Chapter 1
Introduction

1.0 Background of the study

Modern day cities and towns have evolved over a period of time. As time progressed, human civilization evolved into more organized and complex habitations and the modern day city stands at the top. Hunting and gathering were replaced by villages which further evolved into cities. The early part of the 19th century saw a rapid growth of cities (Hurriot and Thisse, 2000). The speed with which our planet was urbanized was spectacular. In 1950, the world urban population was 734 million out of which 448 million was in the developing countries. By the end of the 20th century the world urban population increased to more than 5 billion with 2 billion in the developed countries and the rest in the developing countries (U.N 1990).

In recent years, the world economy has achieved considerable economic and social development. The adoption of market oriented policies and the active participation of the private sector has contributed immensely to this development process. Although significant economic and social progress has been made, this has resulted in the widespread degradation and depletion of our natural environment[1]. The analysis of long term consequences of economic growth was shown in the form of natural resource limits in Malthusian scarcity (1798), Ricardian scarcity (1817), Mill's stationary state (1857) and Jevons's coal question. The essence of the environmental problem is the economy-producer behaviour and consumer desires. Without the economy, most environmental issues are simply research questions of concern with no policy significance.

[1]This came into focus from the mid sixties with the writings of Rachel Carson ("The Silent Spring"), Barry Commoner ("The Closing Circle") and The Club of Rome ("The Limits to Growth).

1.1 Major concepts

i) Environment

Environment provides the resources to satisfy the basic needs of human life. Apart from this it plays an important role in the ethical, religious, social and cultural values of societies. Palmer (1998) adds political, economic, technological, moral, aesthetic, and spiritual aspects to the environment. Human beings are dependent for their living, health, and enjoyment of life on the basic biological systems. Ecosystems provide many services to mankind such as recreation, tourism, etc. This multiplicity in nature indicates the complexity of the issues concerning natural resource management. Benefits derived from the sustainable use of natural and environmental resources are generally categorized into three groups: ecosystem services, biological benefits and socio-economic benefits. Ecosystem services include the protection of water resources, soil formation and protection, nutrient storage and cycling, pollution breakdown and absorption, contribution to climate stability, maintenance of ecosystems and recovery from unpredictable events. Ecological diversity is essential in the maintenance of ecosystems. Any degradation in ecosystems will not only affect production of plants and animals but also represent real threats to human life on the planet. Biological benefits represent the bulk of human consumption, whether direct consumptive use (i.e., food consumption, medicinal resources, wood products, breeding stocks, etc.) or indirect consumptive use (i.e., recreation, bird watching, ecotourism, etc.).Socio-economic benefits that can be generated from sustainable and efficient use of environmental resources include recreation and ecotourism.

ii) Economics and environmental economics

Economics being a science of choice analyses how people choose to employ scarce resources that could have alternative uses in order to produce goods and services and to distribute them for consumption, in the present or in

the future, among various persons and groups in society. This definition of economics when applied to environmental resources, becoming scarce due to their overuse around the world, we are at the center of environmental economics, which seeks the optimal use of environmental resources in order to sustain and maintain environmental quality. During the last four decades a number of important human problems have been explained and analysed in the subject which have enlarged its frontiers.

iii) Tragedy of the Commons

In traditional economic thinking, privately held resources will not be mismanaged or depleted, since depletion would not be in the interests of the owner of the resource. Certain resources like grazing land, ground water basin and forests are considered as common property resources that are often jointly owned by local communities. These resources have two characteristics (a) non-excludability and (b) non-rivalry in the sense that one member uses more, less will remain for others. These features make it prone to depletion or degradation as its use is pushed beyond the limit of sustainable yield. This process, by which a common property resource is depleted because no individual has an incentive to conserve, was first outlined by biologist Garrett Hardin in 1968 as 'The Tragedy of the Commons' while dealing with the problem of over exploitation of grazing land with open access. It is a tragedy, as it would be in the interest of all if everyone were to conserve, without access or restrictions, however, this will not happen.

iv) Market failure

Environmental problems are considered as problems of non-optimal pricing and misallocation of resources. For many environmental goods there is either the complete absence of markets or they are incomplete. The presence of complete markets for each good is essential for the optimal distribution of

resources in the economy and the lack of it will result in the inefficient distribution of resources. Environmental degradation and pollution occur when the market fails to take into account the true value of environmental quality to the society. The absence of a market has led to the unregulated use of the environment and its wide spread degradation.

v) Paretian optimality

According to Pareto, an optimal distribution of resources is reached if it is impossible to redistribute resources in the economy in such a way that it benefits one individual without harming another. Pollution and environmental degradation are cases of market failure that results in the non-optimal distribution of resources. This is the result of externalities and incomplete markets. Externalities are one of the main causes of market failure (Arrow 1969). The presence of externalities creates Marginal Social Costs (MSC), which even a competitive economy fails to consider during pricing. In general economic theory, the price fixing is done by considering the marginal private cost (labour. rent. etc.). The exclusion of the externality induced social costs will result in non-optimal production of goods. (Samuelson P.A.1954, Bator 1958, Akerlof.G 1970).The market is incapable of controlling environmental degradation due to the public good character of environment (non-exclusion and non-rivalry in consumption). The presence of incomplete markets makes it difficult to fix a price for the environment that will reflect its true value and hence alternative methods have to be used to find out the value of environmental quality.

vi) Waste

Waste can be simply defined as useless remains or byproducts. Solid waste can be defined as the non-liquid waste materials arising from domestic, trade, commercial, industrial, agricultural and mining activities and from the

public services (WHO, 1976). Although waste can be generally defined as worthless and useless byproduct (Webster's 1984), a more specific and precise definition is given by environmental literature. Gilpin (1976) gave a comprehensive definition for waste and defined waste as a matter, liquid, solid, gaseous or radioactive which is discharged or emitted or deposited in the environment in such a volume, constituency or manner as to cause alteration of the environment. Allaby (1977), extended the definition by adding the disposal component of waste and defined waste as any substance, solid liquid or gaseous for which no use can be found by the organism or system that produces it and for which a disposal method has to be devised. Hoornweg et al (1999), defined waste as an unwanted material intentionally thrown away for disposal.

vii) Solid waste

The issue of solid waste emerged in the literature mainly due the environmental awareness created by the publication of 'Silent Spring' by Rachel Carson in the early seventies. One of the earlier definitions for solid waste was given by World Health Organisation (W.H.O) in 1971 defining solid waste as waste arising out of man's activity which is not free flowing. Another important definition was given by Gilpin (1976, 1996), defining solid waste as all material of solid and semi solid character that the possessor no longer considers of sufficient value to retain. Solid waste is broadly defined as including non-hazardous industrial, commercial and domestic refuse including household organic trash, street sweepings, hospital and institutional garbage, and construction wastes; generally sludge and human wastes are regarded as a liquid waste problem outside the scope of MSW (Olar Zorbeck et al 2003). Cointreau (1982) defined solid waste as organic and inorganic waste materials produced by households, commercial, institutional and industrial activities, which have lost their value in the eyes of the first owner. Sinha (1997) defined solid waste as a heterogeneous mass of useless material, which may originate from homes or commercial or industrial activities. The Municipal solid wastes

(Management and Handling) Rules (2000) by the Central Pollution Control Board, India defines solid waste as commercial and residential wastes generated either in solid or semi solid form, excluding industrial hazardous wastes but including treated biomedical wastes. The Ecological Solid Waste Management Act of The Republic of Philippines (2000) defines solid waste as all discarded household, commercial waste, non-hazardous institutional and industrial waste, street sweepings, construction debris, agricultural waste and other non-hazardous/non-toxic solid waste.

viii) Municipal solid waste

Solid wastes are now classified in different ways. On the basis of sources of origin it is classified into industrial, hospital and Municipal Solid Waste (MSW). It is also classified into hazardous and non-hazardous categories on the basis of the toxicity of materials in the waste. Municipal solid waste can be generally defined as wastes generated by residential, commercial, industrial, institutional, construction, demolition, process and municipal services. But this definition is not strictly followed by studies and in most of the studies wastes generated by industrial, construction and demolition and municipal services are excluded. Schübeler (1996) points out that although certain contaminated medical wastes and hazardous industrial wastes are not included by definition, in many nations these are in fact part of the municipal waste stream. Municipal solid waste has been defined by The Ecological Solid Waste Management Act of the Republic of Philippines (2000) as the wastes produced from activities within local government units which include a combination of domestic, commercial, institutional and industrial wastes and street litters.

ix) Solid waste management

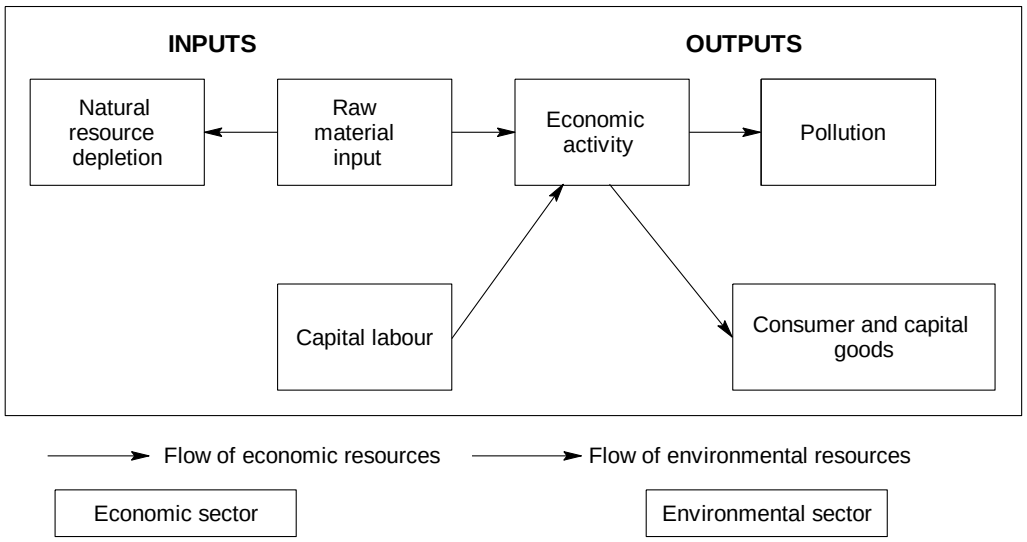
Solid Waste Management (SWM) as a concept has evolved over a period of time. The earlier definitions gave importance to the operational

aspects of solid waste management starting from the generation of waste to its final disposal. Gilpin (1976) defined solid waste management as a planned system of effectively controlling the production, storage collection, transportation, processing and disposal or utilization of solid waste in a sanitary, aesthetically acceptable and economic manner. It includes all the administrative, financial, legal and planning functions as well as the physical aspects of solid waste handling. The Ecological Solid Waste Management Act 2000 of the Philippines considers solid waste management as a discipline associated with the control of generation, storage, collection, transfer and transport, processing and disposal of solid wastes in a manner that is in accord with the best principles of public health, economics engineering, conservation, aesthetics, and other environmental considerations, and that is also responsive to public attitudes. Babu Ambat (2000) defines solid waste management as the process associated with the control of generation, storage, collection, transfer and transport, processing and disposal of solid wastes in a manner to public attitudes. In its scope, solid waste management includes all administrative, financial, legal planning and engineering functions inorder to counter the problems raised by solid wastes.

1.2 Environment-economy interaction

There exists a close relation between economy and environment. Figure: 1.1 shows the interrelationship between the economy and the environment

Figure: 1.1



Source: Prabha Panth (2005).

Input used in the economic activity not only includes labour and capital but also raw materials. As economic activity increases, exploitation of natural resources also goes up, leading to its depletion. On the output side, along with the conventional economic goods, pollution is also an output. Economic activity which includes production and consumption requires inputs of natural resources and releases pollution, which imposes environmental costs. Environmental costs include natural resource depletion, pollution and the break down of the life support system of our planet.

1.3 Economic growth, urbanisation and environmental degradation.

Rising population, rapid urbanization and increased use of natural resources have given rise to a number of serious environmental problems like loss of bio diversity and habitat destruction, depletion and degradation of forest resources, marine resources, air and water pollution, waste disposal.etc. According to World Development Report (1999-00), Economic growth and urbanisation are closely related trends. Urbanisation stimulates severe

environmental problems which mean that a higher rate of economic growth and urbanisation results in increased environmental problems. So there exists a close link between economic growth, urbanisation and environmental degradation. Loss of crops and grazing land, depletion of the world's tropical forests, species extinction, rapid human population growth, shortages of freshwater resources, over fishing, habitat destruction, pollution, threats to human health, global climate change, acid rain and pressures on energy resources are the ten main threats to environment. There are now about 6 billion people in the world and the global population is currently increasing by about 78 million people per year Population is rapidly consuming the once vast supply of natural capital, especially the resources of deep and rich agricultural soils, natural sources of groundwater, and biodiversity (Nancy Kanbar 1999).Environmental pollution is a problem faced by both developed and developing countries. But unlike the developing world, the developed world has already started taking measures to tackle environmental pollution. The task of dealing with pollution is quite challenging for the developing countries due to so many constraints.

The increase in urban solid waste produced by society is becoming a huge problem all over the world, leading to high levels of pollution and destruction of natural resources. In most urban areas, waste is collected either by a government agency or private contractors, which is considered as a basic government function in the developed countries. Most cities do not collect the totality of wastes generated and only a fraction of the waste collected receives proper disposal. The insufficient collection and inappropriate disposal of solid wastes represent a source of water, land and air pollution, and pose risks to human health and the environment. Around 30-50% of populations in many developing countries are urban (Thomas-Hope 1998). In many African countries the growth rate of urban areas exceeds 4% (Senkoro 2003). Globally, in 1985, 41% of world population lived in urban areas and 2015 it will be around 60% (Schertenleib 1992). Developing nations spend between 20% and 40% of their municipal revenues on waste management (Thomas-Hope 1998, Schübeler 1996, Bartone 2000), but this is not enough to keep pace with the

magnitude and scope of the problem. It is projected that the total expenditure on solid waste management activities in Asia may double from an estimated $25 billion in 1999 to $50 billion in 2025(World Bank 1999). African countries while prioritizing their environmental concerns has rated solid waste as the second most important problem after water quality since less than 30% of urban populations have some access to proper and regular garbage removal (Senkoro 2003).

1.4 Statement of the problem.

The Urban Solid Waste Management (USWM) is one of the challenges faced by modern urban societies in the world. The issue of USWM has been widely addressed by researchers. The global burden of MSW amounted to 1.3 billion metric tons in1990 and is estimated to increase at an annual rate of 2.7 % by the year 2010 (David.N.Beede et al 1995). The issue of waste and pollution are inseparable, when defined in a narrow sense. Solid wastes are the most visible form of pollution. It is argued that the source of most of the environmental problems lies in the inability of the economic system to take account of the valuable services the natural environment provides us. The provision of waste sinks to receive and assimilate all types of wastes from the economic system is such a service. Solid waste pollution occurs when the ecosystem functioning is hampered by an over load in the carrying capacity of the natural environment due to the sheer bulk and complexity of waste (David Pearce et al 2000). The changing economic trends and rapid urbanisation complicate solid waste management in developing countries. As a result solid waste is not only changing in quantity but also changing in composition from organic to non-biodegradable wastes like paper, packing waste, plastics, glass, metal wastes among other wastes which lead to the low collection rates (Bartone et al 1993).The quantities and characteristics of solid waste produced vary from country to country and the factors that influence it are the average level of income, the sources, the population, social behavior, climate, industrial production and the market for waste materials (Baldisimo 1988). Unplanned

human settlements, rapid resource use and improper waste disposal worsen the situation and affect the life of the present and future generations.SWM in most cities of developing countries is highly unsatisfactory. The social task of waste management has always been to get rid of it (Murray 1999).

Improper solid waste management causes all types of pollution. The main impacts created by solid waste pollution are health impacts, environmental impacts like contamination of surface and ground water due to indiscriminate dumping of wastes and the formation of leachate, economic impacts like land price decrease and social impacts like disamenity effects. The major problems due to solid waste in developing countries are i) health hazards from uncollected waste ii) health hazards from collected but poorly disposed of waste iii) the economic burden of waste disposal on towns and cities (David Pearce et al 1994).

Although human health risks associated with solid waste handling and disposal are present in all countries, the problems in underdeveloped nations are more acute and widespread. The health risks are classified into four main categories: i) presence of human fecal matter ii) presence of potentially hazardous industrial waste iii) the decomposition of solids into constituent chemicals which contaminate air and water systems and iv) the air pollution caused by consistently burning dumps and methane release (Cointreau, 1982). Insects and rodents breed on solid wastes and can spread diseases like cholera and dengue fever. The U.S Public Health Services have identified twenty two human diseases that are linked to improper solid waste management. The health risks from waste are caused by many factors, including: The nature of raw waste, its composition (e.g. toxic, allergenic and infectious substances), and its components (e.g. gases, dusts, leachate, sharps); The nature of waste as it decomposes (e.g. gases, dusts, leachate, particle sizes) and their change in ability to cause a toxic, allergenic or infectious health response; The handling of waste (e.g. working in traffic, shoveling, lifting, equipment vibrations, accidents); The processing of wastes (e.g. odor, noise, vibration, accidents, air

and water emissions, residuals, explosions, fires); The disposal of wastes (e.g. odor, noise, vibration, stability of waste piles, air and water emissions, explosions, fires) (Cointreau,2005).

Human fecal matter is present in every solid waste system in developing nations and the intensity of the problem varies with the prevalence of proper sanitary disposal systems such as municipal sewerage or on-site septic systems, outhouses, etc. This presents a potential health problem to waste workers, scavengers, other users of the same municipal drop-off point, and small children who play in or around waste containers. The disease pathways include placing contaminated hands in the mouth or eating food, through vector insects such as cockroaches or mosquitoes, or by directly inhaling airborne dust particles contaminated with pollutants. In Indian landfills, roundworms (Ascaris spp.) and whipworm (Trichuris spp.) were commonly found, especially in those landfills located near lower-income neighborhoods and slums (Cointreau 1982).

Kerala has achieved high health standards in areas like birth rate, death rate, Infant Mortality Rate (IMR), Life Expectancy, control of infectious diseases, etc. but the state now faces problems like high morbidity rate, reemergence of infectious diseases, life style diseases etc.(Economic Review ,2004). The table1.1 shows the occurrence of major infectious diseases in Kerala.

Table1.1: **occurrence of infectious diseases**

Disease	2003	2004	2005	2006	2007	2008
Leptospirosis	1569	1082	1366	1811	1220	1288
Dengue	3546	686	1028	1011	677	734
Chicken guinea	-	-	-	70731	24052	24683
Cholera	61	91	27	12	4	6
Malaria	2586	1584	1322	1805	1203	1481

Source: Directorate of Health Services, Kerala (2008)

The table: 1.1 shows that the occurrence of Leptospirosis and Malaria are quite prevalent in the state. The emergence of Chicken guinea is another disturbing trend. The occurrence of dengue and cholera has shown a declining trend. Statement showing the sex-wise break up of cases and death due to communicable diseases in Alappuzha district is given in the appendix.

Solid wastes are generally disposed by incineration, land filling, and composting. Land filling is the most popular and commonly used method of solid waste disposal. It is found that land fills causes serious health and environmental risks in the form of externalities like formation of leachate and landfill gas leading to water and air pollution and disamenity effects like increased population of pests, flies, vermin, and visual impacts. (Lee and Jones-Lee 1993, UNEP 1999, CPCB 2000). The decomposition of waste into its constituent chemicals is a common source of local environmental pollution. The problem is acute in developing nations since those countries could not meet the high environmental standards accepted in developed countries. With rapid urbanization human settlements encroach upon landfill space for living. Landfills present long-term threats to groundwater and surface water that are hydrologically connected. Major concern is about leachate or "garbage soup," the watery solution that result after water passes through a landfill. Leachate presents several risks to human health and the environment as it affects the current and future quality of groundwater. Leachate composition varies relative to the amount of precipitation and the quantity and type of wastes disposed. In addition to numerous hazardous constituents, leachate generally contains nonhazardous parameters that are also found in most groundwater systems. These constituents include dissolved metals (e.g., iron and manganese), salts (e.g., sodium and chloride), and an abundance of common anions and cations (e.g., bicarbonate and sulfate). These constituents in leachate are found at greater concentrations than concentrations present in natural groundwater systems. Leachate from MSW landfills has high values for total dissolved solids and chemical oxygen demand, and a slightly low to moderately low pH.

