municipal solid waste management in Kolkata which is one of the four metropolitan cities in India generates solid waste at a rate of 450-500g per capita per day. The problems associated with handling these wastes have increased at an alarming rate over the past few years. No source of segregation exists, and there is only limited (60 per cent) house to house collection. The threats of groundwater pollution as well as the saturation of an existing landfilling site, are the most pressing problems for the city today. Corporation spends 70-75 per cent of its total expenditures on a collection of solid waste, 25 -30 per cent on transportation, and less than 5 per cent on final disposal (Chattopadhyay et al., 2009).

The Government of Kerala (Kerala Economic Review, 2004) estimated that about 2500 tonnes of solid wastes are generated per day in the State of which about 50 per cent is collected for disposal. The study (Malinya Muktha Kerala Action Plan, 2007) indicates that Kerala generates an average of 6000 tonnes of waste every day. A study by Varma (2013) found that 10044 tonnes of municipal solid waste per day are generated in Kerala due to various household activities and other commercial and institutional activities. The results of these studies show that waste generation in Kerala is increasing at an alarming rate. The study identified that increasing urbanisation, changing lifestyle and rise in tourism are the main reason for the rise in waste generation in Kerala. Ministry of Environment and Forest, Government of India (2016), pointed out that Kerala is a State considered to be having a developed modern society. The consumption of more resources results in the generation of more waste. All types of waste including solid, hazardous and biomedical waste generation in the State are more compared to other States in the country. The responsibility of collection, treatment and safe disposal of all types of solid wastes rests with the generator. Most of the Grama Panchayats in Kerala are showing the characters of urban areas particularly in respect of municipal solid waste generation. So the State should plan to have a municipal waste management system in all the Grama Panchayats areas.

2.3.2.1 The Magnitude of Household Waste Generation

World bank study on solid waste shows that 30 per cent of all municipal waste covers residential, household and industrial waste while it is generated two or three times higher perspective to rural Asian fellow (World Bank, 1999). The same is supported by Chavan & Zambare (2013) that the primary sources of municipal solid waste consists of domestic, institutional, commercial activities, garden and municipal services. Asian Development Bank (2013) on solid waste management in Nepal notified that household waste contributed about 50 –75 per cent of the total municipal solid waste, i.e. 317 g/capita/day in 58 municipalities of Nepal. Out of this, organic waste accounted for the highest fraction. With rising urbanisation and change in lifestyle and food habits of residents, the amount of household solid waste has been increasing rapidly, and its composition is also changing (Adebo, 2012).

By estimating the quantity of waste generation among the different group (estimated by weight), it showed that with the increase in social status the per capita waste generation is also increased, especially about biodegradable organic waste which accounts for three-quarters of total waste. Differences in livelihood patterns between the residential estates influence the scale and composition of household waste (Okalebo et al., 2005**).** With rising urbanisation and change in lifestyle and food habits of residents, the amount of household solid waste has been increasing rapidly and its composition changing (Adebo, 2012).

The overall household waste composition estimated that garden waste (20 per cent of the total), paper and board (18 per cent), wood and furniture (5 per cent), kitchen waste (17 per cent), general household sweepings (9 per cent), metal packaging (3 per cent) glass (7 per cent), wood (5 per cent), scrap metal (5 per cent), soil (3 per cent), textiles (3 per cent), and 2 per cent being disposable nappies. The excessive packaging of consumer products is one of greatest sources of unnecessary household waste where 50 per cent of the total the waste is made up of paper, plastic, glass and metal packaging (Cunningham, 2009). Seasonal household solid waste generation (Havlicek & Richardson,1971)and economic analysis of the composition of household solid wastes (Richardson, 1978) examined the influence of seasonal variations on solid waste generation along with other factors like household income, household size and age structure at Indianapolis, U.S.A.

Half of the solid waste in Kerala is generated from household waste since the collection of wastes from residence is not done properly most of the domestic wastes ends up in the streets or barren lands in the city (Varma, 2007). The average generation of waste from a household is found to be 0.289 kg per person per day. The total waste generated is estimated at 867 kg per day. These include vegetables, fruits wastes, leftover food, fish and meat wastes, paper, plastics, metals, glass etc. (Ashalakshmi & Arunachalam, 2010).

2.3.2.2 Factors Influencing Waste Generation.

The urban pollution growth and solid waste generation are concerning issues in the present scenario. Solid waste generation scenario in an urban area has changed due to population growth, urbanisation and ignorance. The unplanned urbanisation and massive growing slum are influenced to solid waste generation in unidentified quantities in the six major cities such as Dhaka, Rajshahi, Khulna, Chittagong, Barisal and Sylhet in Bangladesh (Salequzzaman et al., 2001). The Rangpur district is a newly emerging divisional city which is located at the northern part of Bangladesh where rapid population growth and its unplanned development are significantly attributed to per capita solid waste generation and improper management strategy. The solid waste generation rate is gradually increased in the city, and it is around 23.94 tonnes per day (Rakib et al., 2014).

Cities in developing countries, like Kenya, are facing an increasing generation of waste and accompanying problems associated with waste collection and disposal (Begum et al., 2007). This is mainly due to the increase in population growth and rapid economic expansion. The problem of solid waste in Eldore Municipality explores high waste generation, lack of disposal sites, inadequate waste collection by local authorities, and household/individual poor disposal habits (Banga et al., 2011).

The high rate of urbanisation, the rising standard of living and rapid development accompanied by population growth have resulted in an increased generation of solid waste in urban areas in Uganda. Unfortunately, this has not been accompanied by an equivalent increase in the capacity of the relevant urban authorities to deal with the problems. This has, as a result, become one of the most pressing and challenging environmental problem in Uganda (National Environmental Management Authority (NEMA, 2004).

The quantity and rate of solid waste generation in the various States of Nigeria depend on the population, age, location, education, occupation, level of industrialisation, socioeconomic status of the citizens and the kinds of commercial activities being predominant (Ajani, 2008; Babayemi & Dauda, 2009). Some social components like income level, education and age limit showed a significant positive correlation with waste segregation, and recycling behaviour in the Rangpur district is a newly emerging divisional city which is located at the northern part of

Bangladesh. Unregulated waste generation was negatively impacted by environmental and human health (Rakib et al., 2014).

The daily per capita waste generation in Kathmandu metropolitan city, Nepal is 0.29kg and is lower in the core zone than in the outer and middle zones. This indicates that as there are more open spaces to throw the waste people usually generate more waste. Besides the geographical area of the homestead, household size and income are the major determining factors for the total quantity of wastes generated in all the zones. The waste component relationship shows that the size of the household and income are the major factor determining the total quantity of the waste in all the zones. It was also found that education has a negative effect on waste generation (ADB, 2013).

High population, rapid economic growth and change in living standard accelerate the generation of municipal solid waste in Indian cities (CPCB, 2004; Sharholy et al., 2006). The quantity of wastes generated from households varies, according to income, food habits, age, lifestyle, educational and occupational status (Afroz et al., 2008; Kayode, 2011; Sankoh, 2012; Limbu, 2013; Olayungbo et al., 2014; Trang et al., 2016). Similar to other developing countries, population explosion coupled with rapid urbanisation, rising income and consumption and increasing economic activities have changed the lifestyle of Indian society into “throw-away society” (Ashalakshmi & Arunachalam,2010). The per capita waste generation in urban areas varies with the size of the population and has been reported to be of the order of 350g to 400 g per day in average Indian towns (Kala & Khan, 1994). Similarly increasing urbanisation, constant change in consumption pattern and social behaviour have increased the generation of municipal solid waste in Kerala beyond the assimilate capacity of the environment (Varma, 2007). It leads to an urgent need of comprehensive municipal solid waste management system for the state Kerala.

2.3.3 Health and Environmental Issues of Solid Waste

A clean environment is crucial for human health and economic development. Thus inadequate collection and disposal of waste presents some problems for human health and productivity as majority households, especially in areas of low income, use crude methods in waste collection and its disposal (World Bank, 1999). Management of waste is a demanding and challenging undertaking in all European countries, with important implications for human health and well-being, environmental preservation, sustainability and economy (WHO, 2015).

As urbanisation continues to take place, the management of solid waste is becoming a major public health and environmental concern in urban areas of many developing countries (Cairncross & Feachem, 1993; Ogawa 2008). The solid waste management system in a developing countries displays an array of problems including low collection coverage and irregular collection services, crude open dumping and burning without air and water pollution control and the breeding of flies and vermin (Ogawa, 2008). Inefficient management and disposal of municipal solid waste is the cause of environmental degradation in most developing cities. Improper disposal of waste leads to obnoxious conditions and the spread of communicable diseases (Yedla & Kansal, 2003).

Huge quantum of waste generation, inadequate infrastructure for its management and its adverse impact on human health are the challenging issues of waste management. An unregulated waste generation has a negative impact on environmental and human health (Rakib et al., 2014). A quarter of the diseases faced by humanity today occur due to prolonged exposure to environmental pollution by solid waste, lead, mercury and infectious agents from healthcare facilities as well as dioxins and other harmful emissions released during the recovery of valuable materials from e-waste. These wastes not only affect the health of waste pickers but also contribute to air, land and water contamination (WHO).

Indiscriminate disposal of solid waste in dumpsites located within urban areas has proved to be a problem to nearby residents in most developing cities of the world. Open dumps have environmental safeguards; they can pose major public health threats and environmental effects in urban cities. In Freetown city of Sierra Leone, both nearby residents and far away residents in solid waste dumpsite suffered from related diseases such as malaria, chest pains, diarrhoea and cholera, due to the location of the dumpsite closer to their settlements. The solid waste issue highlights the need for the Freetown city council to properly manage and relocate the dumpsite to a safe distance from all human settlements and provide resettlement and environmental education programs for all persons living less than fifty meters away from the dumpsite as interim measures (Sankoh et al., 2013).

With rising urbanisation and change in lifestyle and food habits of residents, the amount of household solid waste has been increasing rapidly and its composition changing (Adebo, 2012). Over the last few years, the consumer market has grown rapidly leading to products being packaged in different forms including the use of cans, aluminium foils, plastics, and other such non-biodegradable items that cause incalculable harm to health and the environment (Adebo, 2012).

The unprecedented growth in urban population has led to an expansion in the size of the Nigerian cities, with drastic changes in land allocation for residential, commercial, industrial and educational activities. This is further increasing the dimensions of environmental and health hazards resulting from drainage blockages, waste accumulation, disposal problems, noise pollution, among others. There are some problems associated with inappropriate waste management mechanism in the densely populated localities. Open waste piles create health problems and pollute underground water, ultimately causing waterborne diseases (Salifu, 2001).

Due to the dysfunctional state of many municipal waste management authorities, many cities have been overrun by open dumps. For instance, more than 50 per cent of residents of Maiduguri in northern Nigeria and Ughelli in southern Nigeria dispose of their waste in open dumps. Indiscriminate disposal of waste has also resulted in the preponderance of toxic heavy metals in agricultural soils and consequent bio-accumulation in plants as well as groundwater contamination (Nnaji, 2015).

Uncontrolled generation of solid waste and improper disposal coupled with poor collection services poses a great threat to the environmental quality and human health (Jin et al., 2006; Afroz et al., 2009). Uncontrolled dumping and poor household solid waste management leads to contamination of water, attraction of insects and rodents and increases flooding due to blockage of drainage canals or gullies (Andrew, 2009). Improper solid waste management causes pollution and health risk, which is the main concern in environmental management in developing countries. In most cities the use of open dumps is common for the disposal of wastes, resulting in soil and water resources contamination. The majority of the residents are very much concerned about the poor condition of the environment due to the inappropriate and improper solid waste management. Improper solid waste dumps are spreading different diseases and environmental impacts in Rawal Pindi city Pakistan. It spread infectious diseases, land and water pollution, obstruction of drains and loss of biodiversity. Open dumps are also responsible for the blockage of drains, breeding of flies and spread of epidemics. The study concluded that open dumping and open burning must be strongly discharged by considering the overall negative impact (Ejaz et al., 2010).

Urbanisation and population growth are solely responsible for the high, increasing rate of solid waste, and its proper management is a major problem of Municipal Corporation. The study by Alam & Ahmade (2013) and Sing (2013) focus on the sources and components of solid waste, type and the quantity of solid waste disposed of, methods of solid waste disposal and impact of improper waste management on health. The result shows that excreta and other liquid and solid waste from households and the community, are a serious health hazard and lead to the spread of infectious diseases.

Multiple factors like population density with high degree of commercialisation and rapid urbanisation have resulted in problems of solid waste disposal and produce 120,000 tonnes of solid waste per day in India in 2014 and its detrimental consequences (De & Debnath, 2016). The study explores the adverse health effects prevalent in the community associated with the solid waste disposal system in Garia of Kolkata. A disposable garbage area of Kolkata was selected in Garia, and the nearby households (within 500 m from the disposable wasteland) were randomly selected to study the effect of garbage disposal on the health of the adjacent residents. It indicates the failure of the existing facilities, a high volume of waste generation, inadequate collection space, and the presence of open-dump sites which generates serious health risks. It was observed that the people living in this area have poor health like allergy, asthma, skin irritation and other gastrointestinal diseases. The public perception indicated that most people lack knowledge of the harmful effects of waste heaps including that they are breeding grounds for flies, cockroaches, and mosquitoes, rodents etc. which are responsible for transmission of germs and zoonotic infections to the people living nearby. The findings of the study will help the stakeholders to take the necessary steps to eradicate the problem and to grow a healthier environment (De & Debnath, 2016).

The landfill is the most popularly used method of waste disposal which includes burying the waste in lands all over the world. The waste landfill sites are a major source of land, air, ground and surface water pollution. This is very harmful to the people especially those who resides near landfill sites. Environmental pollution by such type of waste dumping shows short and long-term effects on health. Gas released from waste landfill site is the main factor in polluting the environment and hazardous effect on health as various types of cancer and birth problems etc. Self-reported health problems like irritations of skin, nose & eyes, allergies, psychological disorders, headache, fatigue, and gastrointestinal problems have been documented due to landfills (Maheswari et al., 2015).

Disposal of solid waste causes soil, air and water pollution which provides a breeding ground to biological vectors such as flies, rodents and insects pests. From these biological vectors number of diseases like diarrhoea, dysentery, worm infection, food poisoning, dengue fever, cholera, leptospirosis and bacterial infection are caused. (Pradyumna, 2013). Similarly solid waste disposal sites are found on the outskirts of the urban areas, turning into the child sources of contamination due to the incubation and proliferation of flies, mosquitoes, and rodents; that, in turn, are disease transmitters that affect the population's health, which has its organic defence in a formative and creative state. The effects of the dump site on the surrounding human settlement in the Mangwaneni area of the Golf Course dumpsite in Manzini city were assessed. The possible impacts of the dump site on the health and the environment and results show that the residents whose houses are less than 200 meters from the dumpsite are victims of malaria, chest pains, cholera, and diarrhoea.

However, residents whose houses are more than 200 meters are also affected with the chest pain and bad smell from the dumpsite, but mainly when the wind is blowing in their direction. The study concludes that dumpsites should be located at least 200 meters away from human settlements. Therefore, the study recommends that dumpsites should be properly located and managed to minimise its effects on the environment. The government and municipalities should revise laws regarding the locations of the dumpsites (Abul, 2010).

Many Ghanaian communities are faced with issues of solid waste disposal and health risks that undermine efforts towards ensuring a clean environment and good health for all (Suleman & Duah, 2015). Solid waste disposal and health issues among residents in the Sawaba community showed that issues of improper solid waste disposal had posed a threat to the health of residents. The results showed that residents living close to open dump sites had contracted related diseases such as malaria, skin infections among others as a result of improper refuse disposal. The available scientific evidence on the waste-related health effects is not conclusive but suggests the possible occurrence of serious adverse effects, including mortality, cancer, reproductive health, and milder effects affecting well-being through annoyance due to odour WHO (2015). The Environmental and Health department and residents in the community are concerned and hoping a lasting strategy would be found to ensure a clean environment and good health for all (Suleman & Duah, 2015). The study (Shyjan et al., 2005) focuses on the health and environmental impact of waste treatment plant on the local community by posing the case of the Vilappilsala waste treatment plant, Kerala. The solid waste disposal has become a severe problem due to increasing urbanisation which demands more attention. The study revealed that poor sections of the society especially village folk bearing the brunt of the consequences of the waste disposal habits of the upper class in the cities.

All these studies recommend following a policy of waste minimisation and elimination of landfills. Economic instruments like taxation and subsidies as well as regulatory measures have been suggested to reduce health impact (Chakrabarti, 2004). Planning and implementing a comprehensive program for waste collection, transport, and disposal along with activities to prevent or recycle waste can eliminate these problems (Cunningham, 2009). Open dumping and open burning must be strongly discharged by considering the overall negative impact (Ejas et al., 2010). The study (Abul, 2010) recommends that dumpsites should be properly located and managed to minimise its effects on the environment. The government and municipalities should revise laws regarding the locations of the dumpsites.

2.3.4 Solid Waste Management: Challenges

Management of solid waste is one of the greater challenges for development all over the world. It is not because of its impact on the environment or health, but poor implementation of SWM hinders the nation’s progress towards sustainable development (Vitharana, 2014). SWM is becoming a big challenge for the cities for the developing countries due to increasing population and rapid urbanisation which in turn have accelerated waste generation rate (William, 2000; Zhang et al., 2010; Guerrero et al., 2013). Rapid urbanisation and consequent collapse of solid waste management of cities is a global phenomenon (Okalebo et al., 2005**).**

Many cities in developing Asian countries face serious problems in managing their solid waste. The annual waste generation increases in proportion to the rising population and urbanisation and issues related to disposal have become challenging as more land is needed for the ultimate disposal of these solid waste. The problems relating to mounting solid wastes are fast acquiring gigantic proportions in the developing countries of Asia (Ray, 2008). Most of the countries, nevertheless, continue to primarily focus on achieving high economic growth and pay scant attention to waste management. The study takes a detailed look at the inadequacies of waste management in Asia and underscores the need for greater international engagement in tackling the menace.

The vulnerability of pollution of surface and groundwater is high in low income developing countries like Kenya because local authorities rarely considered the environmental impact of MSW in disposal sites (Henry & Yongsheng, 2006). Poor servicing of MSW collection vehicle, the poor state of infrastructure and the lack of adequate funding made the situation pathetic. The role of the informal sector through the community-based organisation (CBO), NGOs and the private sector in offering solutions towards the improvement of MSWM also are explored. In Nepal, 58 Municipalities were unable to manage municipal solid waste effectively because of the lack of technical and human resources, statistical records, proper planning, insufficient budget and lack of political leadership (ADB, 2013).

The costs of the SWM system increased significantly due to rising costs related to waste transportation (Lohri et al., 2014). As the efficiency of fee collection from households is only around 50 per cent, the total amounts of revenues are not sufficient to cover the running costs which result in a substantial yearly deficit. The study presents four options on how the financial sustainability of the SWM system might be enhanced: (i) improved fee collection efficiency by linking the fees of solid waste collection to water supply; (ii) increasing the value chain by sales of organic waste recycling products; (iii) diversifying revenue streams and financing mechanisms (polluter-pays, cross-subsidy and business principles); and (iv) cost reduction and improved cost-effectiveness. A strong alliance between the Municipality and private enterprise is important so that appropriate solutions for improved financial sustainability of an SWM system can be sought and implemented.

Municipal waste management services are unable to cope with over-burden solid waste generation and its management facility due to lack of workforce, insufficient materials and support (Enayetullah et al., 2005; and Hasan et al., 2006). The problem of solid waste management has been a concern which has existed for long in Lagos metropolis and other big Nigerian cities **(**Ojeshina & Longe, 1996; Ayotomuno & Gobo, 2004). The management of solid waste is today one of the important obligatory functions of the Local Government Areas (LGAs) in the entire country. Solid waste management is a major problem worldwide and in Kenya, since it is faced with several challenges from clogged drainage and sewers, waterborne diseases like typhoid, cholera and diarrhoea, increased upper respiratory diseases and malaria (Henry et al., 2006). Solid waste management has been the responsibility of local authorities, but the fact is now changing with the realisation that local authorities are not capable of managing waste on their own (Henry et al., 2006). This is unsustainable and Kenyan cities, and towns end up with endless heaps of garbage (Andrew, 2009). From a study done in Malaysia, attitudes and behaviours were found to affect household solid waste management but tend to differ based on the size of the households and households that have positive attitudes toward waste management have satisfactory behaviors, supporting Ajzen's theory of planned behaviour[12] (Budhiarta et al., 2012).

SWM is one of the basic essential services being provided by Municipal Authorities in India to keep urban centres clean and hygienic. However, it is one of the most poorly rendered services, i.e. the system applied are unscientific in some areas whereas outdated and inefficient, and population coverage is low in other areas (Dheeraj et al., 2013). MSW practices in India found that the major problem which was an underestimation of generation rates and therefore, underestimation of resource requirement, lack of technical and managerial inputs, lack of reliable and updated information and an ad hoc approach to waste management resulting in inefficient utilisation of resources (Goel, 2008).

Municipal solid waste is normally disposed of in an open dump in many Indian cities and towns, which is not the proper way of disposal because such crude dumps pose environmental hazards causing an ecological imbalance concerning land, water and air pollution. (Kansal et al., 1998). Environmental degradation costs India about Rs 3.75 trillion ($80 billion) annually equivalent to 5.7 per cent of India's GDP with air pollution being a major contributor. The study (Patil, 2013) focused on diagnosing the present situation of solid waste and on evaluating the existing solid waste management in Belgium city of Karnataka State. The present system of MSWM in Belgium city is satisfactory based on MSW (M&H) Rule 2000. Solid waste should be recognised as resource material for the production of energy, compost and fuel depending upon the techno-economic viability, local condition and sustainability of the project on a long-term basis. However, the study by Chandra & Devi (2009) found that the present system of municipal solid waste management in

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12 Ajzen's theory explains that individual behavior is driven by behavior intentions, where behavior intentions are a function of three determinants: an individuals' attitude toward behavior, subjective norms and perceived behavioral control (Ajzen, 1991).

Mysore city is not adequate as per Municipal Solid Waste (Management and Handling) Rules, 2000.

TERI (Tata Energy Resources Institute, 1998) calculated the amount of land that was occupied by waste disposed of post-independence, until 1997. The study estimates that the waste generated by 2001 would have occupied 240 sq.km or an area half the size of Mumbai; waste generated by 2011 would have occupied 380 sq.km or 90 per cent of Chennai, the fourth biggest Indian city area-wise; waste generated by 2021 would need 590 sq.km which is greater than the area of Hyderabad (583 sq.km), the largest Indian city, area-wise. The position paper on the solid waste management sector in India, published by Ministry of Finance in 2009, estimates a requirement of more than 1400 sq.km of land for solid waste disposal by the end of 2047 if MSW is not properly handled and is equal to the area of Hyderabad, Mumbai and Chennai together.

The cost-benefit analysis (CBA) of the MSW management system in Mumbai, with an emphasis on various implicit costs and benefits, noted that the system of waste management in Mumbai is found to be inefficient. There is a need for improvement in structure, organisation and efficiency of both the formal and the informal waste management sector in Mumbai. Cost-benefit analysis shows that a very important part of waste management, i.e. the value of recyclable material and the value of land is neglected resulting in undervaluation of the system by $6 per every ton of waste disposal (Yedla & Kansal, 2003).

Municipal solid waste management (MSWM) is a challenging problem for developing countries. The highest per capita solid waste generation rate in India is in Chennai (0.6 kg/d). Chennai is divided into 10 zones of 155 wards and collection of garbage is carried out using the door-to-door collection and street bin systems. The collected wastes are disposed at open dump sites located at a distance of 15 km from the city. Recent investigations on reclamation and hazard potential of the sites indicate the need for the rehabilitation of the sites (Esakku & Swaminathan, 2007). With rapid urbanisation, the country is facing massive waste management challenge. Over 377 million urban people live in 7,935 towns and cities and generate 62 million tonnes of municipal solid waste per annum. Only 43 million tonnes (MT) of the waste is collected, 11.9 MT is treated, and 31 MT is dumped in landfill sites. Solid waste management is one among the basic essential services provided by municipal authorities in the country to keep urban centres clean. However, almost all municipal authorities deposit solid waste at a dump yard within or outside the city haphazardly. Experts believe that India is following a flawed system of waste disposal and management (Lahiri, 2017).

The important and significant factors that affect household attitudes toward waste management include household size, source reduction, reuse and recycling measures, frequency of waste collection, participation in training programs and waste disposal method (Pereira & Medina, 2008). Even then people should realise that SWM is not only as a government responsibility, but every individual should also do it since the waste is produced from households (Idris et al., 2004). The main challenge associated with MSW in Kerala is inefficient and inadequate management which results in the dumping of waste into water bodies, roadside etc. It also pointed out the lack of a proper financial base for urban local bodies as they depend too much on government grants. ‘Clean Kerala Mission’ set up in 2003 to find a solution to the problem. The present waste management system can only be improved by ensuring public participation through very serious motivational efforts (Malinya Muktha Keralam, 2007).

In short, the burden on the municipal solid waste will necessitate huge expenditure on MSW management. The generators are responsible for the proper management of waste. However, though the local bodies are the main stack holders, the community participation is very important (Ministry of Environment and Forest Government of India (2016). The study (KSUDP, 2006) revealed that even as the warning alarm regarding proper management of waste has been sounded across India, the problem seems to be particularly exacerbated in Kerala. However local issues and sentiments have prevented even the collection of solid waste. The result recalls us that the stunning Kerala landscape has been converted to stinking, garbage strew one.

2.3.5 Sustainable Waste Management Policy

ISWA (Seventh International Solid Waste Association) with International Congress and Exhibition pointed out some remedies for sustainable waste management in developing countries. The study concluded by suggesting that the traditional hierarchy should not be emphasised for the management of municipal solid waste under low-economic conditions. The privatisation of solid waste services on the hierarchy should be considered. Scavengers or informal waste pickers should be incorporated into the formal sector and be provided with sanitary working conditions; and if waste reduction and recycling activities are implemented, they should be promptly rewarded. In developing countries, informal waste-pickers (scavengers) play an important role in solid waste management systems (Sanchez et al., 2006). The study integrates the role of scavengers in a dynamic model of production, consumption, and recovery. Partnership for solid waste management between public and private sector operators in developing countries may improve the efficiency of the entire sector and create new opportunities for employment (Ahmed & Ali, 2004).

The study (Turner et al., 1998) surveys recent developments in the context of waste management policy and the emergence of resources such as recycling credits and the landfill tax. Economic instruments like green taxes are more effective and efficient which can play a significant role in the policy area. In the early days, the wastes did not create any problem for the community as the quantity of waste generated was within the assimilative capacity of nature. Today, the scenario is quite different and the urban environment all over the world poses a serious threat from excessive generation of solid waste. Cities in the world are facing a high level of pollution while the situation in developing countries is still more acute. Municipal Corporations of developing countries are not able to handle the increasing quantity of waste, which leads to uncollected waste on roads and other public places (Begum, 2001).

The 3R approach ‘reduce, reuse, and recycle’ is becoming a leading philosophy for improved solid waste management. The 3R approach help minimise the amount of waste from generation to disposal and thus to manage the waste more effectively and to minimise environmental and health risks associated with it. United Nations Environment Programme (UNEP) is promoting the concept of ISWM (Integrated Solid Waste Management) which has been introduced to streamline all the stages of waste management that is segregation of waste, collection, transportation, treatment and final disposal. UNEP is assisting member countries in following an ISWM based on 3R approach. These experiences could be useful for other countries to develop and implement ISWM to achieve improved public health, better environmental protection, resource conservation and resource recovery (Memon, 2010).

United States' Environmental Protection Agency (2002) also suggested an Integrated Solid Waste Management (ISWM) approach that considers how to prevent, recycle and manage solid waste. The report focuses on waste prevention, recycling and composting, and disposal (landfilling and combustion). The segregation of waste at source and promotion of recycling or reuse of segregated materials, reduce the quantity of waste and the burden on landfills and provides raw materials for manufactures are the best strategies for efficient waste management. The composition of MSW shows mostly organic matter (45.3 per cent), so composting is a good method for treatment (Sharholy et al., 2008).

The study (Shekdar, 2009) conceptually evaluates issues surrounding the sustainability of SWM. It proposes a multi-pronged integrated approach for improvement that achieves sustainable SWM in the context of national policy and legal framework, institutional arrangement, operational and financial management and public awareness and participation. The study proposed an action plan framework would be useful across a variety of country-specific scenarios. In an economy producing solid waste, efficiency can be reached using a set of specific and complementary policies: a tax on virgin materials use, a tax on consumption and disposal, and a subsidy to the recovery of material**.** NGOs played a significant role in building capacity of the informal sector for collection, sorting, recycling and processing. Connecting the issues with the Millennium Development Goals, government agencies are depending on the network of the NGOs to reach to build the capacity of this sector in increasing efficiency and also meet the goals (Singh & Chari, 2010**)**.

Kerala State Industrial Development Corporation provides a solution to Kerala's waste crisis by suggesting setting up of waste disposal units at household level via composting /vermin culture or the installation of biogas units, the participation of NGO's and community organisations etc. can play a major role in helping to deal with the solid waste management crisis. The present waste management system can only be improved by ensuring public participation through very serious motivational efforts (Malinya Muktha Keralam, 2007).

2.3.5.1 Household Waste Management

As an environmental package, the disposal of solid waste from different sources, such as households markets, commercial areas, slaughterhouses, hospitals and industries, therefore assumed crucial importance. The waste collection can be done through the door-to-door collection which involves the use of containers or dustbins within the households and communal collection that involves the use bins placed near markets, in residential areas and other appropriate locations (Spies et al., 2006). A considerable number (59.4 per cent) of households in urban Kampala Uganda are engaged in some form of separation of solid waste. Unfortunately, some of the waste separated is either buried or burnt. This pollutes the environment and has severe health implications. Studies show that it is very important to discourage this polluting practice and highlight its health implications (Banga & Margaret, 2013). The study also shows that waste separation is significantly related to household income, the gender of the respondent, the level of awareness of recycling activities in the area and the educational level of the respondent.

Furthermore, the results show that people are aware of and have a positive attitude towards both the separation and recycling of solid waste. Households' participation in separation activities is not very high, but when promoted can result in great benefits. Attempts must be made by the council to improve waste separation. To achieve this, the council should concentrate first on awareness campaigns about the consequences of waste mishandling and the benefits of solid waste separation (Banga & Margaret 2013).

Household solid waste handling methods involve; control of waste at source, waste storage and separation at the source, collection, transportation and disposal (Cunningham, 2009). Control of waste at source greatly reduces the volume of solid waste if people compost and utilise the daily organic waste in their kitchen or garden as manure (Andrew, 2009). Waste should be separated at the source for easy collection and transportation for final disposal, and people should segregate the inorganic waste such as papers, plastics, fused bulbs, blades, glass wares and empty bottles at the source (Andrew, 2009). Household waste is commonly placed in plastic bags or other containers and stored at the collection centres in community containers which are placed at the roadsides to be collected by vehicles or hand-operated carts (Tay-joo et al., 2007).

Households contribute 49 per cent (Koshy, 2010) of the total solid waste generated in Kerala, followed by hotels, marriage halls, institutions, shops, etc. In Kozhikode city, 47 per cent of the total collected wastes is coming from the household sector (Master Plan for Calicut City- 2035). Hence, studies show that household waste management is a crucial factor in urban solid waste management. The Kollam Corporation which produced 70 per cent of household waste has installed the aerobic composting unit at Kappalndimukku for the disposal of household wastes. For disposing of the waste, a user has to pay 5Rs/kg of waste. However, people prefer other methods of waste disposal over the aerobic composting unit because of economics. A study on the solid waste management of Arppukara Grama Panchayat of Kottayam district is conducted here proposes, to examine the quality and quantity of the solid waste generated in the Panchayat and also its impact on the existing social, economic, environmental and ecological systems (Ashalakshmi & Arunachalam, 2010). Kudumbasree plays a dominant role in the door-to-door waste collection from households throughout Kerala.

As expected, household-related factors affected the household waste management; family size, disposal method used, source reduction, reuse and recycling measures, the frequency of waste collection, participation in training programs and the education level of the household head. The education level of a family head was negatively associated with the practices regarding household solid waste management indicates that improving general public awareness concerning the problem of solid waste management should be a high priority of the responsible authorities and the general public as well (Bernard & Mildred, 2015).

The research examined a range of environmental behaviour, attitude and perception of respondents on household solid waste management such as solid waste management system, services, patronage of services and cost recovery methods. Public opinion and perception on the solid waste management system are characterised by irregularity and inefficient collection system; with poor monitoring of the private waste service providers by the local authority. Willingness to pay for waste management services provided by the private service providers, the private sector participation operators is higher among the middle and high-income socio-economic groups than in the low-income group. However, with the application of sustainable environmental education greater success ratio could be achieved (Longe et al., 2009).

2.3.6 Willingness to Pay towards Improved Waste Management

Many studies on willingness to pay have been carried out using the Contingent Valuation Method (Whittington, 1990). Some of these studies did willingness to pay for clean water, wildlife viewing and improved sanitation services (Juana, 2001). In Botswana, an empirical study used the CVM to analyses willingness to pay of an individual for a reduction in air pollution (Tsimamma, 2001). These studies found that factors such as age, gender, income, time spend in the area, attitude towards waste, household size and education level were some of the factors that affect willingness to pay. However, this part of the study focuses on reviews of some empirical studies on SWM by using CVM.

Solid waste management is generally a public good that cannot be optimally provided under the present market conditions since the commodity is characterised by non- rivalry and non-excludability in consumption. Solid waste collection and disposal services require a different market situation from the ordinary market pricing mechanism to achieve optimal resource allocation. This is because the environmental services are often underpriced or no priced (Anaman & Jair, 2000; Jin et al., 2006) and hence to maximise social welfare levels resources must be allocated in a way to bring about most beneficial changes. It is therefore important to come up with a technique that can evaluate the environmental magnitude important for use in decision making. Stated preference techniques are the primary means of valuing non-market benefits (Jin et al., 2006) and the commonly used non-market valuation technique is the contingent valuation method (Mitchell & Carson, 1989; Carson et al., 2001; Jin et al., 2006). Contingent valuation method has been used to estimate the value people place on environmental commodities by creating hypothetical market scenarios to elicit their willingness to pay for them (or willingness to accept compensation).

Contingent valuation method is a non-market valuation method commonly used to find the economic values of environmental commodities. It is a method that uses hypothetical survey question to elicit people's preference for the public good by finding out what they are willing to pay for specified improvement in them (Mitchell & Carson, 1989). CVM is one of the most widely used and generally accepted techniques for estimating the TEV (Total Economic Value) of many classes of public goods and services that few economic techniques can handle. Its results are relatively easy to interpret and to use for policy purposes. For example, monetary values can be presented regarding mean or median WTP per household or aggregate values for the target population (Fonta et al., 2008; Fonta & Ichoku, 2005).

The contingent valuation method, the most widely applicable of the stated preference methods, used to establish empirical grounds for pricing the services of a new solid waste management improvement facility in Enugu State, Nigeria, initiated by the UK Department for International Development, the State's Environmental Protection Agency, and State and Local Government Programme. CVM can be fruitfully used to support the design and implementation of new SWM facilities, and that analysis of the valuation function can give qualitative information that is difficult to identify using baseline surveys or most conventional economic valuation techniques.

CVM has helped to solve a serious problem in environmental policy analysis like the need to assign a value to non-market goods and services. CVM is now the most widely used economies survey approach (Gregory, 2000). Contingent valuation is particularly attractive because it can estimate values where markets do not exist or where market substitutes cannot be found. It is widely used to measure existence values, option values, indirect use values and non-use values. The contingent valuation method is superior to other valuation methods because it can capture use and non-use values (Niringive & Douglason, 2010**)**. The CV method has improved significantly during the last 50 years. One of the pioneers in the field of CV surveys, Smith (2011), argues that CV research has witnessed robust progress, enabling a better understanding of consumer preferences.

Cities in developing countries experiencing rapid urbanisation and population growth too often lack the financial resources and institutional capacity to provide needed municipal infrastructure for adequate solid waste management, despite citizens' demand for it. To socially justify the need for better municipal solid waste management services, especially in the light of the limited availability of public funds, it is important to quantify the monetary value of the potential social and environmental benefits offered by them. So it is essential to estimate society's willingness to pay improved municipal solid waste management. To this direction, relevant studies from the global scientific and grey literature in the field of municipal solid waste management valuation are analysed**.**

Municipal solid waste management continues to be a major challenge for local governments in both urban and rural areas across the world, and one of the key issues is their financial constraints. Recently an economic analysis was conducted in Eryuan, a poor county located in Yunnan Province of China, where willingness to pay for an improved solid waste collection and treatment service was estimated and compared with the project cost. They find that the mean willingness to pay is about one per cent of household income and the total willingness to pay can cover the total cost of the project (Wang et al., 2011). The study (Hagos et al., 2012) focus on the current municipal sanitation fees and the willingness to pay (WTP) of residents of Mekelle city, Ethiopia for improved urban waste management, and suggests mechanisms for cost recovery. Study results reveal that the current city fee for sanitation is far below the WTP of the residents.

Ad hoc studies in solid waste management in Kenya attempts to solve waste problems in the country which focus on supply-side of waste disposal and collection, which have not been successful. The result is the inefficiency of present policy and methods evidenced by the continued piling of solid wastes (Joel et al. 2012). So the use of demand-oriented valuation to waste management is practised to analyses the economic value of improved solid waste management in Eldoret Municipality based on 199 sampled household respondents. A contingent valuation method (CVM) and multiple regression techniques are used to identify the determinants of willingness to pay (WTP) values. Results show that residents are WTP on average Kshs 363 per month for solid waste management improvements. This indicates peoples' desire for change in improved waste management. The WTP estimates can be used by urban planners and administrators to determine the socially optimal charges for solid waste services and use it as a tool to estimate taxable revenues.

Considering the rapid spatial and population growth of most urban areas with decreasing coverage levels, and with an increase in the level of waste generated, confronted by increasing public demand for improved services, the need arises for a more efficient method of waste management. This, therefore, gives rise to the need to evaluate the household solid waste management system in Minna metropolis, Niger State Nigeria. Specifically, the study examined the types of waste generated and methods of disposing of solid waste, level of awareness and reliability of waste disposal methods, the willingness of households to pay for solid waste management and the factors affecting the willingness of households' to pay for solid waste management in the study area (Ojo et al., 2015). Majority of the households were willing to pay to sanitise their immediate environment given the advantages of improved waste management services. Based on the findings of this study, it is therefore recommended that a participatory community approach should be used by the government to create more awareness on solid waste management among the people.

Contingent Valuation Method (CVM) was employed to estimate households' willingness to pay for improved solid waste management (Niringive & Douglason, 2010**)**. The CVM has been used by several scholars to study WTP for solid waste management services (Atlaf & Deshazo, 1996; Basili et al., 2006; Fonta et al. 2008). These studies concluded that the majority of the households are willing to pay for improved waste management services, contrary to the widely held belief that most households consider the free provision of solid waste collection services to be a responsibility of the government. The studies also concluded that solid waste collection service is a normal economic good and not a luxury good.

Solid waste disposal, in particular, has become a daunting task for the municipal authorities. An assessment of a household's willingness to pay for improved solid waste management service in Sekondi-Takoradi Metropolis, Ghana used a contingent valuation method as a method of valuation (Padi et al., 2015). CVM is used to measure WTP in Katmandu metropolitan city about 80 per cent of the households are willing to pay for improved waste management and the mean annual willingness to pay per household is 88.4 USD in 2014 (Damigos et al., 2016). The willingness to pay is highest in the outer zone and lower in the core zone. The main factor determining the "Willingness to Pay" is income. Results show that residents are WTP on average Kshs (Kenyan Shillings) 363 per month for solid waste management improvements. This indicates peoples' desire for change in improved waste management (Joel et al., 2012).

CVM is employed to identify the determinants of WTP for SWM (Jin et al., 2006). Models like multiple regression (Joel et al., 2012; Ojo et al ., 2015; Mmolawa & Narayana, 2007), Probit and Tobit models (Banga et al., 2011; Hagos et al., 2012; Padi et al., 2015) were used in the empirical analysis to determine the factors that influence WTP of the household for improved waste management. The outcome of the study shows that, environmental awareness, occupation, income, perception and house ownership significantly determined households willingness to pay for an improved SWM service. The outcome of the study (Atlaf & Deshazo, 1996; Basili et al., 2006; Fonta et al., 2008; Hagos et al., 2012) shows that WTP of households is positively influenced by income, education and total disposal method are available to households, occupation and environmental awareness. More so, educational programs about the dangers of waste in our communities should be organised by various organisations in a quest to increase environmental awareness to increase the WTP for improved environmental quality in general and improved solid waste management in particular (Padi et al., 2015).

Studies (Atlaf & Deshazo, 1996; Basili et al., 2006; Fonta et al., 2008) show that income and households WTP is directly related. Also, Jin et al. (2006) found that residents concern about solid waste problems and education positively influenced the WTP of households. Mmolawa & Narayana (2007) and Fonta et al., (2008) found that the gender of the household also influences the WTP. Contrary to this, the study by Banga et al., (2011) found that gender has no significant influence on the decision to pay for improved solid waste management. Another interesting result is those households who are staying in their home are willing to pay more for waste collection than those who are tenants. The WTP is influenced by income, education, age and total disposal methods available to the household (Joel et al., 2012). The study revealed that age, income, household expenditure, environmental awareness and household size influenced the value placed on the service of solid waste management (Ojo et al., 2015).

The data gathered for a study in Botswana showed the level of peoples' willingness to pay for an improved solid waste disposal service by income groups. It was noted that generally people are willing to pay and their willingness to pay depends on their ability to pay. That is, those earning high income are willing to pay more than those with lower income (Mmolawa & Narayana, 2007). This study also found that variables such as gender of the household head, education level, household size, time spent in the area, satisfaction from the service, income of the households and attitude towards waste each had a significant impact on the willingness to pay.

However, the age of the household head, which was expected to have a strong influence on the household's willingness to pay, turned out to be statistically insignificant.

