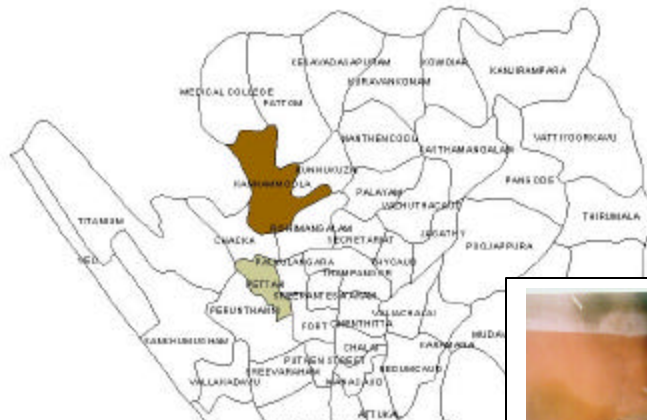


**STUDY OF THE ATTITUDE AND PERCEPTION OF COMMUNITY
TOWARDS SOLID WASTE MANAGEMENT – A CASE STUDY OF
THIRUVANANTHAPURAM CITY – PHASE II.**



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CHAPTER I

INTRODUCTION

Solid Waste Management is one of the important obligatory functions of not only urban local bodies but also of rural local bodies. But this essential service is not efficiently and properly performed by the local bodies of Kerala, resulting in many health and sanitation problems. It is observed that lack of financial resources, institutional weakness, improper selection of technology, transportation systems and disposal options, public's apathy towards environmental cleanliness and sanitation have made this service unsatisfactory.

The fundamental objective of Solid Waste Management program is to minimize the pollution of the environment as well as utilizing the waste as a resource. These goals should be achieved in a way that is financially sustainable, i.e. using methods that can be afforded by the community over the long term and with minimum risk to the persons involved.

Methods of solid waste management vary greatly with types of wastes and local conditions. The best systems are designed by fixing together the fundamental goals, a clear analysis of local conditions and factors, an understanding of the full range of technology options that are available and an awareness of the traditional wisdom and systems that the local people have developed.

It is a common knowledge that waste is nothing but useful material at wrong place. There is no material in this world, which is not useful in one-way or the other. Also there is no material, which is created out of nothing. There are several cycles in the nature, which sustain the world. It is man's ignorance that he considers certain things as waste and certain other thing as useful. Waste disposal is an immediate and critical issue for the community now and ineffective or irresponsible disposal of solid waste pollutes the environment and pose health risk to public. Waste management technologies like land filling and incineration are not a complete solution to this problem. No one wants a waste management site in his or her neighborhood. Just as types of wastes are changing, so must the attitude of people towards waste must change. People now realize that the solution lies in using waste as a resource rather than to be destroyed. The strategies that can be adopted for integrated solid waste management are i) to reduce the amount of solid waste generated ii) to recycle as much refuse as possible iii) to incinerate or to change to compost the waste with appropriate environmental controls and with energy recovery options and iv) to continue sanitary land filling for selected waste items. Reducing and reusing are

the most viable alternatives; however, no single method will control the waste problem as effectively as a comprehensive program that relies on a number of solutions for different situations. Source reduction (eliminating unnecessary packaging and buying and reusing fewer toxic products) and recycling are the methods of choice and

the direct involvement of citizens is essential. Land filling and incineration are used only for the waste that cannot be used as a resource. The government could affect waste management in a number of ways by establishing national recycling goals and packaging standards, adopting a clearly stated policy on source reduction and implementing educational programs on all approaches to waste minimization. The government could also set an example for the states and stimulate markets for recycled products by requiring government purchase of products containing recycled materials.

The benefits of recycling come not only from the sale of recycled materials and conservation of resources but also as a result of reducing expenses or from avoiding costs. The savings derived from not paying tipping fees for land filling or incinerating the materials, which are recycled should be included in any cost/benefit analysis of recycling. The cost of extending the life of a current landfill or of closing an old landfill and developing a new one must also be taken in account. The waste management problem is complex because it involves a multitude of scientific, technical, economic and social factors. Due to the complexity of the situation, it will require the cooperation of government, industry and individuals working as partners rather than adversaries to find a long-term solution.