MSW leachate contains hazardous constituents, such as volatile organic compounds and heavy metals. Wood-waste leachate contains typically high amounts of iron, manganese, and tannin and lignin. Leachate from ash landfills is likely to have elevated Ph and to contain more salts and metals than other leachate. The alkaline nature of the solid waste is responsible for the increase in the soil pH (Goswami et al 2008). For safe application of the solid waste compost for growing food crops, the pH value of the compost should be in the range 5.5-8.5(Giasquini et al 1988). A typical leachate quality of municipal solid waste is given in the appendix.

Another major environmental concern is release of methane gas and carbon dioxide by decomposing garbage. Methane is a by-product of the anaerobic respiration of bacteria, and these bacteria thrive in landfills with high amounts of moisture. Methane concentrations can reach up to 50% of the composition of landfill gas at maximum anaerobic decomposition (Cointreau-Levine, 1996). In developing countries few landfills have the facility for methane recovery as the required capital for methane recovery installations is lacking. The methane gas seeps into porous soil surrounding the waste and eventually migrates into basements and homes, posing an explosion risk. Carbon dioxide buildup in nearby homes could be a cause of asphyxiation. Carbon dioxide is readily absorbed for use in photosynthesis but methane is less easily broken down, and is considered 20 times more potent as a green house gas. For every metric ton of unsorted municipal solid waste (containing 0.3 Mt carbon), 0.2 Mt are converted to landfill gasses. Of this gas, carbon dioxide and methane each comprise 0.09 Mt. it is believed that landfill gasses supply 50% of human-caused methane emissions and 2-4% of all worldwide greenhouse gasses, this is clearly an area of concern in global environmental issues (Hoornweg, et al 1999 and Johannessen 1999).

One of the important economic impacts created by the solid waste is the impact on residential property values. Residential property values are affected

by factors like good road network, infrastructure facilities (water, electricity, drainage, etc) accessibility (in terms of traffic flow) and demand, location and distance. Apart from this, residential property values are affected by the generation and management of solid waste (Ogedengbe et al 2006). The social impacts created by MSW include the unpleasant odour when garbage is left uncollected and the unpleasant odour due to landfill site, the dirty surroundings, breeding of mosquito, worms, insects and flies due to the landfill site and the uncollected garbage and the release of smoke and poisonous gases giving rise to safety problems. These impacts are also refered to as disamenities due to MSW (Blore .I et al 1996).

The present study has focused on the MSWM and the health, socio, economic and environment impacts due to improper SWM in Alappuzha municipality. Alappuzha district with an area of around 1400 Sq.Km and a population of about 21 lakh is one of the most densely populated districts in the state of Kerala. The Alappuzha municipality with an area of 46.77 sq kms is divided into 50 wards and has a population of 177029 with 37595 households as per 2001 census (Panchayat Level Statistics 2006). The place, surrounded by backwaters has become a major tourist spot. Wastes are disposed by households, industries, hotels, hospitals, slaughter houses etc. The two canals, the commercial canal and the vadaicanal which was one of the main attractions of the town is now a dumping place for wastes. Against this background the study is carried out with the following hypotheses and objectives.

1. 5 Hypotheses

1) Solid waste management of Alappuzha municipality has created health, environmental, economic and social impacts on the population.

2) Willingness to Pay (WTP) for an improved solid waste management system depends on income, education, children, house ownership, gender and environment ethic.
3) WTP has a positive relation with income, education, children, house ownership and a negative relation with gender.

1.6 Objectives

1. To examine the origin and nature of the urban solid wastes.
2. To analyse the existing SWM practices
3. To study the health, environment, socio-economic impacts of solid waste management.
4. To study the nexus between WTP and improved solid waste management system.
5. To examine the factors that influence the WTP for the improved solid waste management system.
6. Suggestions.

1.7 Data and methodology

Both primary and secondary data were used for the study. Primary data was collected using a questionnaire survey. Details can be seen in the approach to the study chapter. Secondary data were collected from various sources such as economic survey, economic review, pollution control board, municipal office, socio-economic unit foundation, Alappuzha and the office of health officer, Alappuzha.

1.8 Limitations

This study has the following limitations. Statistics relating to the MSW are scattered and inadequate. Municipalities don't keep adequate data and

quantifiable treatment of the environmental issue is hardly possible. Within the constraints, tools that are popularly used to analyse environmental issues are used based on a sample study. The limitations applicable to any sample study will be applicable to the present study also.

1. 9 Structure of the study

Chapter 1 deals with the introduction to the study. It includes the statement of the problem, the hypotheses and the objectives of the study. Chapter 2 gives the review of literature. Chapter 3 deals with approach to the study and includes the statistical tools used for analysis. The following chapter gives a brief overview of the generation rates, nature and composition of USW at a global level. The next chapter deals with urban solid waste management approaches. Chapter 6 outlines the salient features of the study area, solid waste generation, composition of solid waste, financial aspects and the administrative set up of the solid waste management system. Chapter 7 deals with the micro analysis of the impacts of USW management. The penultimate chapter deals with the statistical treatment and the final chapter gives the important conclusions of the study and suggestions.

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Chapter 2

Review of Literature

Extensive literature exists in urban solid wastes management. These studies help us to understand the issue and its impacts on the environment. Majority of the studies conducted in this area of research is in respect of developed countries As regards Kerala, the impact assessment studies have done by researchers which highlight the seriousness of the issue. More micro level studies are needed to address the issue. A brief review of the available literature sheds light into this area of research.

Wertz (1976) analysed the economic factors influencing household production of refuse considering two Detroit suburbs in the U.S and estimated the income elasticity of demand for household waste management services as 0.27.

Richardson et al (1974) and Richardson (1978) analysed the seasonal household solid waste generation and an economic analysis of the composition of households solid wastes respectively. They 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. The income elasticity of demand for household waste management services was estimated as 0.24.

Baldismo (1988) while analysing scavenging of municipal solid waste in Bangkok, Jakarta and Manila, observed that the quantities and characteristics of solid waste produced vary from country to country and identifies the factors that influence it as the average level of income, the sources, population, social behaviour, climate, industrial production and the market for the waste materials.

Jenkins (1993) in his study on American municipalities and found that waste generation increased with increase in the percentage of population in the age group between 18 and 49. She also developed a model where households maximize utility, which positively depends on the consumption of goods and negatively on the quantity of recycling. The budget constraint included a disposal charge for municipal solid waste collection. The quantity of municipal solid waste generated was found to be sensitive to the price of municipal solid waste collection. Analysing data for in American municipalities, she found that a $1.00 dollar fee per 32-gallon trash bag would reduce waste generation by 15 percent. She estimated that such a pricing system would improve social welfare by $650 million per year ie around $3 per person per year. The average price elasticity for municipal solid waste collection was -0.12.

Mclain (1995) identified the changes in lifestyle in the last 50 years as the main cause for the increased solid waste generation in the U.S.A. The increase in nuclear families, increase in women's participation in work and the usage of modern kitchen equipment has increased the need for packaged foods which has accelerated the rate of after consumption waste. It was found that, in the U.S about 33% of the waste consisted of containers and packaging materials.

Beede and Bloom (1995) assessed the relative importance of growth in real per capita income and population in determining municipal solid waste generation rates. Analysing data from a cross section of 36 countries the income elasticity of was estimated as 0.34 and population elasticity as 1.04. Again using time series data for the U.S. (1970-1988) and for Taiwan (1980-1991), they found the income elasticities as 0.86 and 0.59 and population elasticities as 0.63 and 1.63. Using data set for households, they found that household waste generation as income inelastic and an approximately unit elasticity with respect to population.

De Konning H et al (1995) surveyed 21 Latin American countries and showed that the per person generation rate of industrial hazardous waste sludge and solids is a function of the country's industrialization. Countries like Brazil and Mexico had high rates of over 0.3tons/person/year and countries like Bolivia and Equador had lower rates of less than 0.1tons/person/year.

Dennison et al (1996) while conducting a survey of household waste characteristics in the city of Dublin, Ireland, showed the relationship between socio-economic factors and the composition of the waste generated in Dublin. Using a sample of 857 households, the study identified prosperity and household size as the important variables. The data showed substantial differences in the relative composition of the waste stream as compared with the earlier studies undertaken in the late 1970s. The proportion of organic waste was found to be in excess of 45% by wt. in the study as compared with 34% in 1977/78. The results showed a big difference between the prosperous and the less prosperous section of the city's population with regard to individual and overall waste generation.

Martin Medina (1997) analysed the relationship between the municipal solid waste generation rates and income for 123 countries. A curvilinear shape was found for the relationship between the two variables which shows that as a country develops its waste generation rate increases but as it reaches the middle income and upper income range the generation rate decreases.

Podolsky and Spiegel (1998), analysed municipal waste disposal, unit pricing and recycling opportunities on 149 municipalities in New Jersey in the U.S and identified a negative relation between average household size and waste generation rates indicating a possibility of household diseconomies of scale in waste generation. They also found that urban households generated less solid waste when compared with rural households mainly due to the space constraint in the urban areas.

Hong (1999) examined the effect of unit pricing system upon household solid waste in Korea. He used a data set of 3017 households from 20 cities in Korea and estimated the household solid waste generation being income inelastic at 0.10. Kinanman and Fullerton (1997), Hong et al (1999) and Jenkins et al (2003), in their respective studies found a negative relation between household size and solid waste generation.

Houtven and Morris (1999) in their study examined household behaviour under alternative pay-as –you-throw systems for solid waste disposal and observed that the amount of mixed waste increased considerably with the number of small children and adults between the age group 25 to 64 years. They also found that urban households generated less solid waste when compared with rural households.

Sterner and Bartelings (1999) considered the attitudinal variables that influenced the quantity of municipal solid waste generated by households in Swedish municipalities. It was found that apart from economic incentives a proper recycling structure would induce the households to invest more time in recycling and composting.

Bhattarai.R.C. (2000) analyzed the household behavior on solid waste management in Kathmandu metropolitan city and found household size and income as the major determining factors for the total quantity of wastes generated.

Salhofer (2001) has dealt with four different approaches to analyze waste generation rates. i) Input –output models: In input –output models the input of the waste generator is assessed by using production, trade and consumption data about products related to the specific waste stream; ii) Factor models: These models consider analyzing factors like income, housing types etc

which describe the processes of waste generation; iii) Region specific classification iv) Single point of generation based classification and v) Macro level classification.

P.Beigl et al (2003) has identified the parameters that explain the present situation and to assess the future amount of municipal solid waste generated per capita in different European cities. Gross domestic product was found to be a significant factor in cities with high prosperity but not for cities with a lower economic output. Of the social indicators, a positive relationship existed between the percentage of the medium age group (15-59) and municipal solid waste generation while a negative relationship existed between the average household size and the solid waste generation.

Hong et al (1993) has examined the solid waste generation and recycling behaviour of the households within a household Portland, Oregon, U.S.A, by developing a household recycling choice model and a demand function for municipal solid waste disposal. The model was applied to a sample of households from the Portland, Oregon metropolitan area. It was found that the marginal pricing with zero charges for recyclables may provide incentives for households to dispose of less waste through garbage collection services which may be done by generating less total waste or by increasing recycling effort. A positive but small relation was found between an increased price of waste collection and the quantity of municipal solid waste generated.

Morris et al (1994) considered the effectiveness of marginal cost pricing of garbage on waste generation and recycling. They identified that price increase on disposal did not affect recycling as it reduced the household's increased total waste generation.

Miranda et al (1994) found that introducing unit pricing and recycling programs can affect significantly the quantity of municipal solid waste

generated. They also found that market based incentives on the management of residential municipal solid waste will improve the efficiency of residential solid waste management.

Fullerton and Kinanman (1996) has analysed the effect of volume based pricing program in Charlottesville, Virginia, U.S and found that the programme had a substantial effect on the volume but no effect on the weight of waste as the weight per bag increased. Volume based collection fees will result in practices called 'Steatle Stomp' as the households compact garbage into fewer bags. It was estimated that there was a 28% reduction in garbage but it may be due to illegal dumping.

Ackerman (1997) found that the initial introduction of unit pricing system results only in slight reduction in waste disposal through dumping. Kinnaman and Fullerton (2000) finds that if illegal disposal or burning options exists as a choice for the households to dispose waste then unit pricing will increase illegal dumping. Jenkins (1993), Blume (1991) and Miranda and Aldy (1998) have also come up with the same conclusions. Dinan (1993) argues that a uniform tax on all types of garbage might be inefficient if materials within the waste stream produce different social costs.

Bruvoll A. (1998) analysed the effect of income, waste management fees and population density on the overall amount of waste generated and of income, fees and recycling services on the choice of waste management methods. It was found that the overall quantities of municipal solid waste are not influenced by income. Economic incentives were found to be effective in influencing the selection between different waste management methods. Landfill fees reduce the waste amounts landfilled and increase recycling and incineration. But the effect of landfill fees on total waste generation is negative but not significant.

Pratt.R.M. et al (2000) has analysed the impact of Waste minimization clubs on waste minimisation. Waste minimization clubs are formed to encourage industry and commerce to adopt waste minimization methodology. A good majority of the clubs have helped in achieving a significant reduction in solid, liquid and gaseous waste along with financial savings due to higher efficiency.

Mongkolnchaiarunya, J. (2005) explains the new practices that were introduced in the city of Yala in Southern Thailand to deal with the problem of solid waste management. One of the practices was known as 'Garbage for Eggs' in which the residents were allowed to exchange recyclable material for eggs. The important objectives of the project were waste reduction, community empowerment through self reliance, establishing new relationships of equality and less dependence between poor communities and the municipal administration.

Kaseva et al (2005) considered the effect of privatization on solid waste collection and disposal in Dar es Salaam city, Tanzania. The total solid waste generation was around 2425 tons/day. It was found that with privatisation the solid waste collection improved by 10% to 40% of the total waste generated in the city daily in 2001. The study recommends the use of waste recycling and composting activities in order to attain sustainability in waste management.

A good number of studies have considered the effects of landfills and incinerators on property value decrease, ground water contamination and health. One can find a number of studies dealing with the property value decrease due to the proximity to landfills. The observation is that as the distance from the landfill increases, the property value increases. Hedonic property price study were done to estimate the disamenity costs.

Havlicek et al (1971), used hedonic method to consider the effect of five landfills on property values in Fort Wayne, Indiana, USA. The price survey of 182 house sales from 1962-70, within the neighborhood of the landfill showed that there was a $9800 increase in house price per mile from the landfill. A study done at same place by Havlicek (1985) found that the house price rose by 5% per mile away from the landfill.

Gamble et al (1982) analysed the effect of water contamination due to the presence of a hazardous waste site in Pleasant plains, New Jersey, U.S.A using hedonic method. A price survey of houses sold both before and after 1974 found a 10% fall in house prices for 1.5 –2.25 miles from the landfill. Baker (1982), in his study estimated a 21% to 0.55% fall in the house prices as the distance from the land fill increased from 0.5 miles to 1.25 miles from the site.

Michaels et al(1990) using hedonic method, examined the effects of 11 hazardous waste sites on property values in the suburban Boston, U.S.A, during the time period 1977-81. The average increase in property values was found to be $253 dollars per house with increased distance from the waste site.

Nelson et al (1992) examined the effect of landfill in Ramsey, Minnesota, USA on property values. Using hedonic method, the price survey of 708 house sales during 1979-1989, within 2 miles close to the landfill was considered. The house price was predicted to rise by an average of $4896 or by 6.2% as the distance from the landfill increases by a mile. Hirshfeld et al (1992) using hedonic method found a value reduction of 30% to 13% as the distance increased from 0.5 miles to 1.25 miles from the landfill site.

Keil et al (1995), analysed the effect of incinerators on property value in Massachusetts. The study used hedonic method and covered a period of 18 years and 2593 house sales within that time period. It was found that during the

construction of the site there was a reduction of 1.7% per mile in the house value had increased to 3.2% per mile when it was completed.

Ogedengbe et al (2006) has examined the effect of waste management method on property values in Ibadan city, Nigeria. Eleven firms of estate surveying and valuation out of thirty-six registered estate surveying and valuation firms in the study area were selected using systematic random sampling technique. In addition, 15 properties within the axis of three refuse dump sites were selected using stratified random sampling technique to know how their rental values are affected by the generation and management of these dump sites. The results showed that the waste dumps have significant negative impact on the property values in the area.

Bacud et al (1994), analysed the water quality of drinking wells around the Payatas dumpsite in Quezon City, Manila, Philippines and has shown the acidification of ground water and the increased presence of nitrates and Coliform bacteria.

Pushpakumari (1997) analysed the effects of pollution of Travancore Titanium Products and brings out the adverse impacts of pollution from the factory. The areas very close to the factory were more prone to the pollution hazards. It was found that 19% of the people in the experimental group were affected by respiratory and related diseases. Other effects include low coconut yield, declining fish yield and fish species, corrosion of fishing crafts and gears, increasing trend of the locals leaving their traditional fishing to other occupations.etc.

Shameer Das et al (2000) in their study examined the health impacts of environmental pollution by solid waste disposal from Grasim Industries, Kerala. The effluents from the industry were found to pollute the river Chaliyar and thus directly affecting the population living nearby. It was also found that the

discharges from the factory was degrading the ecological quality of the area in the form of contaminated water, polluted air, solid wastes and noise. Around 56% of the people surveyed were affected by some diseases caused by pollution. The lower and lower middle income group were most affected. The main health problems were in the form of the occurrence of diseases like persistent coughs, bronchitis, asthma, headache, cancer and eye irritation.

Nilanthi et al (2003) has analysed the environmental impacts associated with current waste disposal practices in Moratuwa, Sri Lanka, a suburb municipality in SriLanka. Municipal officials, over 300 households and landfill operators were interviewed to examine current practices and related environmental problems. Groundwater samples from the vicinity were analyzed and it showed levels of certain chemical parameters well above acceptable limits. Landfill gas emissions and possible green house gas contributions were theoretically calculated using Scholl Canyon Model for gas estimations. The main environmental problems identified in the study were the release of landfill gas and leachate. The significant amount of landfill gas which is generated from the site is released to the atmosphere contributing to global warming. Leaching of pollutants into ground water has also been found to be a significant concern due to the high use of ground water for residential purposes and due to the possible illegal disposal of industrial waste along with MSW. From the public perception worst impacts of present solid waste disposal practices are seen as direct social impacts such as odor, breeding of pests and loss in property values.

Elma Torres et al (2004) has analysed the health risk perception of communities located in Metro Manila airshed in Philippines. Majority of the respondents recognized environmental factors as sources of various disease symptoms and illness. The community considered proper disposal of solid waste as more important than clean air. The respondents had a positive attitude towards pollution control as majority of them were willing to pay for clean air.

N.Raman et al (2008) have analysed the impact of solid waste on ground water and soil quality on places closer to Pallavaram solid waste landfill in Chennai. The physical and chemical parameters like Ph, electrical conductivity, total dissolved salts, total suspended solids, alkalinity calcium, magnesium, chloride and metals like sodium, potassium, lead, cadmium were studied. It was found that parameters like pH, hardness of water, calcium, and manganese were beyond the acceptable limits in accordance with the IS 10500 drinking water quality standards. In the case of alkalinity, and metals like copper, manganese, cadmium, nickel and chromium their presence were beyond the acceptable limits.

Utpal Goswami et al (2008) analysed the impact of municipal solid waste dumping on soil quality in Guwahati city. Soil samples were collected from different depths of the abandoned municipal solid waste dumping ground at Adabari in Guwahati city. The study found that the experimental value for the physico-chemical parameters increased for the solid waste treated soli when compared with the control soil. The soil pH and electrical conductivity were high and the presence of phosphorous pentoxide and calcium carbonate were found to be high.

Altaf et al (1996) studied the household demand for improved solid waste management at Gujranwala, Pakistan using C.V method. The approach of the study was to integrate demand side information into the planning process. The average willingness to pay was estimated as Rs.8.04 per month per household. The significant variables affecting the WTP were education, household expenditure discretionary income and wealth.

Willis and Garrod (1997) estimated the WTP using C.V method to reduce noise, odour and windblown dust and litter from a landfill using a choice experiment study. The study used a sample of 79 residents around the chosen landfill. It was found that the Marginal WTP to reduce the number of days when

respondent suffers from dust and windblown litter from the site is £0.12 to £0.19per day and the Marginal WTP to reduce the number of days when respondent can smell the site from their home: £0.10 to £0.15 per day.

Rogier Marchand (1998) analysed whether demand side information along with WTP and affordability to pay will prove to be the most important factors to improve the solid waste management in the urban areas of developing countries. A study on the affordability and WTP for solid waste management services in Tingloy, Philippines using C.V method was conducted and the average WTP for an improved solid waste management system was found as15.75 Pesos per month per household.