The review shows that WTP of households are directly influenced by income, education, age, occupation, environmental awareness and availability of disposal methods among which income is considered as the main factor that determines willingness to pay. In the application context, it is found that CVM can be used successfully to determine the factors that determine willingness to pay towards improved solid waste management. Charging different rates for different income groups is highly recommended as it seems to be affordable and it will generate more revenue for the government. CVM has been there as a pioneer strategy for assessing the WTP of the community related to the economic and ecological issues of development projects. This has a potential role especially in the major issues of the contemporary world, i.e. solid waste management and allied issues. Tracking the studies on WTP reflects the need for scaling insight into various domains of CVM and WTP in a realm where the echoes of community versus project frictions are very common.

A thematic summary of the literature surveyed on various dimensions of solid waste generation, management and willingness to pay is given in Annexure 2.2.

2.4 Summing Up

On the theoretical side, the subject has initially benefitted from a neoclassical perspective of environmental economics. Neoclassical economists made important contributions to the environmental theories during the 1950s. In particular common property nature of many environmental resources as the root cause of many economic externalities (Gorde & Scott, 1954) and defines waste as a negative externality. Externalities can cause market failure if the price mechanism does not take into account the full social costs and social benefits of production and consumption. The studies on externalities have become extensive in recent years because of the link between the economy and the environment. As with externalities, neoclassical theorists treat public goods as examples of market failure. Where public goods are concerned, the problem is that these goods often will not be produced by the market. The study got value additions regarding incorporating valuation techniques of change in environmental quality specifically contingent valuation method. As far as an empirical side is concerned, studies mainly focused on waste generation, issues and challenges of waste management. Though there are studies that address the solid waste issues and challenges, there is a dearth of studies linking waste management towards a sustainable society.

2.5 Gaps in the Existing Studies

The study carried out an extensive review of researches on economy and environment, the magnitude of solid waste generation, health and environmental issues of solid waste, challenges of waste management and WTP for improved waste management by using CVM.

As it is evidenced from the review of literature, these issues were highly debated at global level but most of them were without an empirical support. Most of them were a magnification of the consequences of the ecological and economic aspects of solid waste and allied issues. It is inferred from the literature that the research culture has not penetrated significantly to the core aspects in a specific manner which spread light to evolve sustainable waste management.

Kerala is largely moving from a rural to semi-urban and urban culture, and it is meaningful and valuable to specialise on urban households. As a densely populated State, enormous waste generation and its unscientific management will invariably affect the masses inhabiting the urban areas and environmental quality. It will create multi-dimensional but far-reaching repercussions for the urban population and environment which cannot be solved at the same level as it was originated. Hence, a system approach with empirical data is to be adopted. Changing issue of environmental quality related to solid waste has to be addressed by using theory and empirics. The present study attempted to find the practices of waste management and causative elements of waste generation by employing econometric approach.

The review also ignited to think on the possibility of alternate models of SWM by incorporating active involvement of household. Generally, households are willing to pay for environmental quality in general and improved waste management in specific. However, how much they are willing to pay for improved environmental quality and the various factors that influence has not adequately attempted in the literature. Changing issue of environmental quality related to solid waste has to be addressed by using theory and empirics. These led to the need for the present study which is stated as ‘Solid waste management and willingness to pay among urban households in Kerala: Practices and determinants’.

CHAPTER 3

Research Design

- ***Data***
- ***Analytical Framework***
- ***Empirical Methods***

CHAPTER-3

Research Design

This chapter is an elaboration on the methodology adopted for the current study. It encompasses components related to data, analytical framework including contingent valuation methods, empirical methods used and the logic behind using those methods in the context of this research. A quantitative approach is followed in which the data is analysed using parametric tests to reach valid conclusions. The following section overviews the methodology used in this research.

3.1 Data

This section brings various components related to data including source, location, period of collection, sample design, the collection procedure, collection tools and pilot study which are presented in the subsections from 3.1.1 to 3.1.6.

3.1.1 Data Source

The study requires both primary and secondary data. Primary data are collected from 384 sample households through stratified random sampling method. This is also supplemented by data gathered from the FGD (Focus Group Discussion) with Kudumbasree, Corporation sanitary workers, 'Niravu' (private service provider), waste treatment plant workers and interview with plant manager, Njeliyanparambu waste treatment plant, Kozhikode. However, the major focus is on the households in Kozhikode Corporation.

These are supplemented by information from secondary sources such as different published sources of various government departments. It includes the National Environmental Engineering Research Institute (NEERI, 1995, 1996); Ministry of Environment and Forest, Government of India (2016); Kerala State Pollution Control Board (KSPCB, 2015, 2016 & 2017), Government of Kerala; Central Pollution Control Board (CPCB, 2000, 2004, 2011-2018); Malinya Muktha Kerala Action Plan (2007); Census of India (2001 & 2011); Kozhikode City Census Report (2011); Economic Review of State Planning Board (2004 & 2010-16); Report of Waste Management and Disposal Survey (2014-15); Annual report of Kudumbasree

(2016) and Master Plan for Kozhikode Urban Area (2035). Moreover, the knowledge reviews were collected from books, national and international journals, working papers obtained from many libraries of various Universities in India and different websites.

3.1.2 Locale and Period of the Study

The present study conducted in Kozhikode Corporation of Kerala. Kozhikode city was declared India's first litter-free city in 2004 (Koshi, 2010). The Kozhikode City with 458gms of solid waste has the highest per day per capita generation of solid waste in Kerala followed by Cochin with 419gms and Kannur with 313gms (Integrated Solid Waste Management, Government of Kerala, 2007). Kozhikode stands at the third position in case of solid waste density (Solid waste per sq. km), the town of Ponnani and Cochin with a measure of 2.63 is at the top (Integrated Solid Waste Management, Government of Kerala, 2007).

The model, solid waste management programme, implemented in Kozhikode Corporation in 2004. Uniformed women are doubling up as auto-drivers, and as household litter-pickup girls as a part of the new model. The project is funded jointly by the Union Ministry for Environment and Forests, State Pollution Control Board and Kozhikode Municipal Corporation (Koshi, 2010). It has been treated as a remarkable step for the safe disposal of household waste in the Corporation.

Even though Kozhikode city declared India's first litter-free city in 2004, the total quantity of solid waste generated in Kozhikode Corporation is estimated as 250-350 tonnes per day. Household contributes major share of the total solid waste generated in Kozhikode Corporation (Master plan for Kozhikode Urban Area, 2035). Hence the study focuses on solid waste management among households in Kozhikode Corporation as a representation of urban Kerala. The data for the study are collected from the sample households during the period from April 2017 to July 2017.

3.1.3 Sample Design

For collecting primary data, 20 per cent of the total wards (15/75) were selected by stratified random sampling. The whole wards were divided into two strata on the basis of mean distance (mean distance is 8 km) from the waste treatment plant. Strata I represents the wards within the mean distance, and Strata II represents wards away from the mean distance. Strata I consists of 33 wards and Strata II consists of 42 wards. The study selected 20 per cent of wards from each stratum that is seven and eight respectively. Each ward represents 24-28 households in proportion to total households in each ward.

The wards like Valiyangadi, Kuttichira, Chevayur, Puthiyara, Nadakkavu, Karaparambu, Chelavoor and Vellimadukunnu were randomly selected from Strata II and Kolathara, Kundayithod, Nallalam, Areekad, Payyanakkal, Bepore and Mankavu were selected from Strata I. A total of 384 households were fixed as sample size which includes 204 households from the Strata II and 180 households from Strata I. The method of sample size calculator is utilised for fixing the sample size where a total number of households, i.e., 171877 as the population at 5 per cent margin of error and 95 per cent confidence level. A detailed account of the sampling design adopted in the study is given in Table 3.1.

Table 3.1: Sample Design

Strata	Ward no: and name	No. of sample households	Total sample households	Percentage
Strata- II (42 Wards)	15.Vellimadukunu	25	204	53
	17.Chelavoor	25		
	21. Chevayur	26		
	27. Puthiyara	26		
	57. Mukhdar	24		
	61. Valiyangadi	25		
	65. Nadakkavu	25		
	69. Karaparambu	28		
Strata-1 (33 Wards)	34. Mankav	24	180	47
	41.Arekkad	24		
	42. Nallalam	28		
	43. Kolathara	27		
	44. Kundayithod	26		
	47. Bepore	27		
	55. Payyanakkal	24		
TOTAL (75)	**15 (75)**	**384**	**384**	**100**

Source: Author's Compilation

3.1.4 Data Collection Procedure

The study collected data from three categories:

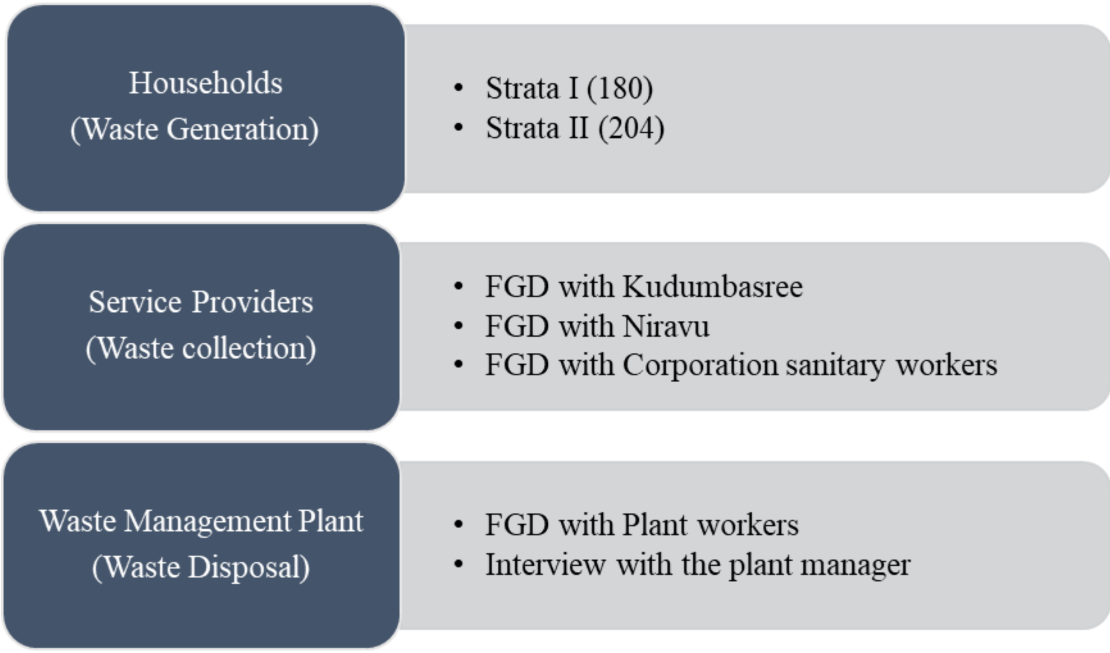
1. Persons responsible for the waste generation
2. Persons involved in waste collection
3. Persons involved in waste management

The first category consists of households, institutions, industries, markets, and hospitals which are the major waste generators in Kozhikode Corporation. Among them, households are selected for the present study. The study has made all the attempts to make the data collection systematic and genuine. The researcher directly approached the households and explained the need and significance of the study.

In addition to the data gathered through the interview schedule, the study collected data from the service providers in waste collection. Corporation sanitary workers, Niravu (private service provider) and Kudumbasree are engaged in the solid waste collection in Kozhikode Corporation. Focus Group Discussion with these service providers were conducted to gather information about the waste collection service.

Njeliyanparambu waste treatment plant is the only plant in Kozhikode Corporation which recycles the collected organic solid waste and produces vermin compost by windrow composting system. Focus Group Discussion with plant workers and interview with plant manager were carried out to gather information about waste management practices. The waste treatment plant at Njeliyanparambu helps a lot in waste management process. Hence the working of this plant was also considered for the study. During all these phases of data collection at most care has been taken to gather valid data.

Figure 3.1: Data Collection Procedure



Source: Author's Compilation

3.1.5 Statistical Methodology for the Data Collection

The present study is both descriptive and analytical, and the research problems and the interview schedule are framed accordingly. The researcher used closed-ended and open-ended questions to collect primary data. The interview schedule is the main tool used to collect pertinent data from the selected sample households. For this purpose, a well-structured interview schedule is framed with the help of the research supervisor and the research experts. The interview schedule is re-reframed in light of their comments and feedback. It is administered after a thorough revision based on the data collected through a pilot study.

The interview schedule is prepared with the objective of getting information related to the solid waste generation and management practices followed by households in Kozhikode Corporation. This interview schedule involves a waste profile analysis highlighting the volume of various types of waste generated, disposal mechanism followed, storage and segregation practices, involvement of different service providers in waste collection like residents associations, self-help groups, corporation sanitary workers and private agencies. The questions regarding challenges of waste management and willingness to pay of the households towards improved solid waste management are framed. Focus Group Discussion with Kudumbasree units, Corporation sanitary workers, Niravu workers, plant workers and interview with plant manager supplement information about the solid waste collection, disposal and management.

3.1.6 Pilot Study

A pilot study is conducted to evaluate the feasibility and to improve the study design before performing full scale research. After developing the interview schedule with wide coverage of data (data related to solid waste generation, management and willingness to pay towards improved waste management), it is pre-tested with a few samples among the selected sample households in Kozhikode Corporation. Necessary modifications and changes are incorporated after the pilot study by considering all the issues.

3.2 Analytical Framework

The analytical framework attempted in this chapter is organised in the following order. An examination of the application of the contingent valuation method for valuing environmental quality is given in section 3.2.1 followed by the application of dichotomous choice method of CVM to elicit willingness of the people. A brief description of the variables and the theoretical expectations are sequenced in subsection 3.2.3.

3.2.1 CVM for WTP Estimation

The study adopted contingent valuation method to elicit the value people attach on a clean environment in general and improved waste management in specific. When market data are unavailable, economists adopt an alternative estimation method that relies on hypothetical market conditions. Such methods typically use surveys to inquire about the individuals' willingness to pay (WTP) for some environmental initiative. This survey approach to estimation is known as the contingent valuation method (CVM) because the results are dependent, or contingent on the particular hypothetical market.

The steps of CVM followed in the study are:

1. Identification and description of the environmental quality characteristics to be evaluated.
2. Identification of households to be approached.
3. Design and application of a survey interview schedule.
4. Aggregation of household response to estimate values.

Designing the interview schedule in order to make people reveal the maximum willingness to pay is a crucial part of the CVM. The interview schedule should comprise:

1. A clear statement of the environmental features or amenity that people are asked to evaluate.
2. A set of questions which will describe the socio-economic characteristics of households.
3. Questions to elicit willingness to pay towards improved waste management.
4. Questions to elicit willingness to pay towards different features of the project.
5. Questions to elicit willingness to pay towards public and private service providers.

The households will be provided with information on and when the service is available, payment method expected, how much others will contribute, the institution that will be responsible for the delivery of the service and the quality and reliability of the services. Generally, four basic approaches (see Chapter 2, section 2.2.5) are used to elicit the preference of the individuals, and the choice of any method depends on individual judgment (Bishop and Heberlein, 1990).

3.2.2 Dichotomous Choice Method

The present study employs the dichotomous choice method of contingent valuation to elicit the willingness of the people towards improved waste management. The respondents are first asked whether they are willing to pay anything, even a small amount, for the improvement explained to them in the scenario. If the answer is 'yes' to the participation question, a dichotomous format (double bounded) of the valuation question is asked. In this case, the respondent is then presented with an initial bid, and asked whether he or she is willing to pay that amount or not. If the response to the initial bid is "yes", the respondent is then presented with a higher bid (twice the initial bid) and asked he or she is willing to pay the offered amount.If the response to the initial bid is "no", the respondent is presented with a lower bid (half the initial amount) and asked if he or she is willing to pay that amount. The double-bounded format is finally followed by an open-ended follow-up question soliciting the maximum amount that the household is willing to pay. The follow-up question helps in identifying inconsistent responses and outliers. Two different bids (Rs.100 and Rs.200) are used in this study and households are assigned randomly to any one of these bids. For those answered "no" to the participation, the question is asked to give reasons for their unwillingness to pay. By information available from the interview schedule, a general willingness to pay can be derived which is likely to be of the following form:

$$WTPi = f \{Q_i, Y_i, T_i, S_i\}$$

Where Q_i is the quantity/quality of the attribute, Y_i is the income, T_i is an index of tastes and Si is an index of socio-economic factors.

This method is also known as the stated preference technique, as the people are directly asked to state their value rather than inferring values from the actual choice. The main aim of the CV survey is to create a hypothetical market, as close to a real market, to obtain hypothetical bids that conform to actual bids if the actual market had existed. CVM is now the most widely used economics survey approach (Gregory, 2000), and it is particularly attractive because it can estimate values where markets do not exist or where market substitutes cannot be found.

3.2.3 Variables and Theoretical Expectation

The study examines the factors that determine waste generation among households in Kozhikode Corporation. For analysing this objective, dependent and independent variables are identified by apriory information and sound theoretical expectations. Household waste generation is identified as the dependent variable, and socio-economic variables like the monthly expenditure of households, household size, size of homestead and education level are identified as independent variables. Besides, enabling variables such as practice of segregation and availability of waste disposal service are also examined to state its relation to household waste generation. An alternative model by identifying per capita waste generation as a dependent variable is also employed to keep robustness of the study.

Theoretically, we expect a direct relationship of monthly income of the households, monthly expenditure and household size with waste generation. The theory shows that higher income and expenditure are directly influenced the consumption level of households. The expectation of a positive relationship between the size of the homestead and the generation of waste is supported by the notion that the people who possess sufficient land for disposing of their solid waste are not much concerned about waste generation and its disposal. In contrast to this, the study expects a negative relationship between waste generation and education level because educated members are supposed to have relatively higher levels of knowledge, awareness and interest in environmental quality.

Factors that determine willingness to pay of households towards improved waste management is examined on the basis of sound theory. Here, willingness to pay off household is identified as the dependent variable and socio-economic variables like household's monthly expenditure, household size, size of homestead and education level are identified as independent variables. Enabling variables such as availability of waste disposal service, the quantity of waste generation and proximity to dumping yard are also identified to examine its relationship with willingness to pay towards improved waste management by the household. Theory expects a direct relationship of household's monthly expenditure, level of education, size of households and quantity of waste generation with WTP. The study expects that education level of the household positively related to WTP for improved waste disposal services because the environmental responsibility of the educated people increases as the level of education increases and the tendencies to adopt and pay for improved disposal services also increase.

In contrast to this, the theory expects a negative relation of willingness to pay with age and availability of waste disposal service. An inverse relation between age and willingness to pay is expected as the younger generations are found to be willing to pay more for the door to door solid waste collection service than older. It is also expected that gender of the respondent will have an influence on WTP that female respondents are expected to pay more on improved waste management than males because females are more concerned about household waste and its management. Willingness to pay of the households across the proximity to dumping site is also observed. It is expected that willingness to pay is high among the households in Strata I because households in Strata I are the real victims of solid waste pollution.

The expected relationships are examined by sound theoretical background, and the results are tested by employing econometric model like multiple regression model (see chapter 5 and 7).

3.3 Empirical Methods

The present study is quantitative; both descriptive and inferential statistics are used for analysing the data in order to reach valid generalised conclusions. The empirical methods employed in the study are sequenced from 3.10.1 to 3.10.6.

3.3.1 Preliminary Analysis

The preliminary analysis was done to understand the nature of distribution, deviation and spread of data. Basic descriptive statistics are computed for each dependent and independent variables.

3.3.2 Discriminant Analysis

Discriminant function analysis is a statistical analysis to predict a categorical dependent variable (a grouping variable) by one or more continuous or binary independent variables (predictor variables). It is useful in determining whether a set of variables is effective in predicting category membership. The study employed discriminant analysis to identify the most prominent service quality dimensions of both public and private service providers and to identify how far the households are discriminated among private and public service providers. To trace out the importance of independent variable to a discriminant function as the first step, the test of equality of group means was performed. Wilks' Lambda test is conducted to test equality of group mean.

3.3.3 Principal Component Analysis

The principal component analysis is a dimension reduction technique employed to reduce various dimensions of service qualities of public and private service providers into two components Factor 1 and Factor 2. Factor 1 exemplifies service quality dimensions of the public service provider, and Factor 2 exemplifies service quality dimensions of the private service provider.

3.3.4 One-way ANOVA

The study employed one way ANOVA to examine whether there is any statistically significant difference between the mean willingness to pay towards different features of the hypothetical project such as ensuring clean environment, provision of safe drinking water, control of rodents and mosquitoes, waste recycling to produce gas for household consumption and construction of a controlled landfill with a large lifespan**.**

Major assumptions of ANOVA such as normality, homogeneity of variance and linearity are tested. The normal P-P plot is used to examine the normality of the distribution. Levene's test of equality of error variance is utilised to test the homogeneity of variance. Levene's test is significant (the value of significance is less than 0.05) which shows that variance is significantly different. To rectify this, the study utilised an adjusted F test namely the Brown-Forsythe statistic as an alternative. One way ANOVA is an omnibus test statistic that cannot state which specific group is statistically and significantly different from each other. Hence, Games-Howell post hoc test is employed to determine which specific groups are different from each other.

3.3.5 Multiple Regression Model

The study employed a multiple regression model to determine the factors that influence waste generation among urban households. In this regression analysis, the total solid waste generation of households per week is regressed by several explanatory variables such as monthly expenditure of household, household size, size of the homestead, education level, the practice of waste segregation and availability of waste disposal service.

An alternative regression model is employed to examine the factors that determine the per capita waste generation among the urban households in the study area to keep the robustness and for theoretical construct. In this model per capita waste generation is regressed by several explanatory variables such as monthly expenditure of household, size of the homestead, education level, practice of waste segregation and the availability of waste disposal service.

WLS (Weighted Least Square) model is employed to estimate the factors that influence willingness to pay of urban households towards improved waste management. In this regression analysis, the maximum willingness to pay of households per month is regressed by several explanatory variables such as monthly household expenditure, household size, education level, gender, age, the quantity of waste generation, availability of waste disposal service and proximity to dumping site.

To ensure that the collected data can be subjected to multiple regression, the study has to check the basic assumptions such as the linear relationship between the outcome variable and independent variable, multivariate normality, multicollinearity and homoscedasticity. Scatter plots of the dependent variable against independent variables are generated to check linearity. The distribution of residuals follows normal distribution properties can be checked by drawing a histogram and PP plot. Simple correlation matrix and variance inflation factors are employed to check the problem of multicollinearity. White's test is employed to check the problem of heteroscedasticity. Weighted Least Square model is employed while seeing the problem of heteroscedasticity in Ordinary Least Square model. Since it is a cross-sectional study, it is not essential to check the error autocorrelation. The goodness of fit of the model has been tested with 'R^2' and 'F'. The significant relationship between dependent and independent variables are examined by the values of 't' and 'p'.

3.3.6 Venn Diagram

The magnitude of overlap in the distribution of waste disposal service between public and private service providers and overlaps in WTP towards public and private service providers are analysed through Venn diagrams using the software Venn diagram plotter. The magnitude of overlaps in WTP towards organic and inorganic waste disposal is also elicited through a Venn diagram.

The details of the analysis by using this methodology are presented in chapter 5, 6 and 7.

CHAPTER 4

Solid Waste Management: Policy Initiatives and Practices

- ***Classification of Solid Waste***
- ***Solid Waste Management and Policy Initiatives: Indian Context***
- ***Solid Waste Management and Policy Initiatives in Kerala***
- ***Solid Waste Management Practices in Kozhikode Corporation***
- ***Conclusion***

CHAPTER - 4

Solid Waste Management: Policy Initiatives and Practices

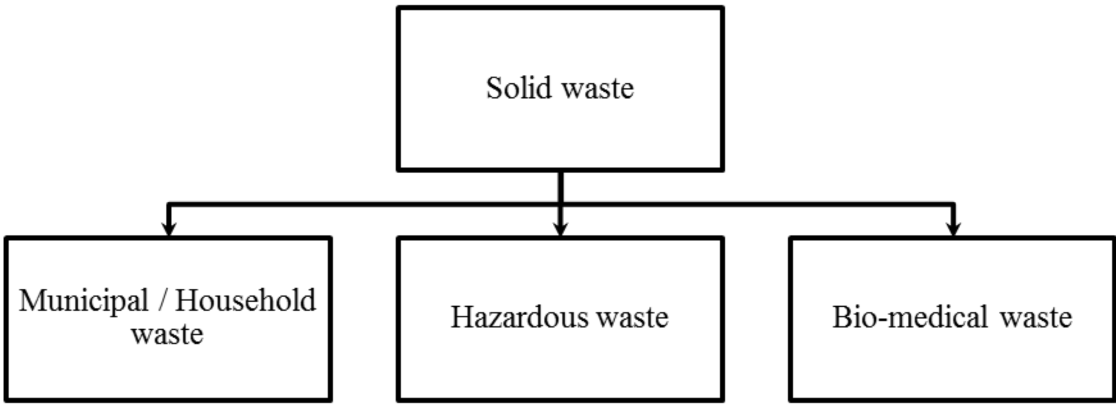
With the advancement in the human cycle of growth, the generation of solid waste did not pose any serious health hazards and public bad to the environment. Because the solid waste was degradable and it got easily mixed up with soil. Later, the industrial revolution led to an enormous increase in the production of different types of goods that lead to the generation of solid waste; the majority which was in the form of non-biodegradable and became a public bad. Increasing generation of solid waste has become an important environmental issue in recent years, and it is one of the impacts of human exploitation on the environment.

Solid waste management has received relatively little attention in the urban development policies of most low- and middle-income countries. Adequate budgeting, cost accounting and financial evaluation are essential for the effective management of solid waste. Responsibility of planning, functioning and investment programme in solid waste management are remain with the local government. So, the role of State and local government bodies in waste management is to be studied. This chapter focuses on the extent of solid waste generation, policy initiatives and practices in Indian and Kerala context generally and Kozhikode Corporation in specific. At this juncture, it is worth enough to analyse the different categories of waste generation general and in specific.

4.2 Classification of Solid Waste

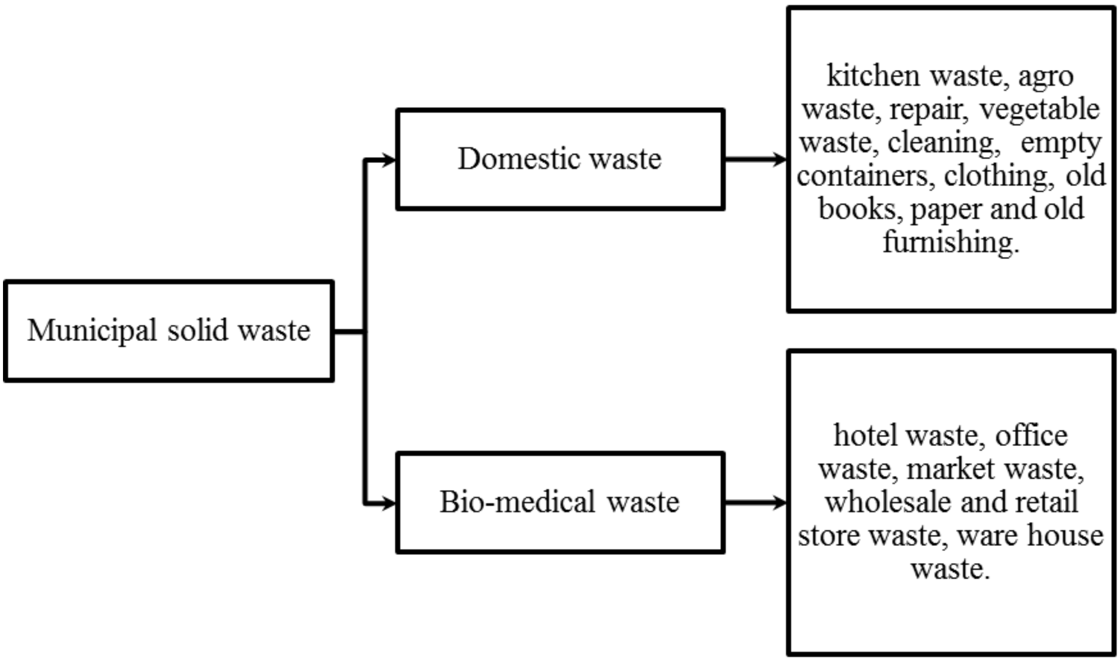
"Solid waste means solid or semi-solid domestic waste, sanitary waste, commercial waste, institutional waste, catering and market waste and other non-residential wastes, street sweepings, silt removed or collected from the surface drains, horticulture waste, agriculture and dairy waste, treated bio-medical waste excluding industrial waste, bio-medical waste, e-waste, battery waste, and radioactive waste generated in the area under the local authorities and other entities" (Solid Waste Management and Handling Rule, 2016).The solid wastes can be classified into different types depending on their sources such as municipal or household waste, hazardous waste and biomedical waste which is given in Figure 4.1 and 4.2.

Figure 4.1: Classification of Solid Waste



Source: edugreen.teri.res.in.solidwastetypes.

Figure 4.2: Classification of Municipal Solid Waste



Source: yourarticlelibrary.com

Municipal solid wastes consist of household and commercial wastes. They are waste resulting from municipal activities and services such as waste from streets, sanitation wastes, dead animals, market wastes, construction and demolition debris and abandoned vehicles. The term is commonly applied to incorporate domestic waste and commercial waste. Industrial and hospital waste is considered hazardous as they may contain toxic substances. Certain types of solid waste are also hazardous that could be highly toxic to human, animals and plants; are corrosive, highly inflammable or explosive; and react when exposed to certain things. *E.g., gases.*

According to the Municipal Solid Waste (MSW) Rules 2000, "MSW includes commercial and residential waste generated in a municipal or notified area, in either solid or semisolid form, excluding industrial hazardous wastes, but including treated bio-medical wastes" (Toolkit for Solid Waste Management, 2012). It includes waste generated by household and waste of a similar nature generated by commercial and industrial premises, by institutions such as schools, hospitals, care homes and prisons, and from public spaces, such as streets, bus stops, parks and garden. Household wastes are discarded materials from households that are generated in the normal process of living and dying. The other terms are a municipal solid waste, domestic waste, MSW, non-dangerous waste.

Hazardous waste includes old batteries shoe polish, paint tins, old machines and medicine bottles. Hospital waste contaminated by chemicals used in hospitals is considered hazardous. These chemicals include formaldehyde and phenols, which are used as disinfectants and mercury which is used in thermometers or equipment that measure blood. In the industrial sector, the major generators of hazardous waste are the metal, chemical paper, pesticides, dyes, refining and rubber goods industries.

Hospital waste or bio-medical waste is generated during the diagnosis, treatment or immunisation of human being or animals or in research activities in these fields or the production or testing of biological. This type of waste is highly infectious and can be a serious threat to human health if not managed scientifically. The hospital waste includes solid waste in the form of disposable syringes, bandages, cotton swabs, body fluids, human excreta, expired medicine and other chemical and biological waste.

Table 4.1 shows a detailed description of sources and types of solid wastes generated in municipal localities in a developing country as well as in Kerala.

Table 4.1: Sources and Types of Solid Waste

Source	Typical waste generators	Types of solid wastes
Residential	Single and multifamily dwellings	Food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, electronics, batteries, oil, and household hazardous wastes.
Industrial	Light and heavy manufacturing, fabrication, construction sites, power and chemical plants	Housekeeping wastes, packaging, food wastes, construction and demolition materials, hazardous wastes, ashes, special wastes etc.
Commercial	Stores, hotels, restaurants, markets, office buildings, etc.	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes etc.
Institutional	Schools, hospitals, prisons, government centres	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes etc.
Construction and demolition	New construction sites, road repair, renovation sites, demolition of buildings	Wood, steel, concrete, dirt, etc
Municipal services	Street cleaning, landscaping, parks, beaches, other recreational areas and wastewater treatment plants	Street sweepings, landscape and tree trimmings, general wastes from parks, beaches, and other recreational areas, sludge etc.
Process	Refineries, heavy and light manufacturing, chemical & power plants, mineral extraction and processing	Industrial process wastes, scrap materials, off-specification products, slag, tailings etc.
Agriculture	Crops, orchards, vineyards, dairies, feedlots, farms	Agricultural wastes, hazardous wastes like pesticides etc.

Source: Koshi, (2010).

4.3 Solid Waste Management and Policy Initiatives: Indian Scenario

India is rapidly shifting from agriculture-based nation to industrial and services oriented country. Urbanisation contributes to increased municipal solid waste (MSW) generation, and unscientific handling of municipal solid waste degrades the urban environment and cause health hazards. Indian cities and towns are found littered with garbage and represent an ugly look at many places within the city /town (The National Action Plan of MSWM, CPCB, 2015-16). As per the CPCB report (CPCB, 2012), municipal solid waste generation in India is 1, 30,000 tonnes per day (47.5 million tonnes per annum) (CPCB, 2012; Kerala Economic Review, 2017). The waste generation was about 1, 00,000 tonnes per day in the year 2000 as per the report of the Ministry of Urban Development (MoUD, 2000), Government of India. Thus, CPCB reports (2012) show that waste generation in the country is increasing at an alarming rate.

CPCB with the assistance of NEERI has surveyed solid waste generation in 59 cities (35 metro cities and 24 State capitals: 2004-05) in India. Among them, some major and minor cities regarding waste generation are given in table 4.2. Table 4.2 shows that Port Blair ranks top in per day waste generation rate followed by Cochin City which is a representation of Kerala. The Kohima City of Nagaland is having the lowest rate of waste generation among the Indian cities followed by the Imphal City of Manipur. Thus, the increasing waste generation over the years is posing serious challenges to urban local authorities. CPCB studies (2005-2006) have revealed that the waste generation rate varies from 0.12 to 0.60 kg per capita per day.

Table 4.2: Waste Generation Rate in Selected Cities in India

Sl. No	Name of City	Population (As per 2001 census)	Area (Sq. Km)	Waste Quantity (TPD)	Waste Generation Rate (kg/c/day)
1	Port Blair	99,984	18	76	0.76
2	**Kochi**	**5,95,575**	**98**	**400**	**0.67**
3	Chennai	43,43,645	174	3036	0.62
4	Pondicherry	2,20,865	19	130	0.59
5	Vishakhapatnam	9.82,904	110	584	0.59
6	Jammu	3,69,959	102	215	0.58
7	Kolkata	45,72,876	187	2653	0.58
8	Delhi	1,03,06,452	1483	5922	0.57
9	Coimbatore	9,30,882	107	530	0.57
10	Panaji	59,066	69	32	0.54
11	Ranchi	8,47,093	224	208	0.25
12	Nagpur	20,52,066	218	504	0.25
13	Jabalpur	9,32,484	134	216	0.23
14	Lucknow	21,85,927	310	475	0.22
15	Gandhinagar	1,95,985	57	44	0.22
16	Rajkot	9,67,476	105	207	0.21
17	Guwahati	8,09,895	218	166	0.20
18	Imphal	2,21,492	34	43	0.19
19	Nashik	10,77,236	269	200	0.19
20	Kohima	77,030	30	13	0.17

Source: CPCB Annual report (2005-06) & Census of India (2001).

Presently, no systematic and authentic data on municipal solid waste generation at the national level and subsequently at state, district and city/town level is available (CPCB, 2015). As per The National Action Plan for municipal solid waste management (CPCB-2015), waste generation in the country is 1, 41,064 tonnes/day and out of which, 127531 tonnes/day (90 per cent) is collected and 34,752 tonnes/day (27 per cent of the collected waste) is processed. Some selected Indian

States (major and minor) concerning waste generation, collection, treatment and landfilling are given in Table 4.3.

Table 4.3: Generation, Collection and Treatment of Solid Waste in Selected Indian States -2016

Sl.No	States	Generated (TPD)	Collected (TPD)	Treated (TPD)	Landfilled (TPD)
1	Maharashtra	22,570	22,570	5,927	
2	Uttar Pradesh	19180	19180	5197	
3	Tamil Nadu	14500	14234	1607	
4	Gujarat	9988	9882	2644	
5	West Bengal	9500	8075	851	515
6	Karnataka	8697	7288	3000	
7	Delhi	8370	8300	3240	
8	Telengana	6740	6369	3016	3353
9	Madhya Pradesh	6678	4351	-	
10	Rajasthan	5037	2491	490	
11	Kerala	1339	655	390	
12	Uttrakhand	918	918	Nil	
13	Arunachal Pradesh	116	70.5	0	
14	Mizoram	552	276	Nil	
15	Goa	450	400	182	
16	Tripura	415	368	250	
17	Nagaland	344	193	-	-
18	Meghalaya	208	175	55	122
19	Manipur	176	125	-	
20	Sikkim	49	49	0.3	

Source: Annual Report –CPCB (2013-14 & 2014-15), National Action Plan for Municipal Solid Waste Management (CPCB-2015)

Table 4.3 shows that Maharashtra ranks top in waste generation, (22570 TPD) among the Indian states. As per the CPCB report (2015), Andaman Nicobar, Daman Dieu & Dadra, Jharkhand, Haryana. Maharashtra, Sikkim, Uttar Pradesh and Uttrakhand could have to collect a hundred per cent of the generated waste against an Indian average of 90 per cent. The waste treatment facility is not available in some parts of the country like Assam, Bihar, Daman Dieu & Dadra Nagar Haveli, Lakshadweep, Madhya Pradesh, Manipur, Nagaland, Puducherry and Uttarakhand. Data indicate that the state with no waste processing facility is taken into consideration in a highly prioritised manner. While considering the case of Kerala state, it could have to collect about half (49 per cent) of the generated waste and process 59.5 per cent of the collected waste.

High population, rapid economic growth and change in living standard accelerate the generation of municipal solid waste in Indian cities (Sharholy et al., 2006; CPCB 2012). Waste management should be taken in a highly prioritised manner for a better and sustainable living. So the government of India brought about a certain institutional framework for proper waste management. Some policies and perspectives were evolved to reduce waste and to ensure a quality environment for quality living. A Synoptic profile of the same follows.

4.3.1 Institutional Policy Framework

The Ministry of Environment and Forests (MoEF) together with Central and State Pollution Control Boards are taking care of the issues related to solid waste management. Some rules and regulations were there in Environment Protection Act-1986 for improving solid waste management. SWM falls under State list as it is considered as public health and sanitation as per the Indian constitution. Due to its local nature, SWM is the responsibility of Urban Local Bodies (ULBs). The government of India implemented some legislation to conserve and protect the environment like

- Environment Protection Act – 1986
- Hazardous Waste Management and Handling Rules – 1989
- Manufacturing, Storage and Transportation of Hazardous Waste Rules –1989
- Bio-Medical Waste Management and Handling Rules – 1998
- Municipal Solid Waste Management and Handling Rules – 2000
- Plastic Waste (Management and Handling) Rules – 2011

- E-Waste (Management and Handling) Rules – 2011
- Solid Waste Management Rules, 2016

In India, implementation of municipal solid waste rules (MSWR) is a major concern of urban local bodies across the country, and municipal solid waste governs Municipal Solid Waste (Management and Handling) Rules 2000 (MSWR). The collection, transportation and disposal of municipal solid waste are chaotic and unscientific in India. The hazardous manner of dumping of solid waste has serious environmental implication regarding groundwater pollution and contribution to global warming. Indian waste management rules are founded on the principles of "sustainable development", "precaution" and "polluter pays". These principles form an integral part of Indian environmental law jurisprudence, as observed by the Supreme Court of India in various decisions. It emphasises municipalities and commercial establishments to act in an environmentally accountable and responsible manner. The increase in a waste generation as a by-product of economic development has led to various subordinate legislation for regulating the manner of disposal and dealing with generated waste are made under the umbrella law of Environment Protection Act, 1986 (EPA**)**. Specific forms of wastes are the subject matter of separate rules and require separate compliances, mostly like authorisations, maintenance of records and adequate disposal mechanisms (Lahiry, 2017)

The Ministry of Environment and Forest notified Municipal Solid Waste Management and Handling rule 2000 made it mandatory for all municipal authorities in the country, irrespective of their size and population, to implement the rules. To improve the systems, the following seven objectives are given;

- Prohibit littering on the street by ensuring storage of waste at source in two bins, for bio-degradable and recyclable wastes.
- Primary collection of biodegradable and non-biodegradable waste from the doorstep on a day-to-day basis using containerised tricycle/handcarts/pickup vans.

- Street sweeping covering all the residential and commercial areas on all the days of the year irrespective of Sunday and public holidays.
- Abolition of open waste storage depots and provision of covered containers or closed body waste storage depots.
- Transformation of waste in covered vehicles on a day to day basis.
- Treatment of biodegradable waste using composting or waste to energy technologies meeting the standards laid down.
- Minimise the waste going to the landfill and dispose of only rejects from the treatment plants and inert material at the landfills as per the standard laid down in the rule.

The Union Ministry of Environment, Forest and Climate Change (MoEFCC) recently introduced solid waste management rules (SWM) 2016 which replaced the Municipal Solid Waste (Management and handling) rule 2000, which have been in place for the past sixteen years.

4.3.1.1 Solid Waste Management Rules, 2016

The Government of India has revamped the Municipal Solid Waste Management and Handling Rules 2000 and introduced the new Solid Waste Management Rule, 2016 on April 8, 2016. The Ministry of Environment, Forest and Climate Change shall be responsible for overall monitoring the implementation of these rules in the country. It shall constitute a Central Monitoring Committee under the Chairmanship of Secretary, Ministry of Environment, Forest and Climate Change shall frame National Policy on SWM and coordinate with States/UTs, provide technical guidelines, financial support, training to local bodies, etc. Schedule 1 of the Solid Waste Management Rules, 2016 recommends certain criteria of specification for sanitary landfills like criteria for site selection, development of facilities at the sanitary landfills, specification for landfill operation, pollution prevention, water quality monitoring, ambient air quality monitoring, plantation at landfill sites, post care of landfill sites, specific provision for hilly areas and closure and rehabilitation of old dumps. Standards of processing and treatment of solid waste are given schedule 2 of the rule. The waste processing facilities shall include composting as one of the technologies for processing of bio-degradable waste. Many steps had been taken by the government to prevent pollution from compost plant

These rules are applicable to areas under every urban local body (Mega-city to Panchayat level), outgrowths in urban agglomerations, notified industrial town, areas under the control of Indian railways, ports and harbors, special economic zone, places of pilgrim, domestic, institutional, commercial and any other non-residential solid waste generator situated in the areas. It applies to waste generators like household and hotels & restaurants, event organisers, street vendors and market associations, the community having more than area 5000 sq. m, etc. Some duties are assigned to waste generators and authorities that waste generators shall segregate waste and store separately and hand over to municipal workers or authorised waste pickers. MNRE shall facilitate infrastructure for waste-to-energy plants and provide a subsidy. State/UT shall prepare state policy, adopt 3-R^s, identification of common/regional landfills, and notify guidelines of buffer zones. District Collector/Magistrate shall facilitate identification of landfill site, quarterly review the performance of local bodies. CPCB shall coordinate with SPCBs for monitoring and annual reports, formulation of standards, review new technologies, prepare guidelines for buffer zones restricting from residential, commercial and construction activities areas; and inter-state movement of waste. The time frame for implementation of SWM Rules is instituted as one year for landfill identification, two years for procurement of waste processing facilities, two years for ensuring segregation of waste, three years for setting up sanitary landfills and five years for bioremediation/capping of old landfills.