1.1 Solid Waste

Solid Waste is the term used to describe non-liquid waste material arising from domestic, trade, commercial, agricultural and industrial activities, and from public services. Waste is a combination of various heterogeneous discarded materials. It is commonly known as garbage, refuse, rubbish or trash.

Solid Waste is differentiated by their origin, physical form, detailed composition and risk potential. The quantity and the composition of some types of solid wastes, such as municipal waste, varies from day to day, season to season and from locality to locality.

1.1 Classification of Solid Waste

Solid Waste is classified based on their origin, treatability and risk potential.

1.1.1 *Classification based on Origin*

- a) Food Waste: Food wastes are the animal, fruit and vegetable residues resulting from the handling, preparation and eating of foods. They are putrescible and decompose rapidly causing malodour.

- b) Rubbish: This comprises combustible and noncombustible solid wastes of households, institutions of commercial activities etc excluding putrescible materials. The combustible rubbish consists of materials such as paper, cardboard, furniture parts, textiles, rubber, leather, wood and garden trimmings. Non-combustible rubbish consists of items such as glass, broken crockery, plastic, discarded tins, aluminum cans and materials made of ferrous and non-ferrous metals.
- c) Ashes and residues: Materials remaining from the burning of wood, coal, coke and other combustible wastes in homes, stores, institutions, industrial and municipal facilities for the purpose of heating and cooking and above all the remains of combustible wastes are categorised as ashes and residues. Ashes and residues are normally composed of fine powdery materials, cinders, clinkers and small amounts of burned and partially burned materials.
- d) Demolition and construction wastes: Waste from demolished buildings and other structures are classified as demolition wastes. Wastes from the construction, remodeling and repairing of individual residences, housing complexes, multi-storied flats, commercial buildings etc are classified as construction wastes. The constituents of this waste are stones, concrete, bricks, plaster and plumbings.
- e) Municipal wastes: Wastes such as street sweepings, roadside litter, litter from municipal dustbins, dead animals and abandoned vehicles. Municipal waste includes rubbish, trash and almost all types of waste.
- f) Industrial process wastes: Industrial process waste includes the solid and semi-solid wastes from industrial plants. The specific characteristics of these materials vary depending on the nature of the manufacturing process.
- g) Agricultural wastes: Agricultural wastes are residues resulting from cultivation of plants and raising of livestock such as crop residues from fields and waste from feedlots.

1.1.2 Classification based on Characteristics

Based on characteristics, solid wastes can be classified as biodegradable and non-biodegradable. This classification is based on the quality of solid waste generated from different sources. The biodegradable waste consists of all carbonaceous wastes that can be biodegraded into useful or less polluting products by the action of microorganisms and such animals like Annelids and Insects. Non-bio degradable wastes include inorganic wastes, and non-degradable polymeric organics like certain type of plastics.

1.1.3 Classification based on Risk Potential

Wastes that pose a substantial danger immediately or over a period of time to human, plant or animal life are classified as hazardous wastes. A hazardous waste exhibits the characteristics like ignitability, corrosivity, reactivity or toxicity. They are classified into following categories as radioactive substances, chemicals, biological wastes containing radioactive materials, flammable wastes and explosives. The chemical category includes wastes that are corrosive, reactive or toxic. The biological waste category is represented by dangerous wastes emanating from hospitals and biological research facilities.

1.2 Sources of Solid Waste

1.2.1 *Waste from Residential areas*

The wastes generated from residential areas are generally classified as domestic waste. Waste generated from residential areas varies a lot based on the socio-economic and cultural situations. In high-income residential areas where gas or electricity is used for cooking, the waste generated will be less compared to the houses using wood and charcoal as fuel. Paper, cardboard, tin and bottles are found to be more in prosperous settlements and in commercial areas.