Viniegra et al (2001) determined the economic value of an improvement in environmental quality due to an alternative household garbage collection and selection system for the inhabitants of San Pedro Choula in Central Mexico using C.V. method. The average monthly willingness to pay (WTP) for the improved collection system was estimated at $1.85 /month /household. The income elasticity for environmental quality was found to be 0.13. The significant variables affecting the WTP were income, age and trust in government. Education, wealth, children, gender and environmental ethic were found non-significant.

Chutrat et al (2007) estimated the willingness to pay (WTP) to pay environmental taxes and their opinions on the environmental management of the households of Khon Kaen in Thailand using C.V method. It was found that the households were willing to pay taxes for their environment up to 20.88 Thai Baht per month. Their willingness to pay the taxes depended upon the education and income levels.

Reyer Gerlagh et al (1999), has proposed a new paradigm of SWM, to achieve a socially and environmentally responsible solid waste management in

India. A range of activities, issues and processes like the types of waste generated, the number of stakeholders and economic activities involved, and the various economic, social and environmental effects of SWM which includes legitimisation of the informal system, public participation and partial privatisation are considered. A linear programming model to evaluate the effectiveness of different SWM alternatives is applied to the city of Bangalore with the main objective to minimise the overall system costs and to identify low cost alternatives to manage household, institutional and industrial waste. The model incorporates social and environmental objectives associated with SWM to find sustainable solutions. The model is comparable with input-output modeling with additional objectives given as side constraints. The significance of the model is in showing the important interdependencies in the waste management sector and is an important step in evaluating integrated SWM in developing countries.

P.B.Anand (1999), examined how households in Madras view garbage problems, their preferences for improved services and the extent to which they would pay for them. It also includes a comparison between areas served and not served by Civic Exnora units where neighborhoods organize their own primary collection. Information was collected from focus group discussions, household interviews from across a range of income levels and spatial locations and in-depth interviews with those who manage the Civic Exnora units. The findings highlight that people are willing to cooperate and pay only for waste collection. Analysis also shows that concern for waste management cuts across all income groups. Of all the waste management services, households seem to be least concerned with final disposal. They also show how the financial viability of neighbourhood collection schemes such as the Civic Exnora units depends on having transfer stations close by, to which the collected wastes can be taken.

Babu Ambat (2000), identified the types and estimated the quantities of waste generated in each ward of Thiruvananthapuram City Corporation. It was

estimated that a total of 290-300 tons of solid waste were generated in the city. The contribution of the households was 181 tons followed by markets (40 tons) and hotels and restaurants (30 tons).The medical waste was about 13 tons. The non-degradable waste like plastics, paper, metals and glasses were collected from the source or from the disposal sites by a group of rag pickers. They sell these wastes to the wholesale dealers who will transport these wastes to Salem and Coimbatore for recycling. The technology optimization study considered composting as the best method for disposing waste in Trivandrum since the degradable waste content (50%) is high in the solid waste stream. Biomethanation was suggested for institutions, hotels and marriage halls. The important aspects of the solid waste management action plan included a) segregation and characterization of the wastes at the source itself b) decentralized collection from the primary source and centralized collection from secondary sources c) strengthening the existing informal waste collection sector d) detailed transportation network planning.

Reghunandhan (2001) studied the generation, composition, disposal methods and collection and transportation problems of solid waste management in Chalakudy town and Pattambi town. The Chalakudy Municipality generated on an average 1.5 to 2 tones of waste per day which was dumped on two open landfills.. The proportion of organic waste was found to be around 73%. Pattambi town generated around 2 tones of waste per day whose organic component was found to be 66%. Slaughter houses (35%) and shops (21%) were the main sources of waste while households contributed around 6% to the total waste generated. The main methods of disposal of wastes were by dumping in pits (49%) and into common bins (22%).

P.R.SreeMahadevan Pillai (2002) in his study on the disposal and management of waste in Palakad municipal area analysed the composition of waste, waste generation and disposal habits of the people. Laboratory experiments were done on the waste to understand the chemical composition of

the waste. The proportion of organic waste was found to be 35.4%. Dumping of waste in ones own premise was found to be very common in Palakad (around 65% of the households did that). The utilization of municipal waste bins was considered to be very low at 15%. The study recommends the installation of a completely mechanized solid waste treatment plant for processing mixed waste.

C.N.Ray (2003), examined the present solid waste management scenario in the city of Ahmedabad and has identified the problems of the existing systems and analysed the steps taken by the city corporation to rectify the problems.

Babu Ambat (2003), analysed the current practices of solid waste storage, the present waste management practices, the communities perception on the existing collection and management system in Thiruvananthapuram city. The study also examined the changed attitude of the community, people's preference and willingness to cooperate and pay for an improved solid waste management practice and also identified the new initiatives at the local level for waste management. Lack of space and practice are considered to be the main reasons why wastes are not segregated and thrown on the road side. People are not willing to do any segregation of waste except the news papers. Majority of the hospitals dump the waste in the dumper placer containers or burn it in the hospital premises. It was found that 55% of the households reduce, reuse and recycle the waste materials. Majority of the low-income and middle income houses burn 60% of the waste generated and sell the rest for a nominal rate. 88% of the people feel that they have a role to play in solid waste management showing the change in the attitude of the people towards solid waste management. People prefer a door to door collection system and were willing to pay for an improved service of solid waste collection.

Varkey Mathew (2003), examined the quantity and quality of the solid waste generated in Kottayam town. Random and cluster sampling methods were

used for selecting the households. The total waste generated per day was about 52.3 tons and the per capita generation was 0.62 kg/per day. It was found that the storage capacity of the community bins being inadequate. Vermicomposting was considered as the most effective method for organic wastes.

Madhushree Sekher (2004), analysed the process of municipal waste management in the city of Bangalore while focusing on the situation in Karnataka. The paper considers the characteristics of municipal waste generated, the management practices involved and the role of the stakeholders in the overall process. Inadequate municipal service, unscientific disposal system, lack of civic awareness in waste management lack of a proper market for recycled waste products .etc. are found as the most important deficiencies in the waste management system.

The review shows that solid waste management has emerged as a subject of great interest and various aspects of the issue have been looked into. One of the glaring deficiencies is the lack of studies focusing on densely populated small towns in developing countries and the absence of studies analysing the socio economic and environmental impacts of solid waste management. In this context, the present study intends to bridge a gap in this area of research.

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Chapter 3
Approach to the Study

3.1 Methodological approaches to environmental valuation

Economic valuation of resources needs to be undertaken, when the market fails to generate the true prices of the resource in question. An economic valuation helps compute the true price of a resource. Market failures are common for environmental resources mainly due to externalities which cause difficulties in valuation. Economic valuation of environmental resources can help make decisions on resource utilization and allocation more meaningful. The price paid for an economic good or service shows the consumer's Willingness to Pay (WTP). An economy provides a mix of marketed and non-marketed goods. Environmental goods and services come under the category of non-marketed goods. Economic valuation means giving monetary values to the non -market goods and services and the economic valuation of the environment means giving monetary values to environmental goods and services. In a market the individual will buy a good when he finds that the WTP is greater than the price. Assigning monetary values for environmental goods means finding a measure of WTP or WTA (willingness to accept a compensation for giving up the benefit) for an environmental good. Economic valuation is all about finding a WTP or WTA measure when market is incapable of providing that information.

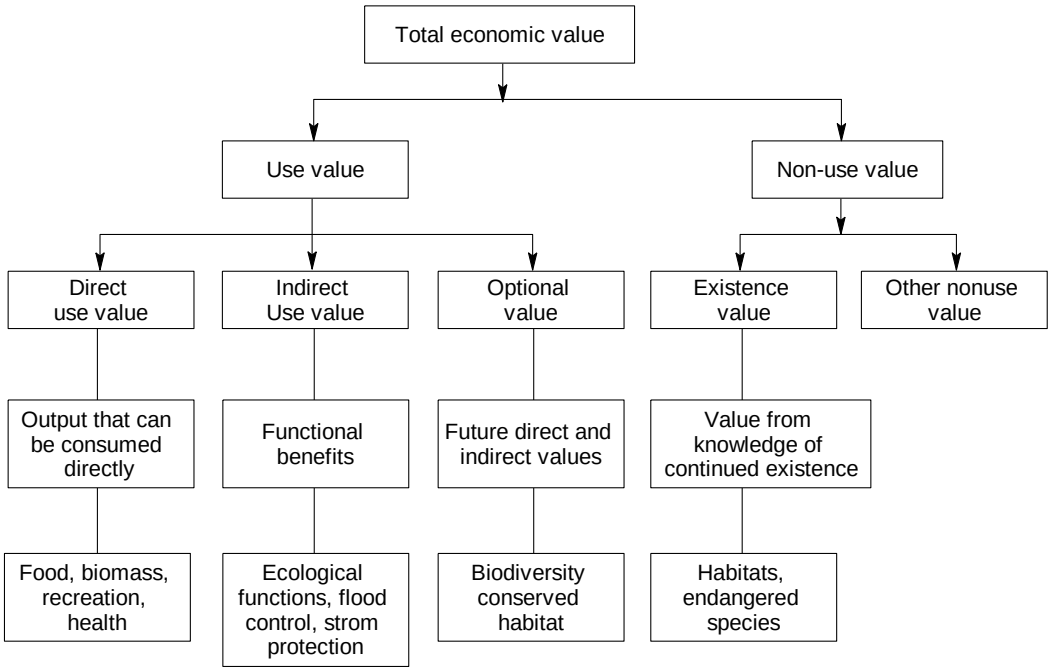
3.2 Economic values of environmental assets.

To find out the economic value of the environment, the concept of Total Economic Value (TEV) is used. Identifying and determining the economic values of environmental resources 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. Figure: 3.1 show the various concepts associated with TEV.

Figure: 3.1

Concepts associated with TEV



Source: Jepma C.J and M.Munasinghe (1998)

TEV is the sum total of the use and non-use value of the environmental good. The use value refers to the values derived from the actual use of the resource and includes direct use values, indirect use values and the option values. Direct use values refers to the direct use of a protected area, for instance, for activities such as recreation, tourism, natural resource harvesting, hunting, gene pool services, education and research. These activities can be commercial, meaning 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 means 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 refers to the values that are not associated with the actual use of the resource include existence values and bequest values. The existence values is the value derived from the knowledge that a good is existing and bequest values are those which is derived by the fact that others are benefiting or will benefit from the good. 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.

3.3 Non-market valuation

The valuation of environmental issues like biodiversity loss, global warming, and species extinction is highly complex. Economists have developed new ways for calculating the economic and social values of 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 (Pearce1992). In economic valuation the theoretical statement is that preferences are already formed and economists try to find out the true underlying preference about environmental goods and services (Clive L.Spash et al 2001). Environmental economics has developed techniques whereby such values can be imputed. In the market place 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 forms an integral part in the determination of the balance between conservation and development and in the choice of environmental standards.

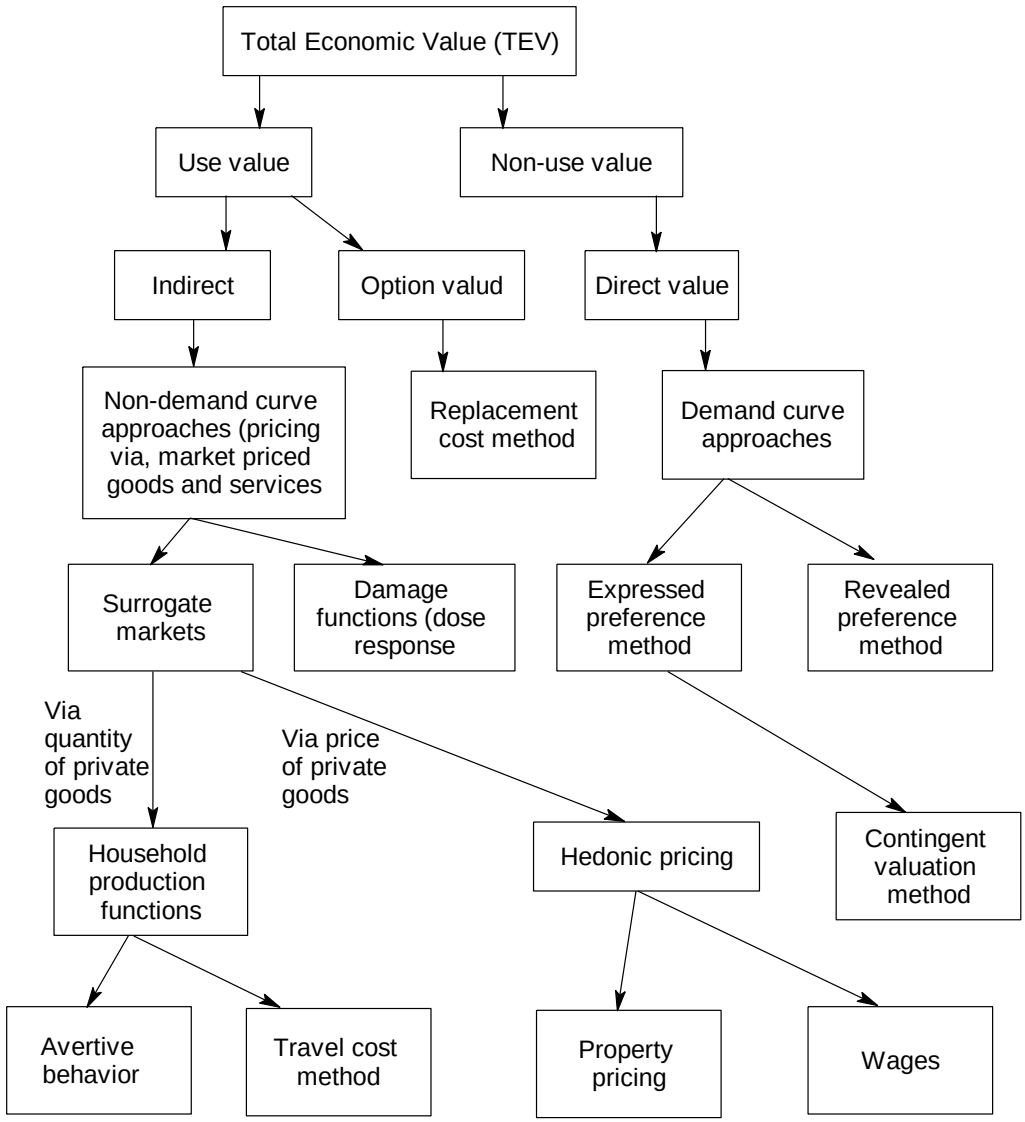
3.4 Overview of methods for environmental valuation.

A variety of economic techniques and models have been developed for environmental valuation. Valuation methods can be classified as follows.

1. Physical linkage methods(Scientific)
2. Abatement cost methods(Technical)
3. Behaviourial linkage methods(Economic)

A large number of techniques have been developed over the years for the purpose of environmental valuation. Figure:3.2 shows the various methods used for the valuation of the environment.

Figure:3.2 Methods for valuation and pricing ecological goods and services



Source: V. Santhosh et al

Different methods for eliciting both market and non-market values from people for environmental goods and services have been developed over the last few decades. The widely used methods include

a) Hedonic Pricing
b) Travel Cost Method
c) Contingent Valuation method.

3.5 Hedonic Pricing Method (HPM)

This method uses existing markets like housing or labour markets to determine the value of an environmental good. The basic assumption of the method is that property values or wages shows a stream of benefits, some of which are attributable to the environmental good. The main task is to isolate that value which is attributable to the good. Hedonic pricing can be used to establish aesthetic values of biodiversity, value environmental damages and their effects on property values or wages. The HPM attempts to estimate an implicit price for non-marketed environmental attributes by looking at real markets in which those characteristics are effectively traded. Thus, clean air and peace and quiet are effectively traded in the property market since purchasers of houses and land do consider these environmental dimensions as characteristics of property (Pearce and Moran, 1994). Hedonic pricing is data intensive and becomes difficult where alternative markets are distorted or where information about environmental products is not widespread especially in developing countries.

3.6 Travel Cost Method (TCM)

The Travel Cost Method uses existing markets, determining a person's value of an environmental good from what they spend on traveling in terms of time, travel expenditures and entry fees. TCM is based on the assumption that observed behavior can be used to derive a demand curve and to estimate value for an unpriced environmental good by treating travel costs as the surrogate price for the non-market asset. The area under the demand curve represents the consumer surplus. However, TCM is data intensive, they rely on restrictive assumptions about consumer behavior and they are highly sensitive to the statistical methods used.

3.7 Methodology used in the study: Contingent Valuation Method (CVM)

Valuation of environment is a disputable issue among statisticians and economists. While the accounting approach prefers to record only the actual financial transactions, the economic approach prefers to go beyond this, like in the case of health damages, the statisticians would prefer the cost of illness method (actual expenditure or illness), while economists also account for the loss in human capital that calls for disability adjusted life years (DALY) or statistical value of life (SVOL) or known loss of IQ in children (eg. due to pollution). Even loss of work or output due to absenteeism because of illness is valued in economic approach. For these, economists would like to consider opportunity cost approaches or an even subjective approach such as the contingent valuation method (CVM).

Contingent Valuation is the subject of an immense literature. CVM is used generally for the valuation of public goods especially environmental valuation (Ciriacy-Wantrup, 1947, Davis, 1963, Mitchel and Carson, 1989). The origin of the concept of contingent valuation can be traced to 1947 when Ciriacy-Wantrup considered the question of obtaining values for public goods and a survey method was suggested to obtain such values. The method was not used much till the 1960's as the validity of the values was questioned by economists. The first recorded study using contingent valuation was done by Davis in 1961(Mitchell and Carson 1989). This was followed by a study done in 1969 (Hammack and Brown 1974).

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. Although it can be used to estimate both use and non-use values, 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 willingness to pay (WTP) will reflect the value of the particular environmental quality (Ciriacy-Wantrup, 1947, Davis, 1963, Walsh et al, 1984, Brookshire et al, 1983, Mitchell and Carson, 1989, Choe et al, 1996). 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. According to the contingent valuation literature, WTP should reflect the value the community is having for a better environmental quality. The WTP of an individual is found to be dependent on several factors like income, attitude towards environment, level of knowledge etc. (Mitchell, R. C. et al 1989, Hanemann 1991, Cummings et al, 1986). 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 different set of priorities. To secure a total WTP, an average of the aggregate WTP should be calculated. 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 in question. The questioner should provide the respondent with the proper description of the resource and its potential benefits. The respondent must also be familiar with the hypothetical means of payment, say a local tax, an entry fee etc.

CVM has helped 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 Cost Benefit Analysis of project program alternatives or economic assessments of resource losses. CVM is now the most widely used economics 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. CVM is widely used to measure existence values, option values, indirect use values and non-use values.

CV method, which is a simple and flexible non-market valuation method, has been severely criticized mainly on two aspects, the validity and reliability of the results and the effects of biases and errors (L.Venkatachalam, 2003). The major sources of bias are

i) Strategic bias: The strategic bias is similar to the" free rider" problem. It occurs when the respondents of CVM deliberately understate or overstate the monetary value of the good in order to manipulate the policy decision in their favour It is suggested that questionnaires should be designed in such a way that the respondents are unable to behave strategically (Mitchell and Carson1989, Hoovenagel 1990). However, most CVM studies have not found strategic bias to be significant (Pearce & Turner, 1994).

ii) Hypothetical bias: Since the market created in the CV method is hypothetical, it will create hypothetical bias which is defined as the difference between the real and hypothetical payments (Cummings et al, 1986).

iii) Design bias: The design bias arises from three sources. The first is the starting point bias or the initial bid bias. When the questioner suggests the first bid, the starting point, it is possible that this will influence the respondent in some way by suggesting the range over which the bidding game will be played (Pearce & Turner, 1994). The second source of the design bias is the vehicle bias or the instrument of payment, used in the approach. The respondent might be sensitive to some ways of payment, such as taxes, entrance fees, donations. The third source of the design bias is the information bias. The information quality and sequence, given to the respondent, regarding the resource in question, will influence his answers significantly.

3.8 Approaches used to elicit preferences.

Generally four basic approaches are used to elicit the preference of he individuals. Although four methods are available, the choice of any method depends on the individual judgment (Bishop et al 1990).

i) 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. These individual estimates of WTP may be summed to provide an estimate of aggregate WTP—and hence total economic value. There are two types of bidding games—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.

ii) 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.

iii) 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 (Nunan, 1996). It is the first round of a bidding game.

iv) 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 their type of household on other public goods.

3.9 Sample design

For the analysis, the focus is on the municipality of Alappuzha. To conduct the CV survey, a pre tested questionnaire was used. The unit of analysis is the individual household. As the Municipality consists of 50 wards, 20 households each from each ward were taken at random and the total sample size was 1000. A house to house survey was undertaken. The data relating to WTP were collected using the iterative bidding format.