Moreover, the Government of India formulates a special action plan for cities according to nature and quantity of waste generation. The National Plan further outlines packages and combinations based on the quantum of waste generation, an approach to be adopted and environmental standards to be maintained. The bigger cities generating waste more than 1000 tonnes per day will have to opt for high waste consuming technologies like a waste to energy and composting. So that waste processing plants became as sustainable and economically viable. Small city, say generating <1000 tonnes, should adopt for composting and RDF (Refuse Derived Fuel). In further smaller States, where waste generation is less than 100-500 tonnes per day, they can compost and production of RDF. Cities generating waste less than 100 TPD may not require high-cost waste processing and disposal technologies. Such a town can design a proper system for waste collection, storage and transportation considering the local situation. As per the CPCB report (2017), the cities with an estimated waste generation of more than 1000 t/d is given in Table 4.4.

Table 4.4: Major Waste Generating Metro Cities in India

Name of City	Population (2011 census)	2004-05	2010-11	2015-16
Mumbai	12,442,373	5320	6500	11000
Delhi	11,034,555	5922	6500	8700
Chennai	7,088,000	3036	4500	5600
Bangalore	8,443,675	1669	3700	3700
Hyderabad	6,731,790	2187	4200	4000
Ahmedabad	5,577,940	1302	2300	2500
Kolkata	4,496,694	2653	3670	4000
Surat	4,467,797	1000	1200	1680
Pune	3,124,458	1175	1300	1600
Kanpur	2,765,348	1100	1600	1500

Source: CPCB Annual report (2017) & Census of India (2011).

All these policies towards sustainable waste management practices by the government are expected to be reflected in the better quality of life due to improved health and general wellbeing, economic gains, better aesthetic surroundings and overall environmental up gradation.

4.4 Solid Waste Management and Policy Initiatives in Kerala

Kerala is the twelfth largest State by the population of 33,387,677 (2011 Census) and is divided into 14 districts with the State capital Thiruvananthapuram. The State covered an area of 38863 Sq. km with population density 860 /sq.km (2011 Census). There are 60 municipalities, six Corporations and 999 Village Panchayats in the

State. It is estimated that about 2500 tonnes of solid wastes are generated per day in the State of which only about 50 per cent is collected for disposal (Economic review, 2004). Currently, 10044 TPD of municipal solid waste (MSW) is generated due to various household activities and other commercial and institutional activities (Varma, 2013). The per capita generation of solid waste is theoretically better measure than the total waste generated in an area. Per capita waste generation is relatively high in Kerala compared to other States due to the peculiar consumption pattern in the State (Malinya Muktha Keralam Action Plan, 2007).

Kerala is a State considered to be having a developed modern society. The consumption of resources results in the generation of waste. In Kerala, there are 93 municipal authorities responsible for MSW management (CPCB 2017). As per the CPCB report (2017-18), solid waste generation in the State is 3831.553 TPD. It was 1339 TPD out of which, 655 TPD of MSW is being collected in the State, and 390 TPD is processed/treated (CPCB, 2014-15). The annual MSW generation in Kerala is 3.7 Million tonnes (Varma, 2007; Economic Review, 2017). Accordingly, the total MSW generation in Kerala is given in Table 4.5.

Table 4.5: Extent of Solid Waste Generation in Kerala (2013)

Region	Population (2011)	Per capita MSW generation (gram/day)	Total MSW Generation (TPD)
Corporation	3011629	470	1415
Municipalities	12923297	350	4523
Grama Panchayats	17471135	235	4106
Total	33406061		10044

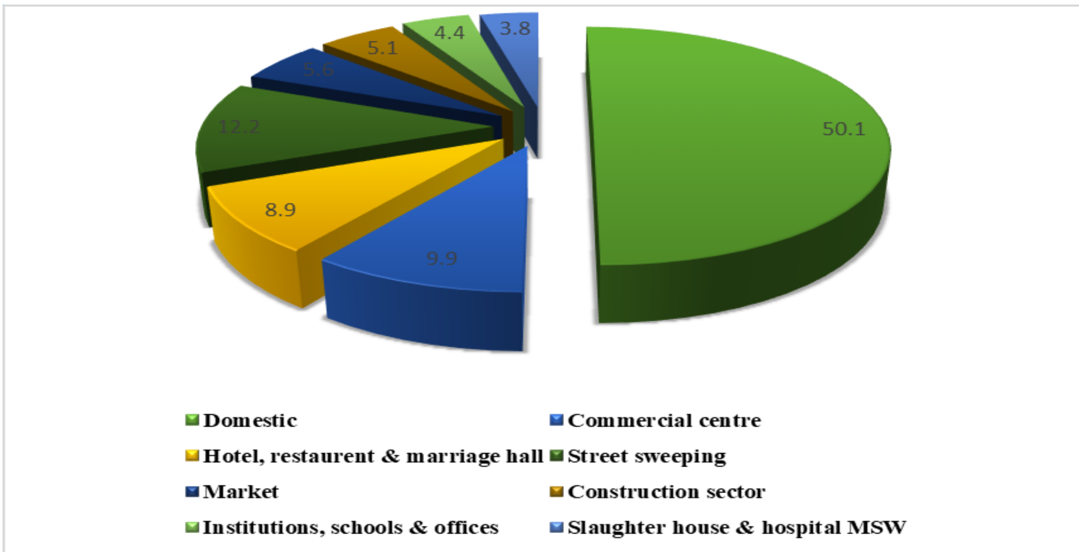
Source: Census of India (2011) & Economic Review (2017)

Table 4.5 shows that per capita waste generation in the Corporations of Kerala is high compared to municipalities and grama Panchayats which indicates that urban people generate more waste than the rural people. Table 4.5 also indicates that 14 per cent of the waste is generated by the city Corporations, 45 per cent by the municipalities and the rest by the Grama Panchayats. Detailed sampling studies in major urban centres of the State indicated that the waste generation is 17.5 per cent higher (Varma, 2014).

4.4.2 Sources and Composition of Solid Waste in Kerala

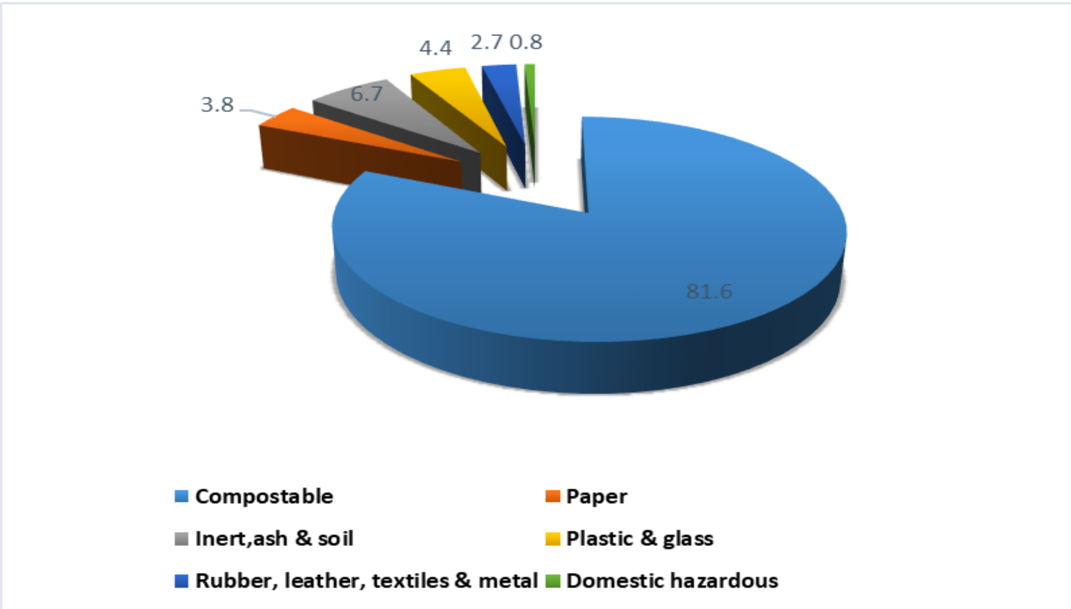
The sources and composition of solid wastes generated in Municipal localities in Kerala are given in Figure 4.3 and 4.4. Figure 4.3 shows that households are the major generators of solid waste in Kerala.

Figure 4.3: Sources of Solid Waste in Kerala



Source: Kerala economic review (2017)

Figure 4.4: Composition of Solid Waste in Kerala



Source: Kerala economic review (2017)

Figure 4.4 shows the composition of solid waste in Kerala where a substantial share of the total solid wastes constitutes compostable wastes followed by inert, ash, paper, plastic, metal, rubber, glass etc.

Kerala is one of the few Indian States that took effective measure to address waste management by launching a clean mission in 2002. Later in 2007, Malinya Mukta Keralam campaign was launched that succeeded in creating the conducive environment for a mission mode action plan to achieve the goal of clean Kerala. Besides the government of Kerala also took steps by institutional reform to conserve and protect the environmental quality.

4.4.3 Waste Management and Policy Initiatives

The sanitation history of Kerala dates back to 1900 when bucket type latrines were first introduced in Trivandrum. It progressed well in selected pockets with the support of international agencies and got a fillip during the People's Plan Campaign since 1996 when the responsibility of sanitation was devolved to the local governments. The government launched Kerala Total Sanitation and Health Mission (KTSHM) to support the local governments for achieving improved hygiene through behavioural change in sanitation practices. The menace of solid waste was increasing and the local governments, most were not having technical support, trained workforce and financial capacity to deal with the situation. Consequent to the increased inflow of plastics to the municipal waste and reduced consumption of market waste in agricultural activities, two major cities of the State, Njeliyanparamba, Kozhikkode and Vilappilsala, Trivandrum set up centralised composting plants in the year 2000.

In 2004, the Government launched the Clean Kerala Mission (CKM) to create a garbage-free Kerala. The mission provided technical support and fund to the local governments for complying with the provisions of Municipal Solid Waste (Management and Handling) Rules, 2000. It facilitated the establishment of a few centralised plants and decentralised waste management systems, especially in markets and institutions. In 2006, a detailed sectorial status study on municipal solid waste management was taken up with the support of the Water and Sanitation

Programme-South Asia of the World Bank. The results of the study and the experience of KTSHM and CKM enabled the State to prepare a comprehensive Zero Waste Kerala (Malinya Muktha Keralam) Action Plan in 2007. Accordingly, institutional reform was effected by merging KTSHM & CKM and forming the Suchitwa Mission (SM) in 2008. The Suchitwa Mission evolved an Overflow Waste Management (OWM) strategy thereby thrust was on segregated collection and storage of waste and treatment of bio-degradable at source as far as possible. While this strategy was gaining acceptance, there was a build-up of local agitation due to poor social and environmental safeguards at some of the centralised waste management system.

Consequently, the Government in 2012 declared its intent to install centralised waste to energy plants, but it did not happen. Subsequently, the Government modified the waste management strategy and assigned the responsibility of waste management to the producer. In line with this, the Suchitwa Mission extended assistance to local governments and many of the local governments initiated actions. One notable example is the Alappuzha Municipality which got recognition from the United Nations as one of the five cities in the world that are working towards curbing pollution through sustainable solid waste management practices.

In 2016, the government launched the Haritha Keralam Mission as an enabling entity to regain the past glory of Kerala in cleanliness. The mission, launched on December 8, 2016, working with concerned missions such as Suchitwa mission, Mahatma Gandhi National Rural Employment Guarantee Scheme, Kudumbasree mission, Saksharatha mission etc. The mission launched various campaigns for improved waste management. The mission is functioning through three sub-missions namely water conservation, safe agricultural production and waste management. Waste management is proposed to be improved by adopting over-flow management options. It involves segregation of waste at sources, conversion of biodegradable waste to manure or gas at the source itself, as far as possible, establishing decentralised composting facilities for those sources having constraints and centralised option for treating overflows. The mission also involves the collection of all the non-biodegradable by establishing material collection facilities and promotion of material reuse and recycling through Resource Recovery Faculties. It is also proposed to adopt centralised waste management solutions for major cities and centralised seepage treatment plants in various districts.

In order to intensify waste management activities in the State, a special campaign, 'freedom from waste campaign' was launched on August 15, 2017, after month-long preparatory activities. A series of training was undertaken at various levels in which 3.1 lakh people were trained for carrying out a participatory study on the current waste management status in households and institutions, prepare a plan of action for each ward of local governments and declare freedom from waste. About 300 local governments have revised their projects or evolved new projects and planned to launch it on November 1, 2017, as targeted. These projects addresses components of comprehensive waste management components such as segregation of waste at source, Haritha Karma Sena for facilitating non-biodegradable waste collection from source and biodegradable waste for those locations having constraints, establishing material collection facility and resource recovery centres for non-biodegradable waste management, installing household, institutional and decentralised facility for treating biodegradable waste, borrowing help and assistance from Haritha Sahaya Sthapanam as well as Clean Kerala Company. The projects that are initiated will be brought to fully operational by January 1, 2018, and by March 31, 2018, waste management activities will be initiated in all the local governments.

Besides, the State government is providing incentives by way of grants for putting up municipal solid waste management programs. The government of India under the Ministry of Environment and Forests is having a funding mechanism by sharing the investment cost under their model facility scheme. The generators are responsible for the proper management of waste. However, though the local bodies are the main stakeholders, community participation is very important. The awareness and education of the public are equally of importance in this case. Private sector participation in waste management is one of the best choices open to boost the performance of public services

Moreover, there is some legislation on the treatment of wastes, both national, as well as State level, was initiated in the State on municipal solid waste are:

1. The Revised Municipal Solid Waste Management Rule, 2016
2. The Municipal Solid Waste (Management and Handling) Rules, 2000
3. The Municipalities Act, 1994
4. The Panchayath Raj Act, 1994
5. The Environmental (Protection) Act, 1986

Thus the various initiatives of the local government, especially in the last few years, generates confidence about the capacity of Village Panchayats, municipalities and Corporations to move on to scientific management of waste.

4.5 Solid Waste Management Practices in Kozhikode Corporation

Kozhikode as a district came into existence on 1st January 1957. After the formation of Kerala State in 1956, when Malabar district was divided into three districts, the Central district with headquarters at Calicut was named as Kozhikode. (Kozhikode City Census 2011). Kozhikode city is governed by Municipal Corporation which comes under Kozhikode Metropolitan Region. As per provisional reports of Census India, the population of Kozhikode in 2011 is 431,560; of which male and female are 206,157 and 225,403 respectively. Although Kozhikode Corporation has population of 431,560; its urban / metropolitan population is 2,028,399 of which 964,960 are males and 1,063,439 are females. (Kozhikode City Census 2011). Kozhikode city was declared India's first litter-free city in 2004 (Koshi, 2010).

Solid waste management is an unsolved problem faced by Kozhikode Corporation even though Kozhikode Corporation was declared India's first litter-free city. Uniformed women are doubling up as auto-drivers and as household litter-pickup girls, handle over 300 tonnes of city's solid waste. The solid waste management project priced Rs.6.13 crores is funded jointly by the Union Ministry for Environment and Forests, State Pollution Control Board and Kozhikode Municipal Corporation. Moreover, citizens pay Rs 30 per month for solid waste collection (Koshi, 2010).

Data on the municipal solid waste generation maintained by ULB (Urban Local Body) is based on a number of trips made by the waste vehicles. Generally, there is no practice of weighing the municipal solid waste at any stage. The Kozhikode City with 458gms of solid waste has the highest per day per capita generation of solid waste in Kerala followed by Cochin with 419gms and Kannur with 313gms (ISWM, 2007). In the case of solid waste density (Solid waste per sq. km), the town of Ponnani and Cochin with a measure of 2.63 is at the top. Kozhikode stands at the third position. (ISWM, 2007).

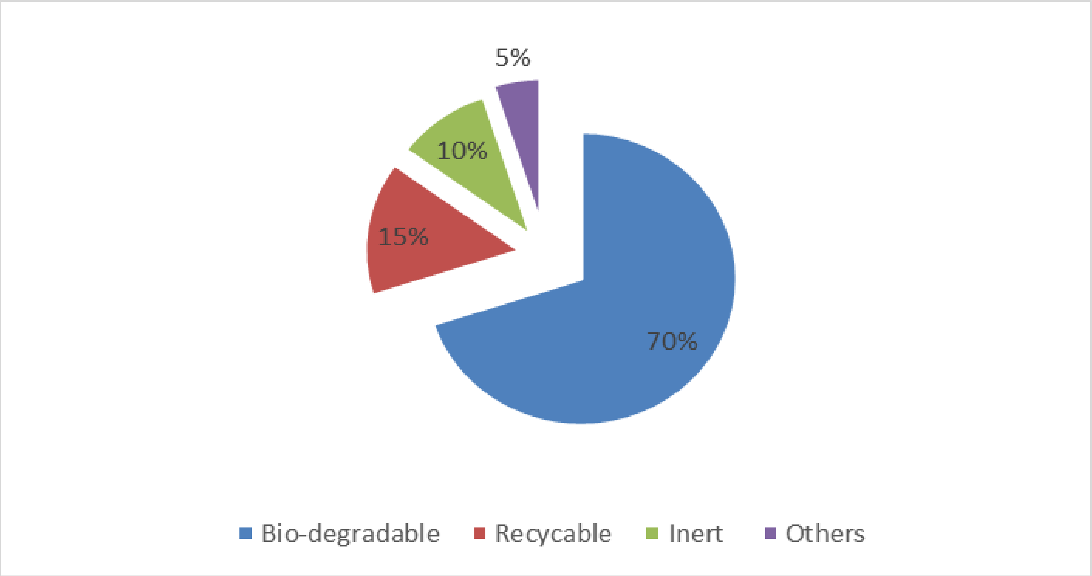
The urban area of Kozhikode district is slightly better off compared to the periphery, considering that it has a waste management plant within its geographical area. The Model Solid Waste Management Programme, implemented in Kozhikode Corporation in 2004 has been treated as a remarkable step for safe disposal of household waste in the city. At the initial stage, waste collection service was introduced in 7 wards under the Suchitwa mission with the help of Kudumbasree on an experimental basis, and it was a great success. In the initial stage, the Kudumbasree members themselves purchased a vehicle for transporting collected waste from the primary point to dumping site. The programme was successful at the beginning stage. By seeing the success, the government supplied vehicles for them, but all the maintenance charge should be carried out at their own expense. The unavailability of spare parts and other issues make the programme a failure one. In the next phase, the Corporation decided to supply uniform, glove, mask, chappal and vehicles to the Kudumbasree members once in a year.

Initially, there were 71 units, each having ten members. Later the number of units has gone down to 65, and it was limited to 18 circles in 2017. A group consisting of 10 members were engaged in the waste collection process in each circle except in the third circle where two groups with 20 members were engaged in waste collection. Recently some of the group operate with three or four members, and each group covers two wards. The drop out of volunteers has been attributed to the low wages the units receive from households and the health issues they suffer. In the initial stage, each household contributed to Rs.30 per month, and the rate has been increased to Rs50 and Rs75. Now it is in the range of Rs.100 -150. The volunteers argue that an amount of Rs150 per month is insufficient to meet fuel expenses and maintenance charge. On average, a Kudumbasree worker can earn around Rs. 6000 per month. Currently, there is a tendency to leave the present job among the kudumbasree workers because of the availability of the high paid job before them.

4.6.1 Extent of Waste Generation

Households, commercial areas like a market, institution, marriage/ community halls, hospitals industrial establishments, residential colonies and public places are the major generators of solid waste in Kozhikode Corporation. The total quantity of solid waste generated in Kozhikode Corporation is estimated at 250-350 tonnes per day. (Masterplan for Kozhikode Urban Area 2035).

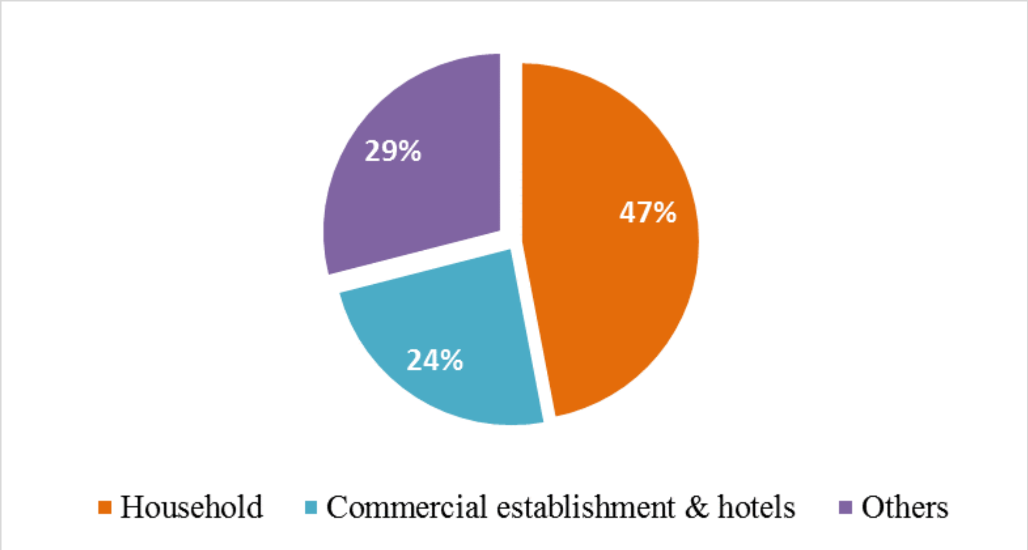
Figure 4.5: Composition of Solid Waste in Kozhikode Corporation



Source: Master plan for Kozhikode Urban Area 2035

Figure 4.5 shows the composition of solid waste in Kozhikode Corporation where bio-degradable wastes contribute 70 per cent of the total waste generated while recyclable wastes like paper, plastic, metal, rubber, glass etc. constitute 15 per cent of the total waste generated. Inert is 10 per cent, and others constitute 5 per cent of the total.

Figure 4.6: Sources of Solid Waste in Kozhikode Corporation



Source: Master plan for Kozhikode Urban Area 2035

Regarding percentage contribution, domestic waste generated from the household account for 47 per cent of total waste. Waste from commercial establishments and hotels account for 24 per cent of the waste. (Masterplan for Kozhikode Urban Area-2035).

4.6.2 Extent of Solid Waste Collection

Three major service providers like Kudumbasree, Corporation sanitary workers and Niravu in collaboration with residents association actively involved in Kozhikode Corporation Calicut in the waste collection process. Kudumbasree collects organic waste from households in all days except Sunday. The collected waste is moved to 32 secondary collection points identified by the Corporation and loaded to secondary collection vehicles (tractors/ trucks). Finally, these wastes are transported to Njeliyanparamba waste treatment plant where bio-degradable wastes are treated into bio-manure while non-biodegradable wastes and rejects are being used for landfilling. The total waste collection in the Corporation is 120-150 tonnes/day. (Govind, 2010).

In coastal wards like Mukhdar and Valiyangadi, Corporation sanitary workers collect bio-degradable and non-degradable waste separately, and no fee is imposed on the households of the coastal area. Majority of the households dispose of their waste in the separate bin. They have no other option before them to dispose of their solid waste. All these organic waste collected by the Corporation sanitary workers are dumped at Njeliyanparambu waste treatment plant.

The Corporation also had a plastic waste recycling unit at West Hill. In the earlier stage, plastic waste is collected from households once in a week and dumped at Corporation owned industrial estate at West Hill. Later, this recycling unit is closed due to technical issues (Govind, 2011). However, NGOs like residential associations are taking much interest in collecting inorganic waste with the help of 'Niravu', a privately owned agency. They collect inorganic waste from households once in 4 or 5 months. Sometimes it may extend to 6 months too. They charge a fee of Rs70-80 per sack.

4.6.3 Status of Solid Waste Treatment

All the biodegradable waste collected by the Corporation sanitary workers and Kudumbasree are transported to Njeliyanparambu dumping yard in Cheruvannur-Nallalam area which is spread across an area of 7 hectares. All the collected waste are dumped in an open surface for drying and finally converted into manure by using a single windrow system. Produced manure are marketed at Rs.400 per sack. One of the major defects of the plant is that it does not have a leachate treatment unit for waste water treatment and drier for drying the waste. So the collected wet wastes need more time for dry, and the open dumping of it became a breeding place of mosquitoes spreads a foul smell to nearby areas. It also creates health issues like allergy, infection etc. to the nearby people.

4.6.4 Issues of Waste Management

The existing solid waste management system is limited to the wards in the old Corporation area. Similarly, street sweeping is done only in certain central areas. The dwindling number of Kudumbasree workers volunteering for these activities has reduced the efficacy. Most often the waste is being spread out by dogs and birds due to irregular clearance of dumping site, improper and open placement of waste bins.

Shops/stalls are not provided with separate bins; hence usually, they throw the waste to the street or drains. The disposal of non-biodegradable waste without any treatment and practice of unscientific landfilling resulting in pollution of the surrounding areas. Appropriate modern technology needs to be employed for processing the wastes. The LSGIs are not equipped with sufficient infrastructure and workforce to undertake and dispose of daily waste. Vigilance and enforcement measures need to be strengthened to penalise negligence in waste disposal, and continuous awareness creation programs have to be taken up. The technical and administrative machinery of the LSGIs needs to be strengthened to guide and manage the decentralised and centralised solid waste management measures (Masterplan for Kozhikode Urban Area 2035).

4.7 Conclusion

Considering the fragile environmental systems of Kerala, the carrying capacity of the State is limited to restrained livelihood and non-aggressive developmental interventions. It implies that improvement in the quality of life of the State is possible only when the pattern and levels of production-consumption activities are compatible with the capacities of the natural environment to assimilate the impacts. Therefore, the growth potential of Kerala sustains only with improved natural resource enrichment and reduced pollution load. It necessitates the caring of environmental security by addressing the issues of land, water and biota as well as waste management. The efforts of the government for enabling environment-linked actions by local governments and development departments supported by mission mode initiatives are expected to bring about a green development pattern for the State that can regain environmental quality. The overflow waste management system is found to provide the most appropriate strategy for solid and liquid waste management in Kerala wherein the priority is for decentralisation and centralisation is subjected to the characteristics of the waste.

CHAPTER 5

Solid Waste Generation: Estimation and Determinants

- ***Estimation of Solid Waste Generation***
- ***Determinants of Solid Waste Generation: Theoretical Approach***
- ***Determinants of Solid Waste Generation: Econometric Approach***
- ***Conclusion***

CHAPTER - 5

Solid Waste Generation: Estimation and Determinants

This chapter is an exploration of the types and quantity of waste generation among urban households in Kerala. It solicits households waste generation with socio-economic and location factors such as education, income level, age, gender, occupational status, household size and proximity to waste treatment plant. It relates the quantity of waste generation with other enabling variables such as practice of segregation of waste and availability of waste disposal service. It examines the expected relationships by theoretical background, and the obtained results are tested through econometric models. The obtained output on theory and empirics are presented here.

5.1 Estimation of Solid Waste Generation

The prime objective of this part of the study is to estimate the quantity of waste generation and to examine the factors that determine waste generation among urban households. Waste issues are of multi-dimensional concern that is environmental as well as socio-economic (Limbu, 2013). Waste generation is the process by which the total amount of household waste that enters the waste stream before recycling, composting, landfilling or combustion takes place (EPA, 1996). In Kozhikode Corporation, households generate waste in the form of organic, non-recyclable plastics like carry bags and bottles, recyclable plastics, paper, glasses, lights, e-waste, sanitary napkins, dresses and other wastes. As found everywhere, organic waste is common to all households, and 100 per cent of the sample generates plastic waste because nowadays, plastics are an unavoidable part of daily consumption. The study collected data on the quantity of waste generation among the households during the previous week of the survey with a recall period of one week to estimate generation of waste among households in urban Kerala.

Table 5.1: Quantity of Solid Waste Generation

The quantity of waste generation per household (In Kg/week)	Percentage to total
0-2	1.3
2-4	37.5
4-6	35.9
6-8	20.8
Above8	4.4
Total	100.0

Source: Estimated from primary data

Average waste generation among households is calculated as 5.3 kg per week (757gms/day per households) with a standard deviation of 1.79 which indicates that there is a small deviation in the waste generation.

Based on the studies carried out by the Centre for Earth Science Studies and data compiled by the Clean Kerala Mission (2007) for all the municipalities and Corporations of the State, the average daily per capita waste generation comes to 0.178 kg with a very high variation from 0.034 kg for Koothuparamba to 0.707 kg for Thalassery (Varma, 2007). The studies carried out by the National Environmental Engineering Research Institute (NEERI, 1996) in Indian cities have revealed that quantum of MSW generation varies between 0.21- 0.35 kg/capita/day in the urban centres and it goes up to 0.5 kg/capita/day in large cities. Per capita waste generation among sample households is calculated as 1.23kg per week (0.176kg per day per capita). The average waste generation in Kerala is found to be 0.289 kg per person per day (Ashalakshmy & Arinachalam, 2010).

5.2 Determinants of Waste Generation: Theoretical Approach

Though our analytical focus is on the examination of factors on waste generation among the households, an understanding of the social, economic and demographic determinants of the households would be useful in setting a background for the detailed analysis. The general notion is that the social environment is the combination of factors such as religion, caste, age, family structure and size, while economic environment is the result of factors such as education, occupation and income. Previous studies (Afroz et al., 2010; Monaravi et al., 2011; Sankoh et al., 2012; Limbu, 2013 and Olayungbo et al., 2014) revealed that socio-economic features of households play a significant role in waste generation, storage and waste management practices followed by them. Hence socio-economic identification of the sample households should be considered in order to develop a wider perspective analysis.

Table 5.2: Descriptive Statistics of Socio-economic Determinants

Variables	Description	Mean	SD
Household size	Household size measured by the number of adults and children	4.6	1.2
Age	The actual age of respondent in years	51.5	8.08
Income	Monthly household income (in Rs.)	26711	26194
Per capita Income	Monthly household per capita income (in Rs.)	6477	3927
Expenditure	Monthly household expenditure (in Rs.)	18236	13876
Per capita Expenditure	Monthly household per capita expenditure (in Rs)	4349	7506
Homestead	Size of homestead owned (in cents)	7.4	4.1
Years of stay	Number of years of stay in the same house	18.2	11.1

Source: Estimated from primary data

Descriptive statistics like mean and standard deviation (SD) of the socio-economic variables are calculated to understand the basic pattern, deviation and spread of the data. It also helps to identify the variables that influence a waste generation. The high standard deviation in the economic indicators indicates that the sample has a representation of all income group. It states that the sample is a true representation of the population. Studies (Afroz et al., 2010; Monaravi et al., 2011; Kayode & Omole 2011; Sankoh et al., 2012; Limbu 2013; Olayungbo et al., 2014) stated that socio-economic factors of the households are the vital determinants of waste generation. The present study also expects some relationship between socio-economic variables and waste generation. The study attempted to examine the impact of socio-economic factors on solid waste generation by posing the case of Kozhikode Corporation.

5.2.1 Waste Generation across Household Size

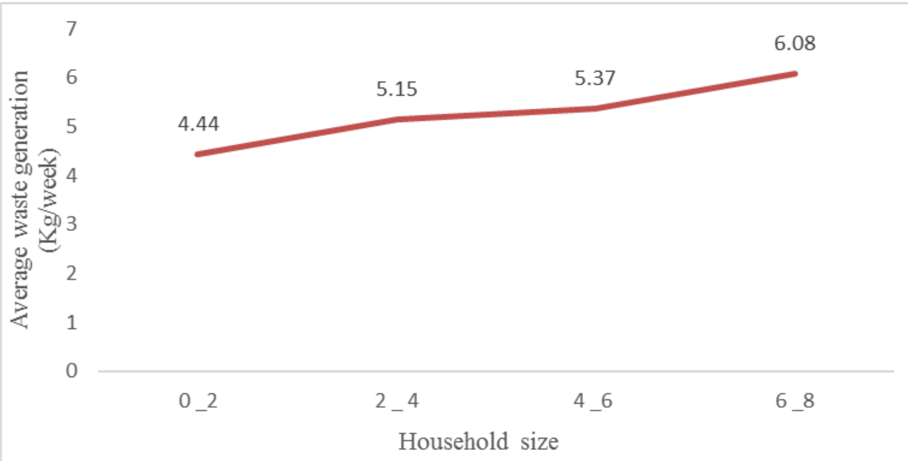
The household size is measured by the number of adults and children feeding on the same source, and average family size in the Kozhikode Corporation area is five as same as the national average at 5. Information gathered concerning the household size are useful to examine the influence of the former on the quantity of waste generation. Descriptive statistics are calculated to understand the basic pattern of waste generation and the deviation of the data.

Table 5.3: Waste Generation across Household Size

Household size	Percentage of households	Waste generation (In kg/week)			
		Mean	Median	SD	CV
0 – 2	6.0	4.44	4.0	2.13	47.98
2 – 4	37.8	5.15	5.0	1.80	34.94
4 – 6	49.7	5.37	5.0	1.69	31.52
6 – 8	6.5	6.08	5.0	1.82	29.99

Source: Estimated from primary data.

Figure 5.1: Average Waste Generation across Household Size



Source: Estimated from Primary data.

Table 5.3 shows that the size of the household and the quantity of waste generation are directly related. Afroz et al., (2010); Monaravi et al., (2011); Sankoh et al., (2012) and Limbu (2013) supported the same. The present study also stated that family size is one of the prominent determinants of waste generation. The increase in the size of the household leads to an increase in resource consumption and thereby increased waste generation. Hence, it is essential to examine the per capita waste generation among sample households and the average per capita waste generation is estimated as 1.23kg per week (0.176kg per day). The estimated result goes in line with the studies of Varma (2007) which shows that the average per capita waste generation in the State is 0.17kg per day (Varma, Clean Kerala Mission, 2007).

5.2.2 Waste Generation across Monthly Income

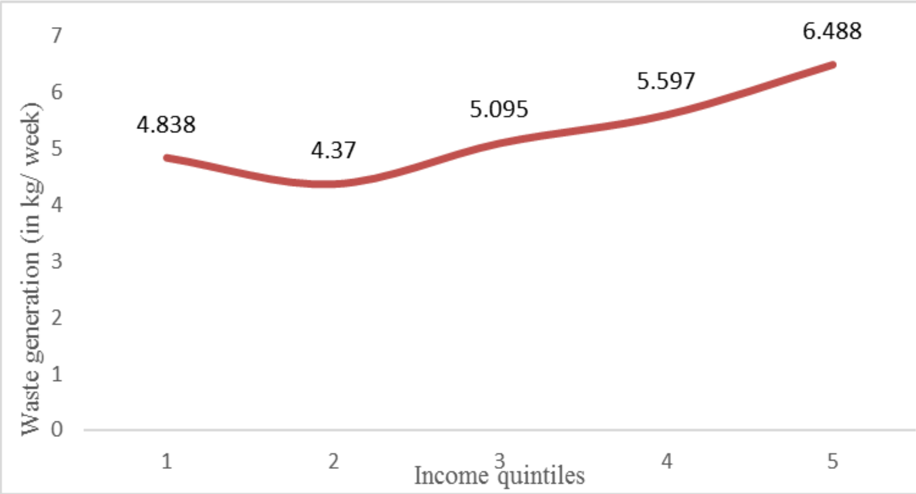
The total households are classified into five quintiles on the basis of income. The first two groups (income quintiles 1 and 2) are considered as lower income group, third as a middle-income group and the bottom two groups (income quintiles 4 and 5) are treated as higher income group. The study analyse average waste generation among different income groups to examine the influence of income on waste generation which is given in Table 5.4.

Table 5.4: Waste Generation across Income Quintiles

Income quintiles	Percentage of households	Waste generation (In kg/week)			
		Mean	Median	SD	CV
1	19.3	4.84	4.0	1.97	40.70
2	19.0	4.37	4.0	1.42	32.49
3	24.7	5.09	5.0	1.72	33.79
4	16.1	5.59	5.0	1.55	27.73
5	20.8	6.49	7.0	1.48	22.80

Source: Estimated from Primary data.

Figure 5.2: Average Waste Generation across Income Quintiles.



Source: Estimated from Primary data.

Figure 5.2 shows that the higher income group generates more waste than the lower income group which indicates that income level and waste generation are directly related. The consumption level and consumption pattern of households change with the increase in income. High income generates higher purchasing power which enables people to buy more and generate more waste at the end. The findings are in line with the research outcomes of Kayode & Omole, (2011); Limbu, (2013) and Astane & Hajilo, (2017) that income is a significant factor that determines waste generation.

5.2.3. Waste Generation across Monthly Expenditure

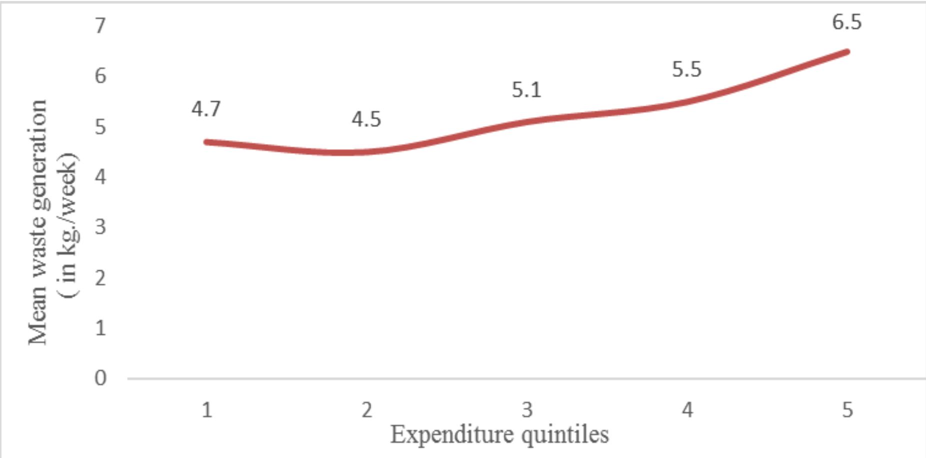
Similar to income quintiles, the total households are divided into five groups on the basis of expenditure known as expenditure quintiles. The first two groups are considered as lower consumption group, third as middle consumption group and the bottom two groups as high consumption group (Table 5.5). The household's average monthly expenditure is estimated as Rs.18236 (Table 5.2). Monthly expenditure of the household is expected to have a positive influence on waste generation.

Table 5.5: Waste Generation across Expenditure Quintiles

Expenditure Quintiles	Percentage of households	Waste generation(In kg/week)			
		Mean	Median	SD	CV
1	24.2	4.7	4.0	1.85	39.36
2	15.6	4.5	4.0	1.41	31.33
3	21.4	5.1	5.0	1.75	34.31
4	18.5	5.5	5.0	1.55	28.18
5	20.3	6.5	7.0	1.55	23.85

Source: Estimated from primary data.

Figure 5.3: Average Waste Generation across Expenditure Quintiles



Source: Estimated from Primary data.

As expected, the study shows a direct relationship between waste generation and consumption expenditure (Figure 5.3). Table 5.5 shows that the lowest consumption group generates an average of 4.6kg waste per week; on the other hand, the high consumption group generates an average of 6.0kg of waste per week. The result indicates that waste generation became high as people moving towards a consumer society. The findings of Limbu, (2013) supported the positive relationship between waste generation and monthly household expenditure.

5.2.4 Waste Generation across Occupation

Occupational distribution of household (Table 5.6) shows that 21.9 per cent of households belong to coolie followed by business (18.5 per cent) and self-employed (15.4 per cent). Since the study is conducted in the city area, only 2.1 per cent of households depend on agriculture. Waste generation across the occupation of the households is given in Table 5.6.

Table 5.6: Waste Generation across Occupation

Occupation	Percentage of households	Waste generation (In kg/week)			
		Mean	Median	SD	CV
Govt. employee	11.7	6.11	6.0	1.34	21.93
Private employee	13.5	5.46	5.0	1.60	29.30
Agriculture	2.1	5.25	5.0	1.83	34.83
Business	18.5	5.54	5.0	2.03	36.64
Coolie	21.9	4.58	4.0	1.41	30.79
Self employed	15.4	5.03	4.0	1.88	37.38
Professional	2.6	7.10	7.0	1.37	19.29
Others	14.3	5.09	5.0	1.95	38.31

Source: Estimated from primary data.

By theoretical expectation and apriori information, it is assumed that as people acquire better job and rise in income, consumption pattern also changes so as to generate different type of waste. As expected, the study shows that average waste generation is higher among professionals followed by government employees (see Table 5.6). It may be due to higher income and greater consumption pattern followed by professionals and government employees. Because professionals and government employees are used more convenient, processed, semi-cooked and packaged goods in consumption, and it becomes the matter of convenience among professionals and employees. This nature of consumption pattern generates solid waste specifically plastic waste. One of the notable facts is that waste generation is low among coolies because of low income and low consumption pattern. The results indicate that the employment status of households also influences waste generation.