1.2.2 *Waste from shops/commercial establishments/vegetable/ fruit markets*

The wastes generated from shops and commercial establishments are mainly recyclable in nature. The vegetable shops/markets generate large quantities of degradable waste including dried plantain leaves used for wrapping agricultural goods.

1.2.3 *Waste from Hotels/Restaurants/Eating stalls*

Hotels and Restaurants generate both degradable and non-degradable waste. The domestic type waste generated will be large in quantity and hence to be removed daily. They can be provided with separate bins for waste collection.

1.2.4 *Waste from Slaughter Houses/Fish markets*

Slaughterhouses and fish markets generate highly putrescible matter. They decay very fast and are the main reason for the malodour near these premises. No proper collection or removal is practiced and hence the waste rots in the premises itself.

1.2.5 Waste generated by street hawkers

Street food vendors and hawkers generate large quantities of waste particularly food waste and plastic paper plates.

1.3 Characteristics of Solid Waste

1.3.1 Physical characteristics

The physical characteristics of solid wastes vary widely based on socio-economic, cultural and climatic conditions. The physical qualities of solid waste like bulk density, its moisture content etc., are very important and to be considered for the selection of disposal, recycling and other processing methods.

1.3.2 Chemical characteristics

Information on the chemical composition of solid wastes is important in evaluating processing and recovery options. In addition, the analysis helps in adopting and utilising proper equipment and techniques for collection and transportation. The chemical characteristics like pH, chemical constituents like carbon content, N, P, K micronutrients etc are to be analysed for the selection of proper waste management technology. But this cannot be readily and accurately measured nor can they be standardised due to its wide range in composition. Each and every category of waste varies with locations and local conditions. However the percentage of Carbon, Hydrogen, Nitrogen and non-combustibles are determined. Higher organic content of Carbon in refuse activates the process of putrefaction.

Thus both physical and chemical characteristics of the solid waste determines the selection of the final method of waste disposal.

1.4 Environmental and health problems associated with solid waste mismanagement

A variety of environmental hazards are associated with the mishandling or mismanagement of refuse. The solid waste which is not properly stored, collected, transported and disposed off will lead to short-term as well as long term health risks. In the long term, there may be dangers arising from waste dumps particularly from it to the pollution of our drinking water sources.

Fly breeding will be encouraged by uncovered piles of rotting refuse and the flies may play a role in the mechanical transmission of faecal-oral diseases. Piles of refuse will also contain mosquito-breeding sites where pools of rain water form in discarded cans, tyres etc. The mosquito *Aedes aegypti* will survive in these conditions and may transmit dengue, yellow fever, and other arboviral infections.

Rats will also breed and live in and around refuse. The main source of food for rats and other small rodents is refuse, and in dump yards they quickly proliferate and spread to neighbouring houses. They may promote and transmit a variety of diseases, including plague, leptospirosis, rat bite fever etc.

Piles of refuse present a fire risk. Flammable waste materials when dumped together at dump yards are a great danger at source. Hot ashes added to the dumped wastes are also a reason for the fire at dump yards. Usually the fire starts with the practice of open burning of refuse. Some times this becomes uncontrollable. When the open dumps are fired, toxic gases will be released to the atmosphere. The dump yards may contain rubber tires, PVC, plastic materials etc and while they burn toxic gases like dioxin, furan etc., are released into the atmosphere, which are deadly poisonous. An additional danger that occur due to fire at dump yards is that large quantities of water will be used for stopping the fire which may result in leaching of toxic materials to ground water.

Badly managed refuse can promote water pollution by rain washing debris out of piles of refuse and into surface water. Ground water pollution may also occur. Piles of refuse rot and smells, which is a nuisance and is aesthetically displeasing in the urban environment.

Where refuse disposal services are lacking much refuse is deposited in open street drains and urban waterways. This causes them to block and can cause flooding. That is,

uncollected refuse obstructs streets and drainage channels. It also creates ideal breeding grounds for mosquitoes.