The interview was structured in the following way

i) Socio-economic information: questions were asked to find out the income, education, occupation, children, environmental ethic and gender of the respondent.
ii) impact information: questions were asked about the health impacts (signs and symptoms, occurrence of the specified diseases, the treatment expenses), economic impacts (decrease in residential land value) social impacts (disamenities) and environmental impacts (water quality deterioration).The aim was to get an idea about the individual perception of the problems and also to create a background for the valuation exercise.
iii) project information: two sets of hypothetical projects one to be done by the municipality and other by private agency and the characteristics and the benefits were explained in a general way.

The aim was to inform the person about the product he or she is paying for.

iv) valuation--the questions related to the valuation were asked. The person was asked about his specific WTP using the bidding format for the improved solid waste management programme.

The questionnaire was prepared by giving adequate consideration to the suggestions given by the National Oceanic and Atmospheric Administration (NOAA) panel. The most important points considered were about conducting interview personally, the payment made should be for a future event and the facts hypothetical projects be made clear and understandable(NOAA 1993). The variables evaluated in the questionnaire include the presence of a list of signs and symptoms and diseases that are normally associated with environmental pollution. These were evaluated for the last three years. They are:

i) Signs and symptoms: cough and cold, fever, headache, diarrhea, skin infection and eye irritation.
ii) Diseases: cholera, jaundice, typhoid, dengue fever, rat fever, chicken guinea, intestinal parasitism.

The following were the indicators used for identifying the disamenities associated with the solid waste management.

i) foul odour.
ii) increased population of flies, vermin, pests, particulate air pollution.
iii) visual impacts (dirty surroundings, litters)

Table: 3.1 Variables evaluated in the questionnaire

Variable	Notation	Concept	Characteristics
willingness to pay	WTP	willingness to pay for the project	continuous and quantitative
house ownership	Hs	owned (1), rented (0)	dichotomous
gender of the respondent	Gen	male (1), no(0)	dichotomous
education	Ed	no formal education (0) primary education (1) secondary education (2) higher education (3)	--
children	Cd	have (1) no (0)	dichotomous
income	AMI	average monthly family income	continuous and quantitative
environmental ethic	Ea	consider environmental project as important (1), no (0)	dichotomous

From the questionnaire, the average WTP of the sample households was calculated.

3.10 Econometric model

The information obtained from the questionnaire was used to test a model, which explained the WTP as a function of variables like average monthly income, education, children, gender, environmental ethic and house ownership. The following econometric model was used

$$WTP = \beta_1 + \beta_2 AMI + \beta_3 Ed + \beta_4 Cd + \beta_5 Gen + \beta_6 Ea + \beta_7 Hs + u$$

Where, AMI = average monthly income of the household

Ed = education of the respondent.

Cd= children in the family.

Gen= gender of the respondent.

Ea = environment ethic.

Hs= house ownership.

β_1, β_2, β_3, β_4, β_5, β_6, β_7 are constants and u is the disturbance term.

3.11 Ordinal regression

Regression methods such as linear, logistic and ordinal regression allow researchers to identify the explanatory variables that determine the outcome variables. The use of linear, logistic and ordinal regression depends mainly on the measurement scales of the dependent variables and the validity of the assumptions of the model. Linear regression analysis is used when the dependent variable is measured on a continuous scale and logistic regression is applicable for the binary outcome. The two methods assume normality and constant variance. To understand the effects of the explanatory variables on all levels of the ordered categorical outcome, ordinal regression method will be appropriate. The design of Ordinal regression is based on the methodology of McGullagh (McGullagh 1980).

In our analysis, we used an ordinal regression model to examine the relationship between the WTP for an improved solid waste management system and the various explanatory variables. Ordinal Regression allows one to model the dependence of a polytomous ordinal response on a set of predictors, which can be factors or covariates. Ordinal regression does not require the assumption of normality and constant variance but requires the assumption of parallel lines

which is assuming that the effect of the independents is the same for each level of the dependent. Ordinal regression is used with ordinal dependent variables, where the independents may be categorical factors or continuous covariates. Ordinal regression models are sometimes called cumulative logit models. Ordinal regression generally uses the logit link function, though other link functions are available. Ordinal regression with a logit link is also called a proportional odds model, since the parameters of the predictor variables may be converted to odds ratios, as in logistic regression. The estimated coefficients reflect how changes in the predictors affect the response. The response is assumed to be numerical, in the sense that changes in the level of the response are equivalent throughout the range of the response.

The main features of the ordinal regression model are i) the dependent variable is a grouped and ordered category ii) the model uses a link function to explain the effect of the independent variables on the ordered category so that the normality and constant variance assumptions are not required iii)the model assumes that the relationship between the independent variables and the dependent variables is independent of the category(Scott et al 1997,McGullagh and Nelder,1989,Bender and Benner 2000).

The models used in ordinal regression are cumulative probabilities, which are the probabilities that the response *Y* (in this case, willingness to pay) falls in a category *j* or below, for each possible *j*. The j^{th} cumulative probability is

$$P(Y \leq j) = \exp(\alpha_j + \beta x) / \{1 + \exp(\alpha_j + \beta x)\}$$

$$j = 1, 2 \ldots J.$$

The model is given by,

$$P(WTP \leq j) = \exp(\alpha_j + \beta_1 AMI + \beta_2 Ed + \beta_3 Cd + \beta_4 Gen + \beta_5 Ea + \beta_6 Hs) / \{1 + \exp(\alpha_j + \beta_1 AMI + \beta_2 Ed + \beta_3 Cd + \beta_4 Gen + \beta_5 Ea + \beta_6 Hs)\}$$

Where *j = 0, 1, 2, 3.*

The cumulative probabilities reflect the ordering, $P(Y \le 0) \le P(Y \le 1) \le P(Y \le 2) \le P(Y \le 3) = 1.$ Models for cumulative probabilities do not use the final one, $P(Y \le 3)$ since it necessarily equals 1. In this study, Y=0 denotes unwillingness to pay, Y=1 denotes willingness to pay less than the specified amount, Y=2 denotes willingness to pay the specified amount and Y=3 denotes willingness to pay greater than the specified amount. The model in detail is given in the analysis chapter.

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Chapter 4

Urban Solid Waste: An Overview

SWM is an urban centric issue which is addressed by both developed and developing countries. Solid waste generation is found to be influenced by factors like production and trade, private consumption, socio-economic factors like income of the household, population, size of the households, level of industrialization, GDP and climate and soft factors such as environmental awareness, legislation or waste management measures etc. (Peter Beigl et al 2003). High income individuals consume more than low income ones, which results in a higher waste generation rate for the former. High income countries generate more than twice the weight of waste percapita when compared with the low-income countries. Generally, the greater the economic prosperity and higher the percentage of urban population, the greater will be the amount of solid waste generation (World Bank, 1999). This chapter outlines the various sources and types of urban solid wastes, a cross country comparison of urban solid waste generation and solid waste in Kerala. In general, the sources of urban waste or Municipal Solid Waste (MSW) are (i) domestic waste (ii) market and commercial waste (iii) street sweeping (iv) industrial waste (v) hospital waste (vi) demolition and building waste and (vii) sewage sludge. (Singdha Chakrabarti, 2005).

4.1 Source and types of urban solid wastes

The table: 4.1 shows the source and types of urban solid wastes

Table:4.1 Source and types of solid wastes

Source	Typical waste generation	Types of Solid Waste
Residential	Single and Multi family dwellings.	Food wastes, paper, cardboard, plastics, leather, yard wastes, wood, glass, metals, ash, special wastes (bulky items, consumer electronics, batteries, tyers) 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 and special wastes.
Commercial	Stores, hotels, restaurants, markets, office buildings**.**	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes.
Institutional	Schools, hospitals, prisons, government offices.	-do-
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, water and waste water plants.	Street sweepings landscape and tree trimmings, general wastes fro parks, beaches and other public places, sludge.
Process	Heavy and light manufacturing refineries, chemical plants, power plants, mineral extraction and processing.	Industrial process wastes, scrap materials, office specification products, slag.
Agriculture	Crops, orchads, vineyards, dairies, farms.	Spoiled food wastes, agriculture wastes, hazardous wastes (pesticides.etc.)

Source: Hoornweg (1999**)**

The given table helps us to understand the different types of solid waste that is generated in an urban area by various sectors. It shows the various sources and types of solid waste generated in an urban area.

Developing countries have solid waste problems different than those found in fully industrialized countries as the waste generation rates and the composition of their waste is different than that of developed nations. The waste generated tends to go up as income increases. First World cities have higher waste generation rates than Third World cities. In the U.S., cities can have waste generation rates of over 1.2 Kg / person / day, while the residents of some African cities generate less than 200 gr. / person / day. A positive relationship also tends to exist between income and waste generation rates within each city, in Mexico City, for example, low-income households generate 2.6 Kg. a day, middle-income households produce 2.7 Kg. a day, and upper-income households, 3.7 Kg. a day (Salazar J,1995).

Cointreau (1982), Blight and Mbande (1996), Arlosoroff (1982), have noted several common differences in the composition of solid waste in developing nations: Waste density 2-3 times greater than industrialized nations; Moisture content 2-3 times greater than industrialized nations; Large amount of organic waste ; Large quantities of dust and dirt; Smaller particle size on average than in industrialized nations.

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4.2 Waste generation per capita in countries- cross-country comparison of solid waste generation

Urbanisation and rapid economic development in developing countries has resulted in increased solid waste generation. The urban solid waste management situation in India too is quite alarming with around 17% of the world's population and an urban population of around 27% of the country's total population. It is estimated that the country generates about 30 million tones

of urban solid waste annually (GOI 1998) and is expected to increase 300 million tones per annum by 2047(CPCB 2000). The per capita generation of waste in India ranges between 0.1 kg and 0.6 kg per day with an average of 0.33 kg (Bhide 1990).There exists a large difference between urban and rural levels of waste generation and also between larger and smaller urban areas and this shows the presence of economic extremes within the Indian society(WHO 1991). The larger cities have greater waste generation due to greater economic activity, prosperity and the culture of consumerism among the residents. Indians in general reuse and recycle extensively within the household and their lifestyle results in a greater conservation of resources which is confirmed by earlier studies (UN 1997). Also the use of packed goods in India is still modest but an increasing trend is noticed in cities in Kerala at present. A comparison of urban municipal solid waste generation per capita figures for low income, middle income and high income countries is given below. Table: 4.2 and figure: 4.1 show the per capita urban municipal solid waste generation in low income countries.

Table: 4.2 Low income countries

No.	Country	UMSW Generation (kg/capital/day)
1	Sri Lanka	0.89
2	China	0.79
3	Lao PDR	0.69
4	Mongolia	0.60
5	Vietnam	0.55
6	Nepal	0.50
7	Bangladesh	0.49
8	Myanmar	0.45
	Average	0.64

Source: World Bank (1997a)

The average urban per capita solid waste generation in low income countries is 0.64kg. Sri Lanka has the highest per capita generation while Myanmar has the lowest with 0.45kg. The following figure represents the data given in the table.

Figure: 4.1 Low income countries

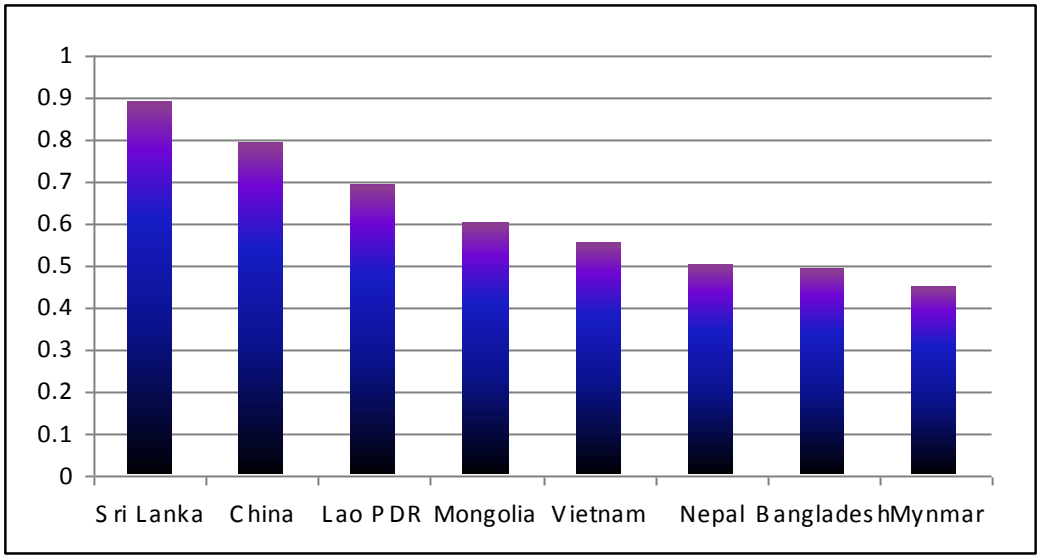


Table: 4.3 and figure: 4.2 show the per capita urban municipal solid waste generation in middle income countries.

Table: 4.3 Middle income countries

No.	Country	UMSW Generation kg/capital/day)
1	Thailand	1.10
2	Malaysia	0.81
3	Indonesia	0.76
4	Philippines	0.52
	Average	0.73

Source: World Bank (1997a)

The average urban per capita solid waste generation in middle income countries is 0.73kg. Thailand has the highest per capita generation and Philippines have the lowest with 0.52kg. The following figure represents the data given in the table.

Figure: 4.2 Middle income countries.

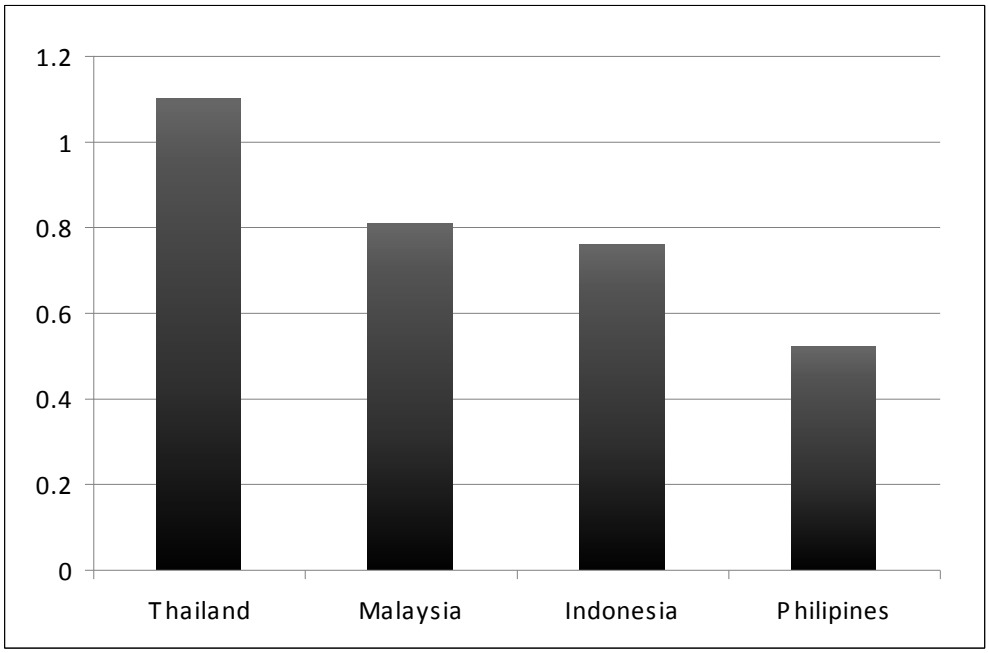


Table: 4.4 and figure: 4.3 show the per capita urban municipal solid waste generation in high income countries.

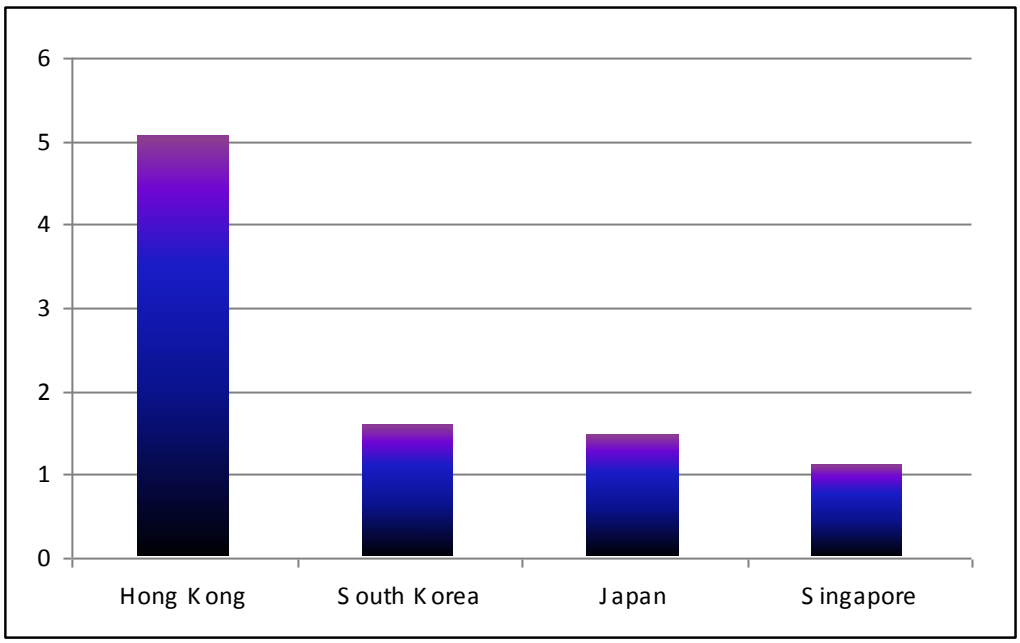
Table: 4.4 High income countries

No.	Country	UMSW Generation kg/capital/day)
1	Hong Kong	5.07
2	South Korea	1.59
3	Japan	1.47
4	Singapore	1.10
	Average	1.64

Source: World Bank (1997a)

Among the high income countries HongKong has the highest urban per capita solid waste generation at 5.07kg while Singapore has the lowest with 1.10kg. The average urban per capita solid waste generation in high income countries is 1.64kg. The following figure represents the data given in the table.

Figure: 4.3 High income countries



4.3 Waste generation per capita in Indian cities

The quantity and characteristics of the waste generated in an urban area depends generally on the size of its population, area, level of economic activities and the culture of the residents (K.N. Nair et al 2004). Per capita waste generation ranges between 0.2kg and 0.6 kg per day in the Indian cities which will work out to about 1.15 lakh MT of waste per day and 42million MT annually. The average per capita waste generation will increase as the city expands (Asnani 2006). The table: 4.5 and figure: 4.4 show the relation between waste generation per capita and population range in Indian cities. The average density of Indian MSW at the point of collection varies from 400 to 600kg/m^3 .At the landfill site, the density is much higher because of compaction and putrefaction.. The density of dumped refuse can increase two folds in about six

months due to putrefaction and self-compaction of biodegradable organic matter. The average density of waste at the landfill site can be assumed to be approximately 1 tonne/m^3 (Sivapullaiah, 1977).

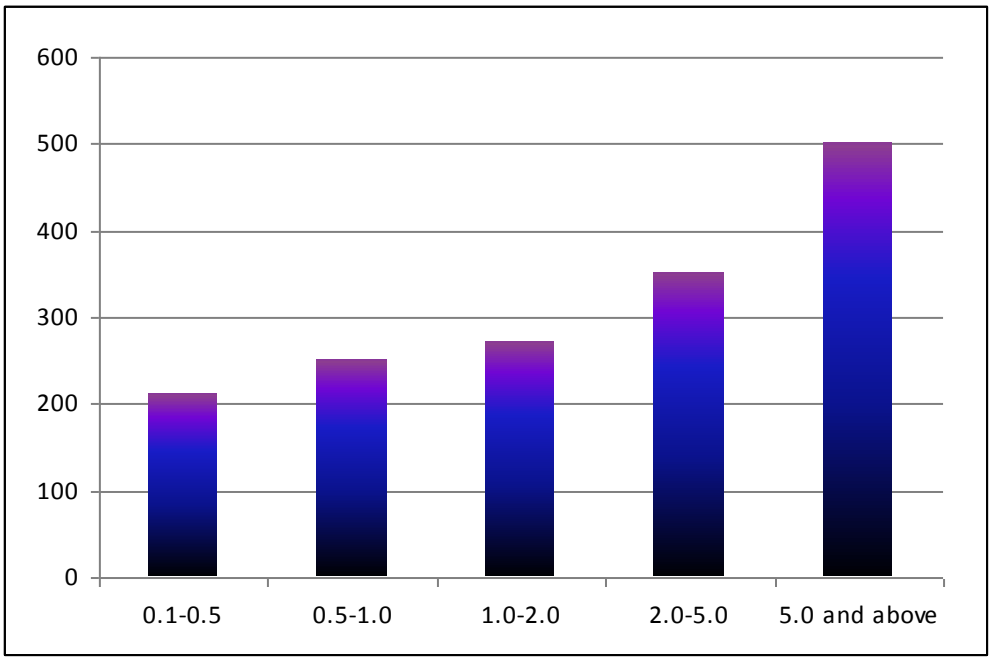
Table: 4.5 Waste generation per capita

Population Range (in million)	Average per capita waste generation gm/capita/day
0.1 -0.5	210
0.5-1.0	250
1.0-2.0	270
2.0-5.0	350
5.0 and above	500

Source: NEERI (1995)

It is clear from the table as the population of the city increases, the waste generation also increases. The following figure represents the data given in the table.