5.2.5 Waste Generation across Educational Categories

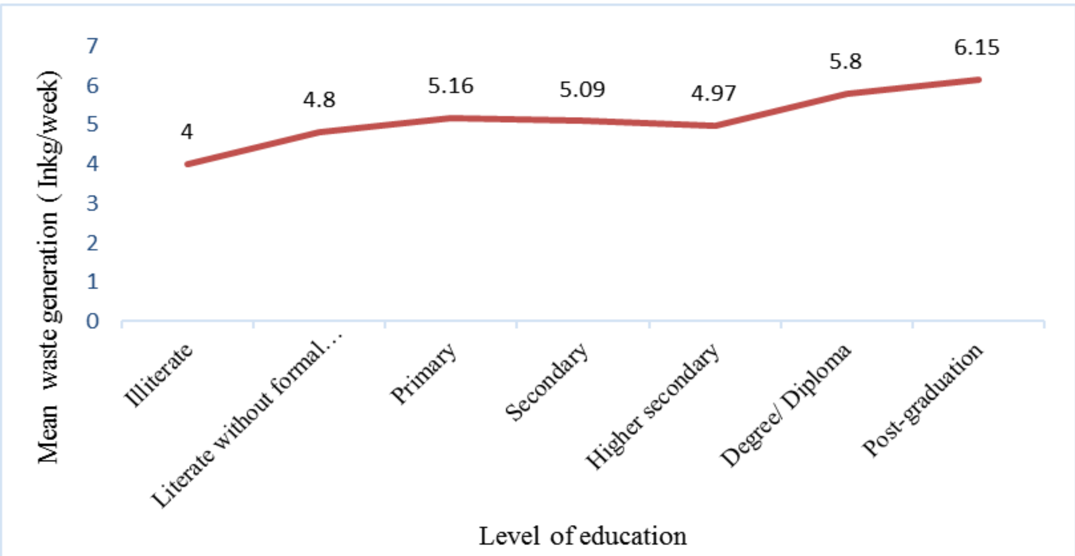
Almost all sample respondents (95.6 per cent) have formal education in which 57.6 per cent completed secondary education and above. The average literacy rate of sample respondents is 99.5 per cent as against 96.53 per cent in Kozhikode city (Kozhikode City Census, 2011). Waste generation across the educational categories of the respondents are given in Table 5.7.

Table 5.7: Waste Generation across Educational Categories

Education	Percentage of respondents	Waste generation (in kg/week)			
		Mean	Median	SD	CV
Illiterate	0.52	4.00	4.0	0.00	0.00
Literate without formal education	3.91	4.80	4.0	2.08	43.12
Primary	38.02	5.16	5.0	1.94	37.59
Secondary	27.08	5.09	5.0	1.81	35.56
Higher secondary	7.81	4.97	5.0	1.22	24.59
Degree/ Diploma	15.89	5.80	5.0	1.54	30.24
Post-graduation and above	6.77	6.15	6.5	1.32	21.40

Source: Estimated from primary data.

Figure 5.4: Average Waste Generation across Educational Categories



Source: Estimated from Primary data.

Table 5.7 indicates a positive relationship between education level and solid waste generation up to the primary level. It shows a decrease in the average waste generation at the secondary and higher secondary level. It indicates that educated members are supposed to have relatively higher levels of knowledge, awareness and interest in environmental quality. However, there is an increase in the waste generation among graduated and above. It may be because of higher income and resulting consumption pattern they followed. The results are going in line with the output of Kayode & Omole (2011) which reported a positive relationship between education of household and waste generation. Contrary to this, the study by Monaravi et al., (2011) & Limbu (2013) concluded that education is negatively correlated with waste generation.

5.2.6 Waste Generation across Size of Homestead

Size of the homestead is expressed in cents, and the average size of the homestead is estimated at 7.5cents. The study explores only 4.7 per cent of the sample possess homestead above 12 cents, and six per cent of the households own only two cents of land which are provided by the Corporation to the landless people in Kattuvayal and Kalluthan Kadavu colony. Table 5.8 shows that 66.6 per cent of the household possesses homestead below the estimated mean (7.5 cents). The study examines the relation of waste generation across the size of the homestead.

Table 5.8: Waste Generation across Size of Homestead

Size of homestead	Percentage of households	Waste generation (in kg/week)			
		Mean	Median	SD	CV
Below 2	5.9	3.96	4.0	1.26	31.82
2 – 4	12.8	5.04	5.0	1.77	35.12
4 – 6	26.0	4.90	4.0	1.89	38.57
6 – 8	21.9	5.74	5.0	1.91	33.28
8 – 10	19.3	5.49	5.0	1.59	28.96
10 – 12	9.4	5.72	5.0	1.34	23.43
Above 12	4.7	5.83	6.0	1.72	29.50

Source: Estimated from primary data

Figure 5.5: Average Waste Generation across Size of Homestead

Source: Estimated from primary data

Table 5.8 shows that households who possess homestead up to six cents of land generate waste below the estimated mean. On the other hand, people who possess homestead above 6 cents of land generate waste more than the estimated mean. It indicates that availability of homestead moves as an incentive to generate solid waste. That is the people who possess sufficient land for disposing of their solid waste are not much concerned about waste generation and its disposal.

Along with socioeconomic factors, enabling factors such as proximity to dumping yard, availability of waste disposal service and practice of segregation of waste are to be examined to check the influence of these factors on waste generation which are given in the following three sub-sections.

5.2.7 Waste Generation across the Proximity to Waste Treatment Plant

Proximity to treatment plant indicates that the distance of residence from Njeliyanparambu waste treatment plant. The mean distance of wards from the treatment plant is 8 Km. Thus total sample households are grouped into two strata on the basis of mean distance (Table 5.9). The people residing in Strata I are closer to treatment plant (within 8 km) and people residing in Strata II are more than 8 km away from the plant. The study examines the quantity of waste generation among households in different strata.

Table 5.9: Waste Generation across Proximity to waste treatment Plant

Strata	Percentage of households	Waste generation (in kg/week)			
		Mean	Median	SD	CV
Strata I	46.9	5.06	5.0	1.72	33.9
Strata II	53.1	5.48	5.0	1.83	33.4

Source: Estimated from primary data.

The results shows difference in the waste generation among different strata. Households in Strata II generate more waste than the households in Strata I. Households in Strata I belong to the low-income group, and their consumption expenditure is also low compared to the households in Strata II. This result indicates, incidentally, victims are the households who generate less waste. The study (Shyjan et al., 2005) stated that the poor sections of the society especially village folk bearing the brunt of the consequences of the waste disposal habits of the upper class in the cities.

5.2.8 Waste Generation and Availability of Waste Disposal Service

Corporation provides waste collection service directly through sanitary workers especially in coastal wards and also provides the same to other wards with the help of Kudumbasree. In the case of inorganic waste, residence association takes the initiative for the waste collection with the help of an agency called 'Niravu'[13]. As we mentioned in Chapter 1, Niravu started as a community-based organisation collectively engaged in promoting organic farming and zero waste management in Vengeri, Kozhikode in 2006. Now, it extends its service as a private service provider in the collection of inorganic waste from households of the Kozhikode Corporation.

The average quantity of waste generation across the availability of waste disposal service is presented in Table 5.10. The details of the service quality dimensions of both public and private service providers are given in Chapter 6, section 6.2.

[13] Niravu is specific to Kozhikode Corporation. But there are alternative mechanism in operation in certain other Corporations. For example, in Thrissur, there are number of waste collection centres (Kiosks) spread across different wards which collects plastic wastes.

Table 5.10: Waste Generation across Availability of Disposal Service

Availability of disposal service	Percentage of households	Waste generation (in kg/week)			
		Mean	Median	SD	CV
Available	47.6	5.89	6.0	1.78	30.22
Not available	52.4	4.73	4.0	1.62	34.25

Source: Estimated from primary data

Table 5.10 shows that majority of the households are not receiving waste collection service from any of the service providers while 47.6 per cent of the sample households are getting collection service either from the Corporation or private agency. Another highlighting fact is that waste generation is more among those who have access to waste disposal service and it is less among the households who have not (see Table 5.10). It shows that waste generation and the availability of waste disposal service are directly related. Corporation provides waste disposal service to its stakeholders as an incentive to ensure environmental quality. Here the results indicate that incentives are move in the opposite direction.

5.2.9 Waste Generation and Segregation

Waste segregation at source is currently one of the biggest challenges for sustainable waste management practices. Waste segregation, also known as the classification of waste, is the process by which waste is separated into different elements operated manually at the household. In Kozhikode Corporation, household generates waste in the form of organic, non-recyclable plastic like carry bags, recyclable plastics, glasses and lights, e-waste, sanitary napkins, dresses and other wastes. The generated waste should be segregated before disposal for effective management. Broadly, segregation can be done in two categories such as degradable and non-degradable. Effective segregation helps less waste goes to landfill which makes it cheaper, easier and better for people and the environment. The study examines the practice of waste separation followed by the households and its relation to waste generation.

Table 5.11: Waste Generation across the Practice of Segregation

Practice of segregation	Percentage of households	Waste generation (in kg/week)			
		Mean	Median	SD	CV
Yes	67.4	5.56	5.0	1.76	31.65
No	32.6	4.69	4.0	1.71	36.46

Source: Estimated from primary data

Table 5.11 shows waste generation across the practice of waste segregation among households. In contrast to the theoretical expectation, it indicates that waste generation is more among the households who follows the practice of segregation.

The expected results are checked by employing the econometric model like multiple regression which is given in the following section 5.3.

5.3 Determinants of Waste Generation: Econometric Analysis

On the basis of the sound theory and empirical exposition made in the previous section, the study follows a multiple regression model to examine the factors that determine waste generation among urban households and to get more scientific results. In this regression analysis, the total solid waste generation among households per week is regressed against several explanatory variables. The study examines the statistical relationship between households' total waste generation as a target variable and household's monthly expenditure, household size, size of the homestead, education level, and availability of waste disposal service and practice of waste segregation as explanatory variables. The multiple regression model is

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + e \text{ .... } (5.1)$$

Where,

Y = Household waste generation (in kg/week)

X_1 = Monthly household expenditure (in Rs.)

X_2 = Size of household (in number)

X_3 = Size of homestead (in cents)

X_4= Educational level (1 if above primary; 0 if below primary)

X_5= Availability of waste disposal service (1 if available; 0 if not available)

X_6 = Practice of waste segregation (1 if yes; 0 if no)

e = Error term

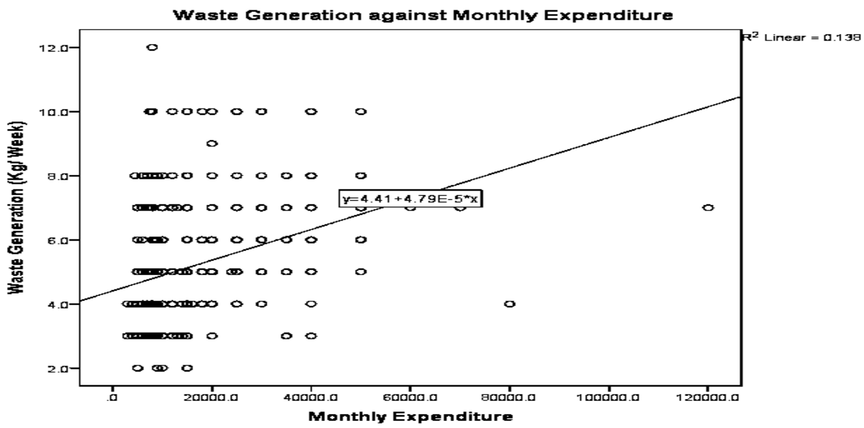
5.3.1. Check for Basic Assumption

To ensure that the collected data can be subjected to multiple regression, the study has to check the basic assumptions such as the linear relationship between the outcome variable and independent variables, multivariate normality, no multicollinearity and homoscedasticity. As it is a cross-sectional study, it is not essential to check the problem of autocorrelation.

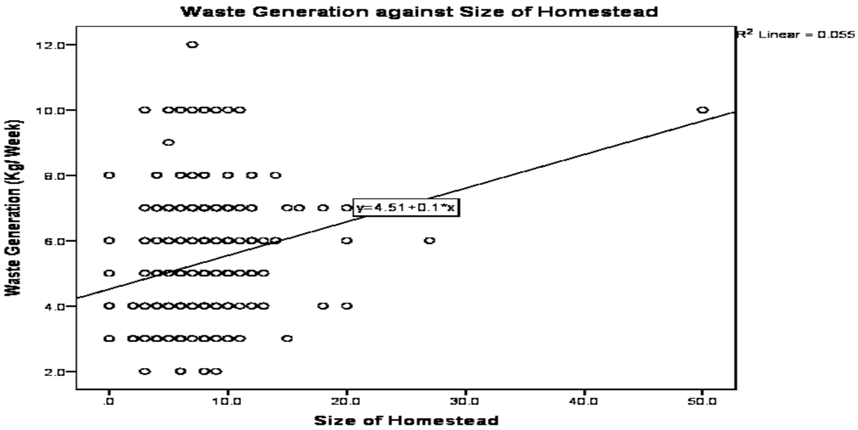
5.3.1.1 Testing for Linearity

Regression model assumes that there must be a linear relationship between the dependent variable and the independent variables. This can be checked with the help of scatter plot[14] which shows the nature of relation like linear or curvilinear. Scatter plots of the dependent variable (quantity of waste generation) against independent variables like the expenditure of households, household size and size of the homestead are generated and presented in figure 5.6. It indicates that a linear relationship between the dependent variable and the above mentioned independent variables. The categorical variables such as the practice of segregation, availability of waste disposal service, and education level of respondents are not plotted.

Figure 5.6: Scatter Plots of Dependent Variable against Independent Variables



[14] A scatter plot is a two dimensional data visualisation that uses dots to represent the value obtained for two different variable. Each units contributes one to the scatter plot and the resulting pattern indicates the type and strength of the relationship between the two variables.



Source: Estimated from the primary data.

5.3.1.2 Testing of Multivariate Normality

The model assumes that residuals (error between observed and predicted) are normally distributed. This can be checked by employing both histogram and normal P-P Plot[15] (Probability- Probability Plot). The distribution of residuals follows normal distribution properties as clear from the histogram and P-P Plot. Normal probability plot of the residuals in Figure 5.7 shows that there is no data which stay far away from the slope line and the results from the histogram (Figure 5.8) also support the assumption. It indicates that the data satisfy the multivariate normality assumption.

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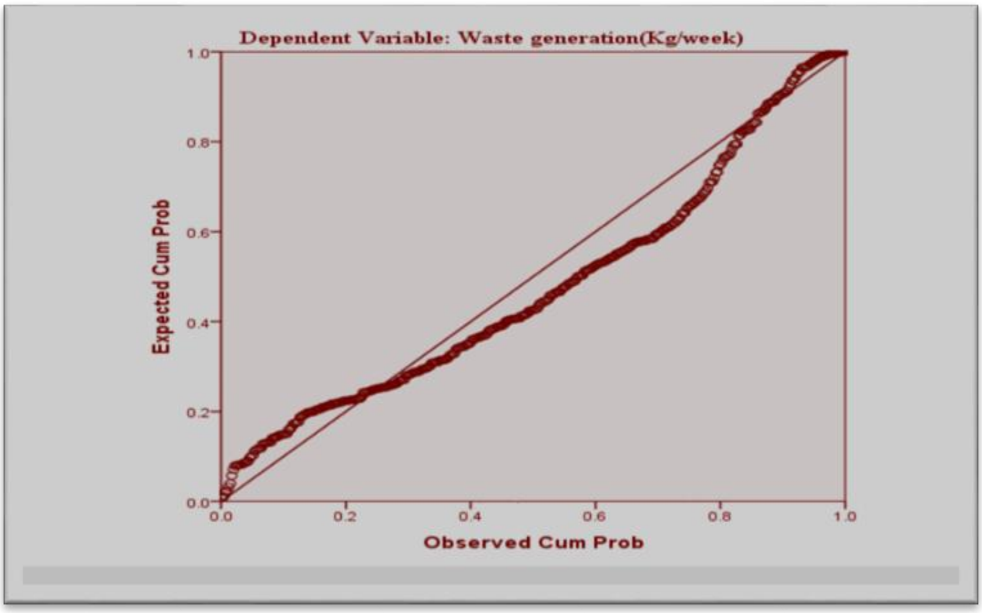
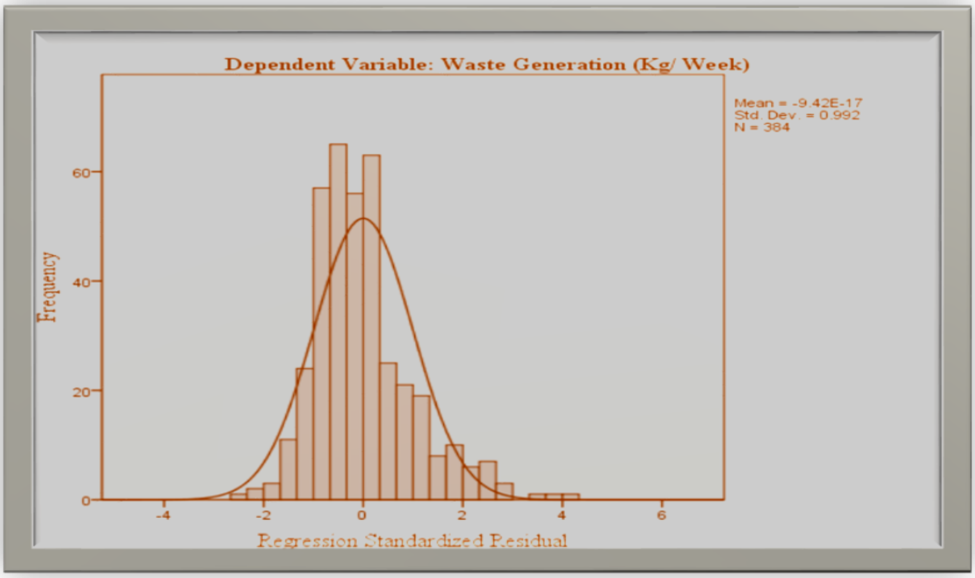
[15] Normal P-P Plot is used to determine normality graphically. If the data are normally distributed, the data points will be close to the diagonal line. If the data points stray from the line in an obvious non-linear fashion, the data are not normally distributed. It is clear from the normal P-P plot below, the data are normally distributed.

Figure 5.7: Normal P-P Plot of Regression Residuals



Source: Estimated from the primary data.

Figure 5.8: Histogram of Regression Residuals



Source: Estimated from the primary data.

5.3.1.3 Testing Multicollinearity

Waste generation estimation model is tested for the problem of multicollinearity. A simple correlation matrix is employed to find the relationship between the explanatory variables. Pearson's correlation coefficient matrix is employed to test collinearity which is given in Table 5.12.

The correlation coefficient matrix (Table 5.12) shows that multicollinearity is not a serious problem in the study. The correlation matrix of the explanatory variables ensures that no two explanatory variables correlate more than 0.5 which indicates that the estimating parameters are not highly correlated to each other.

Table 5.12: Pearson's Correlation Coefficient Matrix

	Exp	Home	Hhs	Edu	Seg	Avail
Exp	1					
Home	.291	1				
Hhs	-.059	-.001	1			
Edu	.410	.234	-.084	1		
Seg	.322	.154	- .062	.292	1	
Avail	.398	.061	.026	.239	.496	1

Exp – Monthly household expenditure
Home – Size of homestead
Hhs – Household size
Edu – Educational level
Seg - Practice of segregation
Avail – Availability of waste disposal service

Source: Estimated from the primary data

5.3.1.4 Testing of Homoscedasticity

Homoscedasticity means the variance of errors is the same across all levels of the independent variables. When the variance of errors differs at different values of the independent variables, heteroscedasticity is present. Berry and Feldman (1985) and Tabachnick and Fidell (1996) pointed out that slight heteroscedasticity has little effect on significance tests. However, when heteroscedasticity is marked, it can lead to serious distortion of findings and seriously weaken the analysis thus increasing the possibility of a Type I error. The white test is used to test heteroscedasticity in a linear regression model. It is a statistical test that establishes whether the variance of the errors in a regression model is constant for homoscedasticity. The results of White test statistic is TR 2= 38.36, with p-value = P (Chi-square (24)>38.36) = 0.03. The results of White's test shows that the variances for the errors are not equal; that is heteroscedasticity is present.

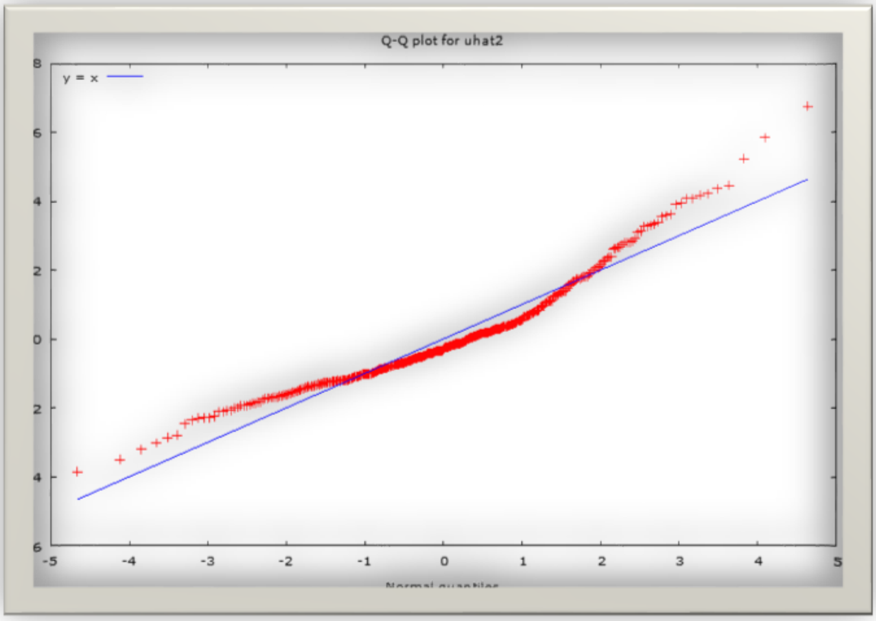
Thus, it is found that the collected data do not satisfy one of the basic assumptions of the Ordinary Least Square (OLS) model. Hence the study employed Weighted Least Square (WLS) model as heteroscedasticity corrected regression model to examine the factors determining waste generation. The procedure involves (a) OLS estimation of the model, followed by (b) an auxiliary regression to generate an estimate of the error variance and then finally (c) weighted least squares, using as weight the reciprocal of the estimated variance. The new model also has to satisfy the basic assumptions. Hence the study has to re-check the assumptions of multicollinearity and normality of the residuals. VIF (Variance Inflation Factor) and histogram or normal Q-Q Plot (Quantile-Quantile Plot) are employed to recheck the assumption of multicollinearity and normality of the residuals respectively.

Table 5.13: Variance Inflation Factors

Explanatory Variables	**VIF Value**
Monthly household expenditure	1.45
Size of homestead	1.13
Household size	1.02
Educational level	1.27
Availability of waste disposal service	1.48
Practice of segregation	1.41

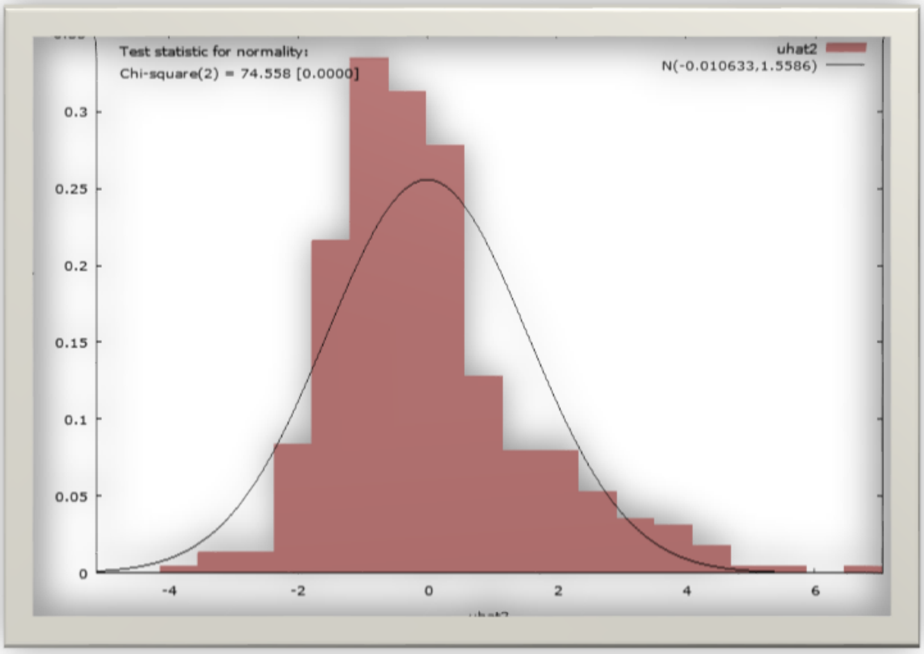
Source: Estimated from the primary data

Figure 5.9: Normal Q-Q Plot of Regression Residuals



Source: Estimated from the primary data

Figure 5.10. Histogram of Regression Residuals



Source: Estimated from the primary data

Variance Inflation Factor (VIF) is used to check the problem of multicollinearity which is given in Table 5.13. The VIF value greater than 10 implies collinearity.

The result arrived shows that VIF value is less than 10 for all the independent variable. It shows that multicollinearity is not a problem in the study. The model also assumes that residuals (error between observed and predicted) are normally distributed. This can be checked by employing both histogram and normal Q-Q Plot (Quantile-Quantile Plot). The distribution of residuals follows normal distribution properties as clear from the histogram and Q-Q Plot. Q-Q plot of the residuals in Figure 5.9 shows that there were no outliers that stay away from the slope line. The histogram (Figure 5.10) also reiterates it. Hence, the regression model is appropriate for further study.

5.3.2 Multiple Regression Model: Household Waste Generation

The results show that collected data satisfied the basic assumptions of the WLS model. Hence the study employed a weighted least squares regression model (heteroscedasticity corrected model) to examine the factors determine household waste generation. The model is

$$Y = \alpha + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + e \quad \ldots\ldots\ldots (5.1)$$

Where,

Y = Household waste generation (in kg/week)
X_1 = Monthly household expenditure (in Rs)
X_2 = Size of household (in numbers)
X_3 = Size of homestead (in cents)
X_4= Educational level (1 if above primary; 0 if below primary)
X_5= Availability of waste disposal service (1 if available; 0 if not available)
X_6 = Practice of waste segregation (1 if yes; 0 if no)
e = Error term

5.3.3 Multiple Regression Model: Per capita Waste Generation

Per capita solid waste generation, a core indicator of environmental pressure is a useful measure for evaluating the intensity of waste generation over time. Moreover, the determination of per capita waste generation is theoretically strong than the household waste generation. It also brings reliable and comparable data than household waste generation. Hence the study tries to accommodate the quantity of per capita waste generation as a dependent variable in place of the quantity of household waste generation with no loss to robustness. The model satisfies the assumptions of OLS underlying homoscedasticity. There are no marked differences between the results of the estimated models. It is not feasible to drop any of the dependent variables because of their theoretical importance. Per capita waste generation is calculated by dividing the total quantity of household waste generation with household size. Hence the new model skips household size as an explanatory variable. The new regression model by keeping per capita waste generation as a dependent variable examines the factors determine waste generation is

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + e \text{ .... } (5.2)$$

Where,

Y = Per capita waste generation (in kg/week)

X_1 = Monthly household expenditure (in Rs.)

X_2 = Size of homestead (in cents)

X_3 = Educational level (1 if above primary; 0 if below primary)

X_4= Availability of waste disposal service (1 if available; 0 if not available)

X_5= Practice of waste segregation (1 if yes; 0 if no)

e = Error term

Table 5.14: Regression Result: Household Waste Generation

Variables	β	Std Error	t	p
Constant	2.418	0.34	7.03	0.000
Monthly household expenditure	.00004	0.00	5.78	0.000
Size of homestead	0.054	0.02	2.26	0.024
Size of household	0.308	0.06	4.97	0.000
Educational level	-0.361	0.19	-1.96	0.051
Availability of waste disposal service	0.706	0.19	3.74	0.000
Practice of waste segregation	0.266	0.18	1.45	0.146
$R^2 = 0.29$		F = 25.58		

Source: Estimated from the primary data

Table 5.15: Regression Result: Per capita Waste Generation

Variables	β	Std Error	t	p
Constant	0.83	0.07	11.63	0.00
Monthly household expenditure	9.53	2.52	3.79	0.00
Size of homestead	0.02	0.01	3.02	0.00
Education level	-0.15	0.07	-2.27	0.02
Availability of waste disposal service	0.15	0.07	2.19	0.03
Practice of waste segregation	0.10	0.07	1.38	0.17
R^2 = 0.13 F =11.59				

Source: Estimated from the primary data

The regression results of the determinants of waste generation are presented in Table 5.14 and 5.15. The overall significance of the model and the significant relationship between dependent and independent variables are examined by 'R^2','F' 't' and 'p' value respectively.

The explanatory variables with the positive coefficients are positively influencing the dependent variable whereas coefficients with negative signs are negatively influencing the dependent variable. The nature and magnitude of explanatory variables influence the dependent variable differently. The variables having 'p' values less than 0.05 are statistically significant, i.e. any change in these variables will cause a statistically significant change in the dependent variable. The explanatory variables like monthly expenditure, size of the homestead, household size, and availability of waste collection service positively and significantly influence waste generation at 5 per cent level of significance. Education level is statistically significant having a negative impact on waste generation. The econometric exercise broadly confirms the variable wise influence on waste generation done separately in the preceding section exception in the case of education.

Monthly expenditure of the household has a positive influence on waste generation. The positive coefficient of household consumption expenditure indicates, holding all other variables constant when household consumes more, the waste generation will increase. Limbu (2013) also reported a positive relationship between waste generation and household consumption expenditure.

The size of the household is another variable which has a positive relation with waste generation. The positive coefficient on household size indicates that a family with more memebers generating more waste than the small family. As expected, the results show that a family with a large size is presumed to generate a higher quantity of waste. Afroz et al., (2010); Monaravi et al., (2011): Sankoh et al., (2012); Olayungbo et al., (2014) support the same and stated that family size is one of the vital determinants of waste generation.

The results show that the size of the homestead and waste generation are positively related. The people who possess sufficient land for disposing their waste at source are not worried about waste generation and its disposal. Whereas, the people who have small land holdings are more concerned about waste disposal and trying to reduce the quantity of waste generation.

The only statistically significant variable which has a negative effect on the waste generation is the education level of respondents. Educated members are supposed to have a relatively higher level of knowledge, awareness and interest in environmental quality. Hence, provision of environmental education and awareness of environmental conservation may reduce waste generation. Hence it is highly essential to educate people to reduce waste generation. These results coincide with earlier studies like Monavri et al., (2011) who reported that education level of the family members negatively influences the waste generation.

A highlight of the result is that waste generation and the availability of waste disposal service are positively related. Waste generation is more among those who have a waste disposal service, and it is less among those who do not have a waste disposal service. It shows changing the behaviour of the public towards incentives[16]. Incentives may not always be straight-forward. For example, the construction of

[16] An incentive is a benefit that motivates a decision maker in favor of a particular choice. Economic incentives are offered to encourage people make certain choice or behave in a way. An incentive can influence different individuals in different ways. Response to incentives are predictable because people usually pursue their self-interest.

safer roads might create a tendency to drive faster. These types of incentives are called perverse incentives[17] which generate negative unintended consequences or cobra effect[18]. Cobra effect occurs when an attempted solution to a problem makes the problem worse, as a type of unintended consequences.

Cobra effect has been noticed in several government incentives like the provision of waste disposal services to households. The intended objective of waste disposal service is to reduce environmental pollution and thereby ensure environmental quality. However, the incentives move undesirably that waste generation increases as the availability of waste disposal increases, and it is significant at the 5 per cent level. Availability of waste collection services make the people less bothered about its management and generates more waste. Hence government intention to manage and dispose of waste properly has an adverse effect as stated in the cobra effect.

Newell & Doll (2015) revealed that in a highly connected world, management actions have multiple outcomes. When an action is taken, the intended outcome might occur along with some unexpected outcomes. What is more likely is that the unexpected outcome will be unwanted and this outcome can be considered as a counter-intuitive 'policy surprises'. If we want to avoid unwanted policy surprise, then we need to improve our intuitions concerning the cause and effect in the complex social-ecological system.

The results show that segregation of waste at source has no relation with waste generation against theoretical expectation. Similarly, the influence of environmental awareness is not examined in the regression model due to its collinearity with other explanatory variables, namely, education level, availability of waste disposal service

17 A perverse incentive is an incentive that has an unintended and undesirable result which is contrary to the interest of the incentive makers.

18 The term 'cobra effect' stems from an anecdote set at the time of British rule of colonial India. The British government was concerned about the number of venomous cobra snakes. The government therefore offered a reward for every dead snake. Initially this was a successful strategy as large numbers of snakes were killed for the reward. Eventually, however, Indians began to breed cobras for the income. When this was realized the reward was cancelled, but the cobra breeders set the snakes free and the wild cobras consequently multiplied. The apparent solution for the problem made the situation even worse (Siebert & Horst 2001).

and practice of waste segregation. Therefore the variable, environmental awareness is skipped to keep robustness of the model.

The results show that the socio-economic variables act as prominent determinants of household waste generation among urban households. The findings of the previous studies like Afroz et al., (2008); Kayode (2011); Sankoh (2012); Limbu (2013); Olayungbo et al., (2014); Trang et al., (2016) are in line with the findings of the present study. These studies indicate that gender, educational background and family size are the prominent socio-economic factors determining household waste generation and variation in the level of household waste generation depends on different socio-economic status.

5.4 Conclusion

The above discussion on solid waste generation among urban households in Kerala involves an estimation of waste generation and factors determining waste generation. It is found that mean waste generation among the sample households is 5.3 kg per week with standard deviation of 1.79. Per capita waste generation among sample households is calculated as 1.23kg per week (0.176kg per day per capita). The waste generation among households has been influenced by monthly expenditure, size of household, size of the homestead, education, and availability of waste disposal service. The highlight of the study is that changing behaviour of the public towards incentives. The intended objective of waste disposal service by the government is to ensure environmental quality. But the results show that government intention ends with an adverse effect called perverse incentive. Besides, proper and scientific planning for waste collection and disposal is advised to educate and inform the public about the necessity of maintaining environmental quality. The study found that education is the only variable that has a negative influence on waste generation. But general education is not sufficient to ensure environmental quality. It shows the need for environmental education. Hence the study recommended for the reframing of the curriculum by including environmental education as a mandatory programme which may bring a desirable result. Though the curriculum at all levels had been reformed incorporating environmental education component as a result of the Supreme Court verdict, the impact of these reforms had not effective. Hence more concerted and effective measures have to be adopted for curricular revision with meaningful content and praxis-oriented approach of the curricular transaction.

CHAPTER 6

Solid Waste Management: Heterogeneous Praxis

- ***Solid Waste Management: Phases and Praxis***
- ***Service Quality Dimensions of Public and Private Service Providers: Discriminant Analysis***
- ***Principal Component Analysis***
- ***Conclusion***

CHAPTER - 6

Solid Waste Management: Heterogeneous Praxis

Growing waste generation in urban Kerala demands better and scientific way of management mechanism. It is important to examine the present management mechanism followed by the urban households in Kerala. This chapter focuses on the heterogeneous practice of waste management followed by urban households and issues and challenges pertaining to waste disposal. Moreover, public private participation has emerged as a promising alternative to improve waste management in different parts of the State. Hence, it also involves service quality dimensions of public and private service providers in waste management and examines how far the households are discriminated private and public service providers. The obtained data are analysed, and the results are presented here.

6.1 Solid Waste Management: Phases and Praxis

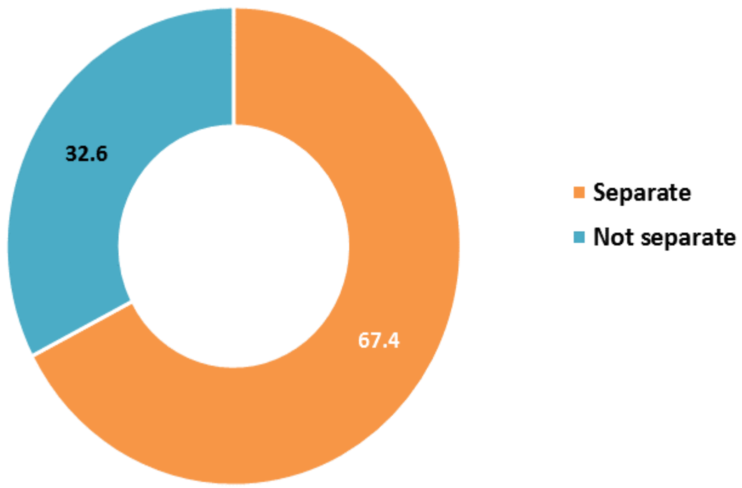
The prime objective of this part of the study is to analyse waste management phases such as segregation, storage and heterogeneous disposal practices followed by urban households. Moreover, it examines the issues and challenges faced by households in solid waste management.

6.1.1 Segregation of Waste

Segregation of waste at source is the key to 'Recycling Revolution' being promoted by the Ministry of Environmental Protection (MoEP). It begins at home, with resident segregates their trash into different categories like organic, inorganic, wet, dry etc. Segregation of waste at source is still in early stages in Kerala and is operational only in Thiruvananthapuram and Kozhikode Corporations, Quilandy Municipality, Chunakkara Village Panchayat and in a few local governments (Kerala economic review, 2017). The practice of solid waste segregation among households is given in Figure 6.1.

Usually, Kudumbasree collects only organic waste from households, and they are not ready to collect inorganic waste. On the other hand, the residence association with the help of 'Niravu' collects inorganic waste from the households. Corporation sanitary workers collect both organic and inorganic waste, and they provide a separate bin for organic and inorganic waste. This nature of waste collection agencies induces the public to segregate waste and create awareness among the public about the need for waste segregation.

Figure 6.1: Segregation of Solid Waste



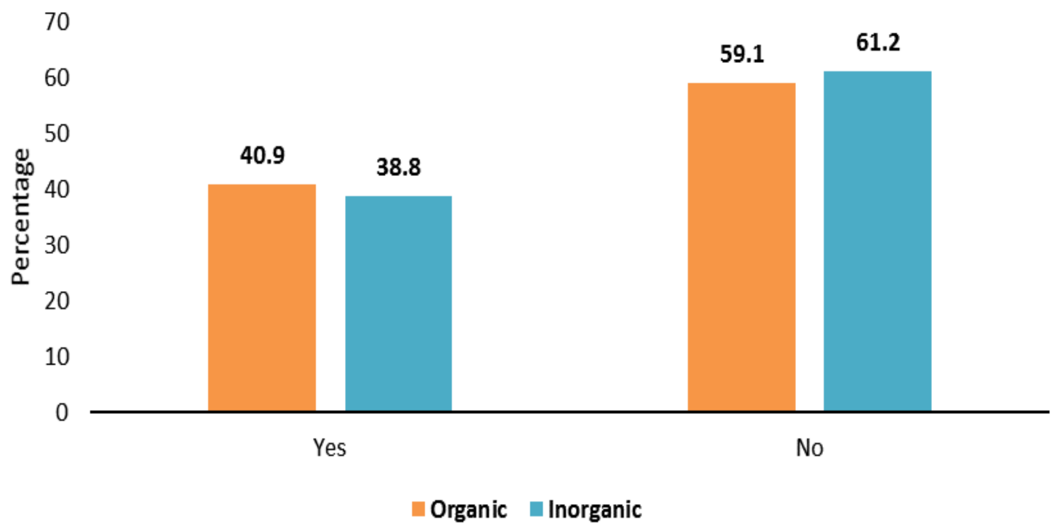
Source: Estimated from primary data.

A substantial part of the sample households segregate waste into organic and inorganic which is a good symptom for better waste management (Figure 6.1). Out of the total households, 32.6 per cent do not practice segregation, and they put forward various reasons for non-segregation such as unawareness about segregation, wastage of time, the absence of a ready market for recyclable waste and difficult to afford separate bin for organic and inorganic waste. The households who follow segregation are aware of the need for segregation for efficient and effective disposal. Some households practice segregation for getting manure from organic waste and having the market for recyclable waste.

6.1.2 Practice of Storage

Storage of waste at source is one of the essential steps of solid waste management. Every household, shops and establishments generate solid waste on a day to day basis. Normally the waste should be stored at the source until it is collected for proper disposal. Some households in Kozhikode Corporation follow the practice of storage of solid waste until its collection and proper disposal. Figure 6.2 represents the availability of a storage facility across the households.

Figure 6.2: Practice of Storage



Source: Estimated from primary data.

Figure 6.2 represents majority of the households do not practice storage of both organic and inorganic waste. Only 40.9 per cent of the households have a storage facility for organic waste and use the durable plastic container for storing. However, in the case of inorganic waste, a major part of the households do not follow any such practice. This is because of the irregular nature of the service provider in the collection of inorganic waste. Moreover, households have to encounter several unforeseen problems such as foul smell, breeding of flies, mosquitoes, etc. while storing waste for a long time.

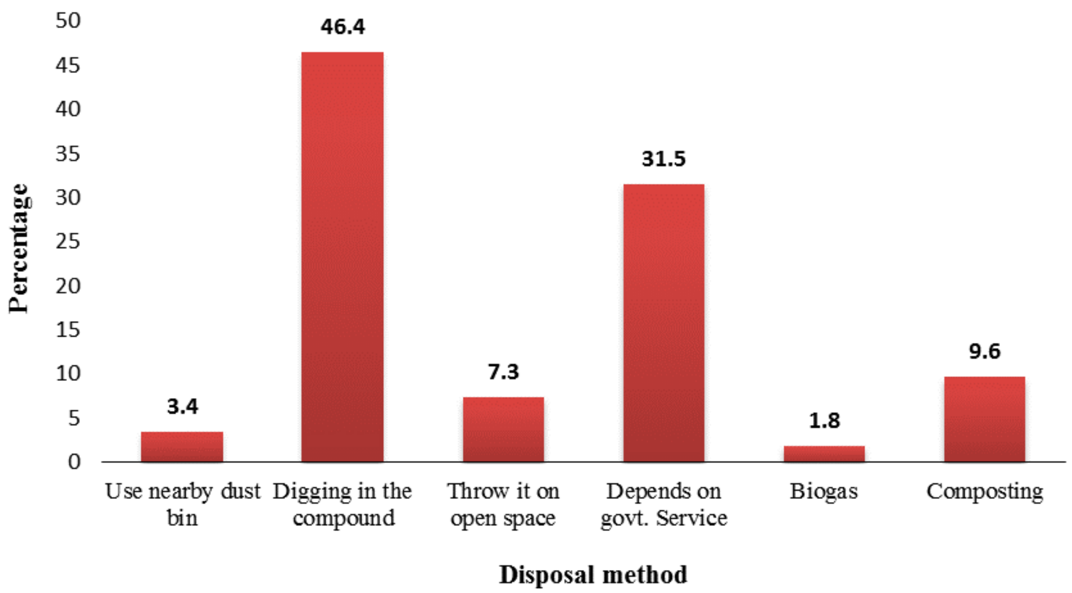
6.1.3 Waste Disposal Mechanism: Heterogeneous Praxis

This section focuses on different waste management practices followed by households towards different types of wastes such as organic, inorganic like non-recyclable plastic, recyclable plastics, glasses, lights and e-waste.