Apart from diseases for which insects and rats are carriers, the handling of refuse can cause illness to workers who work in collection and transportation process. Infection of roundworm and whipworm are common among people who work with solid waste disposal activities without proper protective measures.

It is therefore evident that technologies of waste management, which are simple, practical and economical for use should be developed and they should be both safeguard public health and reduce environmental pollution.

1.5 Storage, collection and transportation of solid waste

Planning and introducing an organized refuse collection service is a complex business. It is very common practice in most of the cities that the waste generated is thrown on the streets, strewn everywhere or heaped up

near the corner of roadside. Garbage generated in households of the City is seldom stored for more than a day and is mostly taken to the Dumper Placer Container or just dumped on the adjacent roadside from where it is collected by the municipal workers while sweeping of the roads. This uncontrolled garbage dumping gives rise to unaesthetic, unhealthy and unhygienic appearance on the roadsides. Due to low purchasing power, people are not able to purchase and maintain standardized garbage bins. So public refuse bins are provided for collection of waste. These may be permanent fixtures that are emptied by labourers with spades into the collection truck or metal bins that can be lifted and emptied. A good type of a refuse container is a covered metal box with sliding panels, which enable the container to be closed after refuse has been dumped. The collection vehicle takes away the metal container and replace with an empty bin.

The tractor-trailer system is the popular mode of community waste storage and collection in Indian cities. Trailers with large volume are kept at specific points for garbage collection and when it is full the tractor comes, takes on the trailer empties it at disposal site or at transit points and return the trailer to it's position.

The transportation of waste to disposal site is a very important aspect of solid waste management. Transfer and transportation of the waste means the facilities that may need for collecting waste from the communal bins to the transit points (transfer stations) and then from there to the final disposal site. The actions involved are waste collection from the roadside waste dumps or communal waste bins, depositing into the vehicle, transporting to the transit points and

from there transporting to the final dumping site or treatment yard. Usually large vehicles like lorries, tractors, tippers are used for transporting the waste.

1.6 Treatment and disposal of solid waste

The technologies for the management of solid wastes have to incorporate the collection of the waste from the source, transportation of the waste to the place of processing and treatment and final disposing. Usually disposal of solid waste on land is viewed as a better though far from the ideal management operation, compared to dumping of the wastes into water bodies.

Before final disposal one can process and treat the waste so as to reduce the "wasteful wasting of waste". Some of the techniques available to achieve this objective are sanitary land filling, pyrolysis, pellatisation, incineration, anaerobic digestion, composting, vermicomposting, conversion to protein, hydropulping, plasma gasification etc.

The functional element of processing and recovery includes all the techniques, equipment and facilities used to improve the efficiency and to recover usable materials, conversion products or energy from solid wastes. Waste recycling is also a part of managing solid waste.

1.6.1 Sanitary land filling

Dumping of waste in a scientifically designed land is called sanitary landfill. Sanitary land filling include confining the waste, compacting it and covering with soil. It not only prevents burning of garbage but also helps in reclamation of land for valuable use.

1.6.2 Incineration

Incineration is a controlled combustion process for burning combustible waste to gases and reducing it to a residue of non-combustible ingredients. During incineration, moisture in the solid waste gets vapourised and the combustible portion gets oxidised and vapourised. CO₂, watervapour, ash and non-combustible residue are the end products of incineration.

1.6.3 Pyrolysis

The heating of combustible portion of solid waste in an oxygen free environment is called pyrolysis. Pyrolysis of solid waste results in the chemical breakdown of organic carbon material into three common ends namely gas, liquid and char. Thus pyrolysis is chemical combustion.

1.6.4 Pelletisation

Pelletisation is the production of fuel pellets from solid waste. The process of conversion of garbage into fuel pellets involves primarily drying, separation of incombustible, size reduction and pelletisation. These pellets may have high calorific value and can be used either independently or as supplementary fuel with other fossil fuels.