Figure: 4.4 Waste generation per capita



4.4 Solid waste generation and solid waste generation rates

Table: 4.6 shows the solid waste generation and solid waste generation rates of city/state capitals in India with more than one million population. Figure: 4.5 and figure: 4.6 represent the data given in the table.

Table: 4.6 Solid waste generation rates

City/state capitals with more than one million population	Waste quantity generated (MT/day)	Waste Generation rate (kg/c/d)
Kohima	12.48	0.12
Nashik	200	0.19
Lucknow	474.59	0.21
Guwahati	166.25	0.21
Gandhinagar	43.62	0.225
Jabalpur	216.19	0.23
Ranchi	208.27	0.246
Nagpur	503.85	0.25
Dehradun	131	0.29
Raipur	184.27	0.3
Indore	556.51	0.35
Bhubaneshwar	234.46	0.36
Patna	510.94	0.37
Ahmedabad	1302	0.37
Faridabad	448.01	0.38
Dhanbad	77.12	0.387
Bangalore	1669	0.39
Bhopal	574.07	0.4
Agarthala	77.36	0.4
Asansol	206.65	0.425
Daman	15.2	0.43
Meerut	490	0.46
Agra	653.57	0.49
Allahabad	509.24	0.51
Ludhiana	734.37	0.53
Jamshedpur	387.98	0.59
Vishakhapatanam	600	0.62

Note: MT/d: metric tones per day; kg/c/d; kilograms per capita per day.

Source: Akolkar (2005).

Figure:4.5 Solid waste generation

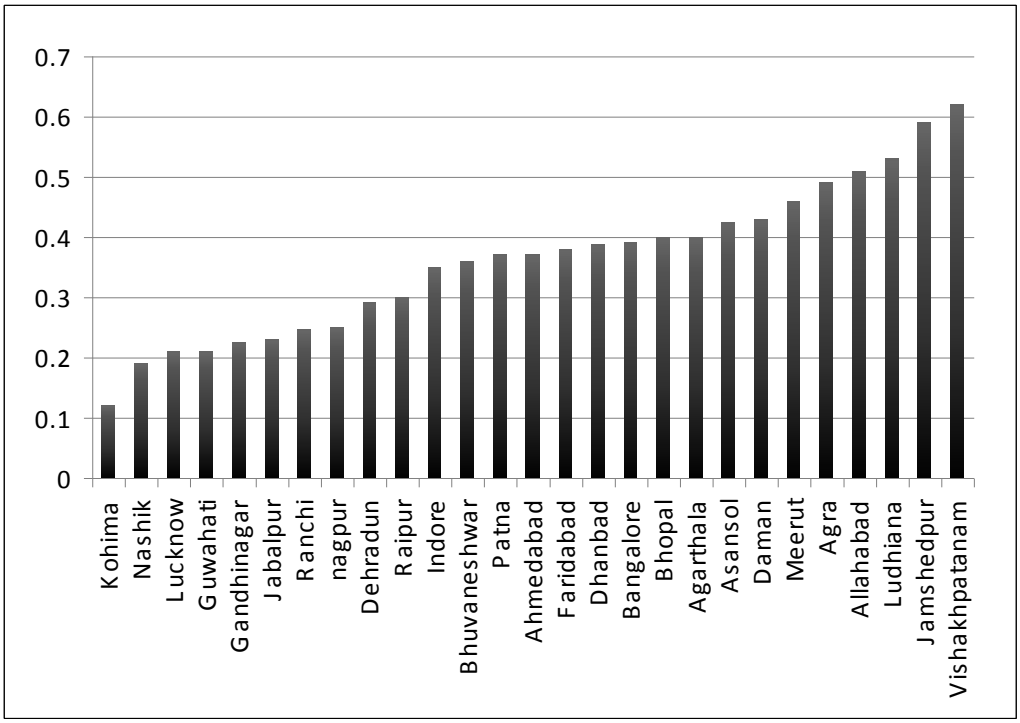
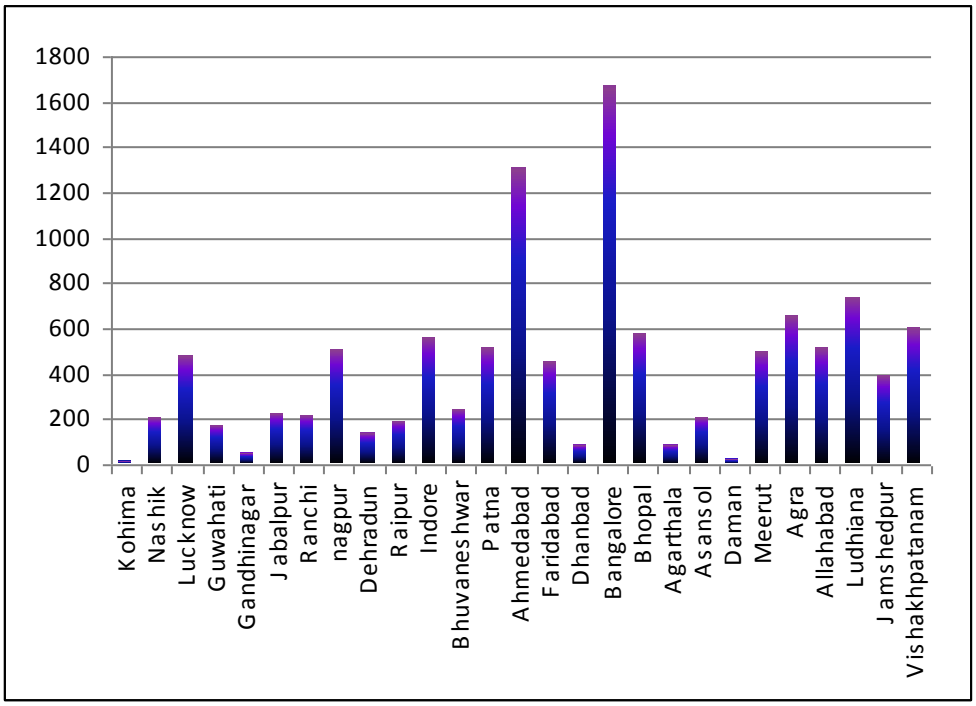


Figure: 4.6 Solid waste generation rates



4.5 Status of solid waste generation in Kerala

The pattern of solid waste generation in Kerala is similar to the pattern of urban solid waste generation in India. The data on the MSW generation maintained by the Urban Local Bodies (ULB) is based on the number of trips made by the waste transportation vehicles or approximation on other basis (Ajayakumar Verma, 2008). Generally, there is no practice of weighing the MSW at any stage, giving the available data little authenticity (SEUF, 2006). It is estimated that about 2500 tones of solid waste is generated per day in the state of which only about 50% is collected for disposal (Economic review,2004). The main issues associated with MSW in Kerala are: inefficient, inadequate and ad hoc primary collection of system, which results in the dumping of solid wastes into water bodies, road side.etc; lack of proper road cleaning; inefficient waste transportation in open trucks; lack of proper technical expertise in SWM ; lack of proper financial base for the urban local bodies as they depend too much on government grants; absence of engineered landfills and crude waste dumping in open dumps resulting in ground water contamination and breeding of mosquitoes, flies, rodents and pests and lack of proper private sector participation in the MSW system (SEUF,2006,economic review 2004). The Clean Kerala Mission was set up in 2003 to find a lasting solution to the problem of SWM. The main objective of the programme was to strengthen the managerial capacity and responsibility of the community and local governments in planning, implementation and maintenance of SWM facilities. The table 4.7 shows the various sources of waste generators in Kerala.

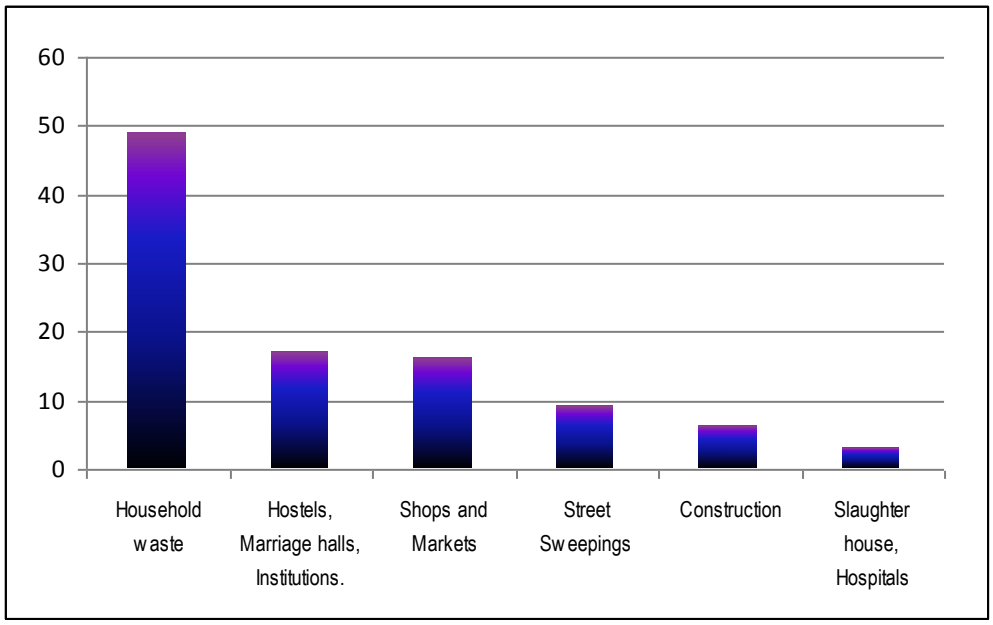
Table: 4.7 Solid waste generation

Sl. No	Source	% to total
1	Household Waste	49
2	Hostels, Marriage halls, Institutions	17
3	Shops and Markets	16
4	Street Sweepings	9
5	Construction	6
6	Slaughter house, Hospitals	3

Source: Malinya Mukta Keralam-Action Plan (2007).

The maximum amount of solid waste comes from domestic waste followed by Hotels, marriage halls and institutions and other contributors followed by shops and markets etc. The following figure represents the data given in the table.

Figure: 4.7 Solid waste generation



The per day percapita generation of solid waste is a better measure than the total waste generated in an area (Muraleedharan.S 2009). The city of Kozhikode with 458gms of solid waste has the highest per day percapita generation of solid waste in Kerala, followed by Cochin with 419gms and Kannur with 313gms. At the same time, 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. Alappuzha town has a solid waste density of 0.86 (Integrated solid Waste Management, Govt of Kerala 2007).

4.6 Composition of MSW in Kerala

The composition of waste in terms of its physical characteristics will give a clear idea regarding the consumption pattern and waste disposal in an

area. It is also important for reduction, reuse and recycling of waste. Higher incomes and economic growth will also affect the composition of wastes. Wealthier individuals consume more packaged products, which results in a higher percentage of inorganic materials –metals, plastics, glass, and textiles. etc. in the waste stream. Large amount of wastes with a higher content of inorganic materials could have a significant impact on human health and the environment. Developed countries, such as the US and Japan have rates of waste generation larger than other countries. European countries generate between 70% and 80% of those of the US (Fields, 1995). Developing countries have solid waste management problems different from those found in fully industrialized countries as the very composition of their waste is different from that of developed nations.

Various studies have shown that the municipal solid waste in Kerala contains a high biodegradable content. The following table: 4.8 shows the physical composition of solid waste in Kerala and the chemical composition of MSW is given in the appendix.

Table: 4.8 Composition of solid waste

Sl. No	Component	% to total
1	Biodegradable	71-83
2	Paper	3.5-5
3	Plastic, rubber, glass, metal	5-9
4	Inerts, earth, domestic hazardous	4.9-11.5

Source: Malinya Mukta Keralam-Action Plan (2007).

The bio degradable component of the solid waste stream is considerably high. It is followed by plastic, rubber, glass and metal. The important urban solid waste management approaches will be discussed in the next chapter.

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Chapter 5
Urban Solid Waste Management Approaches

Studies conducted in Third World Cities have outlined various features of MSWM as: Centralized and undiversified solutions without distinguishing the different needs and heterogeneity of neighborhoods within each city, and between cities; bureaucratic approaches top-down solutions, without or with little community participation; capital intensive approaches involving advanced technology and equipment; formal and conventional solutions considering only the formal sector and neglecting the existence and possible contributions of the informal sector that has developed around waste collection and recycling in many Third World cities (Medina Martin, 1997).

5.1 Solid waste management: developed and developing countries

Industrialized countries have a relative abundance of capital and high labor costs, while developing countries have a relative scarcity of capital and an abundance of unskilled and cheap labor. It is easy for the industrialized countries to devise waste management systems intensive in capital and that save in labor costs, but it is difficult for the developing countries to follow the same approach. Developing countries need socially desirable low-cost, labor-intensive municipal solid waste management solutions that create income opportunities that reduce poverty, especially among the weaker sections of the society. The physical characteristics of cities in developing and industrialized countries differ significantly. Third World cities have large areas with substandard conditions like slums, narrow and unpaved streets. Many immigrants who cannot afford to purchase land occupy vacant land and become squatters. Most of the areas that lack refuse collection service are slum and squatter settlements as local authorities decline to provide refuse collection to squatters as they do not pay taxes and also due to poor road conditions. It is common for Indian cities to have, at any given time, half of their collection

vehicles requiring some kind of repair and spare parts. Faulty or nonexistent maintenance also contribute to the high percentage of idleness. This refusal to provide waste collection has a serious effect on the urban environment. Many Third World cities have an active informal sector that has evolved around solid wastes, which provides income opportunities for migrants, unemployed, children, women, elderly and handicapped individuals. The most common occupations are informal refuse collection and scavenging.

Differences between developed and developing countries in terms of income, standard of living, consumption patterns, institutional capacity, and capital available for urban investments are glaring. Different methods, technologies and systems are used in SWM given the problems linked with solid wastes especially in the disposal stage. It is important that the suitability, affordability and public acceptability has to be considered before selecting the various methods and technologies. Municipal authorities levy taxes, charges, fees, for raising revenues to meet their statutory obligations as per the state laws. Municipalities need adequate and consistent revenue flows to provide a service and in its absence service provision must rely on transfers from another level of government or grants, making the service difficult to sustain. Municipal authorities levy taxes, charges, and fees to gain revenues and to improve their financial situation. However, municipal authorities generally have a major deficit of funds to meet their obligations. Many municipalities do not generate sufficient funds even to pay their staff members' salaries. The principal sources of municipal authorities' income include: property and house taxes, octroi duty water tax, sewerage, drainage, and conservancy tax, city cleaning tax, fees for passing building plans, levies on advertisement through hoardings, signboards etc., rents from municipal properties, fees from licenses for various trades and parking fees.

Despite powers given to impose taxes, most municipal authorities do not levy sufficient taxes. First, many taxable properties are not registered. Second,

the mechanism of tax recovery is poor. The rates of tax recovery generally range between 30 and 50 percent. The financial health of municipalities in India is poor, and they are unable to fulfill their obligations. They therefore depend on the state government for grants. The states give the municipalities grants for paying staff salaries as well as for carrying out development work. This dependence on state government grants is not sustainable in the long term, and municipalities need to find ways to fund services from their own resources. The main sources of grants that municipalities can obtain are State Finance Commission grants, 12th Finance Commission grants, Jawaharlal Nehru National Urban Renewal Mission (JNNURM) grants, Urban Infrastructure Development for Small and Medium Towns (UIDS &MT) scheme grants.etc. (Da Zhu et al 2008).

Financing for Municipal Solid Waste Services generally comes from Share from stamp duty on transfers of property, Share from entertainment tax, Share from education tax in the form of a grant from the provincial or national government. Municipal decision makers do not give adequate priority to SWM. Most of the municipal authorities allocate general municipal funds to cover the costs of SWM services. They most often do not levy any sanitation or city cleaning tax, nor do they impose user fees for waste collection service or for any other SWM service. Very few cities levy user fees for door-to-door collection. Financial allocations go for staff salaries as the first priority, and what is left is spent on visible infrastructure projects. Very little is allotted to improving SWM services, varying between 1 percent and 30 percent of the total municipal budget depending on the size of the municipality. Most of the budget for SWM is consumed in salaries of sanitation workers and transport of waste. Very little or none is set apart for actual treatment and disposal of waste. The percentage of expenditures for various solid waste services is as follows70 to 75 percent on street sweeping, 25 to 30 percent on collection, and 0 to 5 percent on disposal (Supreme Court 1999)

5.2 Conventional systems of SWM

The important conventional systems of SWM are

I) land filling: This is probably the oldest method of waste disposal and is the most popular and commonly used method. Land fills are generally classified into three types

i) open dump sites: a disposal area where the solid wastes are indiscriminately thrown or disposed of without due planning and consideration for environmental and health considerations.
ii) controlled dump sites: a disposal site at which solid waste is deposited in accordance with the minimum prescribed standards of site operation.
iii) sanitary land fills: a disposal site designed, conducted, operated and maintained in a manner that exerts engineering control over significant potential environment impacts arising from the development and operation of the facility.

The features that must be present in order for a landfill to be considered sanitary are: Full or partial hydrogeological isolation through the use of liners to prevent leachate infiltration into the soil and groundwater; collection and treatment infrastructure should be used where leachate is expected to be generated; Formal engineering preparations with an examination of geological and hydrological features and related environmental impact analysis, waste tipping plan and final site restoration plan; Permanent control, with trained and equipped staff to supervise construction and use; Planned waste emplacement and covering, with waste and soil placed in compacted layers as well as daily and final soil cover to reduce water infiltration and reduce odors and pests (Cointreau, 1982).

II) incineration: This method has long been in use in many countries**.** This involves using thermal decomposition to convert solid waste to less bulky less toxic material. It is an easy way to reduce the weight and volume of wastes. Incineration eliminates harmful and pathogenic bacteria, viral constituents and toxic organic compounds. The use of incineration has been found useful particularly that produce pathological wastes. The main concern about incineration is mainly on air pollution and its effects.

III) composting: This is the biological decomposition of the organic portions of solid waste under controlled conditions. It produces compost, which is high in organic matter. Compost is useful as organic fertilizer. Care must be taken to prevent bad effects on ground water.

IV) pyrolisis: This method is described as a process of destructive distillation where complex polymers are broken down to produce solids, liquids and gaseous fractions. Although similar to incineration, Pyrolisis produces a valuable product or recovers energy.

V) vermi composting: In this method certain organic wastes like animal wastes, agricultural crop waste and other solid waste are converted to a useful product. Earth worms are used to speed up the y process of decomposition. The product is useful as fertilizers.

5.3 Recent developments in USWM

The earlier definitions gave importance to the operational aspects of solid waste management. The new ideas that have emerged in the literature of solid waste management are Integrated Solid Waste Management, zero waste model and Ecological Solid Waste Management.

i) Integrated solid waste management (ISWM)

One of the earlier definitions for ISWM was given by Tchobanoglous et al (1993) and Dr. Peter White (1996). Tchobanoglous et al (1993) defined

ISWM as the selection and application of appropriate techniques, technologies and management programs to achieve specific waste management objectives and goals while Dr. Peter White (1996) defined ISWM as something dealing with more about how many treatment options are used to manage the waste handled by the system in an environmentally, socially and economically sustainable way. ISWM consists of a range of treatment options including reuse, recycling, composting, biogasification, energy recovery and land filling. Economic, environmental and social benefits are thus achieved through the creation of system synergies. It involves sorting of wastes at source, composting the biodegradable wastes, processing the recyclables into waste derived materials and using the incinerators for the other wastes to produce energy and construction materials from the ash left over(Pujalte.E.A.1993).

ii) Zero waste approach

Zero waste approach is a unique waste management approach in which waste becomes a source of innovation rather than a source of economic drain. It promotes reuse, recycling and prevention of waste generation. The important aspects of zero waste management approach includes enhancing a community's self sufficiency for resources and resource management, developing a system that will ensure that the natural resources are not converted to forms that will degrade nature, going by the nature's cyclical flow of resources ie from natural resources to useful products to resources reincarnation and also simplicity, utility and aesthetics.

iii) Ecological solid waste management

Ecological solid waste management refers to the systematic administration of activities which provide for segregation at source, segregated transportation, storage, transfer, processing, treatment and disposal of solid

waste and all other waste management activities which do not harm the environment (Ecological Solid Waste Management Act 2000).