6.1.3.1 Disposal of Organic Waste

Cent per cent of the sample households generate organic waste, and they follow different mechanism to dispose of organic wastes such as using nearby dustbin, digging in compound, throwing, employing Kudumbasree volunteers, biogas and composting. The different management mechanism practised by the households are given in Figure 6.3.

Figure 6.3: Disposal of Organic Waste



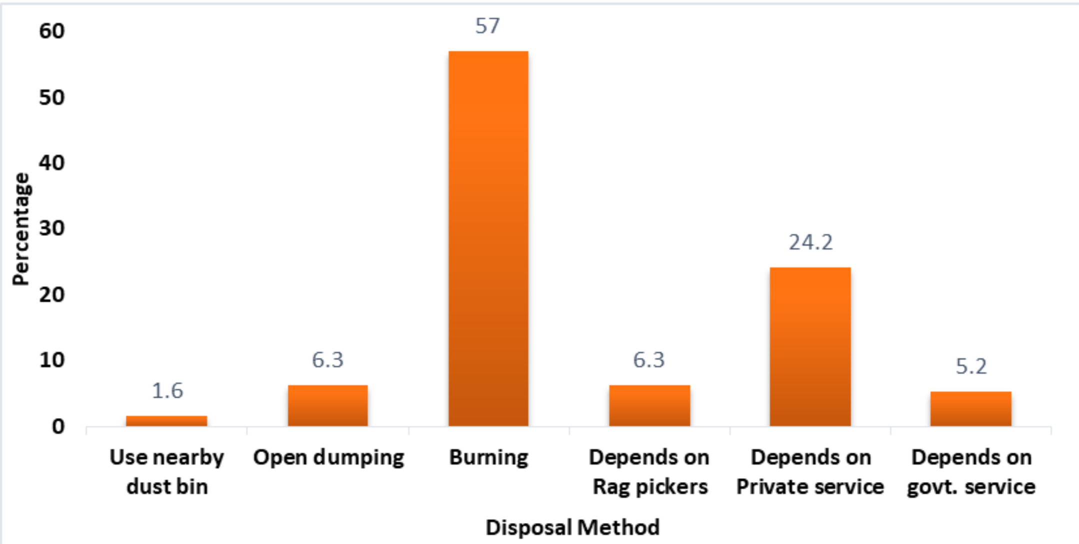
Source: Estimated from primary data.

Figure 6.3 shows that a high percentage of the sample households dispose of their organic waste by digging in the compound, and 31.5 per cent rely on public service like Kudumbasree or Corporation sanitary workers. Kudumbasree volunteers collect waste from 18 circles of Corporation every day except Sunday at a reasonable rate. Corporation sanitary workers collect both organic and inorganic waste from two coastal wards (ward 61 and 58) among the 15 sample wards. A notable feature is that 9.6 per cent of the households dispose of their organic waste by composting like pipe compost, and pit compost. They are satisfied with the composting mechanism because they got enough manure for maintaining their garden. Only a negligible percentage of the households are converting organic waste into biogas and produced cooking gas for which the price is rising nowadays. Government provide financial assistance for maintaining both biogas and composting, and 5.7 per cent of the households have benefitted government assistance for maintaining both biogas and compost. The practice of household level composting of waste which was very common earlier has now fallen into disuse and needs to be restarted.

6.1.3.2 Disposal of Non-recyclable Plastic

Similar to organic waste, cent per cent of the households generate plastic wastes because today plastic is an unavoidable part of daily consumption. Even though the Corporation had taken many steps to make it plastic free, nowadays all the food items are delivered in plastic carry bag majority of which are non-recyclable. The heterogeneous practices of non-recyclable plastic waste disposal across households are presented in Figure 6.4.

Figure 6.4: Disposal of Non-recyclable Plastic



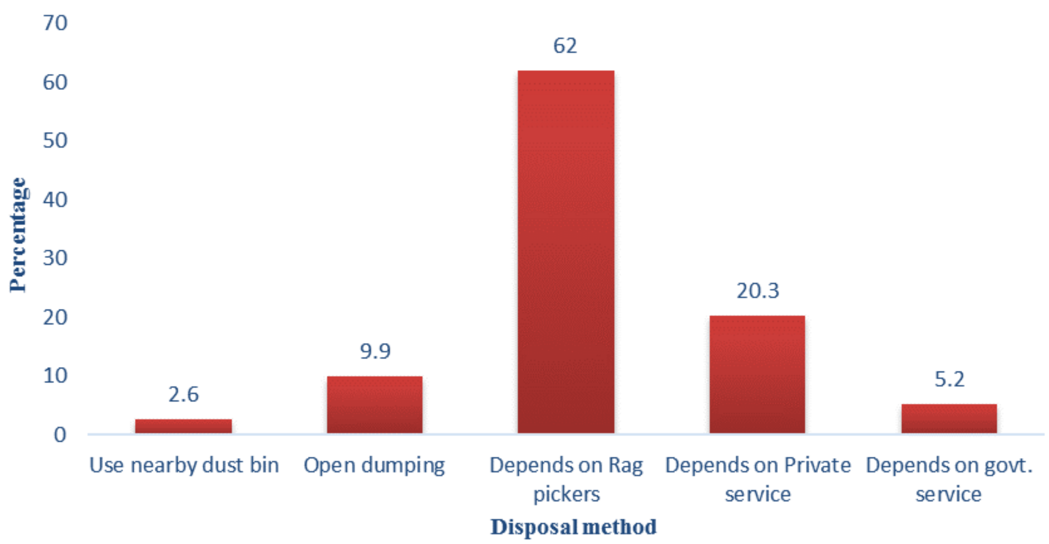
Source: Estimated from primary data.

Figure 6.4 shows majority of households choose burning for disposing of non-recyclable plastic especially plastic carry bags as there is no other option before them. Kudumbasree volunteers are not willing to collect inorganic waste from households. Corporation sanitary workers collect plastic waste, but their service is limited to two wards. The private service provider under the banner of 'Niravu' collects plastic wastes from Kozhikode Corporation, and 24.2 per cent of households rely on these agencies, but they are irregular in the collection. Rag pickers are not willing to collect non-recyclable plastic. However, a negligible per cent relies on rag pickers for managing non- recyclable plastic like carry bags and bottle.

6.1.3.3 Disposal of Recyclable Plastic

Recyclable plastic waste constitutes a notable share in total household solid wastes. The Corporation had a plastic waste recycling unit at West Hill. In the earlier stage, plastic wastes were collected from households once in a week and dumped at Corporation owned industrial estate at West Hill. Later, this recycling unit was shut down due to technical issues (Govind 2011). NGOs like residential associations took interest in collecting recyclable plastic waste with the help of 'Niravu', a privately owned agency. Disposal mechanism followed by the households is shown in Figure 6.5.

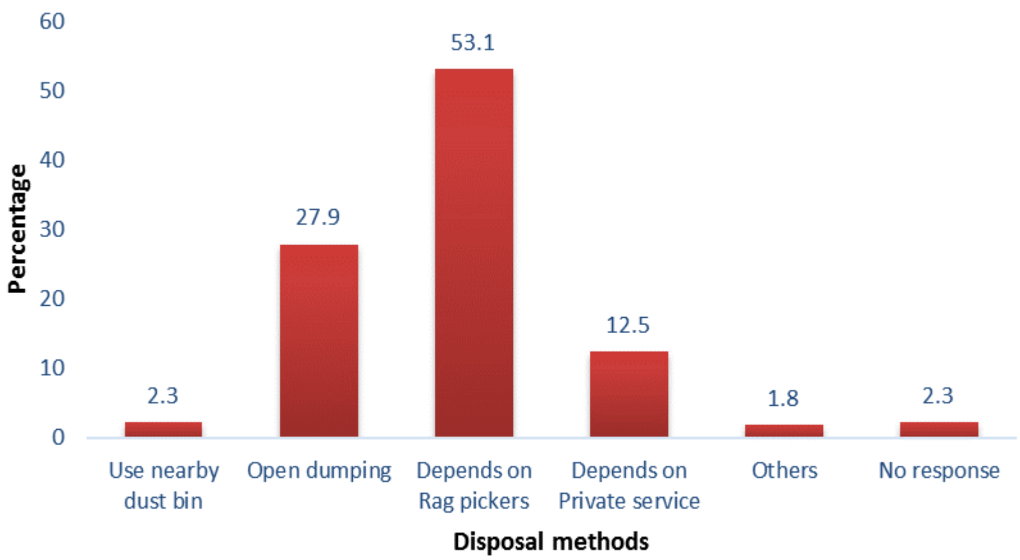
Figure 6.5: Disposal of Recyclable Plastic



Source: Estimated from primary data.

In the case of recyclable plastic disposal, the majority of the sample households (62 per cent) rely on rag pickers which is a common phenomenon in Kerala, and 20.3 per cent rely on private service provider under 'Niravu'. People's concern about waste recycling is considered as a good symptom of environmental awareness.

Figure 6.6: Disposal of Bulb and Glasses



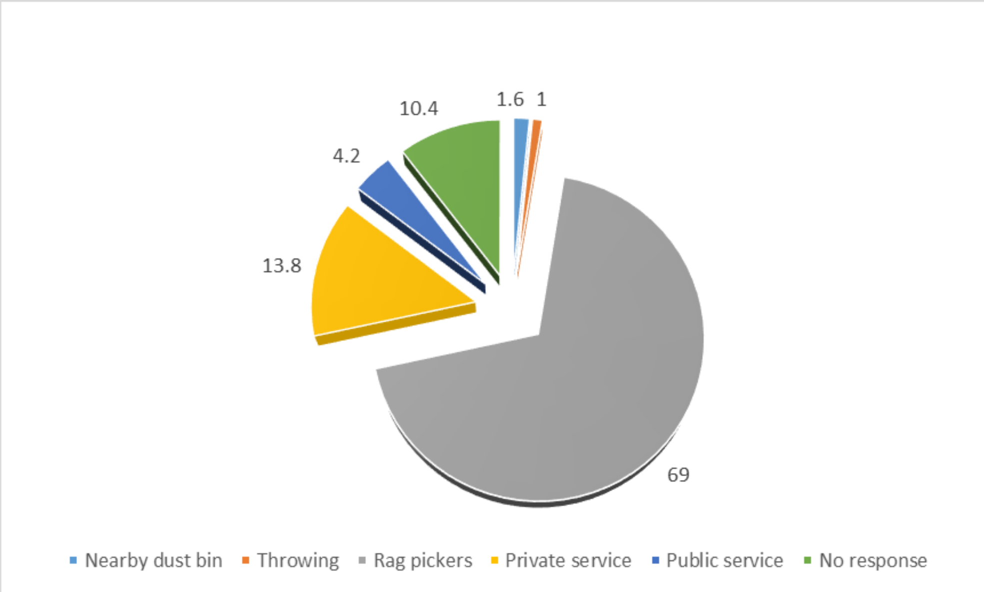
Source: Estimated from primary data.

Figure 6.6 shows 53.1 per cent of the households depend on rag pickers for disposing of the bulb, tube lights and glasses. A dangerous fact is that 27.9 per cent of households openly dump these waste either in their courtyard or open space. They have no other option before them to dispose of such kind of a waste since rag-pickers do not collect all types of glasses and lights. Some of the households rely on private service for disposing of such kind of wastes.

6.1.3.4 Disposal of e-waste

Nowadays e-waste also contributes a share in total solid waste generated among the households. Mobile phones, chargers, parts of other electronic items, etc. are the common e-waste among the households. Figure 6.7 shows the disposal mechanism followed by the households concerning e-waste disposal and found that 69 per cent relies on rag pickers for disposing of e-waste.

Figure 6.7: Disposal of e-waste



Source: Estimated from primary data.

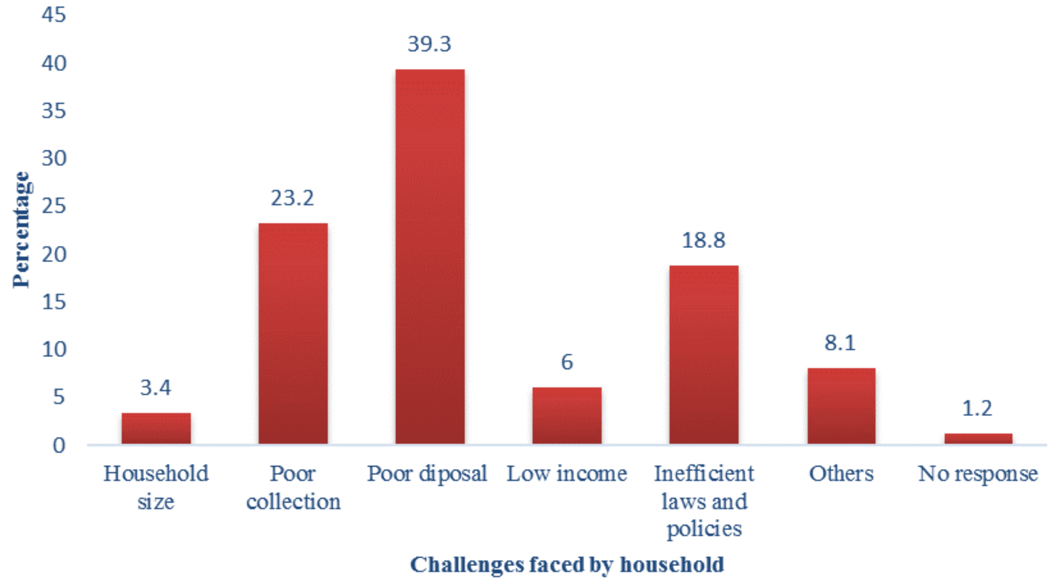
6.1.3.5 Disposal of Other Waste

Besides organic and inorganic waste, other wastes such as old clothes, sanitary pads, furniture etc are generated in households. A substantial percentage (77.6 per cent) of the households dispose of old clothes to the needy ones. When it comes to the disposal of sanitary pads, 88.1 per cent choose burning stating that there is no other choice to dispose of it. It is found that burning of such types of waste emits toxic gases like dioxin and carbon monoxide which causing negative externalities like environmental pollution and health hazards.

6.1.4 Challenges Associated with Waste Management

Waste management is one of the crucial issues around the world. Every economy regardless of it is developed or not, encounters this serious issue. Kozhikode Corporation does not have an exemption too. The household has to face challenges like the irregular collection, improper transportation, substandard disposal, household size, shortage of land, low income, inefficient laws and policies etc. Figure 6.8 represents the challenges faced by the households in Kozhikode Corporation.

Figure 6.8: Challenges of Waste Management



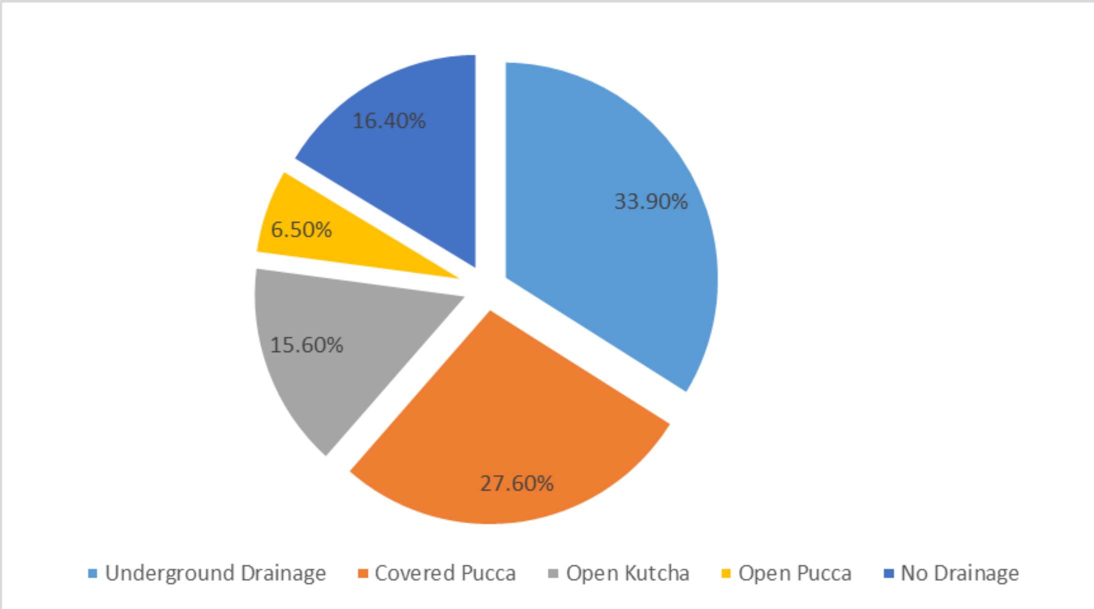
Source: Estimated from primary data.

Figure 6.8 indicates that poor disposal methods are the prime challenge faced by the households while managing solid waste followed by an irregular collection of waste and inefficient laws and policies. Low-Income and high household size slightly affect waste management.

6.1.5 Drainage and Latrine Facility

Drainage types have been categorized as (i) underground: drains or pipes laid below the earth surface (ii) covered pucca: covered drains made of pucca materials like pipes, bricks, stones, cement concrete, etc. (iii) open pucca: open drains made of pucca materials like pipes, bricks, stones, cement concrete, etc. (iv) open kutcha: ordinary channels cut through the ground to allow water to pass and (v) no drainage (Waste Management and Disposal Survey, 2014-15). Drainage system followed by the households is comparatively good in the heart of the city.

Figure 6.9: Nature of Drainage System



Source: Estimated from primary data.

The Figure 6.9 shows 33.9 per cent of the households are equipped with underground drainage system followed by covered pucca, open kutcha and open pucca. However, 16.4 per cent follow no drainage system as they do not have any facility to construct drainage due to small homestead.

In the case of latrine facility, 98.2 per cent have a septic tank with the flush system. However, 1.6 per cent of households use community latrine facilities. This group is concentrated in the Kalluthan Kadavu colony, the heart of the city where 100 households are thickly populated having only two cents of land for each and community latrine facilities are provided by the Corporation for men and women separately.

6.1.6 Rating of Present Solid Waste Management.

The total quantity of solid waste generated in Kozhikode Corporation is estimated as 250-350 tonnes per day (Master plan for Kozhikode Urban Area 2035). All the biodegradable waste collected by the Corporation sanitary workers and Kudumbasree are transported to Njeliyanparambu dumping yard in Cheruvannur-Nallalam area. One of the major drawbacks of the plant is that it does not have a leachate treatment unit and drier for drying the waste. Wastes are openly dumped to sun exposure for drying which forms foul smell around nearby premises causing health hazards like allergy, asthma, infection etc. to the residents. The households were asked for rating the present waste management mechanism followed in Kozhikode city to examine their satisfaction in the present mechanism.

Table 6.1: Rating of Present Solid Waste Management.

Rating	Percentage
Very good	0
Good	0.8
Satisfactory	22.4
Unsatisfactory	61.7
Very bad	15.1

Source: Estimated from primary data.

Rating is carried out on a five-point scale, and it is noted that the majority (61.7 per cent) of the households are not satisfied with the present waste management practices as assumed. This is because it creates environmental and health hazards to nearby residents due to bad odour, water contamination and environmental threats and poor leachate treatment plant.

6.2 Service Quality Dimensions of Public and Private Service Providers in SWM: Discriminant Analysis

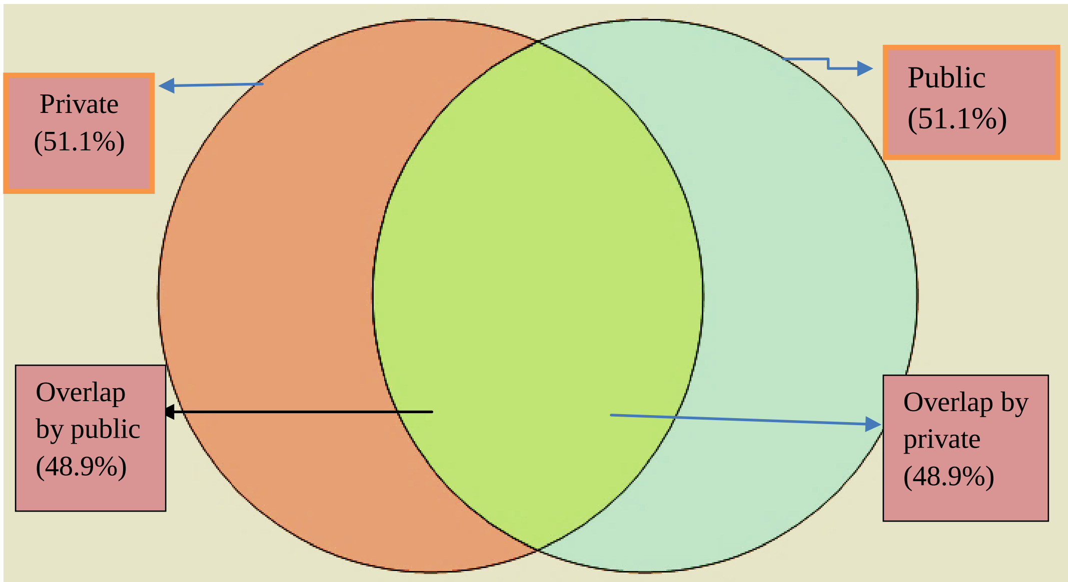
Institutional support and quality may have a positive effect on waste management. So it is essential to analyse the service qualities of providers in waste management in particular and environmental quality in general. The households in Kozhikode Corporation rely on private and public service providers for disposing of solid waste. Of the total households, 31.5 per cent rely on public service for waste disposal. The public service mainly focuses on collecting organic waste from households. Households rely on private service mainly for disposing of inorganic waste especially plastic wastes (31.5 per cent). Table 6.2 shows that 15.4 per cent of the households depends on both public and private service for disposing of waste. Hence, 47.6 per cent of the households are relying on either public or private service providers for disposing of waste. The magnitude of the distributional overlaps in the availability of waste disposal service is presented in the following Venn diagram 6.10.

Table 6.2: Availability of Waste Disposal Service

Public / Private		Public Service: Avail	Public Service: Not avail	Total
Private service	Avail	15.4	16.1	31.5
	Not Avail	16.1	52.3	68.5
Total		31.5	68.5	100

Source: Estimated from primary data

Figure 6.10: Distributional overlap in the Availability of Waste Disposal Service



Source: Constructed from primary data.

The study uses the overall percentage of overlapping across the availability of waste disposal service to construct a Venn diagram. While considering the distribution of the waste disposal service, there is equal domination of both public and private service providers. Availability of waste disposal service towards public owned projects overlaps 48.9 per cent of the private leaving 51.1 per cent distinct region. Similarly, the overlap by availability of waste disposal service towards private into the domain of public owned project is 48.9 per cent. Distributional overlaps at the aggregate level shows the equal domination of public and private owned projects.

The study used discriminant analysis to identify the most prominent service quality dimensions of both public and private services and to examine how far the households are discriminated private and public service providers. Service quality dimensions like regularity in waste collection, collection charge, efficiency in collection, the attitude of the collector, feasibility in the collection (collection of inorganic waste like recyclable and non recyclable wastes), and overall performance of the service providers are taken into consideration for the analysis.

To trace out the relative significance of the different dimensions of service quality, as a first step, a test of equality of group means was performed. Wilks' Lambda test[19] is conducted to test the equality of group means. The results of the test of equality of group means are given below.

Table 6.3: Service Quality Dimensions of Public and Private Service Providers

Public/ Private	Average Mean Score			SD	Wilks' Lambda	F value	Df 2	p Value
	Public	Private	Total					
Regularity in collection	2.92	4.48	3.69	0.726	0.426	323.9	240	0.00
Collection Charge	2.65	2.88	2.76	0.604	0.951	12.37	240	0.00
Efficiency in collection	2.79	3.09	2.95	0.590	0.934	16.84	240	0.00
Attitude of the collector	2.74	2.80	2.77	0.585	0.997	0.69	240	0.40
Feasibility in collection	3.55	3.04	3.29	0.742	0.878	33.31	240	0.00
Overall performance	3.05	3.51	3.28	0.573	0.869	36.19	240	0.00

Source: Estimated from primary data.

[19] Wilks Lamda is a test static used to test whether each dimension of service quality is significantly different in between public and private. The significance of Wilk's Lambda is tested through F-test

Wilk's Lambda test is found to be significant for all dimensions except the attitude of the collector. The overall significance of the model is established through the Wilks Lamda (0.36) translated to a chi-square value (241.12) with a degree of freedom six is found to be significant (***$p = 0.00 < 0.05$).***

Table 6.3 interpreted on the basis of the mean difference between public and private service providers towards different dimensions. Mean value of public and private service providers towards different dimensions shows that households favour public provider in dimensions such as regularity in waste collection, collection charge, efficiency and overall performance. In case of feasibility in the collection, households prefer private service provider. This could be because private agencies collect inorganic waste, but the government agencies do not cater to this.

Environmental theorists argue that environmental qualities like air, water, natural beauty etc. are examples of public goods. Waste collection and its management are carried out mainly for maintaining environmental quality which is considered as a public good. Environmental goods are not privately owned, and therefore market principles could not be applied. The study found that there is an indication of market failure in determining the price of environmental quality. In such a situation, it justifies the need for government intervention. Government is also seemed to be a failure in ensuring some dimensions of service quality like feasibility in waste collection. Government failure has paved the way for private service provider like 'Niravu' in collaboration with residence association to enter the market and ensure feasibility in the collection. That is private service provider ensure the collection of all types of inorganic waste. They collect inorganic waste from households at Rs.70 per sack and finally transport it to States out of Kerala. The government system is a failure in ensuring feasibility indicates that public service provider collect only organic waste from households and failure in collecting inorganic waste. In brief, the empirical results from the above analysis go in line with the literature on market failure and government failure.

Table 6.4: Classification Results of Original Grouped Cases

		Public/ Private	Predicted Group Membership		Total
			Public	Private	
Original	Count	Public	108	13	121
		Private	12	109	121
	Percentage	Public	89.3	10.7	100.0
		Private	9.9	90.1	100.0

.Source: Estimated from primary data

Classification results of original grouped cases show that 89.3 per cent of original public cases are correctly classified, and it is 90.1 per cent for private cases. Table 6.4 also reveals that 89.7 per cent of original grouped cases are correctly defined.

The standardised canonical discriminant function coefficients are used to compare the relative importance of the variables for the two groups. The following Table 6.5 shows the results of standardised canonical discriminant function coefficients. It reveals that the variables with large coefficients have a greater impact on explaining the variability. It shows that the variables with positive coefficients are regularity in waste collection, waste collection charge and total performance. Among these three, the variable considered to be important for the public agency is regularity in the collection which has larger coefficients. All the other variables, namely, efficiency in collection, the attitude of the collector and feasibility in the collection have negative coefficients, and among these three, feasibility in the collection is more dominant in the private sector.

Table 6.5: Canonical Discriminant Function Coefficients

Variables	Function
Regularity in collection	0.990
Waste collection charge	0.127
Efficiency in collection	-0.015
The attitude of the collector	-0.319
Feasibility in collection	-0.401
Total performance	0.054

Source: Estimated from primary data.

Structure matrix is the canonical loading or discriminant loading of the discriminant function (see Table 6.5). It contains the structure coefficients which shows the relative importance of the discriminating variables by total correlation, the important variable that discriminates between the two agencies can be ascertained. It reveals a correlation between each variable in the model and the discriminant functions.

Table 6.6: Structure Matrix

Variables	Function
Regularity in collection	0.87
Waste collection charge	0.17
Efficiency in collection	0.19
The attitude of the collector	0.04
Feasibility in collection	-0.28
Total performance	0.29

Source: Estimated from primary data

From the Structure Matrix, it is observed that regularity in the waste collection is the variable that has the maximum loading from among variables with positive coefficients ***(0.87)*** and feasibility in the collection has the maximum loading among negative coefficients ***(-0.28)***. Hence, regularity in the waste collection is the most important variable for discriminating the public agency from the private while, feasibility in the waste collection is more dominant for discriminating the private against the public.

6.3 Principal Component Analysis

In the discriminant analysis, the study analysed six dimensions of service quality. Using principal component analysis[20] through the varimax rotation,[21] the study

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[20] P**rincipal component analysis** is a dimension-reduction tool to reduce a large set of variables to a small set that still contains most of the information in the large set. It is a mathematical procedure that transforms a number of (possibly) correlated variables into a (smaller) number of uncorrelated variables called principal components. The number of principal components are less than or equal to the number of original values. It provides a road map for how to reduce a complex data set to a lower dinsion to reveal hidden simplified dynamics that often underlie it (Shlens 2003).

[21] Varimax rotation is used to simplify the expression of a particular subspace in terms of a few major items each

reduced those six dimensions into two factors. This is based on the apriori information that we have gained from the discriminant analysis. Factor 1 typically exemplifies the service quality dimensions of public service providers whereas Factor 2 exemplifies the service quality dimensions of private service providers and these two factors explain 72.5 per cent of the total variability.

Table 6.7: Rotated Component Matrix

Dimensions	Factor Loadings	
	Public	Private
Regularity in collection	**0.762**	-0.030
Waste collection charge	**0.785**	0.330
Efficiency in collection	**0.748**	0.502
Attitude of the collector	**0.863**	0.197
Feasibility in collection	0.043	**0.935**
Total Performance	0.502	**0.562**

Source: Estimated from primary data.

The factor loadings for the six factors extracted and rotated using the Varimax Rotation method and the loadings are reported in Table 6.7. The dominant loadings in each factor are shown in bold letters. It shows the rotated component matrix which is the rotated loadings of each dimension on to factor 1 and factor 2. Factor 1 denoting preference towards public service providers has significant loadings of four dimensions namely regularity in collection, waste collection charge, efficiency in collection and attitude of the collector. Factor 2 denoting preference towards private service providers has significant loadings of two dimensions namely feasibility in the collection and total performance. From factor analysis it can be inferred that regularity in collection, waste collection charge, efficiency in collection and attitude of the collector forms the major factor that contributes to the preference of the people towards public service providers while dimensions like feasibility in collection and total performance contribute to the preference of the people towards private service providers. This suggests indirect validation of the theoretical construct.

Table 6.8: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	Percentage of Variance	Cumulative Percentage	Total	Percentage of Variance	Cumulative percentage
1	3.4	56.9	56.9	3.42	56.99	56.99
2	0.9	15.4	72.4	0.93	15.41	72.41
3	0.6	10.5	82.9			
4	0.5	8.9	91.8			
5	0.2	4.7	96.5			
6	0.2	3.5	100.0			
Extraction Method: Principal Component Analysis.						

Source: Estimated from primary data.

Table 6.8 shows the eigenvalues associated with each linear component (factor) before extraction, after extraction and after rotation. Before extraction, the study had six components of service quality dimensions. The eigenvalues associated with each factor represents the variance explained by that particular component and also displays the eigenvalues regarding the percentage of variance explained. It is clear that the first two factor explains 72 per cent of the total variance. There is no marginal improvement if we take three or more factor. It should be clear that the first two factors explain the relatively larger amount of variance whereas subsequent factors explain only a small amount of variance.

The results of service quality dimensions of both public and private service providers show that households strongly prefer public service provider in regularity in the collection since Kudumbasree volunteers and Corporation sanitary workers collect solid waste from household every day except Sunday. Public service providers are highly successful in this dimension but failed in ensuring feasibility in the collection. Government failure has paved the way for private service providers to enter the market and ensure feasibility in the collection. They collect all types of plastic (recyclable and non-recyclable) waste from households but fail in keeping regularity.

The formal privatisation of solid waste collection activities has often been flagged as a suitable intervention for some of the challenges of solid waste management experienced by public service providers. It was found that while the public sector performed comparatively well in some dimensions, the private sector also had areas of competitive advantage. For instance, the private sector used the collection crew more feasibly, whereas the public sector was found to be more regular. The study recommends that, while formal private sector participation in the waste collection has some positive effects regarding the feasibility of service rendered, it has to be enhanced by creating sufficient capacity within the public sector on information about services contracted out and evaluation of performance criteria within the contracting process.

Solid waste management service is non-exclusive, meaning that once it is provided to some sector of a community, it benefits the overall public welfare, not only restricted to the residents that specifically receives service. The service is also non-rivalled, meaning that any resident can enjoy the benefit of the service without diminishing the benefit to anyone else. Because solid waste management is an urban issue, government level responsibility falls under the local or metropolitan authorities. This does not, however, means that local government bodies have to accomplish the task of solid waste service delivery entirely by their staff, equipment, and fund. This is where the role of the private sector takes the lead (World Bank, 1994).

6.4 Conclusion

The above discussion on the present practice of solid waste management among households in Kozhikode Corporation examines the heterogeneous practice of waste management followed by the households and issues and challenges pertaining to waste disposal. Both public and private service providers are actively engaged in the waste collection where public service providers like kudumbasree collect organic waste from households, and private service is limited to the collection of inorganic waste. Service quality dimensions of both public and private service providers in the waste collection were analysed. The results show that public service provider is preferred on regularity in waste collection and supported private service provider regarding feasibility in the collection. It is because public service provider ensure regularity in collection by collecting day to day organic waste from households, but failure in collecting inorganic waste. On the other private service provider is preferred on feasibility in the collection. They collect all types of inorganic waste from households and ensure feasibility in collection, but failure in ensuring regularity. Not much significant difference can be seen in the other four dimensions that are collection charge, efficiency, attitude and total performance of public and private service. The privatisation of solid waste collection activities has often been flagged as a suitable intervention to overcome some of the challenges of solid waste management experienced by Kerala.

CHAPTER 7

Willingness to Pay for Improved Solid Waste Management: Estimation and Determinants

- ***Estimation of Willingness to Pay: CV Method***
- ***Determinants of WTP: Theoretical Framework***
- ***Determinants of WTP: Econometric Framework***
- ***WTP and Hedonic Pricing***
- ***WTP towards Organic and Inorganic Waste***
- ***WTP towards Public and Private Project***
- ***Conclusion***

CHAPTER - 7

Willingness to Pay for Improved Solid Waste Management: Estimation and Determinants

Since waste management has become an unmanageable process in recent years, most of the government in various countries found it necessary to engage both public and private sectors in waste management. Present management mechanism demands civic involvement for maintaining environmental quality in general and waste management in specific. It insists that household should pay for the collection and disposal of waste. However, community willingness and participation are the operational challenges faced by the authorities in collecting user charge across the State. This part of the study measures preference of the households towards improved solid waste management by the summation of their willingness to pay for it.

This chapter is divided into two parts. Primarily the study explores the household's willingness to pay for improved solid waste management. WTP is elicited by using contingent valuation surveys and estimates the value that households place on a clean environment. The study focuses on estimating factors that determine the households' willingness to pay of the household for a clean environment. A multiple regression model is utilised to determine the factors that influence willingness to pay. Secondly, the household's willingness to pay towards different features of the project is analysed by employing one way ANOVA. It also examines the distributional overlaps in WTP towards organic and inorganic waste and WTP towards private and public owned projects with Venn diagram. The obtained data are analysed, and the results are presented here.

7.1 Estimation of Willingness to Pay: Contingent Valuation Method

Finding financial source is one of the major issues in managing solid waste. Willingness to pay of the household can be treated as one of the financial sources to meet the cost of solid waste management. Willingness to pay shows the value that households attach on a clean environment. Many studies (Whittington, 1990; Juana, 2001; Tsimamma, 2001) on willingness to pay towards improved environmental quality have been carried out by using the contingent valuation method.

The present study uses contingent valuation method (CVM) to elicit the willingness of the households towards improved waste management. The households were asked whether they are willing to pay something even a small amount for the improvement explained to them in the scenario. Table 7.1 shows households' willingness to pay for the improved waste management service in Kozhikode Corporation.

Table 7.1: Willingness to Pay

Willingness	No. of households	Percentage
Willing	320	83.3
Not willing	64	16.7
Total	384	100

Source: Estimated from primary data.

The survey asked the households regarding their willingness to pay (WTP) of any amount per month for improved solid waste management. Table 7.1 reveals that 83.3 per cent of households are willing to pay for a door-to-door waste collection service and only 16.7 per cent of households are not ready to pay any amount for the better management of solid waste. It indicates that the substantial number of households are willing to pay for improved waste management and thereby a good and clean environment. This view is also in line with the research outcome of Fonta et al., (2007); Banga et al., (2011); Joel et al., (2012); Adepoju & Salimonu (2010); Amfo-out et al., (2012) and Ojo et al., (2015).

7.1.1 Dichotomous Choice Method of CVM

A dichotomous choice method of CVM is employed to estimate the actual willingness to pay of the household towards environmental quality. For those who responded 'yes' to the above participation question, a dichotomous format (double bounded) of the valuation questions are asked. In this case, the respondent is presented with an initial bid Rs 100 and asked whether he or she is willing to pay that amount or not. If the response to the initial bid is 'yes' the respondent is then presented with a higher bid Rs 200 (twice the initial bid) and asked he or she is willing to pay the quoted amount. If the response to the initial bid Rs 100 was "no" the respondent is presented with a lower bid Rs 50 (half the initial amount) and asked if he or she is willing to pay that amount. The double-bounded format was finally followed by an open-ended follow-up question soliciting the maximum amount that the household is willing to pay. The follow-up question helps in identifying inconsistent responses and outliers. Two different bids (Rs.100 and Rs.200) were used in this study and households were given with anyone of these bids randomly.

Table 7.2: WTP on Different Bids: Dichotomous Choice Approach

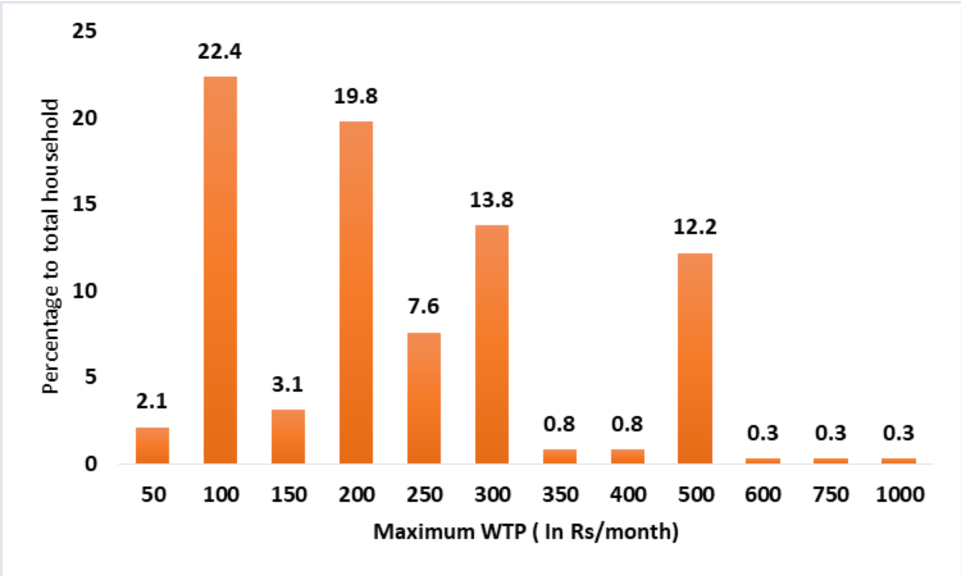
Initial bid (In Rs/Month)	Yes-Yes (in %)	Yes- No (in %)	No- Yes (in %)	No-No (in %)	Total
100	55.73	25.52	2.08	16.67	384
200	13.80	41.93	25.52	18.75	384

Source: computed from primary data.

Table 7.2 shows the proportion of 'yes- yes' answering pattern drops as the bid amount is increased. At an initial bid of Rs. 100, 55.73 per cent of households were willing to pay at least Rs.200 for the door to door waste collection system, whereas only 13.8 per cent of households were willing to pay Rs 400 at the second bid Rs.200. In a well-developed CVM survey, the number of yes answers should decline as the bid amount increases (Carson 2000). The proportion of 'no-no' answers increases as the bid amount on the WTP question are increased. At bid amount of Rs 100, there are 16.67 per cent 'no-no' households, implying that they are not willing to pay at least Rs 50 and 18.75 per cent answered 'no-no' to the highest bid Rs.200. The remaining answering patterns, 'yes-no' and 'no-yes' responses, indicate that the respondent's maximum WTP lies between the initial amount and the increased and decreased bid amounts respectively.

Those who responded 'no' to the participation question (16.7 per cent) are asked to give reasons for their unwillingness to pay. The main reason given by sample households for their unwillingness (WTP= 0) is their inability to pay (31.2 per cent). In support of this, Ojo et al., (2015) pointed out 7.7 per cent of the population in Minna metropolis revealed lower income is the main reason for unwillingness. Satisfaction in the present management mechanism, the unimportance of the scheme, responsibility of Corporation and lack of faith in collection agencies are the various reasons given by the households concerning their unwillingness to pay.

Figure 7.1: Maximum Willingness to Pay



Source: Estimated from primary data.

Figure 7.1 shows the actual willingness to pay for improved waste management by urban households. The households are asked to state their maximum willingness to pay as a monthly service charge to address the growing solid waste problem. The results show that the maximum WTP is lies between Rs.50 and Rs.1000.The amount with the highest occurrences is Rs.100 followed by Rs.200.