5.4 Satellite accounts for waste management

Waste management is one of the important aspects of environmental management which needs to be incorporated in the system for Environmental and Economic Accounts (SEEA) as a satellite account. An I-O framework used in the conventional system of National Accounts (SNA) can be used to first include waste management sector, formal and informal. A waste account can be defined as the organisation of data on the production and disposal of waste into a framework hat allows their integration with the economic data in the system of National Accounts. The developed countries may exclude the informal sector in the SEEA. But for developing countries the integration of the informal sector into the SEEA becomes imperative. The SWM sector in the Mumbai city consists of both formal an informal sector. A leading industrialist in Mumbai calls ‘rag pickers’ as “over environmental entrepreneurs”. The informal SWM sector is primarily responsible for undertaking the critical ob of retrieving valuable materials from waste. They generate important positive benefits for the environment (UN 1997).

Concerns over environmental degradation and depletion of natural resources resulting from increased urbanisation and industrialization, as well as improper disposal and non-use of wastes, has necessitated the development of new solid waste management systems. It is a complex task which requires appropriate organizational capacity and cooperation between numerous stakeholders in the private and public sectors. The salient features of the study area will help us to have an insight into the gravity of solid waste management issue which is given in the following chapter.

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Chapter 6

Salient Features of the Study Area

Alappuzha, district was formed on 17th August 1957. It has Arabian Sea on the west, a good network of backwaters, lagoons and fresh water rivers land. The district lies between 9 ^{0} 5 ' north latitude, 76 ^{0} 17 ' and 76 ^{0} 44 ' east longitudes. It is bounded on the north by Ernakulam district, east by Kottayam and Pathanamthitta districts south by Kollam district and the west by Arabian Sea. The district at present consists of 6 taluks and 91 revenue villages. There are 12 block panchayaths and 5 Municipalities. In 12 block panchayaths there are 73 grama panchayaths. It is the smallest district in terms of area but has the highest density of population (1492 /Sq.km). The total geographical area is 1414 sq. Km. The population of the district as per the Census 2001 was 2109160**.** The only district in Kerala having no high lands and forest, it has a coastline of 82 kms. Heavy rainfall, high humidity and a fairly stable temperature throughout the year are the climatic features of the district. The actual average rainfall during 2004 was 2804m.m. The administrative setup, geographical features and comparative demographic particulars of the state and district is given in the appendix.

Alappuzha known as the 'Venice of the East' was the first planned town or municipality in the state of Kerala. The formation of the municipality of Alappuzha was done under the supervision of the then Diwan of Alappuzha Raja Kesava Das. Alleppey town was formed on 1919. The Alappuzha municipality is full of man made canals and bridges designed for promoting trade by water and road. There was also a sea bridge in Alappuzha port for foreign trade. With the development of Cochin port and road transport, the importance of Alappuzha port diminished. The municipality has an area of 46.77 sq kms which is divided into 50 wards. The municipality has a population of 177029 with 37595 households as per 2001 census (Panchayat Level Statistics 2006).

6.1 Population growth in Alappuzha municipality

Population growth in Alappuzha municipality from 1901 to 2001 is give in the table: 6.1.

Table: 6.1 Population growth

Year	Households	Population	Decadal growth (%)	Population density
1901	NA	24,918	_	533
1911	NA	25665	+3	549
1921	NA	32074	+24.97	686
1931	NA	43838	+36.68	937
1941	NA	56333	+28.50	1204
1951	NA	116,278	+106.41	2486
1961	NA	1,38,834	+19.40	2968
1971	NA	1,60,166	+15.36	3425
1981	28902	1,69,940	+6.1%	3634
1991	33016	174666	+2.78%	3735
2001	37595	177029	+1.35%	3785

Source: Panchayat Level Statistics 2006, Government of Kerala.

NA – not available

From the table it is clear that there was a population explosion in the town during the decade 1941-1951. Afterwards the growth in population has slowed down considerably and in the last decade during 1991-2001 the growth was a mere 1.35%. The density of population has increased rapidly from 1901 to 1951 and thereafter the rate of increase has declined. The ward wise population of the municipality is given in the appendix.

6.2 Solid waste generation

The amount of solid waste generated will reflect the consumption patterns, sanitation and the waste management issues of an area. The total amount of solid waste generated in the town is around 60 tones per day. Around 30 tones are collected by the municipality to be disposed. The rest of the waste are simply left uncollected. The wastes are not segregated before disposing and all the waste are mixed and disposed. The waste is dumped in an open dump at a place called Sarvodayapuram in Mararikulam South Panchayat with an area of 14.26 acres and is around 3Km from the town(Information given by the Office of the Health Officer, Alappuzha). The solid waste generation in the municipality is given in the table: 6.2.

Table: 6.2 Solid waste generation

Name of the circle	No. of wards	Waste generated in each circle /day
Central Circle	8	12
South I	7	8
South II	10	10
North I	4	3
North II	7	3
Total	36	36

Source: Socio Economic Unit Foundation (2001)

The Central Circle generates the maximum amount of solid waste of 12 tons and the minimum amount of solid waste comes from the North I and II Circles at 3 tons each.

6.3 Chemical characteristics of the MSW

The characteristics of the MSW in Alappuzha municipality are given in the table: 6.3

Table: 6.3 Chemical characteristics

Density	**570kg/m^3**	**Carbon (%)**	**17.98**
Moisture Content	61.61%	Nitrogen (%)	0.53
Calorific Value	2393 k cal/kg	C/N	34.25
Acid/Alkaline Equilibrium	7	Phosphorous as P_2O_5 (%)	0.72
Organic Matter	31%	Potassium as K_2O (%)	0.44

Source: Socio Economic Unit Foundation (2006)

The density of the MSW is 570 kg/m$^{3.}$ The organic component of the solid waste is 31% and the pH value is seven which show the neutral nature of the MSW. The chemical composition of the solid waste in the municipality is given in the appendix

6.4 Financial aspects

Developing nations spend between 20 and 40% of municipal revenues on SWM (Thomas-Hope 1998). In India, it is estimated that between 10 to 40 per cent of the total municipal budget is used for SWM (Bhide, 1990). The consolidated statement of the revenue receipts and revenue expenditure of Alappuzha municipality from 2005-06 to 2008-09 is given in the table: 6.4.

Table:6.4 Financial aspects

Year	**Revenue receipts**	**Revenue expenditure**	**Public health expenditure**	**Sanitation expenditure**	**Sanitation expenditure /revenue expenditure**	**Sanitation expenditure/ Public health expenditure**
2005-06	77173826	66087800	24531792	22842877	34.56%	93.1%
2006-07	59586792	57723196	22068938	19035085	32.97%	86.25%
2007-08	71522439	65485288	27691000	20839912	31.82%	75.25%
2008-09 (B.E)	98009180	98967200	33838000	30175000	30.48%	89.17%

Source: various budget issues of Alappuzha municipality.

B.E: budget estimate

The public health expenditure which includes sanitation expenditure has shown a consistent increase over the years except in the year 2006-07. Sanitation expenditure includes the expenditure on SWM. Sanitation expenditure as a percentage of revenue expenditure and sanitation expenditure as a percentage of public health expenditure are showing a declining trend over the years. The average spending on sanitation is 32.45% of the revenue expenditure.

6.5 Present Solid Waste Management System

The present solid waste management system in the municipality is briefly explained in the following sections.

i) The division of the Municipal area

The division of the Municipal area for the purpose SWM is given in the Table:6.5

Table: 6.5 The division of the Municipal area

Name of the circle	No. of wards
Central Circle	4
South I	14
South II	10
North I	10
North II	12

Source: Information given by the Office of the Health Officer, Alappuzha, 2008

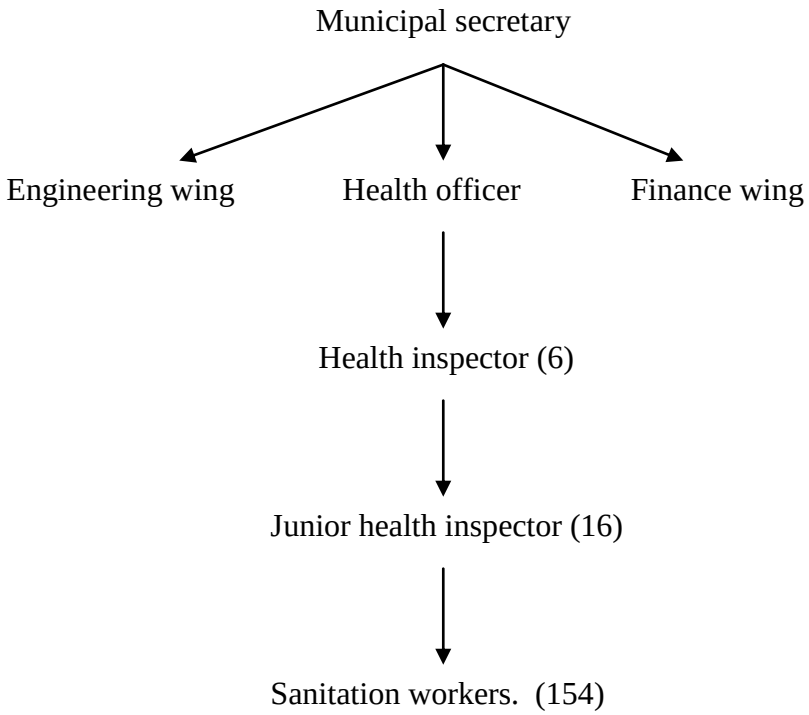
For the purpose of Solid Waste Management, the Municipal area is divided into five main health circles and an anti-mosquito circle. Each circle is under a Health Inspector and two or three Junior Health Inspector. Sanitation work is done by a number of contingent workers consisting of males and females. They are responsible for road sweeping, drain cleaning and removal of

waste to the collection point. Waste is collected from the collection point by the vehicles of the Municipality.

ii) Administrative setup of MSWM

The administrative setup of MSWM of the Municipality is shown in figure: 6.1

Figure: 6.1 The hierarchy of the staff



Source: Information given by the Office of the Health Officer, Alappuzha, 2008

The Municipal Secretary is at the top of the MSW system. There is an engineering wing and a finance wing to look into the technical aspects and to meet the expenses of the MSW management system. The Health officer is a medical doctor who is assisted by the health inspectors and junior health inspectors. The sanitation workers are responsible for the collection and disposal of the solid waste.

iii) Vehicles used in the municipal solid waste management

The details of the vehicles used by the Municipality are given in the table: 6.6

Table: 6.6 Vehicle data.

Name of the health circle	Tipper lorry	Container lorry	Tractor	3 wheeler (Ape)
Central circle	2	1	-	3
South I	1	-	-	1
South II	1	-	-	2
North I	-	-	1	2
North II	1	-	-	-
Total	5	1	1	8

Source: Information given by the Office of the Health Officer, Alappuzha, 2008

There are 15 Vehicles available for the SWM activity in the Municipality. The five tipper Lorries carry the solid waste to the landfill. Three wheeler (Ape) is used to collect waste from the various collection points in the Municipality along with the container lorry and tractors.

6.6 Kudumbasree and MSW

Kudumbasree is actively engaged in the MSW of Alappuzha municipality. There are fifteen groups of the kudumbasree engaged in the process. Six groups are promoted by he DTPC (District Tourism Promotion Council) and nine are promoted by the Clean Kerala Mission. The kudumbasree units collect waste from households, hospitals, shops and industries and hand it over to the municipal disposal system. The collection charges for the households ranges between Rs.30 and Rs.50 and for the other sectors it depends on the volume of waste collected.

After dealing with the salient features of the study area, a brief account of the impacts of UMSWM is given in the following chapter.

References

Bhide A. D. (1990), “Regional Overview on Solid Waste Management in South East Asia Region”, World Health Organisation, New Delhi.

Panchayat Level Statistics (2006), Department of Economics and Statistics, Government of Kerala.

Socio Economic Unit (2001), “Solid Waste Disposal with Peoples Participation: A Project in Alleppey Municipal Area”, Socio Economic Unit Foundation, Alappuzha.

Thomas-Hope, Elizabeth, ed. (1998), “Solid waste management: critical issues for Developing Countries”, Kingston: Canoe Press.

Chapter 7

Micro Analysis of the Impacts of Urban Solid Waste Management

A micro analysis of the variables taken helps to highlight i) the socio-economic characteristics of the sample units ii) various impacts of improper solid waste management iii) present status of solid waste management in Alappuzha iv) role of Kudumbasree in solid waste management v)willingness to pay for improved solid waste management system.

7.1 Socio-economic characteristics

Socio-economic characteristics of the study area were analysed by considering i) gender of the respondent ii) education iii) occupation iv) house ownership v) average monthly income vi) monthly expenditure.

i) Gender of the respondent

The gender of the respondents is given in the table: 7.1.

Table: 7.1 Gender

Gender	Percentage (%)
Male	65.4
Female	36.6
Total	100

65.4% of the respondents were male and 35.6% were females.

ii) Education

The educational qualifications of the respondents is given in the table 7.2.

Table: 7.2 Education

Level of education	Percentage (%)
No formal education	3.4
Primary level	35.3
Secondary level	44.8
Higher education	16.4
Total	**100**

Source: sample survey, 2008.

The table shows that 44.8% have attained secondary education while those with higher education were 16.4%.Only 3.4% of the respondents were without any formal education.

iii) House ownership

The ownership pattern of house is given in the table 7.3

Table: 7.3 House ownership

Ownership	Percentage (%)
Owned	92.1
Rented	7.9
Total	**100**

Source: sample survey, 2008.

The table shows that 92.1%of the respondents have their own house. Only 7.9% depend on rented houses.

iv) Occupation

The occupation of the respondents is give in the table: 7.4

Table: 7.4 Occupation

Occupation	Percentage (%)
Govt job	16.4
Private job	24.2
Business	16.7
Fishing and related activities	31.6
Tourism	5.6
Others	5.5
Total	100

Source: sample survey, 2008.

31.6% of the respondents are engaged in fishing and related activities while 24.2% have private sector jobs. Tourism employs .6% and 16.4% have government jobs. 16.7% of the respondents do business while 5.5% have other jobs.

v) Average monthly income

The range of average monthly income to which the sample households belong is considered in the table 7.5

Table: 7.5 Average monthly income

Income Range (in Rs.)	Percentage (%)
Less than 1000	14.8
1000 – 5000	61.0
5000 – 10000	19.4
Above 10000	4.8
Total	**100**

Source: sample survey, 2008.

75.8% of the respondents have an average monthly income of below Rs.5000.A small percentage of 4.8% belongs to the high income group of Rs.100000 and above.

vi) Average monthly expenditure

The table 7.6 gives the statistics for the average monthly expenditures on food, clothing, utilities, education, health, housing, transport and other expenses.

Table: 7.6 Average monthly expenditure (in Rs)

Food	3049.17
Clothing	886.59
Utilities	894.20
Education	1662.38
Health	846.02
Housing	784.15
Transport	1047.65
Others	1045.00
Total	10215.16

Source: sample survey, 2008.

The highest monthly expense is on food with average an average of Rs.3049.17 and the lowest is on housing with Rs.846.02.

vii) Average monthly expenditure

The range of average monthly expenditure of the respondents is given in the table 7.7

Table: 7.7 monthly expenditure

Expenditure	Percentage (%)
Less than 1000	10.8
1000 – 5000	55.1
5000 – 10000	32.6
Above 10000	1.5
Total	**100**

Source: sample survey, 2008.

Around 66% of the respondents have an expenditure of below Rs.5000. Only a small percentage of 1.5% spends more than Rs.10000.

7.2 Impacts of MSWM

The impacts of MSWM include health impacts to the population, economic impacts, environmental impacts and social impacts. The following section deals with the impacts of improper solid waste management in the municipality.

7.3 Impacts on health

A complex relationship exists between a person's health and immediate environment. Diseases can spread through air, water, food, soil, through environmental factors and lifestyle.

i) Signs and symptoms

The table 7.8 illustrates the signs and symptoms experienced by the respondents.

Table: 7.8 Signs and symptoms

Sl. no:	Signs and symptoms	%age affected
1	Diarrhea	41.7
2	Persistent headache	18.2
3	Fever	33.6
4	Cough and cold	31.3
5	Eye irritation	29.4
6	Skin infection	34.6

Source: sample survey, 2008.

Among the different signs and symptoms identified, 41.7% were affected with diarrhea, 34.6% with skin infection and 33.6% with fever. 18.2% had persistent headache.

ii) Perceived causes of disease signs and symptoms

The table: 7.9 shows the respondent's perceived causes of disease symptoms.

Table: 7.9 perceived causes of disease symptoms.

Signs and symptoms	Physical Environment*	Lifestyle risks**	Non-environment***	Don't know
Diarrhea	91.4	2.4	5.4	0.8
Persistent headache	49.6	38.2	10.8	1.4
Fever	61.7	18.2	18.3	1.8
Cough and cold	86.3	7.7	4.3	1.7
Eye irritation	77.8	6.2	11.5	4.5
Skin infection	89.2	3.4	4.8	2.6

Source: sample survey, 2008.

*air, water, food and soil, **alchohol, drugs, stress, lack of exercise, ***complications due to other diseases.

The respondents mainly attribute physical environmental factors as the cause for disease symptoms. 91.4% and 89.2% of the respondents attribute physical environmental factors as the cause for diarrhea and skin infection respectively. 38.2% considered lifestyle risks as the cause for persistent head aches.

iii) Occurrence of diseases

Table: 7.10 consider the occurrence of diseases among the respondents.

Table: 7.10 Occurrence of diseases

Name of disease	% affected
Dengue	20.1
Cholera	42.7
Jaundice	21.8
Typhoid	30.6
Intestinal parasitism	20.6
Rat fever	33.6
Acute respiratory infection	44.4
Chicken guinea	29.3
More than one disease	33.5
No diseases	5.2

Source: sample survey, 2008.

44.4% of the respondents were affected by acute respiratory infection followed by cholera at 42.7%. Chicken guinea has affected 29.3% of the respondents.33.5% of the respondents were affected by more than one disease. 5.2% were not affected by the given diseases.

iv) Perceived causes of disease

The table: 7.11 shows the respondent's perceived causes for diseases.

Table: 7.11 Perceived causes of disease

Disease	Physical Environment*	Lifestyle risks**	Non-environment***	Don't know
Dengue	85.6	0.4	5.4	8.6
Cholera	83.5	0.5	6.2	9.8
Jaundice	81.8	1.2	9.3	7.7
Typhoid	78.9	1.7	7.5	11.9
Intestinal parasitism	82.6	0 .9	3.5	13
Rat fever	91.6	0.1	2.7	5.6
Acute respiratory infection	80.2	5.7	9.6	4.5
Chicken guinea	94.4	0.3	1.7	3.6

Source: sample survey, 2008.

*air, water, food and soil, **alcohol, drugs, stress, lack of exercise, ***complications due to other diseases.

The respondents mainly attribute physical environmental factors as the cause for the given diseases. 94.4% considers physical environment factors as the cause for chicken guinea. 91.6% of the respondents attribute physical environmental factors as the cause for rat fever.

v) Diseases to children

Table 7.12 shows the effect of diseases on children

Table 7.12 Diseases to children

Response	Percentage (%)
Yes	27.9
No	72.1
Total	**100**

Source: sample survey, 2008.

72.1% of the respondents agreed that children are getting affected by the diseases.

vi) Seasonal occurrence of the diseases

Table 7.13 considers whether the occurrence of diseases has been seasonal.

Table 7.13 Seasonal occurrence of diseases

Response	Percentage (%)
Yes	64.3
No	35.7
Total	**100**

Source: sample survey, 2008.

64.3% of the respondents agreed that the occurrence of the diseases as seasonal.

vii) Season prone to diseases

Table: 7.14 shows the season in which there is a great chance for diseases to occur.

Table: 7.14 Season more prone to diseases

Season	Percentage (%)
Monsoon	47.9
Winter	20.9
Summer	31.2
Total	**100**

Source: sample survey, 2008.

Around 48% of the respondents agreed that the diseases occurred mainly during monsoon season followed by summer season.

viii) Average outpatient expenses

Table: 7.15 consider the average outpatient expense for the treatment of one episode of disease.