The estimated mean willingness to pay for improved waste management by the households is Rs.201 per month with a standard deviation Rs.160. It also indicates on an average, Rs.201 is the market price placed by the households for a clean environment. By multiplying the estimated mean willingness to pay by total households in Kozhikode Corporation, the amount will be Rs.34, 547,277/. This is the estimated amount that total households in Kozhikode Corporation place for environmental quality through improved waste management. This amount shows the willingness of the residents in Kozhikode to purchase improved domestic solid waste management as a commodity. But one notable thing is that at mean WTP, only 55.7 per cent of the households are willing to pay. Hence a socially acceptable fee should be set in which the majority of people are willing to pay.

7.2 Determinants of WTP

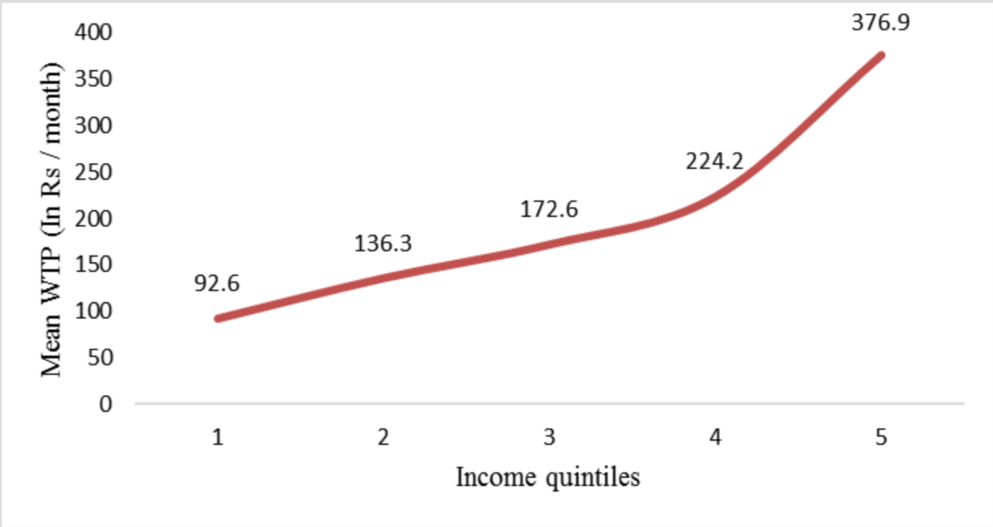
This part of the study examines the type and direction of association of socioeconomic factors of household in general and environmental and demographic factors in particular on willingness to pay. Previous studies (Atlaf & Deshazo, 1996; Basili et al., 2006; Fonta et al., 2008**;** Hagos et al., 2012) stated that households' WTP are influenced by socio-economic characteristics of households like income, education, age, occupation and household size. Along with this, the study examines the influence of enabling variables like proximity to treatment plant, the quantity of waste generation, and availability of disposal methods on WTP. Descriptive statistics are calculated to understand the basic pattern, deviation and spread of the data. It also helps to identify the variables that influence WTP towards improved waste management

Table 7.3: WTP across Income Quintiles

Income quintiles	Percentage of households	Willingness to pay (In Rs./month)			
		Mean	Median	SD	CV
1	19.3	92.56	100	113.38	122.5
2	19.0	136.30	100	125.63	92.1
3	24.7	172.63	150	123.07	71.3
4	16.1	224.19	200	117.26	52.3
5	20.8	376.88	300	144.23	38.4

Source: Estimated from primary data.

Figure 7.2: Average WTP of Households across Income Quintiles



Source: Estimated from primary data.

Here the total households are divided into five quintiles on the basis of income. The Table 7.3 shows that first two groups as lower income group, third as a middle-income group and bottom two groups as higher income groups. Figure 7.2 shows that income level and willingness to pay are directly related. Higher income group is willing to pay more on improved waste management and mean willingness to pay of richest in the higher income group is Rs.376.88 against Rs.92.56 by poorest in the lower income group (Table 7.3). These results are in line with the findings of the previous studies (Atlaf & Deshazo, 1996; Basili et al., 2006; Fonta et al., 2008; Mmolawa & Narayana, 2007) that income and households' WTP are directly related. But things get reversed while checking the proportion of income spent on WTP which is given in Table 7.4.

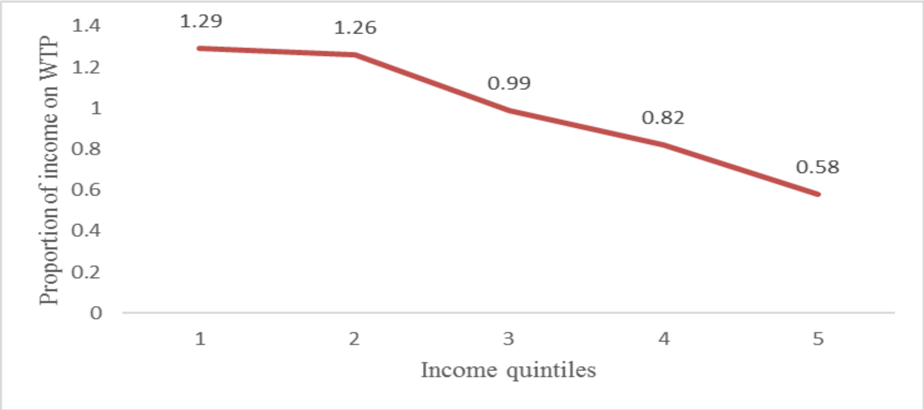
However, the proportion of income spent on WTP by the household is theoretically stronger than level of WTP. Things get reversed while examining the proportion of income spent on WTP (Table 7.4).

Table 7.4: Proportion of Income on WTP

Income quintiles	Percentage of households	WTP in proportion to income			
		Mean	Median	SD	CV
1	19.3	1.29	1.25	1.45	112.40
2	19.0	1.26	1.00	1.22	96.83
3	24.7	0.99	1.00	0.71	71.72
4	16.1	0.82	0.80	0.44	53.66
5	20.8	0.58	0.50	0.21	36.21

Source: Estimated from primary data.

Figure 7.3: Proportion of Income on WTP



Source: Estimated from primary data.

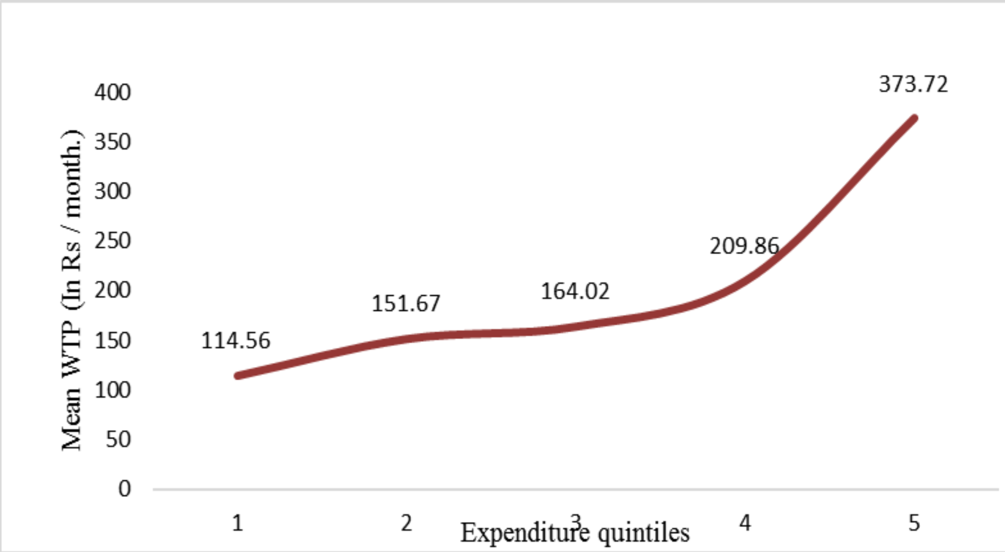
It shows that the proportion of income spent on WTP is high among the low-income group compared to the higher income group. Hence it indicates that lower income groups are willing to pay a higher proportion of their income on improved waste management compared to higher income group. The results imply that environment need not always be a luxury good and poor people might be facing the brunt of waste disposal.

Table 7.5: WTP across Expenditure Quintiles

Expenditure quintiles	Percentage of households	Willingness to pay (In Rs./month)			
		Mean	Median	SD	CV
1	24.2	114.52	100	126.96	110.87
2	15.6	151.67	100	143.49	94.61
3	21.4	164.02	175	116.08	70.77
4	18.5	209.86	200	113.89	54.27
5	20.3	373.72	300	151.56	40.55

Source: Estimated from primary data.

Figure 7.4: Average WTP across Expenditure Quintiles



Source: Estimated from primary data.

Similar to income quintiles, the total households are divided into five groups on the basis of monthly expenditure known as expenditure quintiles. The first two groups are considered as lower consumption group, third as middle consumption group and the group four and five as high consumption group. Table 7.5 shows the direct relationship between WTP and consumption expenditure. Poorest of the low consumption groups are willing to pay Rs.114.52 per month for waste management; on the other hand, the richest of the high spending group is ready to pay Rs.373.72 per month. The results of the present study go in line with the outcome of the previous study by Ojo et al., (2012) that household expenditure influences the value placed on the service of solid waste management. The line graph (Figure 7.4) also shows an upward trend which means a direct relation exists between expenditure quintiles and willingness to pay.

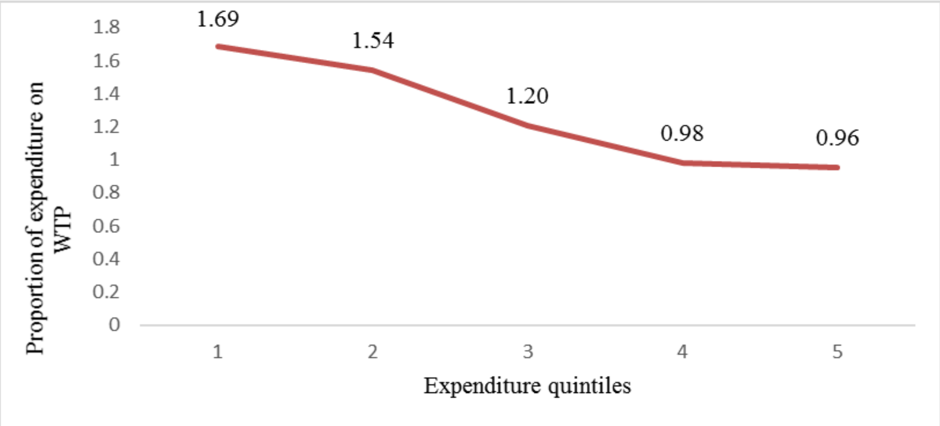
The study also examines the proportion of expenditure on WTP which is theoretically strong. Similar to income, results get reversed while analysing the proportion of expenditure spent on WTP which is given in Table 7.6.

Table 7.6: Proportion of Expenditure on WTP

Expenditure quintiles	Percentage of households	The proportion of total expenditure to WTP.			
		Mean	Median	SD	CV
1	24.2	1.69	1.43	1.77	104.73
2	15.6	1.55	1.00	1.46	94.19
3	21.4	1.20	1.24	0.86	71.66
4	18.5	0.98	1.00	0.51	52.04
5	20.3	0.96	0.86	0.39	40.63

Source: Estimated from primary data.

Figure 7.5: Proportion of Expenditure on WTP



Source: Estimated from primary data.

Table 7.6 & Figure 7.5 indicates that the proportion of expenditure spent on WTP is high among the low-income group compared to the higher income group. It indicates that an inverse relation between economic group of the households and the proportion on WTP.

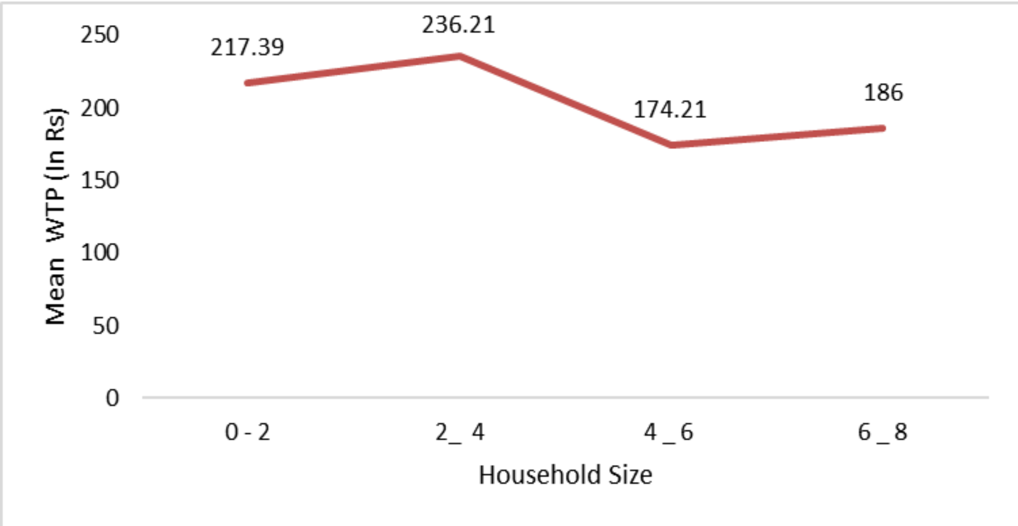
Apriori knowledge suggests that household size is also a dominant factor affecting willingness to pay. Table 7.7 examines the relationship between the size of the household and WTP.

Table 7.7: WTP across Household Size

Household size	Percentage of households	Willingness to pay (In Rs./month)			
		Mean	Median	SD	CV
0 – 2	6.0	217.39	250	150.46	19.21
2 – 4	37.8	236.21	200	160.78	68.07
4 – 6	49.7	174.61	150	154.82	88.67
6 – 8	6.5	186.00	200	164.89	88.66

Source: Estimated from primary data.

Figure 7.6: Average WTP across Household Size



Source: Estimated from primary data.

Table 7.7 shows that willingness to pay is high for the families having 2 – 4 members. Mean WTP of small families is above the estimated mean (Rs.201) and mean WTP of the families with size above four is below the estimated mean. This means that the larger the family size, the lower the households' willingness to pay for waste management because extended family members may help them in managing wastes. Besides, there is a possibility that poor income group possess large family and they are not ready to pay more for waste management due to the overburden. In support of this, Ojo et al., (2015) and Mmolawa & Narayana, (2007) concluded that household size influences the value attached on the service of solid waste management.

The occupatioanal status of the households may have an influence on WTP. The study examines WTP across the occupational status of the household which is given in Table 7.8.

Table 7.8: WTP across Occupation

Occupation	Percentage of households	Willingness to pay (In Rs./month)			
		Mean	Median	SD	CV
Professional	2.6	480.0.	500	63.25	13.18
Govt. employee	11.7	363.33	300	139.56	38.41
Private employee	13.5	211.54	200	125.88	59.51
Agriculture	2.1	218.75	125	192.61	88.05
Business	18.5	223.24	200	167.08	74.84
Coolie	21.9	143.45	100	129.59	90.34
Self employed	15.4	122.88	100	119.74	97.44
Others	14.3	149.09	100	123.04	82.53

Source: Estimated from primary data.

Table 7.8 shows that mean WTP is higher among the professionals that is Rs.480 which is above the estimated mean followed by government employees. WTP is lower in the case of self-employed households. It reveals that government employees and professionals are more concerned about environmental quality because of eco-literacy and environmental responsibility. The outcome of the study is matched with the studies of Atlaf & Deshazo, 1996; Basili et al., (2006); Fonta et al., (2008) and Hagos et al., (2012) that WTP of households is positively influenced by occupational status.

It is expected that more the education, better will be the awareness of the consequences of environmental quality. The study examines WTP across educational categories of households.

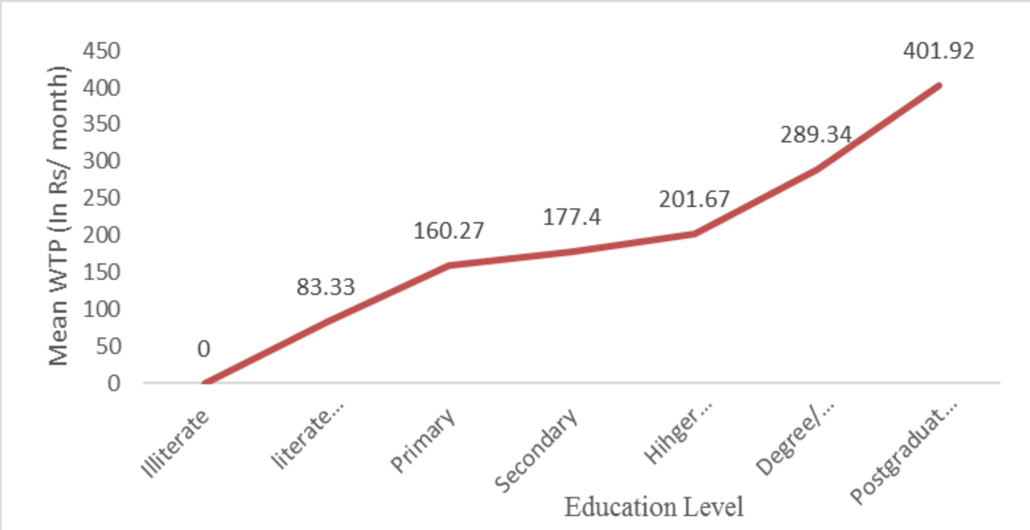
Table 7.9: WTP across Educational category

Educational category	Percentage of households	Willingness to pay (In Rs./month)			
		Mean	Median	SD	CV
Illiterate	.52	0	0	0	0
Literate without formal education	3.91	83.33	100	95.74	114.89
Primary	38.02	160.27	100	144.79	90.34
Secondary	27.08	177.40	100	156.55	88.24
Higher secondary	7.81	201.67	200	108.66	53.88
Degree/ Diploma	15.89	289.34	250	143.79	49.69
Post-graduation	6.77	401.92	500	120.4	29.96

Source: Primary data.

As expected, the study shows that the educational level of the households is positively related to WTP (see Table 7.9). This may indicate that a high level of education strengthens their commitment to adopt and pay for improved disposal services. Adepoju & Salimonu (2010); Basili et al., (2006); Fonta et al., (2008); Hagos et al., (2012); Mmolawa & Narayana (2007) concluded their study by pointing out that education is positively correlated with the WTP. Also, Jin et al. (2006) found that residents concern about solid waste problems and education positively influenced the WTP of households. Educated people are more responsible part of the society who lightened the need for environmental conservation and maintaining environmental quality.

Figure 7.7: Average WTP across Educational Category



Source: Estimated from primary data.

Figure 7.7 shows an upward trend in average willingness to pay in line with education level which reveals the environmental responsibility of the educated people. The positive relationship between education and WTP recommend that the provision of environmental education as a part of the newly defined curriculum may strengthen environmental awareness and responsibility among the public.

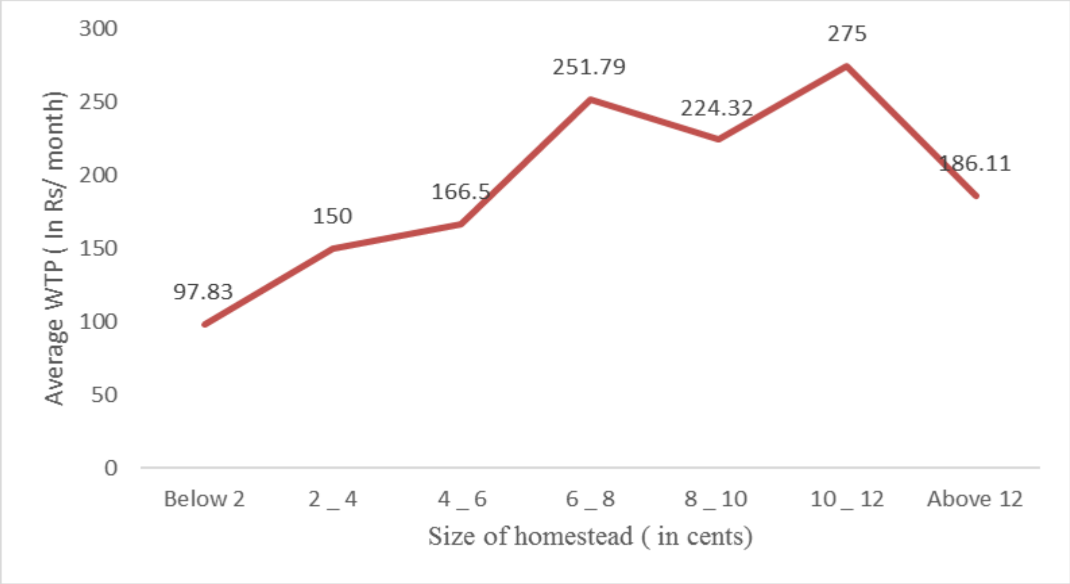
According to the theory of environmental issue, shortage of land makes the problem of waste disposal drastic. Hence, the study examines the influence of the size of homestead on WTP

Table 7.10: WTP across Size of Homestead

Size of homestead	Percentage of households	Willingness to pay (In Rs.)			
		Mean	Median	SD	CV
Below 2	5.9	97.83	100.00	160.59	164.16
2 – 4	12.8	150.00	100.00	120.33	80.22
4 – 6	26.0	166.50	100.00	144.08	86.54
6 – 8	21.9	251.79	200.00	177.91	70.66
8 – 10	19.3	224.32	200.00	157.08	70.02
10 – 12	9.4	275.00	300.00	150.00	54.55
Above 12	4.7	186.11	200.00	125.79	67.59

Source: Estimated from primary data .

Figure 7.8: Average WTP across Size of Homestead



Source: Estimated from primary data.

The study examines the influence of the size of homestead on WTP and results reveal that a positive relationship up to the size of homestead with 6 - 8 cents (Figure 7.8). However, willingness to pay of households having homestead size above 12 cents is below the estimated mean WTP (Rs.201), indicates that people who possess sufficient land for disposing of solid waste are not much concerned about waste disposal.

It is hypothesised that WTP depends on whether the respondent is a woman or a man. Hence, the study examines the influence of gender on WTP.

Table 7.11: WTP across Gender

Gender	Percentage of households	Willingness to pay (In Rs./ month.)			
		Mean	Median	SD	CV
Male	36.2	158.63	100.00	135.12	85.18
Female	63.8	225.31	200.00	167.41	74.30

Source: Estimate from primary data.

Table 7.11 shows the willingness to pay among female respondent is higher (Rs.225.31) compared to male (Rs.158.63). It may be because females normally handle solid waste issues in the home and they are staying back at home. Morover, women near the tretment plant bear the brunt of solid waste disposal. Therefore females are more concerned about waste and its disposal compared to males. Previous studies (Fonta et al., 2008; Mmolawa & Narayana, 2007) found that the gender of the respondent is significantly influencing household's WTP. Contrary to this, the study by Banga et al., (2011) found that gender has no significant influence on the decision to pay for improved solid waste management.

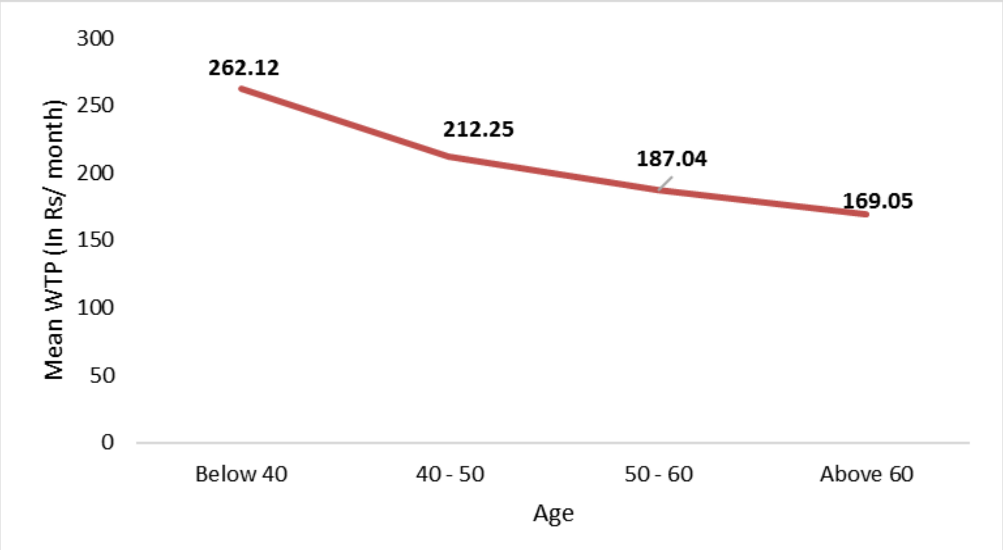
Age wise distribution of household on WTP is examined to check the influence of former on WTP.

Table 7.12: WTP across Age

Age	Percentage of households	Willingness to pay (In Rs/ month)			
		Mean	Median	SD	CV
Below 40	0.8	262.12	250.00	162.03	61.82
40 – 50	38.2	212.25	200.00	155.99	73.49
50 – 60	42.1	187.04	175.00	163.09	87.20
Above 60	10.9	169.05	150.00	144.81	85.66

Source: Estimated from primary data.

Figure 7.9: Average WTP across Age



Source: Estimated from primary data.

Figure 7.9 shows an inverse relationship between age and willingness to pay which means that monetary valuation decreases with the age of the respondent. The younger generation is found to be more willing to pay for the door to door solid waste collection service than the older. However, it may be noted that perception on the value of money may vary among the different age group. Value attach to one rupee for an old man is different from younger. This result is consistent with the findings by Altaf & Deshazo (1996) which stated a negative relationship between age of the respondent and WTP for improved solid waste management. Previous studies of Joel et al., (2012); Ojo et al., (2015) revealed that the age of the household head highly influences the WTP of the households.

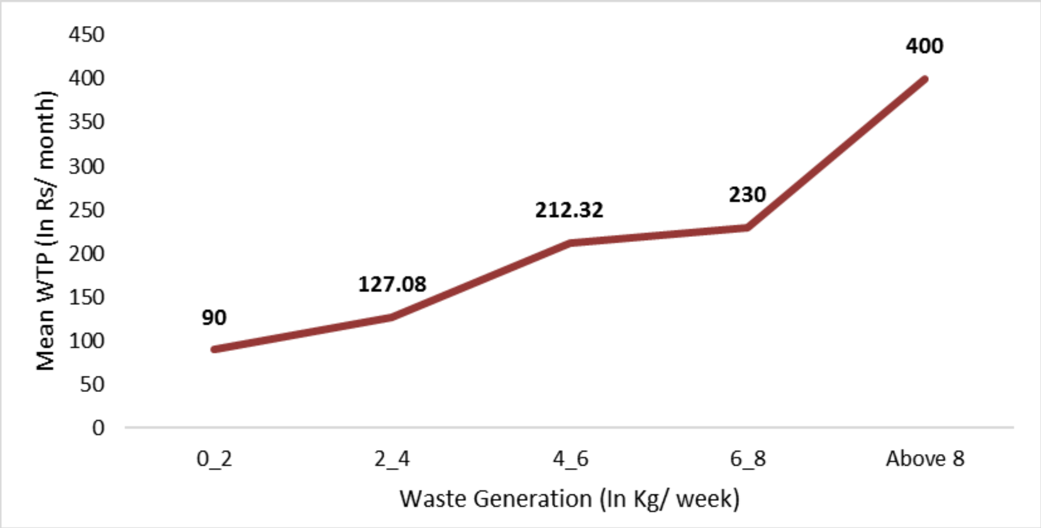
Along with socioeconomic factors, enabling factors such as quantity of waste generation, proximity to dumping yard and availability of waste disposal service are to be examined to check the influence of these factors on WTP.

Table 7.13: WTP across Quantity of Waste Generation

Waste generation in (Kg/ week)	Percentage of households	Willingness to pay (In Rs/ month)			
		Mean	Median	SD	CV
0 – 2	1.3	90.00	50.00	102.47	113.86
2 – 4	37.5	127.08	100.00	115.85	91.16
4 – 6	35.9	212.32	200.00	133.70	62.97
6 – 8	20.8	230.00	250.00	177.99	63.57
Above 8	4.4	400.00	500.00	223.61	55.90

Source: Estimated from primary data.

Figure 7.10: Average WTP across Quantity of Waste Generation



Source: Estimated from primary data.

Figure 7.10 shows the direct relationship between the amount of waste generated by household and their willingness to pay towards waste management. The mean willingness of the people who generate waste 8kg and above is above the estimated mean and the households who generate less amount of waste are willing to pay below the estimated mean.

The study examines households' willingness to pay across the proximity towards waste treatment plant. Here total sample wards are divided into two strata on the basis of the mean distance (the mean distance is 8 km) from waste treatment plant to each ward. Strata I represents household residing within the mean distance, and Strata II represents household residing away from the mean distance.

Table 7.14: WTP across Proximity to Waste Treatment Plant

Strata	Percentage of households	Willingness to pay (In Rs/ month.)			
		Mean	Median	SD	CV
Strata I	46.9	171.11	150.00	135.05	78.93
Strata II	53.1	227.69	200.00	174.49	76.63

Source: Estimated from primary data.

It is clear from Table 7.14 that mean willingness to pay is high among the households in Strata II because households in Strata II are away from the treatment plant and living very near to the heart of the city. They are already paying to Kudumbasree for waste management service, and they have no other way to dispose of waste, so they are interested in having such a well-planned project. Mean willingness to pay of the households in Strata I is Rs.171.11 which is below the estimated mean. It is not because of their reluctance to pay and perception towards environmental quality, but due to their low income compared to households in Strata II. They are very much interested in having environmental quality assured project because they are exposed to high pollution.

But actual willingness to pay may be different from the proportion of income wish to spent for environmental quality. Estimation of the proportion of income and expenditure spent by the households on WTP is theoretically stronger than the actual willingness to pay. Hence, the study examines the proportion of income and expenditure spent by households in different strata on WTP. Results get reversed while estimating the proportion of income and expenditure spent on WTP (Table 7.14)

Table 7.15: Proportion of Income and Expenditure on WTP across Strata

Strata	Percentage to total households	Willingness to pay		
		Mean WTP (In Rs)	Proportion of income on WTP (In %)	Proportion of expenditure on WTP (In %)
Strata I	46.9	171.11	1.16	1.49
Strata II	53.1	227.69	0.84	1.11

Source: Estimated from primary data.

While examining the actual willingness to pay by the households towards improved waste management in different strata, it is clear that actual WTP is high among the households in Strata II compared to Strata I. But the study found that the proportion of income and expenditure spent on WTP is high among the households in Strata I compared to Strata II. This result is theoretically stronger than the previous result because households in Strata I are the real victims of waste disposal as they are proximate to the dumping ground.

Previous studies by Joel et al., (2012) and Fonta et al., (2008) found that WTP of the households is influenced by the disposal methods available for them. The present study also attempted to examine the relationship between these two variables.

Table 7.16: WTP across Availability of Disposal Service

Availability of disposal service	Percentage of households	Willingness to pay (in Rs/ month)			
		Mean	Median	SD	CV
Available	47.7	264.5	250.0	168.0	63.5
Not available	52.3	143.5	100.0	126.7	88.3

Source: Estimated from primary data.

Table 7.16 shows that 47.6 per cent has got waste collection service either from the Corporation or private agency. Corporation provides waste collection service directly through the sanitary workers especially in coastal wards and also provides the same to other wards with the help of Kudumbasree. In the case of inorganic waste, residence association takes the initiative in the collection with the help of an agency called ‘Niravu’. A highlighting fact is that WTP is more (Rs.264.5) among those who got waste disposal service and it is less (Rs.143.5) among those who have no waste disposal service. The results indicate that WTP and availability of waste disposal service are directly related.

The expected results are tested with an econometric model namely multiple regression which is given in the following section 7.3.

7.3 Determinants of WTP: Econometric Approach

By the sound theory and exposition made in the previous section, the study follows a multiple regression model to examine the factors that determine willingness to pay for improved waste management. Empirical studies employed models such as multiple regression (Joel et al., 2012; Ojo et al., 2015; Mmolawa & Narayana, 2007) Probit and Tobit models (Banga et al., 2011; Hagos et al., 2012; Padi et al., 2015) to determine the factors that influence WTP of households for improved waste management. In the regression analysis, the maximum willingness to pay of households are regressed by several explanatory variables which include monthly expenditure of household, household size, education level, gender, age, the quantity of waste generation, proximity to dumping ground and availability of waste disposal service. The model for determining factors influencing WTP of household is defined as

$$Y= \alpha + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + e \ldots\ldots (7.1)$$

Where,

Y = WTP (Maximum willingness to pay in Rs)

X_1 = Household monthly expenditure (In Rs)

X_2 = Size of household (In number)

X_3= Educational category (1 if above primary; 0 if below primary)

X_4= Gender (1 if female; 0 if, male)

X_5 = Age (In years)

X_6= Quantity of waste generation (In kg/ week)

X_7= Availability of waste disposal service (1 if available: 0 if, otherwise)

X_8= Proximity to waste treatment plant (In Km).

e = Error variable

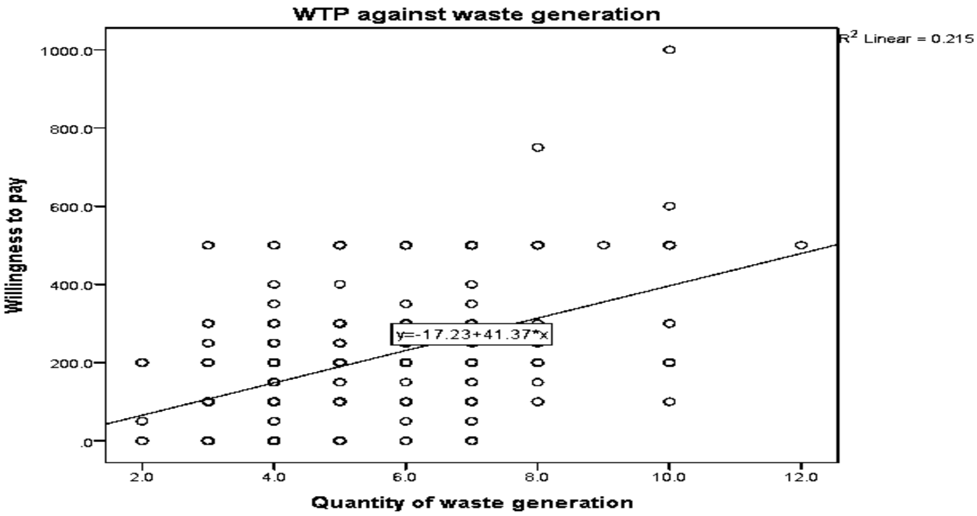
7.3.1. Check for Basic Assumptions

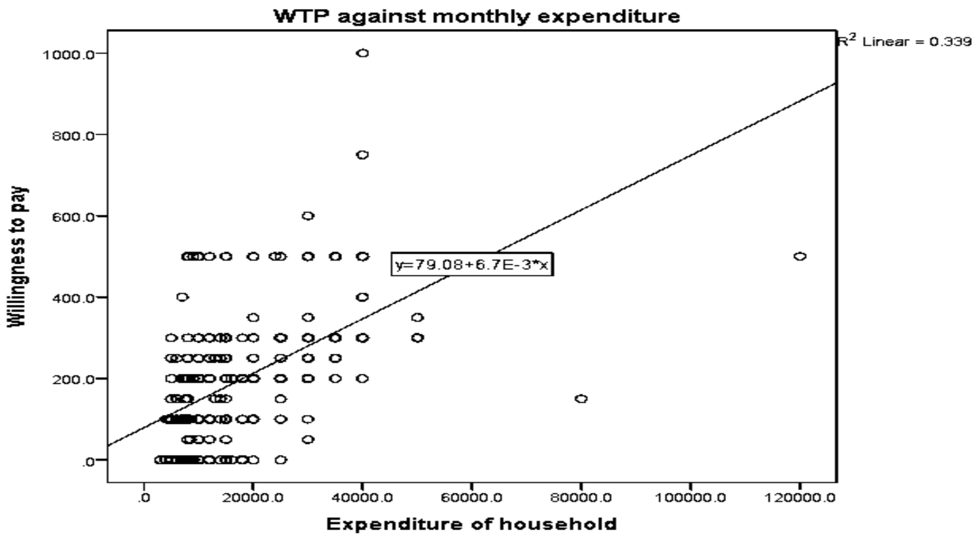
This section starts with checking the basic assumptions of multiple regression such as the linear relationship between the outcome variable and independent variables, multivariate normality, no multicollinearity and homoscedasticity.

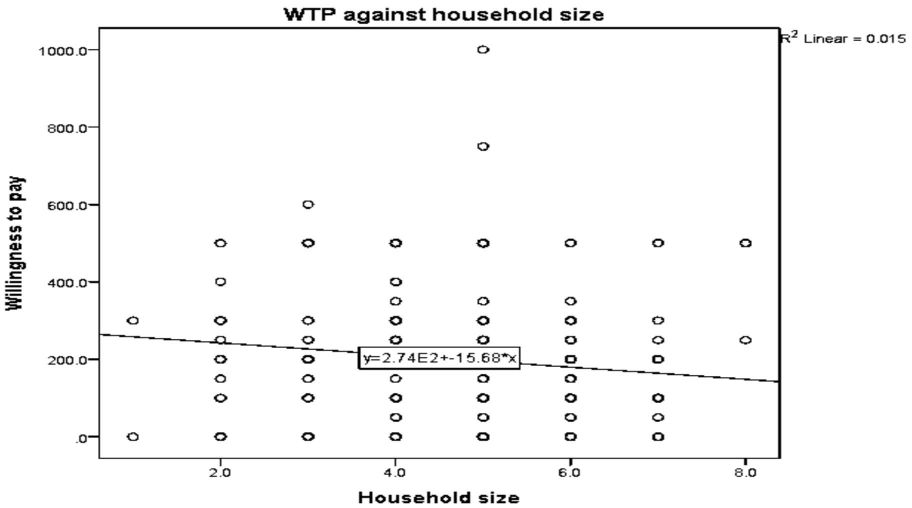
7.3.1.1 Testing for Linearity

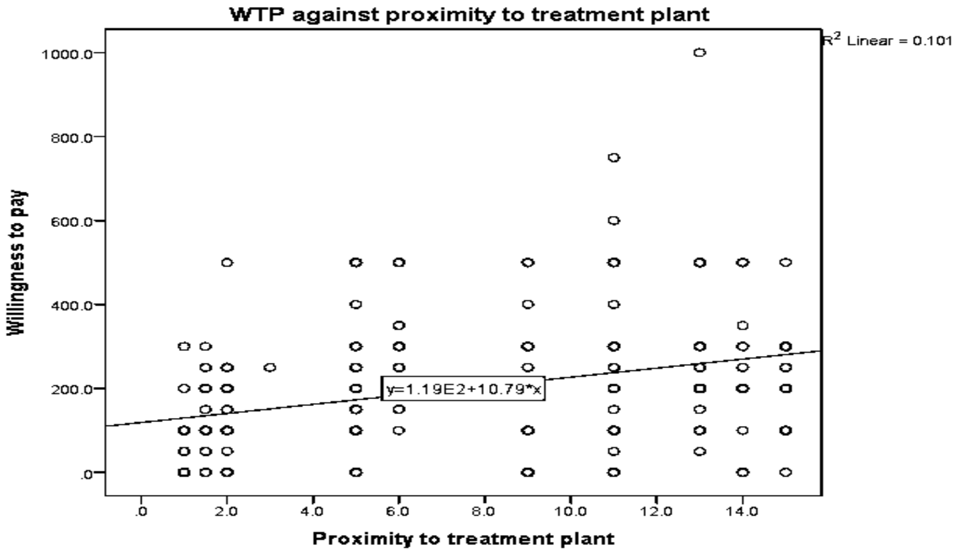
Regression model assumes that there must be a linear relationship between the outcome (dependent) variable and the independent variables. This can be checked with the help of scatter plot which shows whether there is a linear or curvilinear relation. Scatter plots of the dependent variable (maximum willingness to pay) against independent variables such as quantity of waste generation, expenditure of households, household size, age, and proximity to waste treatment plant are generated for checking linearity and found that the model has satisfied the linearity assumption. The categorical variables like the availability of waste disposal service, gender and educational category are not plotted. Scatter plot of the dependent variable against the independent variables is given in Figure 7.11.

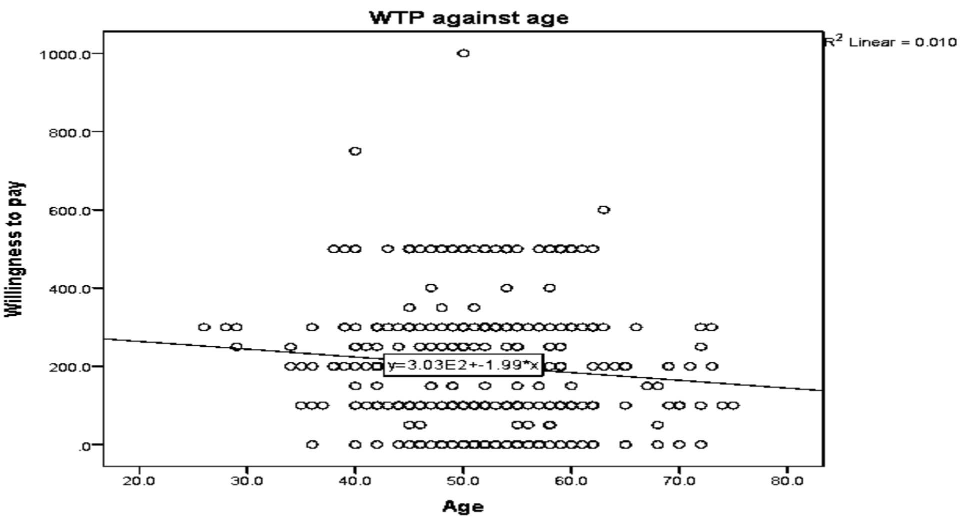
Figure 7.11: Scatter Plots of Dependent Variable against Independent Variables









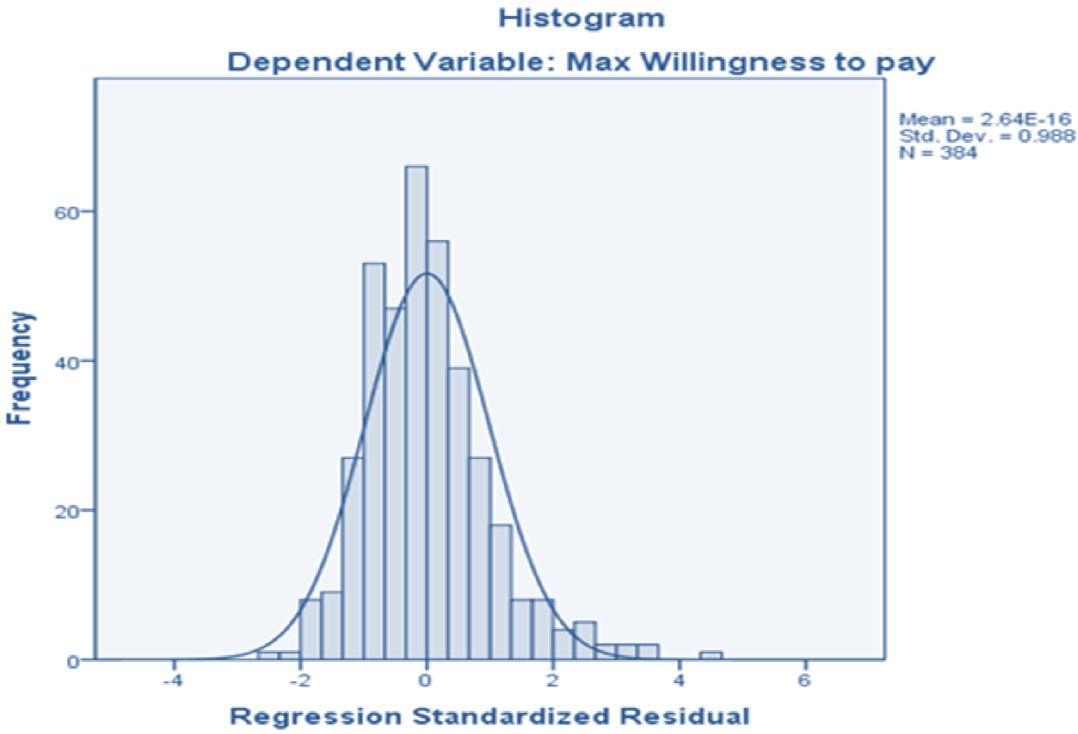


Source: Estimated from primary data.

7.3.1.2 Testing of Multivariate Normality

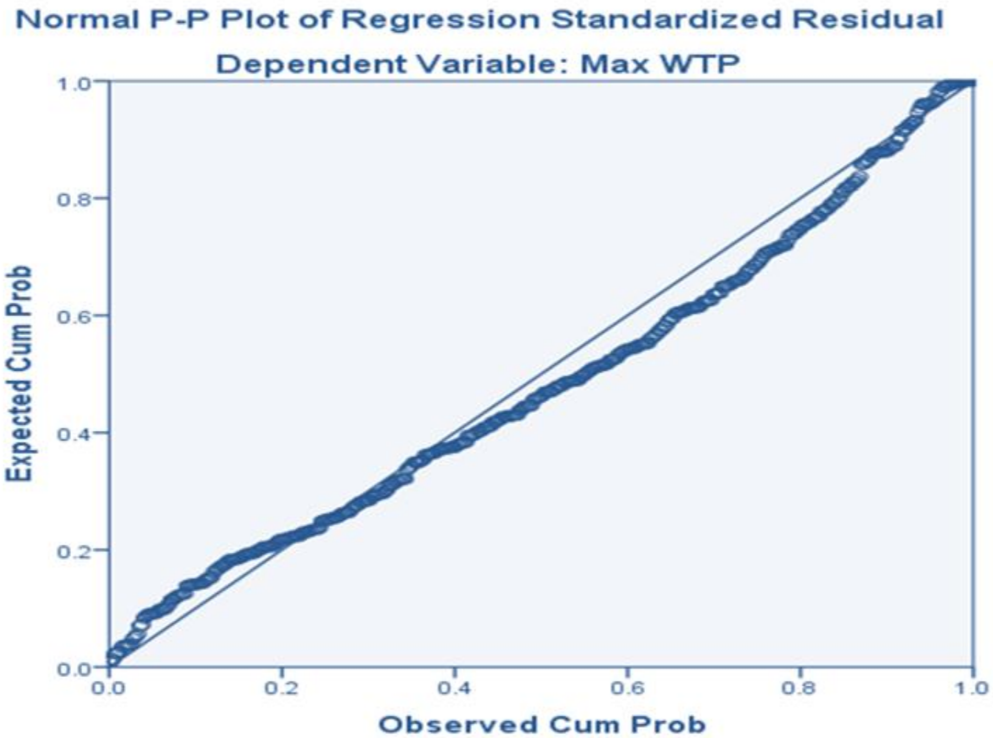
The regression model assumes that residuals (error between observed and predicted) are normally distributed. This can be checked by employing both his P-P Plot and histogram. Normal P-P plot of the residuals in Figure 7.13 shows that there is no data stay far away from the slope line. The result from the histogram (Figure 7.12) also supports the normality assumption. Hence, the study found that the model satisfied the normality assumption.

Figure 7.12: Testing of Multivariate Normality- Histogram



Source: Estimated from the primary data.

Figure 7.13: Testing of Multivariate Normality- Normal P-P Plot



Source: Estimated from the primary data.

7.3.1.3 Testing of Multicollinearity

The WTP estimation model is also tested for the problem of multicollinearity by using Pearson's correlation coefficient matrix. A simple correlation matrix shows the relationship between the dependent variable (WTP) and explanatory variables which is given in Table 7.17.

Table 7.17: Pearson's Correlation Coefficient Matrix

	Qty	Exp	Hhs	Edu	Age	Gen	Avail	Dist
Qty	1							
Exp	.371	1						
Hhs	.205	-.059	1					
Edu	.078	.410	-.084	1				
Age	.087	-.068	.079	-.293	1			
Gen	.078	.084	-.026	.011	-.043	1		
Avail	.324	.398	.026	.239	.109	.089	1	
Dist	.188	.315	-.095	.196	.041	.098	.486	1

Qty – Quantity of waste generation (In Kg)
Exp – Monthly expenditure of households (In Rs)
Hhs – Household size
Edu – Educational category
Age – Age
Gen – Gender
Avail – Availability of waste disposal service
Dist – Distance to the dumping site

Source: Estimated from primary data.

While computing the correlation coefficient matrix, the study omitted the income variable due to its high correlation with expenditure. Households' monthly expenditure is taken as a proxy for monthly household income. Similarly, the study omitted explanatory variable environmental awareness due to its collinearity with education level and availability of waste disposal system. The correlation coefficient matrix (see Table 7.17) shows that multicollinearity is not a serious problem in the study. The correlation matrix of the explanatory variables ensures that no two explanatory variables correlate more than 0.5 which indicates that the estimating parameters are not highly correlated to each other.

7.3.1.4 Testing for Homoscedasticity

Homoscedasticity means the variance of errors is the same across all levels of the independent variables. When the variance of errors differs at different values of the independent variables, heteroscedasticity is indicated. When heteroscedasticity is marked, it can lead to serious distortion of findings and seriously weaken the analysis thus increasing the possibility of a Type I error (Berry and Feldman, 1985; Tabachnick and Fidell, 1996). This assumption can be checked by visual examination of a plot of the standardised residuals (the errors) by the regression standardised predicted value. White test is also used to test heteroscedasticity in a linear regression model. It is a statistical test that establishes whether the variance of the errors in a regression model is constant for homoscedasticity. The present study employed White test to check the problem of homoscedasticity. The results of White test statistic are: LM = 60.54 with p-value = p (Chi-square (41) > 60.54) = 0.03. The results show that the variances for the errors are not equal that is heteroscedasticity is present.

Thus, it is found that the collected data satisfied with all the basic assumptions of the Ordinary Least Square (OLS) model except homoscedasticity. Hence the study employed Weighted Least Square (WLS) model as heteroscedasticity corrected regression model to examine the factors determining willingness to pay. Being the WLS model, the study has to recheck the problem of multicollinearity and normality of the residuals. Variance Inflation Factor (VIF) is used to check the problem of multicollinearity which is given in Table 7.18.

Table No. 7.18: Variance Inflation Factors

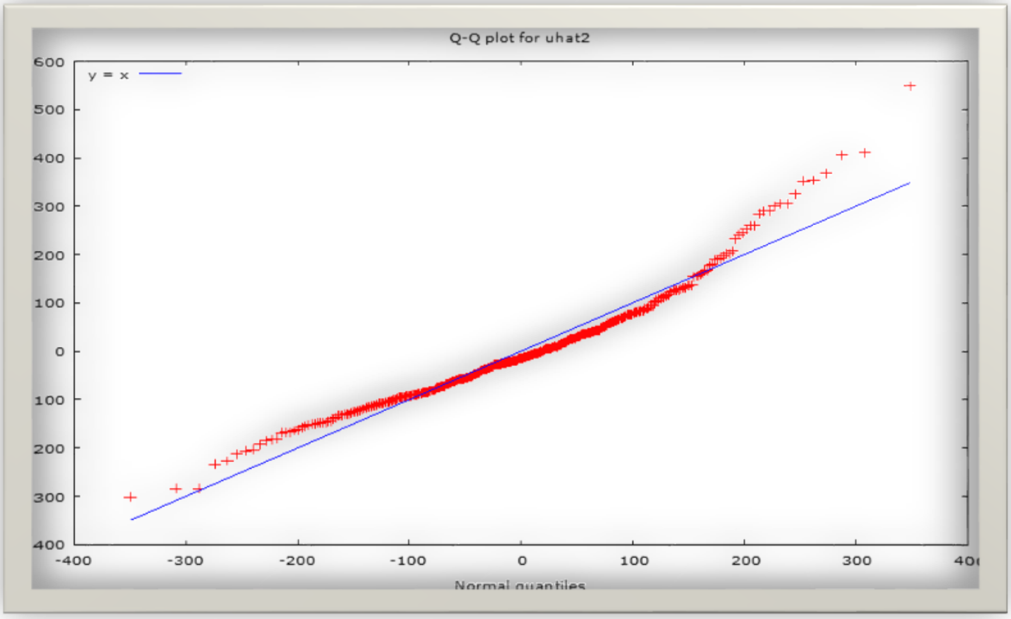
Explanatory variables	VIF value
Quantity of waste	1.30
Expenditure	1.53
Household size	1.09
Education	1.36
Proximity to the dumping site	1.36
Age	1.15
Gender	1.02
Availability of waste disposal service	1.54

Source: Estimated from the primary data.

The VIF value greater than 10 implies a collinearity problem, but the results show that VIF value is less than 10 for all the independent variables. It shows that multicollinearity is not a serious problem in the study.

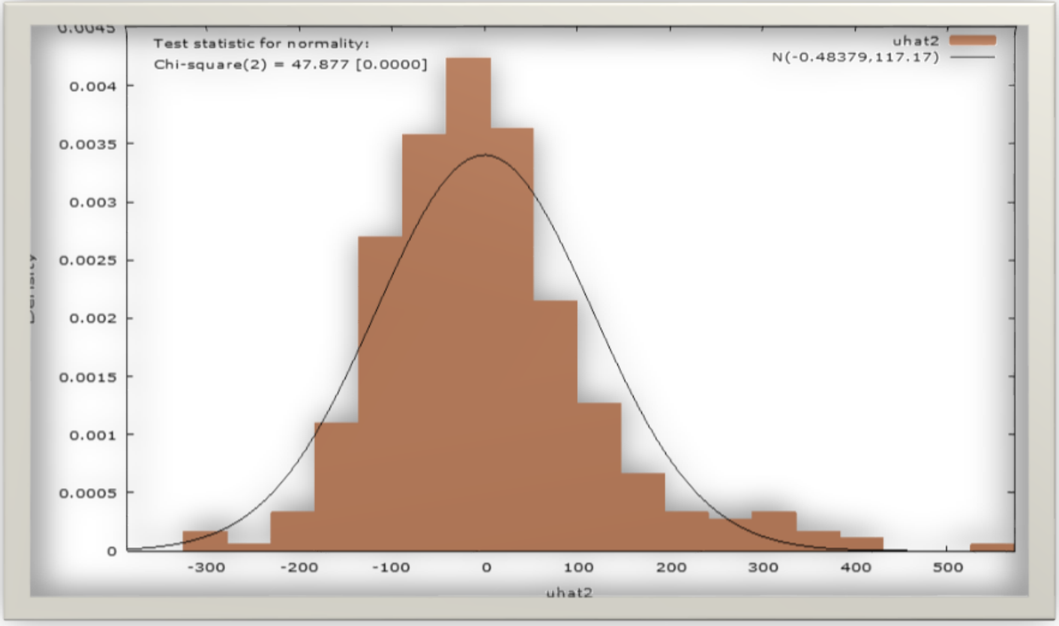
The model also assumes that residuals (error between observed and predicted) are normally distributed. This can be checked by employing both histogram and normal Q-Q plot. Normal Q-Q plot of the residuals in Figure 7.14 shows that there is no data which stay far away from the slope line and the results from the histogram (Figure 7.15) also support the assumption. The distribution of residuals follows normal distribution properties is clear from the histogram and Q-Q plot. Hence, it can be implied that the variables are statistically suitable for regression model.

Figure: 7.14: Normal Q-Q Plot of Regression Residuals



Source: Estimated from the primary data .

Figure 7.15: Histogram of Regression Residuals



Source: Estimated from the primary data.

In delineating the determinants of WTP, sensitivity analysis is done using both linear and semi-log models. There were no marked differences between the estimated models. Among this, we have chosen the one (Table 7.19) for its ability to accommodate both education and family expenditure together without compromising robustness. The explanatory variables like education and family expenditure are found to be correlated (0.41) as evident from the partial correlation coefficient present in Table 7.17. It is not feasible to drop any of these variables because both of them are theoretically important as a determinant of WTP. It is found that the collected data satisfied the basic assumptions of the model. Hence the study employed a weighted least squares regression model (heteroscedasticity corrected model) to examine the factors determine willingness to pay towards improved waste management and the results are given in Table 7.19.

6.4.2. Regression Results: Willingness to Pay

The overall significance of the model and significant relationship between dependent and independent variables are examined by the values of 'R^2' 'F', 't' and 'p' respectively.

Table 7.19: Regression Results: Willingness to Pay towards SWM

Variables	β	Std. Error	t	p
(Constant)	147.43	42.89	3.44	0.00
Monthly expenditure	0.00	0.00	8.77	0.00
Household size	-18.25	4.25	-4.29	0.00
Availability of collection service	28.06	13.16	2.13	0.03
Age	-2.36	0.61	-3.88	0.00
Quantity of waste generated	22.49	4.25	5.29	0.00
Gender	34.05	10.95	3.11	0.00
Education category	-2.96	13.15	-0.23	0.82
Proximity to dumping ground	2.42	1.19	2.03	0.04
$R^2 = 0.48$	F = 43.76			

Source: Estimated from the primary data.

The value of the coefficient of determination (R^2) indicates the factors explain 48 per cent of the variation in willingness to pay in the model. The p-value is significant at ($p < 0.05$) 5 per cent, means that the variables included in the model jointly and significantly explains the willingness of household to pay for solid waste disposal service in the study area.

The explanatory variables such as monthly expenditure, gender, the quantity of waste generation, proximity to dumping ground and availability of waste collection service positively and significantly influence the maximum willingness to pay at 5 per cent level of significance. Household size and age are statistically significant with a negative influence on willingness to pay.

Monthly expenditure of the household is a proxy for monthly income which has a positive influence on willingness to pay. The positive coefficient of households' consumption expenditure indicates, holding all other variables constant when income is high, the willingness to pay of that household will increase. It is noted that generally people are willing to pay and their willingness to pay depends on their ability to pay. The results of the study by Ojo et al., (2012) are in line with the outcome of the present study that household expenditure has a positive and significant influence on the value placed on the service of solid waste management.

The household size is another variable which determines the household's willingness to pay for improved waste management. The results show that household size is negatively related to the willingness to pay of the household. The same is concluded by Adebo & Ajewole (2012); Ojo et al., (2015): Mmolawa and Narayana (2007) and they stated that family size is one of the vital determinants of willingness to pay. The negative sign implies that the larger the size of the family, the lower the household's willingness to pay for solid waste disposal because the extended family members will assist in the disposal of waste. In contrary to this, the study by Hagoes et al., (2012) concluded that family size has no significant influence on the amount of WTP for improved solid waste management.

The age of the respondents has a negative and significant ($p<0.02$) effect on willingness to pay. This means that willingness to pay of ageing population is low compared to the younger people. This may be because of the changing perception on money value among different age group. For the ageing population environmental issues are not a serious concern compared to the youth who are likely to be more sensitive on the environmental quality. This result is consistent with the research outcomes of Afroz et al., (2011); Banga et al., (2011) and Joel et al., (2012). Contrary to these studies, the study by Ojo et al., (2015) found that age has a positive and significant influence on the decision to pay for improved solid waste management. The study by Hagoes et al., (2012) concluded that age has no significant influence on the amount of WTP for improved solid waste management.

The results also found a positive and significant relationship between the amount of waste generated by household and willingness to pay towards waste management. The findings of Hagos et al., (2012) also reached in the same conclusion that households who generate more solid waste have a higher demand for improved solid waste management.

Willingness to pay and availability of waste disposal service are positively related. Willingness to pay is more among those who have a waste disposal service, and it is less among those who do not have a waste disposal service. This is against the result of Joel et al., (2012) who found an inverse relationship between the disposal method available to the household and the willingness to pay. The study by Fonta et al. (2008) found that WTP of the households is influenced by the total disposal methods available to the households.

Proximity to treatment plant also have a significant effect on the amount of WTP for improved solid waste management. As the theoretical exercise, regression result also show that WTP is low among the households who are proximate to treatment plant compared to the households away from the treatment plant. It is not because of their reluctance to pay and perception towards environmental quality but due to their low income. They are very much interested in having environmental quality assured project because they are exposed to high pollution. Moreover, households who residing away from the treatment plant are very near to city and they have no other way to dispose of waste. So they are interested to having a well-planned project and ready to pay more.

Theory expect that level of education of the household have a strong positive influence on willingness to pay, but turned out to be statistically insignificant (0.77 >.05). Empirical exercise shows that no significant relationship between WTP and level of education. Contrary to this, research outcome of Fonta et al., (2008); Mmolawa & Narayana, (2007); Hango et al., (2012); and Joel et al., (2012) are pointing out that education is positively and significantly correlated with the WTP.

The findings of Fonta et al., (2008); Altaf & Deshazo (1996), Joel et al., (2012); Padi et al., (2015); Jin et al., (2006) are in line with the findings of the current study. These studies indicate that socio economic factors like monthly expenditure, gender, income and family size are the prominent determinants of willingness to pay of the urban households. It is concluded that variation in the level of household's willingness to pay depends on different socio-economic status of households.

The policy implications of the study is that solid waste collection and disposal levies are to be introduced as a cost recovery measure because it is clear from the study that generally people are willing to pay for a cleaner environment. User charge should bring as a general policy to recover the cost of waste management so as to ensure environmental quality. Charging different rates for different income groups is highly recommended as it seems to be affordable and it will generate more revenue for the authorities. It is recommended that there should be an intensive public campaign to educate people about the danger of waste in our localities and benefits associated with the clean environment to increase the WTP for improved environmental quality in general and improved solid waste management in particular.

The main purpose of conducting a CVM study is to obtain a welfare measure, such as mean or median WTP. In this study, the welfare measure refers to the amount that households are willing to pay monthly for a door-to-door solid waste collection service. The estimated mean WTP is Rs 201 per month which implies that on an average, each household is willing to pay Rs 201 per month for a door - to - door solid waste collection service.

7.4 WTP and Hedonic Pricing

It may be recalled that the estimate of WTP is based on a hypothetical solid waste management project. This project possesses key characteristics such as ensuring a clean environment, provision of safe drinking water, control of rodents and mosquitoes, waste recycling for gas production and construction of a controlled landfill with a large lifespan. Here, willingness to pay for clean environment is identified as the preference for the abandon of the problem. Willingness to pay for safe drinking water and control of mosquitoes are identified as compensatory intervention. Construction of controlled landfill with a large life span and waste recycling for gas production are identified as alternative mechanism for waste disposal. By estimating the price of these specific features, which generally called as hedonic pricing method[22], study elucidates the preference of the people towards hypothetical project.

Table 7.20: Willingness to Pay – Hedonic Pricing

Features	Percentage to total	Mean	Median	SD	CV
Clean environment	83.3	195.96	200	155.29	79.25
Safe drinking water	83.3	191.67	200	154.17	80.44
Control of mosquitoes	81.8	187.11	200	156.86	p83.83
Gas production	66.4	111.59	100	112.25	100.59
Construction of controlled landfill with a large life span	65.6	110.16	100	112.13	101.79

Source: Estimated from primary data.

Table 7.20 shows willingness to pay of households towards different features of the project. As expected, mean willingness to pay is high (Rs.195.96) towards a cleaner environment because people are more concerned about the need for a clean environment as well as the abandon of the solid waste problem. Mean willingness to pay for safe drinking water is Rs.191.67 followed by willingness towards control of mosquitoes (Rs.187.11). Compared with the first three features of the project (willingness towards the clean environment, safe drinking water and control of mosquitoes), mean willingness to pay towards gas production and construction of landfill with a large lifespan are low which shows people are not much interested in paying for gas production and construction of the controlled landfill. The results show that people prefer abandon of the problem than alternative methods like gas production and land fill. Not much difference can be seen in the preference for abandon of the problem and compensatory intervention. The study employs one way ANOVA to test whether there exists a significant difference in the mean willingness to pay towards different features of the project.

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22 Hedonic pricing is a model, which identifies price of factors according to the premise that price is determined both by internal characteristics of the good being sold and external factors affecting it. It is often used to estimate quantitative value for eco system or environmental service that directly impact market price for homes

7.4.1 Mean Difference Analysis by Using One Way ANOVA

ANOVA is a statistical technique used to test the difference between two or more mean. The present study employed one way ANOVA to determine whether there is any statistically significant difference between the means willingness to pay towards different features of the project like ensuring clean environment, provision of safe drinking water, control of rodents and mosquitoes, waste recycling to produce gas for household consumption and construction of a controlled landfill with a large lifespan. The study has to check whether the data satisfies the basic assumptions of ANOVA before analysing the data.

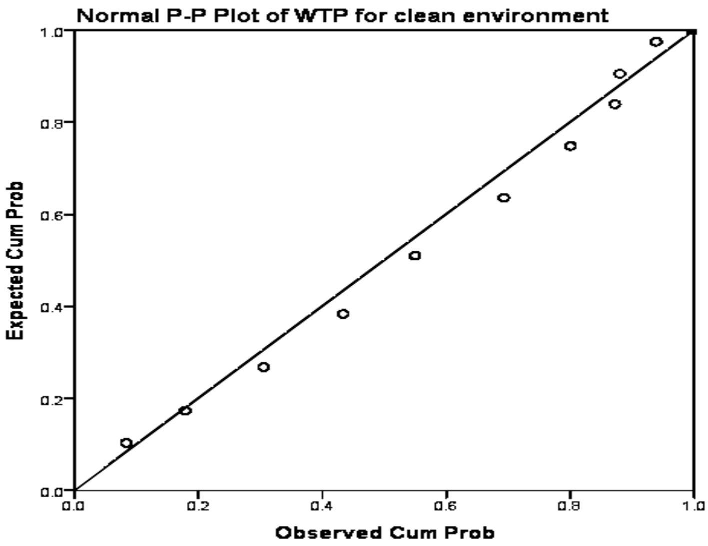
7.4.1.1 Check for Basic Assumptions

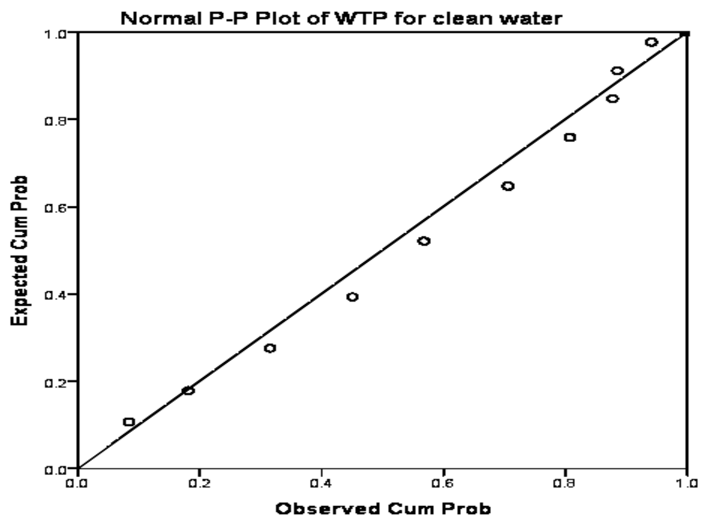
To ensure that the collected data can be subjected to ANOVA, the study has to check whether the data follow the basic assumptions of normality and homogeneity of variance. The observations under considerations are independent. The dependent variables of the study such as willingness to pay towards different features of the project are on an interval scale. The major assumption of homogeneity of variances were checked and are presented in the following sections.

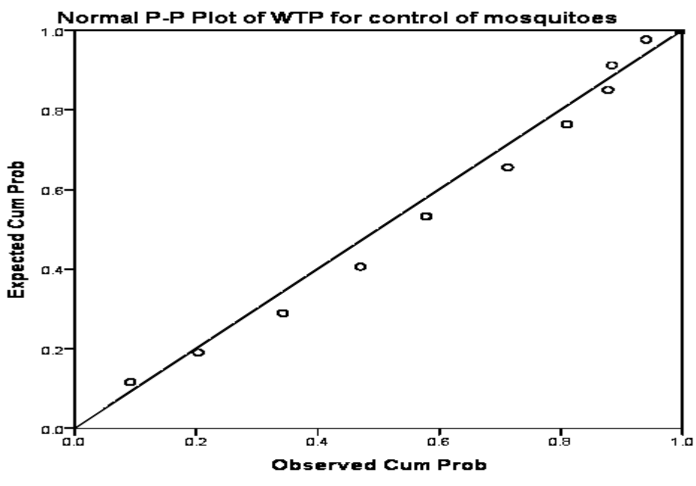
7.4.1.1.1 Check for Normality

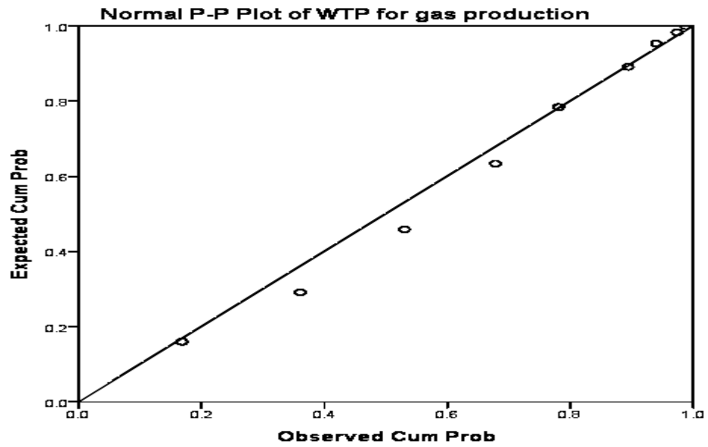
Normal P-P Plot is employed to determine normality graphically. If the data are normally distributed, the data points will be close to the diagonal line. If the data points stray from the line in an obvious non-linear fashion, the data are not normally distributed. The distribution of dependent variables follows normal distribution properties as clear from the normal P-P plot (Figure 7.16)

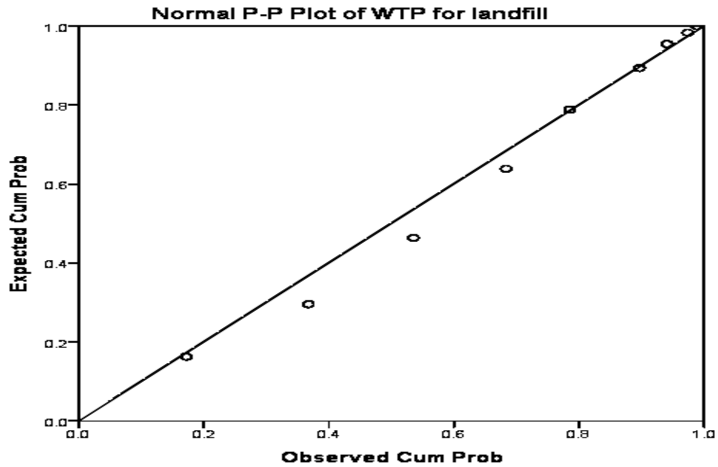
Figure 7.16: Normal P-P Plot of the Dependent Variable











Source: Estimated from the primary data.

7.4.1.1.2 Homogeneity of Variances

For testing the homogeneity of variance, the study employed Levene's test of equality of error variance. It tests the null hypothesis that the variance of the groups is the same. Levene's test is, therefore, testing whether the variance of the five groups is significantly different. Notice that the Levene's test is significant; $F = 15.452$, $p = 0.00$ at the 0.05 alpha level (the value of significance is less than 0.05) which shows variance of the five groups are significantly different. Thus, the assumption of homogeneity of variance is violated for this sample. In order to rectify this, the study utilised an adjusted F test such as the Welch statistic or the Brown-Forsythe statistic as an alternative.

Brown and Forsythe's test is a test for equal population variances. It is a robust test based on the absolute differences within each group from the group median. A robust test of equality of mean is considered when the assumption of homogeneity of variance has not been met. The adjusted F ratio is 38.62 which is found to be significant (i.e., $p < \alpha$), reject the null hypothesis (H_O: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$) and conclude that at least one of the group means is significantly different from the others (or that at least two of the group means are significantly different from each other) and hence the study directly employs ANOVA to check to mean difference.

Table 7.21: WTP towards Features of the Project: One way ANOVA

	Sum of squares	Df	Mean square	F	Significance
Between group	3016960.94	4	754240.23	38.62	.000
Within group	37404589.34	1915	19532.42		
Total	40421550.78	1919			

Source: Estimated from primary data.

The ANOVA results show that F ratio (38.62) is significant ($p =0.00$) at the 0.05 alpha level that is $F (4, 1915) = 38.615$, $p < 0.05$. The 4 and 1915 are the two degrees of freedom values (df) between the groups "effect" and the within-groups "error," respectively. F table usually includes the mean squares, which indicates the amount of variance (sums of squares) for that "effect" divided by the degrees of freedom for that "effect."

One-way ANOVA shows a statistically significant result with an F ratio of 38.615, so alternative hypothesis (H_1: $\mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4 \neq \mu_5$) can be accepted in which there are at least two group means statistically significantly different from each other. It is important to realise that the one-way ANOVA is an omnibus test statistic and cannot tell which specific groups are statistically significantly different from each other. The study needs to conduct a 'post hoc follow-up test' to determine which group means differ from each other. Because of the violation of the assumption of homogeneity of variance (equal variances not assumed), the Games-Howell test is used to determine which specific groups are different from each other.

Group 1- WTP for a good environment

Group 2- WTP for safe drinking water

Group 3- WTP for control of mosquitoes

Group 4- WTP for gas production

Group 5- WTP for construction of the landfill

Table 7.22: WTP towards Features of the Project: Post hoc Test

	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.
Games-Howell	1.00 WTP for good environment	2.00	4.30	11.17	0.99
		3.00	8.85	11.26	0.94
		4.00	**84.38**	9.78	**0.00**
		5.00	**85.81**	9.77	**0.00**
	2.00 WTP for safe drinking water	1.00	-4.30	11.17	0.99
		3.00	4.56	11.22	0.99
		4.00	**80.08**	9.73	**0.00**
		5.00	**81.51**	9.73	**0.00**
	3.00 WTP for control of mosquitoes	1.00	-8.85	11.26	0.94
		2.00	-4.56	11.22	0.99
		4.00	**75.52**	9.84	**0.00**
		5.00	**76.95**	9.84	**0.00**
	4.00 WTP for gas production	1.00	-84.38	9.78	0.00
		2.00	-80.08	9.73	0.00
		3.00	-75.52	9.84	0.00
		5.00	1.43	8.10	1.00
	5.00 WTP for construction of landfill	1.00	-85.81	9.77	0.00
		2.00	-81.51	9.73	0.00
		3.00	-76.95	9.84	0.00
		4.00	-1.43	8.10	1.00

Source: Estimated from primary data.

Table 7.22 shows the results of the Games- Howell follow-up tests. Since the assumption of homogeneity of variance was not met, the study needs to review the Games-Howell information. First, locate the (**I**) group (WTP for the clean environment), then locate the **(J)** group (look at the first line, WTP for clean water). This is the way how WTP for a clean environment is being compared to the WTP for water. In the next column, mean difference (I-J) shows the mean difference for these two groups (1^{st} group mean = 195.96 and 2^{nd} group mean = 191.67, therefore 195.96 – 191.67 = 4.29). The next column of interest is the significance column, which tells the *p*-value (p = .99). The *p*-value is then compared to the alpha level to determine whether this pair is significantly different. No significant difference can be seen in the case of group 1 and group 2.

Further review of the table reveals that the Group 1 (M = 195.96) is significantly different from Group 4 (M = 111.59), with a mean difference of 84.37and a *p*-value of 0.00. Also, Group 1 (M = 195.96) is significantly different from Group 5 (M = 110.16), with a mean difference of 85.81 and a *p*-value of 0.00.

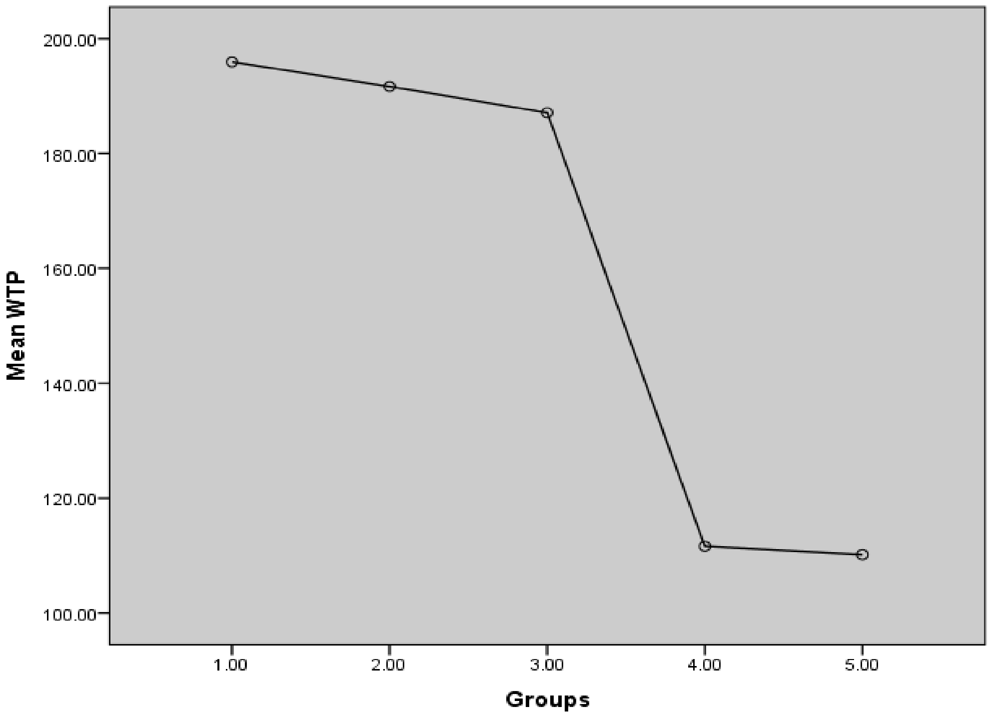
Group 2 (M = 191.67) is significantly different from the Group 4 (M = 111.59), with a mean difference of 80.08 and a *p*-value of 0.00. Also, Group 2 (M = 191.67) is significantly different from Group 5 (M = 110.16), with a mean difference of 81.51 and a *p*-value of 0.00.

Group 3 (M = 187.11) is significantly different from Group 4 (M = 111.59), with a mean difference of 75.52 and a *p*-value of 0.00. Also, Group 3 (M = 187.11) is significantly different from Group 5 (M = 110.16), with a mean difference of 76.95 and a *p*-value of 0.00.

The results of post hoc tests shows that no significant difference can be seen in the preference of the people towards abandon of the problem (WTP for clean environment) as well as the preference towards compensatory alternatives (WTP for clean water and WTP towards control of mosquitoes). But preference towards these two are statistically different from the alternative methods such as construction of controlled landfill and recycling for gas production. It shows people do not prefer alternative methods because alternative methods like controlled land fill may create the issues of waste disposal again. It will not wash out the problem completely. They prefer clean environment which shows preference of the people towards abandon of the solid waste issues. Hence the conclusion derived from the result is that people are willing to pay for hypothetical project mainly for the clean environment.

Mean plot shows a visual representation of the group means and their linear relationship. Such a line graph can aid in interpreting the results.

Figure 7.17: Mean Plot from ANOVA



Source: Drawn from primary data.

The points on the plot are the average of each group. It is much easier to see from this graph that WTP of the sample households are high for the cleaner environment while it is low for the construction of the landfill.

ANOVA found statistically significant differences between mean willingness to pay towards different features of the project. Results also show no significant difference in group 1 with 2 and 3. This shows a willingness to pay towards the first three features of the project (WTP for a clean environment, WTP for safe drinking water and WTP towards control of mosquitoes) are more or less same. Besides, it is found that average willingness to pay towards these three features of the projects are high compared to other two which shows that people are more concerned about the clean environment, safe drinking water and control of mosquitoes than the other two.

7.5 Willingness to Pay towards Organic and Inorganic Waste

In Kozhikode Corporation kudumbasree and Corporation sanitary workers collect day to day organic waste from households, and the private service provider collects inorganic wastes. The present hypothetical waste management plant ensures the collection of both organic and inorganic waste from households and majority of the people are willing to pay for the project. This part of the study attempts to examine the difference in WTP of the households towards organic and inorganic waste management. It also involves the estimation of maximum WTP towards organic and inorganic waste management to examine the preference of the people towards the disposal of these waste.

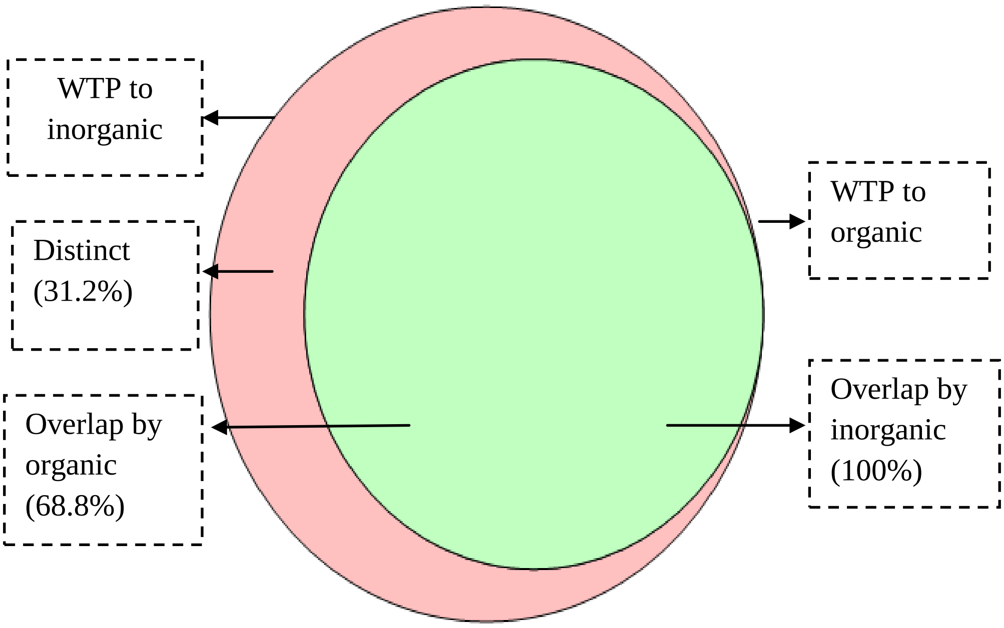
Table 7.23: Willingness to Pay towards Organic and Inorganic Wastes

WTP towards organic and inorganic waste				
		WTP for inorganic waste (%)		Total
		Willing	Not willing	
WTP for organic waste (%)	Willing	57.3	0	57.3
	Not willing	26.0	16.7	42.7
Total		83.3	16.7	100.0

Source: Estimated from primary data.

Table 7.23 shows that in Kozhikode Corporation 83.3 per cent of the households are willing to pay for improved waste management. The highlight of the study is that all these 83.3 per cent are willing to pay for inorganic waste management. On the other, only 57.3 per cent of the sample is willing to pay for organic waste management. The results show that no one is ready to pay for organic waste alone. It indicates that the households' willingness is mainly for the management of inorganic waste. The results strengthen our expected theoretical arguments that the disposal of inorganic waste is a public bad compared to disposal of organic waste. The magnitude of the overlaps in WTP for organic and inorganic waste management is presented in the Venn diagram 7.18.

Figure 7.18: Overlap in the WTP for Organic and Inorganic Waste Management



Source: Constructed from primary data.

The Venn diagram (Figure 7.18) shows the overlapping circles to illustrate the willingness of the households towards both organic and inorganic waste management. Venn diagram exhibits the dominance of the willingness to pay towards inorganic waste. WTP towards inorganic waste overlaps entirely into the region of WTP of organic waste leaving no distinct region. On the contrary, the overlap by the WTP towards organic waste into the domain of WTP of inorganic waste is 68.8 per cent leaving 31.2 per cent as a distinct region to the inorganic waste.

The study estimates the average willingness to pay towards organic and inorganic waste management to examine the difference in mean willingness to pay towards organic and inorganic waste. As expected, the result shows that the mean willingness to pay towards inorganic waste is high (193.0) compared to organic waste (121.1). It implies that the disposal of inorganic waste is difficult as well as public bad when compared to organic waste.