Table: 7.15 Average outpatient expenses

Average expenses	Percentage (%)
Less than 500	96.1
Above 500	3.9
Total	**100**

Source: sample survey, 2008.

96.1% of the respondents had an average outpatient expense of less than of Rs.500 for treating a single episode of a disease.

ix) Average inpatient expenses

Table: 7.16 consider the average inpatient expenses for the treatment of one episode of disease.

Table: 7.16 Average inpatient expenses

Average expenses	Percentage (%)
Less than 500	75
500 – 1000	14.3
Above 1000	10.7
Total	**100**

Source: sample survey, 2008.

75% of the respondents had average inpatient expenses of less than of Rs.500 for treating a single episode of diseases. 14.3% had an expense between Rs.500 and Rs.1000 and 10.7% had expenses above Rs.1000.

x) Frequency of occurrence of diseases

The table: 7.17 consider whether the frequency of the occurrence of epidemics has increased over the last few years in the municipality.

Table: 7.17 Frequency of occurrence of diseases

Response	Percentage (%)
Yes	86
No	14
Total	**100**

Source: sample survey, 2008.

86% of the respondents agreed that the occurrence of epidemics in the municipality has increased the last few years.

xi) Reasons for increase in the occurrence of diseases

The table: 7.18 shows the reasons the respondents give for the increased occurrence of diseases in the municipality.

Table: 7.18 Reasons for increase in the occurrence of diseases

Reason	Percentage (%)
Solid waste pollution	78.6
Other pollution	11.8
Don't know	9.6
Total	**100**

Source: sample survey, 2008.

Around 78.6% of the respondents consider solid waste pollution as the main reason for the increase in the occurrence of diseases. 11.8% consider other types of pollution as the reason while 9.6% didn't know the reason for the increase.

xii) Possession of insurance

Table: 7.19 shows the extent of insurance cover of the respondents.

Table: 7.19 Possession of insurance

Response	Percentage (%)
Yes	37.1
No	62.9
Total	**100**

Source: sample survey, 2008.

62.9% of the respondents have no insurance cover.

7.4) Economic impact

The economic impacts of SWM include the reduction of land value in the area. The following section deals with the opinion of the respondents regarding the residential land value in the municipal area.

i) Impact on land value due to solid waste pollution

Table: 7.20 consider whether the residential land value has decreased due to solid waste pollution.

Table: 7.20 land value

Response	Percentage (%)
Yes	11.2
No	88.8
Total	**100**

Source: sample survey, 2008.

Almost 88.8% of the respondents are of the opinion that pollution hasn't reduced land prices in the municipality.

ii) Land value per cent

Table: 7.21 show the expected residential land value per cent of land in the municipal area.

Table: 7.21 land value for one cent

Value	Percentage (%)
Less than 1 lakh	25.6
Above 1 lakh	74.4
Total	**100**

Source: sample survey, 2008.

About 55.6% of the respondents are of the opinion that the value of one cent of land in the municipal area is below Rs.1 lakh and 44.4% consider it as above Rs.1 lakh.

iii) Land value in the absence of solid waste pollution.

Table: 7.22 consider the whether residential land value in the municipal area will increase in the absence of solid waste pollution.

Table: 7.22 land value in the absence of solid waste pollution

Response	Percentage (%)
Yes	31.1
No	68.9
Total	**100**

Source: sample survey, 2008.

68.9% of the respondents are of the opinion that the land value will not increase in the absence of solid waste pollution.

iv) Change of residence

Table: 7.23 show the willingness of the respondents to change their residence to a place with less pollution.

Table: 7.23 Change of residence

Response	Percentage (%)
Yes	48.1
No	51.9
Total	**100**

Source: sample survey, 2008.

About 48.1% of the respondents were ready to relocate to place with less pollution while 51.9% were not ready to relocate.

7.5) Environmental impact

One of the important impacts of SWM is the deteriorating water quality in the area. The following section deals with the impacts of solid waste management on water quality in the municipality.

i) Source of drinking water

Table: 7.24 shows the main source of drinking water of the respondents

Table: 7.24 Source of drinking water

Source	**Percentage (%)**
Municipal water	73.2
Well water	8.1
Bore well	18.7
Total	**100**

Source: sample survey, 2008.

About 73.2% depend on municipal water as the main source for drinking water while 18.7% depend on bore well. 8.1% of the respondents use well water.

ii) Quality of water

Table: 7.25 considers the opinion of the respondents on whether the quality of water in the municipal area has deteriorated over the last few years

Table: 7.25 Quality of water

Response	**Percentage (%)**
Yes	86.7
No	23.3
Total	**100**

Source: sample survey, 2008.

About 86.7% are of the opinion that the quality of water available has deteriorated over the years.

iii) Reasons for bad water quality

Table: 7.26 consider the main reasons given by the respondents for the bad water quality.

Table: 7.26 Reasons for bad water quality

Reason	Percentage (%)
Solid waste pollution	70.2
Other types of pollution	24.3
Don't know	5.5
Total	**100**

Source: sample survey, 2008.

About 70.2% of the respondents gave solid waste pollution as the reason for the bad water quality. 24.3% give other types of pollution as the main reason for the bad water quality.

7.6) Social impact

The social impacts created by MSWM are in the form of the disamenities felt by the population. The following section gives an analysis of the disamenities felt by the respondents due to solid waste management in the municipality.

i) Disamenities

Table: 7.27 shows the main disamenities associated with solid waste experienced by the respondents.

Table: 7.27 Disamenities

problems	Percentage (%)
Mosquito, flies	61
Air pollution	1.8
Dirty surroundings	2.8
Bad smell	3.1
All the problems	29
None	2.3
Total	**100**

Source: sample survey, 2008.

Mosquito and flies are considered as the main problem due to sold waste. 29% are of the opinion that all the given problems are present in the municipal area due to solid waste.

ii) Ranking of the disamenities

Table: 7.28 show the ranking of the disamenities as given by the respondents in the decreasing order of intensity.

Table: 7.28 Ranking of the disamenities

Problems	Rank	Percentage (%)
Mosquito, Flies	I	75.1
Bad smell	II	22.1
Dirty surroundings	III	2.8
	Total	**100**

Source: sample survey, 2008.

About 75.1% has ranked the disamenity of mosquito and flies as number one. Bad smell is given second rank followed by dirty surroundings.

7.7) Present status of Solid Waste Management

i) Method of solid waste disposal

Table: 7.29 show the various methods adopted by the residents to dispose solid waste.

Table: 7.29 Solid waste disposal

Method	Percentage (%)
Municipal waste bin	77.2
Burning	22.8
Total	**100**

Source: sample survey, 2008.

About 77.2% of the respondents depend on municipal waste bin for disposing solid waste. Burning solid waste is an option for almost 22.8% of the respondents.

ii) Segregation

Table: 7.30 shows whether household solid waste is segregated before disposed by the respondents.

Table: 7.30 Solid waste segregation

Response	Percentage (%)
Yes	16
No	84
Total	**100**

Source: sample survey, 2008.

Only 16% of the respondents segregate the solid waste into bio degradable and non bio degradable before disposal.

iii) MSW collection

Table: 7.31 consider the frequency of the municipal solid waste collection in a week.

Table: 7.31 Frequency of solid waste collection

Frequency	Percentage (%)
Daily	3.3
Once in three days	32.5
Once in a week	63.2
Total	**100**

Source: sample survey, 2008.

63.2% of the respondents put the frequency of collection as once in a week while 32.5% gave it as once in three days.

iv) Rating of MSWM

Table: 7.32 shows the ratings given by the respondents on the MSWM of Alappuzha municipality.

Table: 7.32 Rating of solid waste management

Response	Percentage (%)
Very good	2.4
Good	30.9
Bad	66.7
Total	**100**

Source: sample survey, 2008.

About 66.7% of the respondents rated the municipality's solid waste management as bad. 30.9% rated it as good while only 2.4% rated it as very good.

v) Kudumbasree

Table: 7.33 show the use of Kudumbasree service for solid waste collection by the respondents.

Table: 7.33 Kudumbasree

Response	Percentage (%)
Yes	24.5
No	75.5
Total	**100**

Source: sample survey, 2008.

About 75.5% of the respondents use Kudumbasree for solid waste disposal.

vi) Rating of Kudumbasree

Table: 7.34 show the rating of the respondents on Kudumbasree in solid waste collection.

Table: 7.34 Rating of Kudumbasree

Opinion	Percentage (%)
Good	75.9
Very good	1.5
Bad	22.6
Total	**100**

Source: sample survey, 2008.

About 75.9% rated the performance of Kudumbasree as good while 1.5 rated as very good. The performance of Kudumbasree was as bad only by 22.6%.

vii) Comparison of Kudumbasree and municipality

Table: 7.35 consider a comparison of the performance between Kudumbasree and municipality in solid waste collection.

Table: 7.35 comparisons of Kudumbasree and Municipality

Response	Percentage (%)
Yes	63.5
No	36.5
Total	**100**

Source: sample survey, 2008.

63.5% of the respondents rated the performance of Kudumbasree as better than the municipality while 36.5% rated the performance of municipality as better than Kudumbasree.

7.8 Valuation for an improvement of the SWM

i) Awareness

Table: 7.36 shows the awareness of the respondents about the various prevailing environmental issues.

Table: 7.36 Awareness

Response	Percentage (%)
Yes	89.2
No	10.8
Total	**100**

Source: sample survey, 2008.

89.2% of the respondents were aware of the various environmental issues while 10.8% were not aware about the issues.

ii) Rating of the municipality's environment

Table: 7.37 show the rating given by the respondents on the municipality's environment.

Table: 7.37 Rating of the environment

Opinion	Percentage (%)
Very good	1.6
Good	24.9
Bad	73.6
Total	**100**

Source: sample survey, 2008.

73.6% of the respondents rated the town's environment as bad. About 24.9% considered the environment as good while only 1.6% considered it as very good.

iii) Solid waste pollution and environmental degradation

Table: 7.38 consider the opinion of the respondents regarding the role of solid waste pollution in the environmental degradation of the municipality.

Table: 7.38 Role of solid waste pollution

Response	Percentage (%)
Yes	91.1
No	8.9
Total	**100**

Source: sample survey, 2008.

An overwhelming 91.1% of the respondents cited solid waste pollution as the main reason behind the environmental degradation of the municipality.

iv) Solving solid waste pollution

Table: 7.39 consider the opinion of the respondents regarding solving the issue of solid waste pollution of the municipality without considering the cost involved.

Table: 7.39 solving solid waste pollution

Response	Percentage (%)
Yes	88.4
No	11.6
Total	**100**

Source: sample survey, 2008.

88.4% of the respondents were of the opinion that solid waste pollution must be solved without considering the cost involved.

v) Need for environmental projects

Table: 7.40 show the opinion of the respondents regarding the need for projects solving environmental issues. This opinion given by the respondents is indicative of their environmental ethic.

Table: 7.40 Need for environmental projects

Response	Percentage (%)
Yes	85.3
No	14.7
Total	**100**

Source: sample survey, 2008.

An overwhelming 85.3% of the respondents were of the opinion that there is a need for projects solving environmental issues.

7.9 Cross tabulation of the variables

The following section considers the cross tabulation of the variables monthly income and environmental ethic and education and environmental ethic.

i) Monthly income and environmental ethic

The relation between monthly income and environmental ethic is given in the table: 7.41.

Table: 7.41 Monthly income and environmental ethic

Monthly income(in Rs)	Environmental ethic (%)	
	Yes	No
Less than 1000	82.6	18.4
1000-5000	85.4	15.6
5000-10000	86.7.	13.3
Above 10000	86.8	13.2

The level of income does not seem to play a big role in determining the environmental ethic of the respondent. 82.6% of the respondents belonging to the income category less than 1000 have environmental ethic and as the income level increases there is a slight increase in the possession of environmental ethic.

i) Education of the respondent and environmental ethic.

The relation between Education of the respondent and environmental ethic is given in the table: 7.42

Table: 7.42 Education and environmental ethic.

Education of the respondent	Environmental ethic (%)	
	Yes	**No**
No education	76.4	23.6
Primary education	80.1	19.9
Secondary education	82.6	17.4
Higher education	83.7	16.3

76.4% of the respondents without education possess environmental ethic while 80.1% of the respondents with primary education has environmental ethic. As the education level increases from secondary education to higher education the respondents with environmental ethic increases from 82.6% to 83.7%.

7.10 WTP for improved solid waste management programme.

The valuation process consisted of giving the respondents two hypothetical solid waste management projects. The characteristics and advantages of the projects were explained to the respondents clearly.

i) Project description

The municipality is planning to have two different solid waste management programmes that will take into consideration different aspects of efficient solid waste management starting from generation of wastes to final disposal. The project can also be done by a private agency. The second project will be having additional advantages when compared with the first project and the cost will be high. Contribution from the public in the form of user charges is required.

ii) The first project

It will cost around Rs. 6 crore and the key characteristics of the project are:

i) a new collection system that ensures 100 % collection of solid wastes.
ii) construction of a controlled landfill in the present site with a large life span.
iii) avoiding contamination of ground water.

The valuation exercise used the bidding format and gave Rs.30per month as the starting point. If the willingness to pay was more than Rs.30 the amount was raised in the subsequent question and then the respondent was asked to give the final amount. Similarly, if the willingness to pay was less than Rs.30, a lesser amount was asked in the subsequent question and finally the respondents were asked to give their final amount.

iii) Amount willing to pay for the first project by the municipality

Table: 7.43 shows the distribution of the various amounts willing to be paid by the respondents for the first project done by the municipality

Table: 7.43 Amount willing to pay

Amount	Percentage (%)
More than Rs. 30	34.1
Amount of Rs. 30	16.4
Less than Rs. 30	40.6
None	8.9
Total	**100**

Source: sample survey, 2008.

34.1% of the respondents were willing to pay an amount of more than Rs.30and about 16.4% were willing to pay the amount of Rs.30 About 40.6% were ready to pay an amount of less than Rs.30 and 8.9% were unwilling to pay any amount for the project.

iv) Reasons for willing to pay for the first project by the municipality

Table: 7.44 consider the reasons given by the respondents for willing to pay for the first project to be done by the municipality.

Table: 7.44 Reasons for willing to pay

Reason	Percentage (%)
Health concerns	72.5
Disamenity concerns	22.4
Not indicated	5.1
Total	**100**

Source: sample survey, 2008.

72.5% cited health concerns as the reason for willing to pay for the project while 22.4% gave disamenity concerns as the reason. 5.1% gave no reasons for their decision to pay for the project.

v) Reasons for unwillingness to pay for the first project by the municipality

Table: 7.45 shows the various reasons given by those respondents who were unwilling to pay any amount for the project.

Table: 7.45 Reasons for unwillingness to pay

Reason	Percentage (%)
Can't afford to pay	45.1
Municipality should bear the expense	33.3
No faith in the municipality	16.3
No reasons	5.3
Total	**100**

Source: sample survey, 2008.

45.1% of the respondents cited financial problems as the reason for unwillingness to pay for the project while 33.3% believe that municipality should bear the full expenses. 16.3% has no faith in the municipality and 5.3% gave no reasons for their decision of not to pay for the project.

vi) Amount willing to pay for the first project by the private agency

Table: 7.46 show the amount willing to pay for the first project to be done by the private agency.

Table: 7.46 Amount willing to pay

Amount	Percentage (%)
More than Rs. 30	23.1
Amount of Rs. 30	17.4
Less than Rs. 30	47.6
None	11.9
Total	**100**

Source: sample survey, 2008.

23.1% of the respondents were willing to pay an amount of more than Rs.30and about 17.4% were willing to pay the amount of Rs.30. About 47.6% were ready to pay an amount of less than Rs.30 and 11.9% were unwilling to pay any amount for the project.

vii) Reasons for willingness to pay for the first project by the private agency

Table: 7.47 consider the reasons given by the respondents for willingness to pay for the first project done by the private agency.

Table: 7.47 Reasons for willingness to pay

Reason	Percentage (%)
Health concerns	70.5
Disamenity concerns	23.7
Not indicated	6.8
Total	**100**

Source: sample survey, 2008.

70.5% cited health concerns as the reason for willing to pay for the project while 23.7% gave disamenity concerns as the reason. 6.8% gave no reasons for their decision to pay for the project.

viii) Reasons for unwillingness to pay for the first project by the private agency

Table: 7.48 consider the reasons given by the respondents for their unwillingness to pay for the first project to be done by the private agency.

Table: 7.48 Reason for unwillingness to pay

Reason	Percentage (%)
Can't afford to pay	53.1
Municipality should bear the expense	37.3
No faith in the private agency	5.2
No reasons	4.4
Total	**100**

Source: sample survey, 2008.

53.1% of the respondents cited financial problems as the reason for unwillingness to pay for the project while 37.3% believe that municipality should bear the full expenses. 5.2% has no faith in the private agency and 4.4% gave no reasons for their decision of not to pay for the project.

vii) The second project

It will cost around 8 crore and the key features of the second project are

i) new collection system that ensures 100 % collection of solid wastes.
ii) construction of a controlled landfill with a large life span.
iii) avoiding contamination of ground water.
iv) generation of compost from waste.
v) recycling of waste.

For the bidding format, the starting point amount was kept at Rs.40per month.

viii) Amount willing to pay for the second project by the government

Table: 7.49 consider the amount willing to pay by the respondents for the second project to be done by the government.

Table: 7.49 Amount willing to pay

Amount	Percentage (%)
More than Rs. 40	15.2
Amount of Rs. 40	19.3
Less than Rs. 40	50.7
None	14.8
Total	**100**

15.2% of the respondents were willing to pay an amount of more than Rs.40 and about 19.3% were willing to pay the amount of Rs.40. About 50.7% were ready to pay an amount of less than Rs.40 and 14.8% were unwilling to pay any amount for the project.

ix) Reasons for willingness to pay for the second project by the municipality

Table: 7.50 shows the various reasons given by the respondents regarding their decision of paying for the second project.

Table: 7.50 Reasons for willing to pay

Reason	Percentage (%)
Health concerns	76.5
Disamenity concerns	17.3
Not indicated	6.2
Total	**100**

76.5% cited health concerns as the reason for willing to pay for the project while 17.3% gave disamenity concerns as the reason. 6.2% gave no reasons for their decision to pay for the project

x) Reasons for unwillingness to pay for the second project by the municipality

Table: 7.51 shows the various reasons given by the respondents regarding their decision of not paying for the second project.

Table: 7.51 Reason for unwillingness to pay

Reason	Percentage (%)
Can’t afford to pay	53.2
Municipality should bear the expense	27.3
No faith in the municipality	17.1
No reasons	2.4

53.2% of the respondents cited financial problems as the reason for unwillingness to pay for the project while 27.3% believe that municipality should bear the full expenses. 17.1% has no faith in the municipality and 2.4% gave no reasons for their decision of not to pay for the project.

xi) Amount willing to pay for the second project by the private agency

Table: 7.52 show the amount willing to pay by the respondents for the second project to be done by the private agency.

Table: 7.52 Amount willing to pay

Amount	Percentage (%)
More than Rs. 40	14.1
Amount of Rs. 40	18.2
Less than Rs.40	53.8
None	13.9
Total	**100**

Source: sample survey, 2008.

14.1% of the respondents were willing to pay an amount of more than Rs.40 and about 18.2% were willing to pay the amount of Rs.40. About 53.8% were ready to pay an amount of less than Rs.40 and 13.9% were unwilling to pay any amount for the project.

xii) Reasons for willing to pay for the second project by the private agency

Table: 7.53 shows the reasons given by the respondents for willing to pay for the second project to be done by the private agency.

Table: 7.53 Reasons for willing to pay

Reason	Percentage (%)
Health concerns	78.5
Disamenity concerns	16.9
Not indicated	4.6
Total	**100**

Source: sample survey, 2008.

78.5% cited health concerns as the reason for willing to pay for the project while 16.9% gave disamenity concerns as the reason. 4.6% gave no reasons for their decision to pay for the project.

xiii) Reasons for unwillingness to pay for the second project by the private agency

Table: 7.54 shows the reasons given by the respondents for their unwillingness to pay for the second project to be done by the private agency.

Table: 7.54 Reasons for unwillingness to pay

Reason	Percentage (%)
Cant afford to pay	57.1
Municipality should bear the expense	36.3
No faith in the private agency	4.3
No reasons	2.3
Total	100

Source: sample survey, 2008.

57.1% of the respondents cited financial problems as the reason for unwillingness to pay for the project while 36.3% believe that municipality

should bear the full expenses. 4.3% has no faith in the private agency and 2.3% gave no reasons for their decision of not to pay for the project.

7.11 Average WTP for the projects

The average WTP for the two projects is given in the table: 7.55.

Table: 7.55 Average WTP for the project

Project	Average WTP amount(in Rs)
First project by municipality	26.4
First project by private agency	25.74
second project by municipality	28.67
second project by private agency	27.42

The average WTP for the first project by the municipality is Rs.26.4 while for the same project done by the private agency it is Rs.25.74. For the second project by the municipality the average WTP is Rs.28.67 while for the private project it is Rs. 27.42. Statistical treatment is given in the next chapter.

Chapter 8

Results of the Study: Statistical Treatment

Regression methods such as linear, logistic, and ordinal regression are useful tools to analyze the relationship between multiple independent variables and dependent variable. The regression methods are capable of allowing researchers to identify independent variables related to dependent variable. These methods also permit researchers to estimate the magnitude of the effect of the independent variables on the dependent variable. The application of linear, logistic, and ordinal regression methods depends largely on the measurement scale of the dependent variables and the validity of the model assumptions. To study the effects of independent variables on all levels of the ordered categorical dependent, an ordinal regression method can be appropriately chosen to obtain the valid results.

8.1 Regression analysis for the first municipal project: PLUM (Polytomous Universal Model)

The SPSS Ordinal Regression procedure, or PLUM (Polytomous Universal Model), is an extension of the general linear model to ordinal categorical data (SPSS, Inc 2002). It can specify five link functions as well as scaling parameters. The model involves WTP as the dependant variable and the independent variables are AMI (average monthly income), Ed (Education), Cd (Children), Gen (Gender), Ea (environmental ethic) and Hs (House ownership).

i) Model Fitting Information

Table: 8.1 give the overall test of the model and test the hypothesis that at least one of the independent variables (AMI, Ed, Cd, Gen, Ea, Hs) does not significantly affect the household's WTP.

Table: 8.1 Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	1497.789	114.677	8	.000
Final	1383.112			

Link function: Logit[a].

[a]The link function is the function of the probabilities that results in a linear model in the parameters. The link function specifies what transformation is applied to the dependent variable or to the cumulative probabilities of the ordinal categories. It is the link between the random component on the left side of the equation and the systematic component.

The p – value of the Model fitting information table gives as 0.000, which shows that the overall model is statistically significant or in other words, the independent variables significantly affects the willingness to pay of the households at the 0.05 significance level.

ii) Measuring strength of association- Pseudo R-Square

There are several R^2-like statistics that can be used to measure the strength of the association between the dependent variable and the predictor variables. They are analogies to R-squared in OLS regression not as useful as the R^2 statistic, as their interpretation is not straightforward (Magidson, 1981). These measures don't have the percent of variance explained interpretation and should not be reported in those terms. They can be taken as additional measures of model effect size, with higher values being better. Three commonly used statistics are:

i) Cox and Snell R^2: Cox and Snell's R-Square is an attempt to imitate the interpretation of multiple R-square based on the likelihood, but its

maximum can be less than 1.0, making it difficult to interpret

$$R_{CS}^2 = 1 - \left(\frac{L(B^0)}{L(\hat{B})} \right)^{n/2}$$

ii) Nagelkerke's R^2: Nagelkerke's R-square is a modification of the Cox and Snell coefficient so that it can vary from 0 to 1. Therefore Nagelkerke's R-square will normally be higher than the Cox and Snell measure but will tend to run lower than the corresponding OLS R-square

$$R_N^2 = \frac{R_{CS}^2}{1 - L(B^0)^{2/n}}$$

iii) McFadden's R^2: McFadden's R-square is an information theory measure which is interpreted as the reduction in entropy that the researcher's model achieves compared to the intercept-only model.

$R_M^2 = 1 - \left(\frac{L(\hat{B})}{L(B^0)} \right)$ where $L(\hat{B})$ is the log-likelihood function for the model with the estimated parameters and $L(B^0)$ is the log-likelihood with just the thresholds and *n* is the number of cases (sum of all weights).

Table:8.2 Pseudo R^2

Cox and Snell	.299
Nagelkerke	.389
McFadden	.243

Link function: Logit

Table: 8.2 show that the Pseudo R^2 values are having moderate size effect.

iii) Test of Parallel Lines

This is commonly referred to as the test of parallel lines because the null hypothesis states that the slope coefficients in the model are the same across response categories and lines of the same slope are parallel. Applying the parallel lines test tests if the regression coefficients are not significantly different across levels of the response variable. Since the ordered logit model estimates one equation over all levels of the response variable, the test for proportional odds tests, whether our one-equation model is valid. The assumption is not violated if this test returns a finding of non significance, meaning there is no significant difference between the model where the regression lines are constrained to be parallel for each level of the ordinal dependent compared to the model where the regression lines are allowed to be estimated without a parallelism constraint.

Table: 8.3 Test of Parallel Lines[1]

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	798.363	8.303	7	.307
General	790.060			

[1]The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.

The table: 8.3 given above shows that the assumption is met as the test shows a level of non- significance.

iv) Parameter Estimates

These are the ordered log-odds (logit) regression coefficients. Standard interpretation of the ordered logit coefficient is that for a one unit increase in the predictor, the response variable level is expected to change by its respective

regression coefficient in the ordered log-odds scale while the other variables in the model are held constant. Table: 8.4 represent the parameter estimates.

Table: 8.4 Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold[1]	[wtp1 = 0]	-3.821	.430	78.875	1	.000	-4.664	-2.978
	[wtp1 = 1]	-2.752	.416	43.668	1	.000	-3.568	-1.936
	[wtp1 = 2]	-.174	.400	.190	1	.663	-.957	.609
Location[2]	AMI	.000016	.000534	2.331	1	.084	.00013	3.014E-5
	Cd	-.041	.041	.976	1	.323	-.121	.040
	Gen	-.211	.191	1.228	1	.268	-.585	.162
	Ea	.495	.157	90.343	1	.000	.804	-.187
	Hs	.676	.188	12.535	1	.000	.297	1.034
	[Ed=1]	.196	.421	.052	1	.028	-.922	.730
	[Ed=2]	.379	.205	3.394	1	.065	-.024	.781
	[Ed=3]	.479	.189	6.465	1	.011	.110	.849
	[Ed=4]	0[a]	.	.	0	.	.	.

Link function: Logit.

[a]This parameter is set to zero because it is redundant.

Wtp1 = Willingness to pay for the 1st project (municipality)

[1]This represents the response variable in the ordered logistic regression.

[2]Location refers to the list of independent variable main, nested, and interaction effects in the model.

v) Summary of the Results

The fitted model, based on the output is given by,

$P(WTP = 0) = \exp(-3.821 + 0.000016\,AMI + b_2\,Ed - 0.041Cd - 0.211Gen + 0.495Ea + 0.676Hs)/\{1 + \exp(-3.821 + 0.000016AMI + b_2Ed - 0.041Cd - 0.211Gen + 0.495Ea + 0.676Hs)\}$

$P(WTP = 1) = \exp(-2.712 + 0.000016\,AMI + b_2\,Ed - 0.041Cd - 0.211Gen + 0.495Ea + 0.676Hs)/\{1 + \exp(-2.712 + 0.000016AMI + b_2Ed - 0.041Cd - 0.211Gen + 0.495Ea + 0.676Hs)\}$

$P(WTP = 2) = \exp(-0.174 + 0.000016\,AMI + b_2\,Ed - 0.041Cd - 0.211Gen + 0.495Ea + 0.676Hs)/\{1 + \exp(-0.174 + 0.000016AMI + b_2Ed - 0.041Cd - 0.211Gen + 0.495Ea + 0.676Hs)\}$

$$P(WTP = 3) = 1$$

Where $b_2 = 0.196$ if Ed = 1; $b_2 = 0.379$ if Ed = 2; and $b_2 = 0.479$ if Ed = 3

i) The results from the analysis shows that the variables Ea, Hs and Ed are statistically significant at 5 percent level of significance and AMI is significant at 10 percent significance level (i.e., the p-values for the variables Ea, Hs and Education are less than 0.05 and AMI is less than 0.10).

ii) The parameter estimates table shows that the signs of Children and Gender are with negative coefficients. This means that the households with more number of children tend to be unwilling to pay than those with a less number of children. Then, if respondent is male, the household tends to have a lower probability of paying. Variables AMI, Ea, Hs and Ed on the other hand, have positive coefficients. This means that the higher the average monthly income, the more likely that the household will be willing to pay. Also,

having environmental ethic helps to increase the probability that the households will be willing to pay for the project. The result shows that the individuals who owned their houses tend to a higher probability of paying. Education has also a positive influence on WTP, i.e. higher the educational attainment higher the willingness to pay for the project.

8.2 Regression analysis for the first private project

Ordinal Regression for the first project by the private agency is given below.

i) Model Fitting Information

Table: 8.5 shows the model fitting information for the first project to be done by the private agency.

Table: 8.5 Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	1306.250	38.913	8	.000
Final	1267.338			

Link function: Logit.

The *p* – value of the Model fitting information table is given as 0.000, which shows that the overall model is statistically significant or in other words, the independent variables significantly affects the willingness to pay of the households.

ii) Pseudo R-Square

Table 8.6 shows the strength of the association of the model.

Table: 8.6 Pseudo R-Square

Cox and Snell	.711
Nagelkerke	.816
McFadden	.606

Link function: Logit.

The values of the pseudo R^2show good size effect.

iii) Test of Parallel Lines

Table: 8.7 shows the test of parallel lines or the model.

Table: 8.7 Test of Parallel Lines

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	1416.914	10.712	7	.152
General	1406.202			

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories

The test finds a non-significant value showing that the assumption of parallel lines is met.

iv) Parameter Estimates

Table: 8.8 shows the parameter estimates for the model.

Table: 8.8 Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[wtpp1 = 0]	1.434	.431	11.073	1	.001	.589	2.278
	[wtpp1 = 1]	2.144	.435	24.255	1	.000	1.291	2.997
	[wtpp1 = 2]	2.261	.436	26.854	1	.000	1.406	3.116
Location	AMI	.000076	.000	8.851	1	.056	.000	8.613E-5
	Cd	.075	.049	2.328	1	.127	-.021	.171
	Gen	-.052	.210	.062	1	.083	-.359	.463
	Ea	-.163	.166	.956	1	.328	-.488	.163
	Hs	.984	.188	27.353	1	.000	.615	1.353
	[Ed=1]	-1.057	.551	3.681	1	.055	-2.137	.023
	[Ed=2]	-.301	.219	1.890	1	.169	-.731	.128
	[Ed=3]	-.560	.203	7.579	1	.006	-.959	-.161
	[Ed=4]	0[a]	.	.	0	.	.	.

Link function: Logit.

[a]. This parameter is set to zero because it is redundant

Wtpp1 = Willingness to pay for the first project (Private)

v) Summary of the results

The fitted model, based on the output is given by,

P(WTP = 0) = exp (1.434 + 0.000076 AMI + b_2 Ed – 0.075Cd – 0.052Gen – 0.163Ea + 0.984Hs)/{1 + exp(1.434 + 0.000076AMI + b_2Ed – 0.075Cd – 0.052Gen – 0.163Ea + 0.984Hs)}

P(WTP = 1) = exp (2.144 + 0.000076 AMI + b_2 Ed – 0.075Cd – 0.052Gen – 0.163Ea + 0.984Hs)/{1 + exp(2.144 + 0.000076AMI + b_2Ed – 0.075Cd – 0.052Gen – 0.163Ea + 0.984Hs)}

P(WTP = 2) = exp (2.261 + 0.000076 AMI + b_2 Ed – 0.075Cd – 0.052Gen – 0.163Ea + 0.984Hs)/{1 + exp(2.261 + 0.000076AMI + b_2Ed – 0.075Cd – 0.052Gen – 0.163Ea + 0.984Hs)}

$$P(WTP = 3) = 1$$

Where b_2 = -1.057 if Ed = 1; b_2 = -0.301 if Ed = 2; and b_2 = -0.560 if Ed = 3

i) The results from the analysis shows that the variable Hs is statistically significant at 5 percent level of significance and AMI, Gender and Education are significant at 10 percent significance level (i.e., the p-values for the variables Hs is less than 0.05 and AMI, Gender and Education are less than 0.10).

ii) The parameter estimates table shows that gender, environment ethic and education are with negative coefficients. If the respondent is a male, the household tends to have a lower probability of paying. Similarly, households having education and environment ethic tend to have a lower probability of paying. Variables AMI, Cd and Hs on the other hand, have positive coefficients. This means that the higher the monthly income, the more likely that the household will be willing to pay. The individuals who owned their houses tend to have a higher probability of paying. Having children has also a positive influence on WTP, i.e. having children in the family, higher will be the probability to pay for the project.

8.3 Regression analysis for the second municipal project

Ordinal regression for the second project by the municipality is given below

i) Model Fitting Information

Table: 8.9 consider the model fitting information for the second project to be done by the municipality.

Table: 8.9 Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	1940.333	18.223	8	.020
Final	1922.110			

Link function: Logit.

The p – value of the Model fitting information table gives as 0.020 which shows that the overall model is statistically significant or in other words, the independent variables significantly affects the willingness to pay of the households at the 0.05 significance level.

ii) Pseudo R-Square

Table: 8.10 shows the Pseudo R^2 values for the strength of association between the variables.

Table: 8.10 Pseudo R-Square

Cox and Snell	.677
Nagelkerke	.773
McFadden	.542
Link function: Logit.	

The values of the pseudo R^2show good size effect.

iii) Test of Parallel lines

Table: 8.11 show the test of parallel lines for the model.

Table: 8.11 Test of Parallel lines

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	860.333	8.173	7	.318
General	852.159			

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.

The non-significant value show that the assumption of parallel lines is met.

iv) Parameter estimates

Table 8.12 shows the parameter estimates of the model

Table: 8.12 Parameter estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[wtp2 = 0]	-.188	.394	.229	1	.632	-.960	.584
	[wtp2 = 1]	.751	.395	3.619	1	.057	-.023	1.525
	[wtp2 = 2]	1.422	.397	12.815	1	.000	.643	2.200
Location	AMI	.000069	.000	1.057	1	.304	.000	6.264E-5
	Cd	.179	.074	6.531	1	.011	.044	.335
	Gen	-.286	.183	2.457	1	.117	-.644	.072
	Ea	.201	.140	7.022	1	.010	-.296	.254
	Hs	.401	.175	5.257	1	.022	.058	.745
	[Ed=1]	-.359	.407	.780	1	.377	-1.156	.438
	[Ed=2]	-.152	.195	.610	1	.435	-.535	.230
	[Ed=3]	-.060	.179	.113	1	.737	-.411	.291
	[Ed=4]	0[a]	.	.	0	.	.	.

Link function: Logit.

[a] This parameter is set to zero because it is redundant

Wtp2 = Willingness to pay for the second Project (municipality)

v) Summary of the results

The fitted model, based on the output is given by,

P(WTP = 0) = exp (– 0.188 + 0.000069 AMI + b_2 Ed + 0.179Cd – 0.286Gen + 0.201Ea + 0.401Hs)/{1 + exp(– 0.188 + 0.000069AMI + b_2Ed – 0.179Cd – 0.286Gen + 0.201Ea + 0.401Hs)}

P(WTP = 1) = exp (0.751 + 0.000069 AMI + b_2 Ed + 0.179Cd – 0.286Gen + 0.201Ea + 0.401Hs)/{1 + exp(0.751 + 0.000069AMI + b_2Ed – 0.179Cd – 0.286Gen + 0.201Ea + 0.401Hs)}

P(WTP = 2) = exp (1.42 + 0.000069 AMI + b_2 Ed + 0.179Cd – 0.286Gen + 0.201Ea + 0.401Hs)/{1 + exp(1.42 + 0.000069AMI + b_2Ed – 0.179Cd – 0.286Gen + 0.201Ea + 0.401Hs)}

$$P(WTP = 3) = 1$$

Where b_2 =- 0.359 if Ed = 1; b_2 = -0.152 if Ed = 2; and b_2 = -0.060 if Ed = 3

i) The results from the analysis show that the variables Cd, Ea and Hs are statistically significant at 5 percent level of significance.

ii) The parameter estimates table shows that Gender and education are with negative coefficients. If the respondent is a male, the household tends to have a lower probability of paying. Similarly, households having education also tend to have a lower probability of paying. Variables AMI, Cd, Ea and Hs on the other hand, have positive coefficients. This means that the higher the monthly income, the more likely that the household will be willing to pay. The individuals who owned their houses tend to have a higher probability of paying. Having children and environment ethic has also a positive influence on WTP for the project.

8.4 Regression analysis for the second private project

i) Model Fitting Information

Table: 8.13 show the model fitting information of the model.

Table: 8.13 Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	1477.130	42.411	8	.000
Final	1434.719			

Link function: Logit.

The p – value of the Model fitting information table gives as 0.000, which shows that the overall model is statistically significant or in other words, the independent variables significantly affects the willingness to pay of the households at the 0.05 significance level.

i) Pseudo R-Square

Table: 8.14 shows the PseudoR^2 values for the variables.

Table:8.14 Pseudo R-Square

Cox and Snell	.574
Nagelkerke	.655
McFadden	.409

Link function: Logit.

The values of the pseudo R^2show good size effect.

iii) Test of Parallel lines

Table: 8.15 consider the test of parallel lines for the model.

Table: 8.15 Test of Parallel lines

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	1414.457	.722	7	.936
General	1413.735			

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories

The finding of a non-significant value in this case, shows that assumption of parallel lines is met.

iv) Parameter Estimates

Table: 8.16 give the parameter estimates for the model.

Table: 8.16 Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[wtp2p = 0]	2.461	.418	34.599	1	.000	1.641	3.281
	[wtp2p = 1]	3.562	.429	68.907	1	.000	2.721	4.403
	[wtp2p = 2]	3.884	.433	80.495	1	.000	3.036	4.733
Location	AMI	.000031	.000012	5.738	1	.017	3.082E-5	.000
	Cd	.002	.046	.003	1	.957	-.093	.088
	Gen	.329	.197	2.789	1	.005	-.057	.716
	Ea	.468	.151	9.541	1	.002	.171	.764
	Hs	.789	.184	18.397	1	.000	.428	1.149

[Ed=1]	-.942	.527	3.195	1	.074	-1.976	.091
[Ed=2]	-.182	.218	.700	1	.403	-.609	.245
[Ed=3]	.095	.196	.236	1	.627	-.289	.479
[Ed=4]	0[a]	.	.	0	.	.	.

Link function: Logit.

a This parameter is set to zero because it is redundant.

Wtp2p = Willingness to pay for the second project (Private)

v) Summary of the results

The fitted model, based on the output is given by,

P(WTP = 0) = exp (2.461 + 0.000031 AMI + b_2 Ed + 0.002Cd + 0.329Gen + 0.468Ea + 0.789Hs)/{1 + exp(2.461 + 0.000031AMI + b_2Ed + 0.002Cd + 0.329Gen + 0.468Ea + 0.789Hs)}

P(WTP = 1) = exp (3.562 + 0.000031 AMI + b_2 Ed + 0.002Cd + 0.329Gen + 0.468Ea + 0.789Hs)/{1 + exp(3.562 + 0.000031AMI + b_2Ed + 0.002Cd + 0.329Gen + 0.468Ea + 0.789Hs)}

P(WTP = 2) = exp (3.884 + 0.000031 AMI + b_2 Ed + 0.002Cd + 0.329Gen + 0.468Ea + 0.789Hs)/{1 + exp(3.884 + 0.000031AMI + b_2Ed + 0.002Cd + 0.329Gen + 0.468Ea + 0.789Hs)}

P(WTP = 3) = 1

Where b_2 = -0.942 if Ed = 1; b_2 = -0.182 if Ed = 2; and b_2 = 0.095 if Ed = 3

i) i)The results from the analysis shows that the variables AMI, Gender, Ea and Hs are statistically significant at 5 percent level of significance and Ed is significant at 10 percent significance level (i.e. the *p-values* for the variables AMI, Gender, Ea and Hs are less than 0.05 and Ed is less than 0.10).

ii) The parameter estimates table shows that the variables AMI, Gen, Cd, Ea and Hs, have positive coefficients. This means that the higher the monthly income, the more likely that the household will

be willing to pay. If the respondent is a male, the household tends to have a higher probability of paying. The individuals who owned their houses tend to have a higher probability of paying. Having children and environment ethic has also a positive influence on WTP for the project. Education is with a negative coefficient ie. households having education tend to have a lower probability of paying for the project.

References

Magidson, Jay (1981), "Qualitative variance, entropy, and correlation ratios for nominal dependent variables", Social Science Research 10: 177-194.

SPSS, Inc (2002), "Ordinal Regression Analysis",SPSS Advanced Models10.0,Chicago,II.