7.7 WTP towards Public and Private Project.

Kozhikode Corporation collects day to day organic waste from the households with the help of Kudumbasree and Corporation sanitary workers. A private service provider like 'Niravu' collects inorganic waste from households with the help of residents association. The hypothetical waste management plant ensures the collection of both organic and inorganic waste from households and the majority of the people are willing to pay for the project. Here, the query is whether the households prefer public or private to carry out this project which is presented in Table 7.24.

Table 7.24: Willingness to Pay towards Public and Private Project

Public \ Private		WTP to Private (%)		Total
		Willing	Not willing	
WTP to public (%)	Willing	15.7	55.5	71.1
	Not willing	12.2	16.6	28.9
Total		27.9	72.1	100

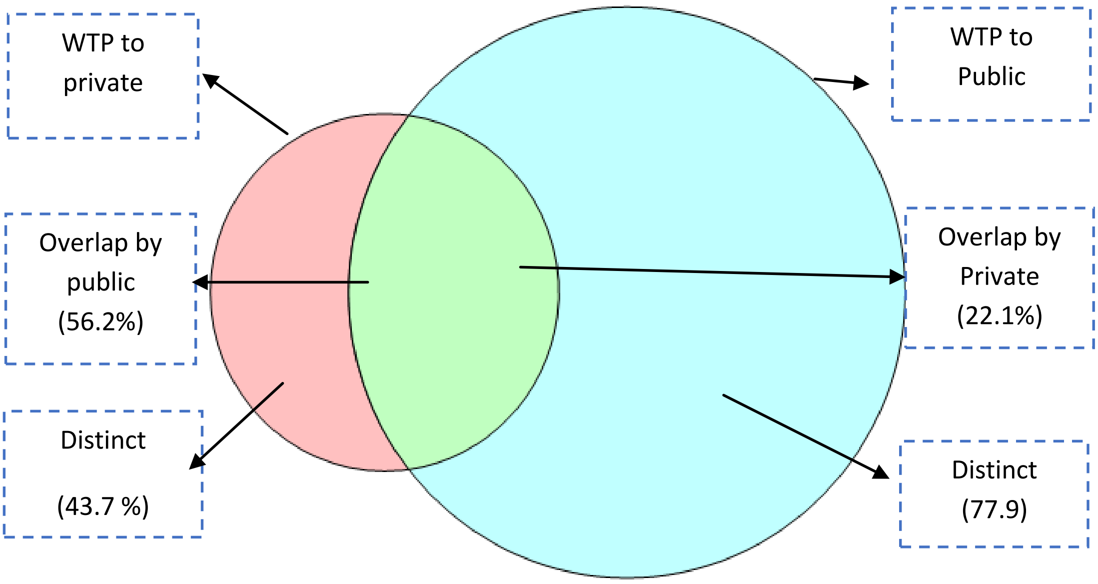
Source: Primary data.

Table 7.24 shows that a substantial percentage of households (71.1 per cent) are willing to pay towards the public agency. It is found that 15.7 per cent of the sample households is willing to pay towards both the private and public. Table 7.24 also shows that 16.6 per cent of the sample households is not willing to pay any amount for waste management towards the public and privately owned project.

Each of these sample households express different opinions for their preference towards public and private project. The results show that households prefer public project mainly because of trust in public service (59.3 per cent). On the other, the major reason for households' preference for the private project is the efficiency of the private sector (75.7 per cent).

The Venn diagram shows the overlapping circles to illustrate the willingness of the households towards both public and private agencies while the differences are represented in the non-overlapping portion of the circles.

Figure 7.19: Overlap in the WTP towards Public and Private Project



Source: Constructed from primary data.

The study examines the households' WTP towards the private and public owned project for improved waste management. Figure exhibits the dominance of public owned project in the household's preference. Venn diagram brings out the distributional overlaps between WTP towards public and private owned project. WTP towards public owned projects overlaps 56.2 per cent of the private leaving 43.7 per cent distinct region. On the contrary, the overlap by WTP towards private into the domain of public owned project was 22.1 per cent leaving 77.9 per cent as a distinct region to the public owned project. Distributional overlaps at the aggregate level for the WTP towards improved waste management shows the complete domination of public owned project.

The study estimates the average willingness to pay of households towards public and private owned project. As expected, the result shows that the mean willingness to pay towards public owned project is high (161.1) compared to private (72.5). It implies that people prefer public owned project because of trust and confidence in government.

Households who are willing to pay are asked to indicate the payment vehicle likely added to the monthly water bill or any other bill or to impose its service charge that they prefer for the household waste management. No one preferred water bill as a means of payment, and 99.1 per cent preferred its service charge for disposing of solid waste. This shows that the residents are satisfied with its billing system as a mean of payment towards waste management. Similarly, the households who are willing to pay are asked to indicate the frequency of payment on a daily, weekly and monthly basis towards the waste management scheme. This is expected to have a positive influence on one's willingness to pay for waste collection. The longer the interval it offers a time frame to the payer that could enhance his willingness to pay and vice versa. The study shows the majority (94.1 per cent) preferred monthly payment as a comfortable frequency and no one preferred daily payment for waste collection.

7.9 Conclusion

This chapter reveals that the majority of the households are willing to pay towards improved waste management mechanism and their average willingness to pay is Rs.201with a standard deviation Rs.160. Willingness to pay of the households is positively influenced by monthly income, household size, size of the homestead, gender, age, availability of waste disposal service and quantity of waste generation. But household size and age have a negative effect on WTP of the households. The education level of the sample household is not significant against the theoretical expectation. The proportion of income spent on WTP is high among low-income group compared to the high-income group. Similarly, the proportion of total expenditure on WTP is high among the households proximate to the waste treatment plant. It is also found that households do not prefer alternative methods of waste management like controlled land fill and gas production because these methods may create all the issues of waste disposal again. It will not wash out the problem completely. Hence, people are willing to pay for hypothetical project featured by ensuring clean environment. Similarly, households are willing to pay more towards inorganic waste compared to organic waste as inorganic waste is remained as a public bad whose disposal is difficult task as far as household is concerned. Sample households prefer public owned project than the privately because of their trust in the public agency. Here, the role of the State is to ensure solid waste management, especially towards inorganic waste with expected utilities from the polluter as they value environmental degradation than the supply of public bad.

CHAPTER 8

Summary of Findings and Policy Implications

- ***Summary of the Procedure***
- ***Summary of Major Findings***
- ***Policy Implications***
- ***Areas for Further Research***

CHAPTER - 8

Summary of Findings and Policy Implications

8.1 Summary of the Procedure

The present study examines solid waste generation, heterogeneous management praxis and willingness to pay for improved waste management by the households in Kozhikode Corporation as a representation of urban households in Kerala. The burden of solid waste generation demands a sustainable and scientific management strategy. There are both public and private service providers engaged in door to door collection of household solid waste. However, the burden of solid waste necessitates huge expenditure for its management. The community willingness and participation are the operational challenges generally faced by the authorities in collecting user charges. Therefore, quantification of the willingness of the community is a pertinent issue at the implementation stage of user charge. Quantity of waste generation and households willingness to pay are the resultant effect of socioeconomic factors of households along with enabling factors such as awareness level, availability of waste collection service, practice of segregation and locational factors. The present research examines the predictive effect of these factors in policy formulation and implementation for sustainable solid waste management practices. The research has thus endeavoured to enquire into the following issues.

First, the study examines the quantity of solid waste generation and the factors that determine waste generation among urban households. This involves an exploration of the types and quantity of waste generated among urban households. To identify the determinants, the quantity of waste generation among households per week is taken as the dependent variable, and socio-economic variables like the monthly expenditure of households, household size, size of homestead and education level are identified as independent variables. Along with this, enabling variables like practice of segregation and availability of waste disposal service are considered to explain its relation with household waste generation. The expected relationships are examined in conformity with economic theory, and the results are tested through econometric models. A multiple regression framework is employed to determine the factors that influence waste generation among households. An alternative regression model is also employed by taking per capita waste generation as a dependent variable to keep robustness and for theoretical construct.

Second, the study examines the heterogeneous practice of solid waste management by urban households in Kerala. It involves an analysis of the perception and practice of waste disposal, practices of storage and segregation and current issues and challenges pertaining to waste disposal. It also involves service quality dimensions of both public and private service providers in waste collection. Discriminant analysis is employed to identify the most prominent service quality dimensions of both public and private service providers in waste collection and to identify how far the households discriminate the service of private and public service providers. Principal component analysis is employed to reduce various dimensions of service qualities of public and private service providers into two components Factor 1 and Factor 2.

Third, the study estimates household willingness to pay towards improved solid waste management. The dichotomous choice method of contingent valuation method is employed to estimate this. WTP towards organic and inorganic waste and WTP towards private and public owned project are elicited through CVM. Venn diagram is followed to examine the magnitude of overlaps in WTP towards public and private service providers and to examine overlaps in WTP towards organic and inorganic waste disposal. The study employed one way ANOVA to determine whether there is any statistically significant difference between the means of willingness to pay towards different features of the project like ensuring clean environment, provision of safe drinking water, control of rodents and mosquitoes, waste recycling for gas production and construction of a controlled landfill with a large lifespan**.** Specific group differences are examined through Games-Howell ‘post hoc test’.

Finally, the study examines the factors that determine the household's willingness to pay for a clean environment by employing a multiple regression model. To identify the determinants, maximum willingness to pay of households per month is taken as the dependent variable, and socio-economic variables like the monthly expenditure of households, household size, education level, gender and age of the respondents are identified as independent variables. Enabling variables like quantity of waste generated, availability of waste disposal service and proximity to waste management plant are also identified as independent variables.

The study collected information from a total sample of 384 households belong to Kozhikode Corporation along with the focus group discussion with waste collectors and plant workers to gather information about solid waste generation, disposal, management and willingness.

8.2 Summary of Major Findings.

The urban households in Kerala generate different types of wastes such as organic, plastic carry bags, recyclable plastics, glasses and lights, e-waste, sanitary napkins, dresses and others. Average waste generation among sample households is 5.3 kg per week with a standard deviation of 1.79, and per capita waste generation is estimated at 1.23kg per week.

The study reveals that monthly expenditure, household size, educational background and size of the homestead are the critical socio-economic correlates affecting the household solid waste generation. Households with higher income generate more waste than the lower income group because of their higher consumption. The size of the households has a positive relation with waste generation because increase in the household size leads to an increase in resource consumption thereby increased waste generation. Households who possess sufficient land for disposing of their solid waste are not much concerned about waste generation and its disposal. The highlighting fact is that waste generation across education showed a negative relation because educated members are supposed to have relatively higher levels of knowledge, awareness in environmental quality and try to follow green consumerism.

Along with socio-economic variables, the enabling variables such as availability of waste disposal service and practice of segregation of waste are the important determinants of waste generation. Waste generation is more among those who have waste disposal service than that who do not have. It shows that waste generation and the availability of waste disposal service are directly related. The intended objective of waste disposal service by the authorities is to reduce environmental pollution and thereby to ensure environmental quality. However, the incentives work undesirably that waste generation increases as the availability of waste disposal services increases. The so-called cobra effect is happening when an attempted solution to a problem makes the problem worse, resulting in unintended consequences. Availability of waste collection service make the people less bothered about its management and generate more waste. It shows changing the behaviour of the public towards incentives. Hence government intention to manage and dispose of waste properly has an adverse effect as stated in the cobra effect.

The increased waste generation demands different methods of management mechanism. A substantial number of households dispose of organic waste by digging in the compound followed by deploying Kudumbasree. A notable feature is that a negligible percentage of household dispose of organic waste by composting like pipe compost and a small group depends on biogas facility. Only a small per cent of the households has benefitted government assistance for maintaining both biogas and compost. The practice of household level composting of waste which was very common earlier has now become defunct and needs to be revived.

Plastic is an inevitable part of consumption, and the disposal of plastic waste especially plastic carry bags or sachets becomes a serious issue. A substantial number of households chooses burning for disposing of plastic carry bags. Private service provider 'Niravu' collects plastic waste from households, but only a small group of households depends on these agencies because of their irregular nature of collection. Rag pickers do not collect non-recyclable plastic. However, households rely on rag pickers for disposing of recyclable wastes, e-waste, bulbs, tube lights and glasses. Households face many challenges while disposing of solid waste such as irregular collection and transportation, poor disposal, shortage of land, low income, inefficient laws and policies etc. The prime challenge of waste management is poor disposal method.

Public and private service providers are engaged in door to door collection of household solid waste. Public service provider mainly focus on collecting organic waste from households whereas private service provider for disposing of inorganic waste, especially plastic waste. The prominent service quality dimensions of both public and private service providers revealed that public service provider is preferred on five dimensions such as regularity in collection, waste collection charge, efficiency in collection, attitude of the collector and total performance. Private service provider is preferred only in the dimension related to feasibility in collection. From the structure matrix, it is observed that regularity in the waste collection has maximum loading towards public service provider. It revealed that regularity in waste collection is the most important variable for discriminating the public agency from the private. Feasibility in the waste collection is more dominant for discriminating the private against the public.

Results from the analysis of service quality offer strong analytical possibilities. The results go in line with the theory that market failure in ensuring environmental quality necessitates government intervention. However, government failure persists in ensuring feasibility in the collection, which paves the way for the intervention of private service provider. The formal privatisation of solid waste collection activities had been often flagged as a suitable intervention for some of the challenges of solid waste management experienced by public service provider. While the public service provider performed comparatively well in some dimensions, the private service provider also had areas where it had a competitive advantage. For instance, the private provider used the collection crew more feasibly, while the public provider is found more regular. Private sector participation is an essential component of waste management. Private sector participation is one of the best choices open to boost the performance of public service like solid waste management.

Finding financial resource is one of the major issues in managing solid waste. Using dichotomous choice method, it is found that a leading part of households are willing to pay for improved waste management and the estimated mean willingness to pay is Rs.201/- per month with standard deviation Rs.160. It indicates that on an average, Rs.201 is the market price placed by the households for a clean environment. By multiplying the estimated mean willingness to pay by total households in Kozhikode Corporation, the amount will be Rs.34, 547,277/. This is the total amount that total households in Kozhikode Corporation place for environmental quality through improved waste management. This amount shows the willingness of the residents in Kozhikode to purchase improved domestic solid waste management as a commodity. At mean WTP, only 55.7 per cent of the households are willing to pay. Hence it is better to set a socially acceptable fee in which the majority of people are willing to pay.

Determinants of the WTP of the households towards improved waste management shows monthly expenditure of the household, availability of waste disposal service and quantity of waste generation directly influence willingness to pay. Mean WTP of the low consumption group is low compared to high spending group. Even then we could not treat these poorest groups as vulnerable concerning their low WTP because their waste generation is also low due to their low consumption pattern. The mean willingness to pay of the households who generate more waste is higher than the estimated willingness to pay. Thus it is concluded that the high-income group generates more waste and at the same time they are willing to pay more. However, things get reversed concerning the proportion of income spent by the households towards a clean environment. The proportion of income spent on WTP is more among the low-income group than among the high-income group. This result strengthens the theoretical construct.

Willingness to pay is low for households who own adequate land for disposing of their solid waste because they are least concerned about waste disposal. Results reveal that the gender of the respondent influences the WTP of the household. Willingness to pay among female respondents is high compared to that of a male as females normally handle solid waste issues in the home. Therefore females are keener about waste and its disposal compared to males. The size of household and age negatively influences the WTP. This shows that the larger the family size, the lower the households' willingness to pay for waste management because extended family members may help them in managing wastes. Besides, there is a possibility that poor income groups have large family and they are not ready to pay more for waste management due to the overburden. An inverse relation between age and willingness to pay reflect that monetary valuation of the environmental quality decreases with the age of the respondents. It also reveals that perception on the value of money may vary among the different age group.

The study observes willingness to pay of the households across the proximity to dumping site and found that WTP is high among the households in Strata II because households in Strata II are living in the heart of the city. Consumption expenditure of the households in Strata II is high which leads to more waste generation and at the same time the size of the homestead to dispose of waste is low. Actual willingness to pay of the households in Strata I is below the estimated willingness to pay. It is not because of their reluctance to pay and perception on environmental quality but due to low income compared to households in Strata II. Things get reversed while estimating the proportion of income and expenditure spent on WTP in different strata. The results bring out that proportion of income and expenditure spent on WTP is high among the households in Strata II compared to Strata I. This is theoretically strong result because households in Strata I are the real victims of issues of waste disposal as they are proximate to the dumping ground.

The study found a direct relationship between willingness to pay of households and availability of waste disposal service. About half of the sample households got waste collection service either from Corporation or private agency. The result shows that WTP is more among those who have waste disposal service and it is less in the case of those who do not have waste disposal service.

As theoretically expected, it is found that education level of the respondent is positively related to WTP for improved waste disposal services. It revealed that as the level of education increases, the tendencies to adopt and pay for improved disposal services would also increase. On the contrary, econometric results show that education has no significant influence on willingness to pay.

Mean willingness to pay towards disposal of inorganic waste is higher than organic waste. The distributional overlap in the WTP for organic and inorganic waste management shows that the households who are willing to pay for organic waste management are completely willing to pay for inorganic waste management. The study exhibits the dominance of households' willingness to pay towards inorganic waste. It shows that inorganic waste is a public bad and disposal of inorganic waste is too difficult compared to organic waste. Similarly, the distributional overlaps in WTP between public and private owned project exhibits complete domination of public owned project. Regularity in the present waste management service by the public sector strengthened households' confidence in public sector project.

The study reflects that mean willingness to pay of households towards the clean environment is high followed by WTP towards safe drinking water and control of mosquitoes. It indicates environmental quality is the major attribute for which people give priority than gas production and construction of the landfill. It is also found that households do not prefer alternative methods of waste management like controlled land fill and gas production because these methods may create the issues of waste disposal again. It will not wash out the problem completely.

The present economic activity and development process poses a serious threat to environmental quality. Human activities related to household solid waste is a threat to environmental quality. Waste generation and the present waste management practices followed by urban households demand special attention to household involvement in the form of willingness to pay for improved SWM thereby environmental quality. The estimated willingness to pay of the households for improved waste management is higher than the actual payment. However, at the estimated mean WTP, only 55.7 per cent of the households are willing to pay. Hence a socially acceptable fee may be set in which the majority of people are willing to pay. The study recommends that public policy can be called for incorporating the contribution of households for better waste management. Thus, the contribution of society towards improved solid waste management can be considered as a reflection of the societal aspiration towards environmental quality and sustainable living.

8.3 Policy Implications

Solid waste management service is non-excludable. Once it is provided to some sector of a community, it benefits the overall public welfare. The service is also non-rivalled, means that any resident can enjoy the benefit of the service without diminishing the benefit to anyone else. As it is an urban issue, government level responsibility falls under the local or metropolitan authorities. This does not, however, means that local government bodies have to accomplish the task of solid waste service delivery entirely by their staff, equipment, and fund. This is where the role of the private sector takes the lead.

The formal privatisation of solid waste collection activities has often been flagged as a suitable intervention for some of the challenges of solid waste management experienced by public service providers. It was found that while the public sector performed comparatively well in some dimensions, the private sector also had areas of competitive advantage. For instance, the private sector used the collection crew more feasibly, whereas the public sector was found to be more regular. The study recommends that, while formal private sector participation in the waste collection has some positive effects regarding the feasibility of service rendered, it has to be enhanced by creating sufficient capacity within the public sector.

The intended objective of waste disposal service is to reduce environmental pollution and thereby ensure environmental quality. However, the resulting move in an undesirable way that waste generation increases as the availability of waste disposal increases. It shows changing the behaviour of the public towards incentives because incentives may not always be straightforward. Here the desire of the government is the protection of environmental quality by collecting waste from households. However, people use this opportunity to generate more waste that is an attempted solution to a problem makes the problem worse. So the government may charge a progressive rate of fee on household waste generation through which incentives can be reframed in the right direction.

If people are informed about the nature of improvement towards solid waste management, the envisaged welfare improvement elicits people's WTP (Hartwick et al., 1998). Therefore, WTP can be used to predict the level of welfare gained from improved SWM system. By the existing system of fees, solid waste management cannot be improved and cannot cover its costs. Therefore, the participation of residents is important to improve the waste management system in the city. Current payment for SWM in the city is much below the WTP of the people. The study recommends that public policy can be called for incorporating the contribution of households for efficient and better waste management. The results can be used as a guide for policymakers concerning issues such as tariff and is also an indication of the benefits of improving solid waste management. Charging different rates for different income groups is highly recommended as it seems to be affordable and it will generate more revenue for the authorities. The study recommends that solid waste collection and disposal levies be introduced as a cost recovery measure because it is clear from the study that generally people are willing to pay for a clean environment. The citizens are eager for improved SWM, so there is a solid reason to increase the fee and acquire sufficient funds to improve and modernise SWM in Kerala.

There should be an intensive public campaign to educate people about the danger of waste in our localities and benefits associated with the clean environment to reduce waste generation and increase the WTP for improved environmental quality in general and improved solid waste management in particular. It is clear that the traditional educational system is not enough to promote environmental awareness among the public. So our educational system should be reframed by incorporating environmental education to promote eco-literacy, green consumerism and environmental responsibility.

8.4 Areas of Further Research

Major academic research contributions of the study are it provides theory-based explanations on waste generation and willingness to pay on the empirical context of the solid waste management system of Kerala. Though there are a few relatively recent studies on the issue of providing strategies and competition in quality dimensions, the present study has tested service quality dimensions of public and private service providers in the waste management system. Moreover, the study found the changing role of public and private service providers in ensuring environmental quality which needs to study in a different region to reach a more generalised conclusion. As such, the study has substantially contributed towards employing a methodology for calculating and presenting actual willingness to pay off the households towards improved waste management to elicit willingness to pay as a welfare measure for ensuring environmental quality. Accordingly, the study recommends further studies with new insights concerning the role of socio-economic factors in affecting household waste generation. The study found that education is the only one variable that has a negative influence on the waste generation which provides hope on the restructuring of the curriculum by including environmental education as a mandatory programme which will bring a desirable result. Besides it is advised to educate and inform the public about scientific planning for waste collection and disposal thereby the necessity of maintaining environmental quality. It is important to study health problems in all the operational areas of MSWM including waste collection, transportation, treatment and disposal. Life of the people near the dumping ground is so pathetic. So it is important to examine the health and environmental problems of people living near the dumping ground.

Even though solid waste management is a highly discussed subject, it is revealed that a very few studies have been conducted so far in this area with a specific contribution to the field of environmental economics in the Kerala context. All operational areas of MSWM require critical attention to its potential for degrading environment and human health. Hence the study throws up some issues for further enquiry. As a densely populated State, in Kerala, slight mismanagement of solid waste will substantially affect the masses inhabiting the urban areas. It will create multi-dimensional but far-reaching repercussions for the urban population. Proper studies on this subject are required to be highly prioritised but getting very little attention presently. The concern of these studies are still more on the availability of integrated waste management mechanism and thereby a movement towards a sustainable society.

ANNEXURE 2.1

Market Instruments for Environmental Valuation

Charges and Fee System is a revenue generating instrument aiming at waste reduction by charging a fee either based on a flat rate or unit rate pricing by local government or by private agencies in charge of service delivery. Waste user charge based on flat rate pricing is a fee charged for delivery of waste service, specifically for collection services, but often designed to cover all source costs, usually based on the ability to pay, size of the property, and level of commercial activity at the property. In a flat rate charging systems, fee is the same for households regardless of the quantity of waste generated by them and hence no incentives to reduce wastes. On the other hand, a charge based on unit pricing scheme is calculated based on volume (or weight) of waste generated by the households or commercial establishments. Empirical evidence shows that while charging household for the volume of waste they discard, it can control the growth of solid waste, reduce collection and disposal costs, extend the life time of existing landfills, and encourage household recycling. The net effect of these charges is households may recycle, compost, or engage in source- reduction according to the private costs they face. Empirical study shows that the bag unit pricing programme will improve social welfare and reduce municipal expenditure on waste disposal services.

Pollution Fee or Tax is the charge for the amount of waste or pollution. Several European nations have air and water pollution chargers; unit pricing for trash pickup, charging by the amount of trash collected (or the size of the container). The charge makes it worthwhile for a producer to cut back, right up to the point where it begins to cost more to reduce pollution than to pay the tax. Pollution Charges are based on 'polluter pays' principle.

Waste Tipping Charge is levied as fee for the payment of unloading service, specifically for transfer, treatment, and / or landfill service. Tipping refers to the collection truck unloading at the service facility. However, it was reported that landfill charges were found to face implementation barriers in Bolivia, Venezuela, with a lack of institutional capacity for the measurement of value.

Product Charges are special fees for handling products with difficult disposal requirements or adverse environmental impacts. Generally the revenue generated through these product charges are used for financing collection, treatment, recovery and disposal of problem products such as batteries, tires etc.

Waste Disposal Tax is a differentiated tax per tonnes of waste for final treatment and / or disposal; with lower taxes charged for more environmentally sound treatment or disposal methods. Many EU countries have introduced waste tax as part of their waste management strategy. A tax on business activities or waste weight / volume discharged that is directed towards safe disposal in a landfill site is called a land fill tax. It is aimed at reducing waste to be land filled and takes care of the external costs associated with landfill.

Deposit Refund and Product has been practiced in many countries for safe disposal of solid waste. A deposit is imposed at the time of purchase of a product and allows the consumer for a refund of the charge at the end of the product cycle. The purpose of DRS is that the consumer must return the product or its container for waste recovery, recycling or safe disposal. Examples include deposit refund system for electric bulbs, beverages and PET (Polyethylene Terephthalate) bottles, soft drink, beer, wine, glass, aluminum cans, pesticide or fertilizer containers etc. Recently, the Forest Department of Kerala has launched “Sabari Wastes” at Pampa for the use of pilgrims at Sabarimala. The innovative step that it has taken to bring down plastic waste is to take back the empty bottle by paying Rs.1/- per bottle to the pilgrims.

ANNEXURE 2.2

Review of Literature at a Glance

Empirical works	Area of the Study	Outcome of the Study
World Bank Study (1999); Roy & Tisdell (1999); Patil (2001); Chaudhary & Sahoo (2001); Barthwal (2002);Waste Composition Study (2009); Jain (2016).	Environment and Development	Development without ensuring a healthy environment cannot be described as sustainable one. Hence successful implementation of policy measures is requisites for healthy and sustainable development.
World Bank (2012); UNEP (2004); Shaharholy et al., (2006); Malinya Muktha Kerala (2007); CPCB (2012-13); ADB (2013); Varma (2013); Okalebo (2014); Nnaji (2015); Jadeja (2015); Ministry of Environment and Forest, Govt. of India (2016);	Magnitude of waste generation in India and Kerala.	Fast expansion of industrial activities, rapid population growth, increasing national income contributes increase in per capita waste generation in India. Urbanisation, changing life style, rise in tourism are the main reason for the rise in waste generation in Kerala.
World Bank (1999); Varma (2007); Kayode (2011); Adebo (2012); Sankoh (2012); Limbu (2013); ADB (2013); Rakib et al., (2014); Olayungbo et al., (2014); Nnaji (2015); Trang et.al., (2016).	Magnitude of household waste generation and factors influencing waste generation	Empirics show that major share of all municipal wastes comes from household wastes. The quantity of waste generated from households varies according to income, food habits, age, educational and occupational status.

Empirical works	Area of the Study	Outcome of the Study
Salifu (2001); Shyjan et al., (2005); Ogawa (2008); Afroz et al.,(2009); Abul (2010); Ejas et al.,(2010); Adebo (2012); Alam & Ahamade (2013); Sing (2013); Sankoh et al., (2013); Rakib et al., (2014);WHO (2015); Nnaji (2015); Maheswari et al., (2015);De & Debnath (2016)	Health and Environmental issues of solid waste.	Uncontrolled generation of solid waste and improper disposal coupled with poor collection services poses a great threat to environmental quality and human health like irritation of skin, nose, eyes, allergies, headaches psychological disorders etc. Besides, Inadequate collection and disposal of solid waste causes soil, air and water pollution which provides a breeding ground to flies, rodents and insects.
Okalebo et al., (2005); Ray (2008); Zhang et al., (2010); Vithrana (2014); Guerrero et al.,(2013); ADB (2013); Dheeraj et al.,(2013); Lohri et al., (2014); Ministry of Environment and Forest, Govt. of India (2016); Lahiri (2017)	Solid *waste management: Challenges*	SWM is one of the most poorly rendered services in developing countries like India i.e. unscientific, outdated, inefficient in some area and population coverage is low in other area. It is because of the lack of technical and human resources, proper planning and inefficient budget and lack of political leadership. The higher per capita solid waste generation is another challenge faced by a country like India. The cost of SWM increased significantly due to rising cost related to waste transportation. Empirical works reveal that the present waste management system can only be improved by ensuring public participation through very serious motivational efforts

Empirical works	Area of the Study	Outcome of the Study
USEPA (2002); Ahmed & Ali (2004); Malinya Muktha Keralam (2007); Shaharholy et al., (2008); Shekdar (2009); Andrew (2009); Memon (2010); Singh &Chari (2010); Koshy (2010); Banga & Margaret (2013); Bernard & Mildred, (2015)	Sustainable waste management policy	The 3R approach 'reduce, reuse and recycle' is becoming a leading philosophy for improved waste management. ISWM has been introduced to streamline all the stages of waste management that is segregation, collection, transportation, treatment and final disposal.Literature show that with the application of environmental education greater success ratio could be achieved in SWM.
Mitchell& Carson (1989); Tsimamma (2001); Carson et al., (2001); Juana (2001); Fonta & Ichoku (2005); Jin et al., (2006); Fonta et al., (2008); Smith (2011); Wang et al., (2011); Hagos et al., (2012); Joel et al., (2012); Ojo et al., (2015); Padi et al., (2015); Damigos et al., (2016);	CVM and WTP towards improved waste management.	WTP of households are directly influenced by income, education, age, occupation, environmental awareness and availability of disposal methods among which income is considered as main factor that determine willingness to pay. In the application context, it is found that CVM can be used successfully to determine the factors that determine willingness to pay towards improved solid waste management. WTP reflects the need for scaling insight into various domains of CVM and WTP in a realm where the echoes of community versus project frictions are very common.

Source: Author's Compilation

Appendix

INTERVIEW SCHEDULE FOR SOLID WASTE MANAGEMENT AND WILLINGNESS TO PAY AMONG URBAN HOUSEHOLDS IN KERALA: PRACTICES AND DETERMINANTS

Introduction

This interview schedule is designed to facilitate the assessment of the current practice of solid waste management and willingness to pay among urban households in Kerala. The information collected by this interview schedule is indented to evaluate the quantity of waste generation, factors affecting waste generation, the status of storage, collection, disposal, awareness level towards solid waste management, willingness to pay for improved waste management and factors affecting willingness to pay among the households in Kerala. To enable an accurate assessment, it is important that the information requested in the interview schedule may be provided as completely and accurately as possible.

1. Descriptive identification of sample household

1. State	.	4..Panchayath	
2.District / ward		5.Name of head of household	
3.Sub District/ Town		6. Name of informant	

2. Household characteristics

1.Household size		11. The total area of land you possess (in cents)	
2.Principal Occupation (code)		12.Whether the household has a compound yard(yes-1, no-0)	
3.Household Type(Code)		13. Type of structure (code)	
4.Monthly income in Rs		14. Ownership status (code)	
5. Average monthly expenditure in Rs		15.Type of family (code)	
6.Religion (Code)		16.Years of stay in the house	
7.Social Group (Code)		17. Do you have ration card (yes-1, no-0)	
8.Whether owns any land (yes-1,no-0)		18.If yes in item 17, type of ration card (code)	
9.If yes in item 8, the type of land owned (code)		19.Type of Latrine (code)	
10. The total area of a homestead. (in cents)		20.Type of Drainage (code)	

CODES FOR BLOCK-2

Item2: Principal occupation: *govt. employee-1, private employee-2, agriculture-3, businessman-4, coolie-5, self employed-6, professional-7, others 9*

Item3: Household type: for rural areas: *self-employed in non- agriculture-1, agricultural labour-2, other labour-3, self-employed in agriculture-4, others-9*

For urban areas: *self employed-1, regular wage/ salary earnings-2, casual labour-3, others-9*

Item6: Religion: *Hinduism-1, Islam-2, Christianity -3, others 9*

***Item 7**: **Social group**: scheduled tribe-1, scheduled caste-2, other backward class-3, others-9.*

***Item 9**: **Type of land:** homestead only-1, homestead and other land-2, other land only-3.*

***Item13: Type of structure**; pucca-1, semi pucca-2, serviceable kutcha-3, unserviceable kutcha-4, no structure-5,*

***Item 14: Ownership status**: owned-1, rented-2*

***Item 15: Type of family**: joint family-1, nuclear-2*

***Item 18**: **Type of ration card**: antyodaya-1, BPL-2, others-9.*

Item 19: Type of latrine: *latrine service-1, pit-2, septic tank/ flush system.-3, others-9, no latrine-4*

***Item-20: Type of drainage**: open kutcha-1, open pucca-2, covered pucca-3, underground-4, no drainage-5.*

3. Demographic particulars of household members

Sl. No.	Name of member	Relation to head (code)	Sex (female-1, male-0)	Age (years)	Marital status (code)	General education level (code)
(1)	(2)	(3)	(4)	(5)	(6)	(7)

CODES FOR BLOCK 3

(3)Relation to head: *self-1, spouse of head-2, married child -3,spouse of married child-4, unmarried child-5, grandchild-6, father/ mother/ father in law/ mother in law-7, brother / sister/ brother in law/ sister in law/ other relatives-8, servant/ employees / other non-relatives-9.*

(6) Marital status: *never married-1, currently married-2, widowed-3, divorced/ separated-4*

(7) General educational level: *not literate-01, literate without formal schooling-02, primary-03, secondary-04, higher secondary-05, degree/ diploma -06, postgraduate and above-07.*

4. Solid waste generation and management practices among urban households

1. Type of solid waste generated in your house

   1. Organic waste (Kitchen waste and paper waste)
   2. Plastic covers and plastic bottles
   3. Recyclable plastic waste 4. E-waste. 5. Glasses and mirror
   6. LED, CFL light and bulbs 7. Old clothes 8. Disposable Nappies.
   9. Others 10. All

2. Among the above following which is more
3. How many Kg (approximately) of solid wastes are generated in your house per week ________
4. Do you have any storage facility for solid waste in your house _______

   1. Yes 0. No

5. If yes, what is it made of?

   1. Plastic 2.Metal 9.Others

6. If no, what is the main problem you noticed in the storage of solid waste?

   1. Foul smell 2.Can't afford bins
   3. Irregular collection 4. An increasing number of Mosquitoes and flies
   5. Segregation 9. Any other

7. Do you separate waste into organic and inorganic?

   1. Yes 0. No

8. If yes, specify the reason for segregation

   1. Efficient disposal of solid waste. 2. To get manure
   3. A ready market for recyclables 9. Others

9. If no, specify the reason for non-segregation.

   1. Can't see the importance of segregation 2. Can't afford separate bins
   3. Segregation is time consuming 4. No ready market for recyclables
   5. I pay for solid waste 9. Others

10. How do you dispose of solid waste?

Sl no	Type of solid waste	Disposal method (code)
1	Organic waste	
2	Plastic covers and bottles	
3	Other plastic waste	
4	E-waste	
5	Glass and mirror	
6	LED, CFL light and bulb	
7	Old clothes	
8	Disposable nappies	
9.	Others	

Code: Use nearby dustbin-1, digging in the compound-2, Throw it on an open space or the street-3, burning-4, depends on private waste collector-5, depends on government services/ Kudumbasree-6, maintain biogas -7, composting-8, any other (specify)-9

11. If the method of disposal is composting, specify.

1. Pipe compost 2. Pot compost 3. Vermin compost 4.Ring compost

5. Pit compost 6.Bio-gas 9. Others

12. Composting mechanism is funded by

1. Own expense 2. Government fund 9. Others

13. What are the challenges associated with solid waste management?

1. Household size 2. Poor collection

3. Poor disposal method 4. Low-income level.

5. Lack of laws and policies 9. Other

14. Are you getting solid waste collection or disposal service from any private agency?

1. Yes, 0. No

15. If yes, how much do you pay for this service per month?

16 . Are you getting solid waste collection service or disposal from Government agency?

1. Yes, 0. No

17 If yes, how much do you pay for this service per month?

18 Kindly give your opinion of the service quality dimensions of public and private service providers in solid waste management based on the following scale.

1. Very good 2. Good 3.Satisfactory 4.Unsatisfactory 5.Very bad

Quality dimensions	Public service provider	Private service provider
Regularity in waste collection		
Waste collection charge		
The efficiency of waste collection		
The attitude of the Collector		
Feasibility in Collection		
Total performance in waste management		

19 Does the waste collector collect both organic and inorganic waste?

1. Yes 0. No

20 If no, which type of waste they collect?

1. Organic 2. Inorganic

21 In the absence of a collection of inorganic waste, how do you dispose of?

1. Landfilling. 2. Burning. 3. Collection rag pickers 4. Throwing. 9. Others

22 What are the reasons for choosing the government / Private service?

1. Proper collection 2. Low cost

3. Collect both organic and inorganic waste 9. Others

23 What do you suggest to improve this condition?

1. Regular collection 2. Charge low price 9. Others

Part-2: Project description

I am presenting a hypothetical scenario before you. The government is planning to start an improved solid waste management project. Kozhikode Corporation has been chosen as the pilot location of this new scheme. The project will take into consideration different aspects of efficient solid waste management starting from generation of wastes to final disposal. The project aims to improve the environmental and living conditions of the residents of your locality. The project would entail each household collecting its solid waste products weekly in subsidised polythene bags and drums for onward collection to the new landfill site. The benefits to be derived from the scheme would include cleaner environment as a result of regular disposal of waste, safe drinking water, control of rodents and mosquitoes, construction of controlled landfills and waste recycling for gas production for household consumption.

The key characteristics of the new project are

- A new collection system that ensures 100 % collection of wastes.
- Cleaner environment as a result of regular disposal of waste.
- Safe drinking water
- Control of rodents and mosquitoes
- Reduction in bad odour
- Waste recycling for gas production for household consumption.
- Construction of a controlled landfill with a large lifespan.
- Avoid contamination of groundwater

I want to find out how much your household would be willing to pay for the sustainability of this project. For the scheme to be sustainable, each household has to contribute some money monthly to a trust fund managed by elected members of this community and the funding agencies. That is to say, the contribution from the public in the form of user charges is required.

Household willingness to pay for improved solid waste management

24 Would you willing to pay for the improved solid waste management in support of the new scheme?

1. Yes 0. No ☐

25 If yes, would you willing to pay Rs 100 per month for this?

1. Yes 0. No ☐

26 If yes, would you willing to pay Rs 200 per month for this?

1.Yes 0. No ☐

27 If yes, what is the maximum amount would you willing to pay per month (in Rs.)?

28 What is the reason ☐

1. For a clean environment 2. To avoid contamination of drinking water

3. To avoid mosquitoes 4. To avoid pollution 9. Other reason

29 If the answer to question 25 is “No”, would you willing to pay Rs 50 per month for this?

1. Yes 0. No ☐

30 If no, what is the minimum amount would you willing to pay per month (in Rs….)?

31 Why are you not willing to pay anything for this improved solid waste management? (Attitude towards willingness to pay)

1. The amount you are asking us to pay is too high
2. We cannot pay due to poor income.
3. We do not have faith in the community trust fund
4. The scheme is not important to us
5. We satisfied with the current situation
6. Waste management is the responsibility of government
9. Other reasons

32 Alternative Bids for the SWM (Rs. Per month)

1	2	3	4
Bids value sets(B)	B^d	B^u	WTP (YY, YN, NY, NN)
100	50	200	
200	100	400	

B- Initial amount.

B^d- second bid if the response to the first bid was "no".

B^u- second bid if the response to the first bid was "yes".

33 WTP (Rs/month) towards different features of the project

1	2	3	4	5	6	7	8
Sl No	Features	B	Bd	Bu	Willingness (YY, YN, NN, NY)	Maximum (if Column 6 is YY)	Minimum (if Column 6 is NN)
1.	Clean environment and reduction in bad odour	100	50	200			
2	Safe drinking water	100	50	200			
3.	Control of mosquitoes	100	50	200			
4.	waste recycling for gas production for house-hold consumption	100	50	200			
5.	Construction of a controlled landfill with a large lifespan	100	50	200			

B- Initial amount.
B^d- second bid if the response to the first bid was "no".
B^u- second bid if the response to the first bid was "yes".

34 Are you willing to pay for the management of organic waste?

1. Yes 0.No

35 If yes, how much would you willing to pay per month…..?

36 Are you willing to pay for the management of inorganic waste

1. Yes 0. No

37 If yes, how much would you willing to pay per month…..?

Willingness to pay towards public and private owned project (In Rs/ Month)

Sl No	Characteristics	Public				Private			
		Willing	Maxi-mum	Not willing	Mini-mum	Willing	Maxi-mum	Not willing	Mini-mum
1	Clean environment and reduction in bad odour								
2	Safe drinking water								
3	Control of mosquitoes								
4	waste recycling for gas production for household consumption								
5	Construction of a controlled landfill with a large lifespan								

Code1-Willing, 0-Not willing

38 Why do you prefer Govt. owned project.

1. More efficient. 2. Faith in Govt. sector

3. Feasibility in management 9. Other reason

39 If you do not prefer Govt. owned project, please specify the reason

1. Cannot afford to pay 2. Govt. should pay

3. Don't have faith in Govt. project 9. Other reasons (specify)

40 Why do you prefer Private agency?

1. More efficient. 2. Don't have faith in faith in Govt. Project

3. Feasibility in management 9. Other reason

41 If you do not prefer Private owned project, please specify the reason

1. Cannot afford to pay 2. Govt. should pay

3. Don't have faith in Private owned project

9. Other reasons (specify)

42 What is the mode of payment?

1. It's own 2. With water bill 9. Any other (specify)

43 What is the frequency of fee collection that you prefer

1. Daily 2.Weekly 3. Monthly

44 How would you rate municipal solid waste management in your locality?

1. Very good 2. Good 3.Satisfactory 4. Unsatisfactory 5.Very bad

45 What is your opinion about the municipal solid waste management in your locality and its implications on society?

46 What is your opinion to treat municipal waste? Suggest to improve

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