1.6.5 Composting

Composting process uses microorganisms to degrade the organic content of the waste. Aerobic composting proceeds at a higher rate and converts the heterogeneous organic waste materials into homogeneous and stable humus like compost.

1.6.6 Vermicomposting

This is the process by which decayed organic waste matter is eaten by a mix of bacteria, fungi and bacteria inside the bodies of earthworms, to convert waste to a digested soil-like excretion of vermi-castings full of microbes.

1.6.7 Conversion to protein

Studies have showed that under aerobic conditions, it is possible to convert the insoluble cellulose in the solid waste by cellulolytic bacteria. These bacteria are then harvested from the media for use as protein.

1.6.8 Hydro pulping

Solid waste with high paper content can be hydro pulped to recover paper fibre from the waste. The method involves use of screens, centrifuges and presses.

1.6.9 Plasma gasification

The plasma gasification for waste materials produces a combustible gas, which can be used in a manner similar to the uses of natural gas, and an inert solid residue, a glass like material which can be used within various industrial and commercial markets. The plasma process can be applied to any waste material including municipal solid waste.

CHAPTER II

SOCIAL AND MANAGEMENT PROBLEMS OF COMMUNITY-BASED SOLID WASTE MANAGEMENT

This chapter gives an overview of the social and management problems encountered on community-based solid waste management projects. Experiences from different countries on social and management problems on solid waste management are reviewed here. The problems have been classified into four categories such as low participation of households, management problems, social operation problems and financial problems. Each category has been divided into two to five subcategories, which correspond to more detailed descriptions of the social and management problem of community-based solid waste management programme.

2.1 Low participation of households

2.1.1 Low community priority for solid waste management

It is not uncommon that low-income neighbourhoods often face considerable problems. Inadequate solid waste management is just one of them and its improvement may not have priority for a community. If solid waste management is not a felt need, this will have consequences for their participation in the service and their willingness to pay.

From the experiences, it has become clear that a felt need is a prerequisite for successful implementation of a community-based solid waste management project. Usually a real need for an improved solid waste collection exists in neighbourhoods, where population density is high, where little space for storage of garbage is available and where dumping sites are far away. Furthermore, the chance that solid waste management is a high-ranking community problem will be higher, when the initiative for a solid waste management project comes from the community itself.

A possible solution to the problem of lack of community priority for solid waste management is education. This solution was tried in Kathmandu, Nepal. A women's organization tried to convince people of the need for proper solid waste handling and it finally achieved a change in behaviour of the community through the provision of buckets and a competition among households for a clean environment. Provision of appropriate incentives appears to be important. Other examples from India also proved that education alone is not enough to make people change their minds and priorities.

Another solution involves consultation with the community on its problems and priorities. Ivory Coast is an example for this. A local sanitation committee discussed the main problems of solid waste collection and decided on solutions. But no attention was paid to willingness and capability to pay, so this project ran into financial difficulties. Also in Cameroon, a management committee was established in each quarter to determine needs and to rank priorities. A more thorough approach was adopted in Mali. During six months the waste collection enterprise in Mali, the GIE Beseya discussed the collection system they wanted to establish in a neighbourhood, with the community through debates in weekly meetings in the community. Their tasks, responsibilities and fees were clarified. A change of project objectives and strategy was the result. But this approach had also a conscientizing effect; so-called 'comités des sages' (committees of elderly people) were installed to supervise the functioning of the GIE. This committee developed into a platform where community concerns and problems were discussed. Gradually these committees obtained more responsibilities: to organize meetings, to distribute information, to deal with financial partners, to keep contact with the municipality.

A more comprehensive community needs assessment study may also lead to a better-designed project. The Panaji project proposal (India) is an example. This included a preliminary study into community perception of major issues concerning solid waste management, such as the present collection system, current practices of waste storage and community-level disposal, willingness to pay, preferences for certain systems and practices such as separation at source, etc. A practical example is Ivory Coast, where a survey on community concerns and priorities was conducted beforehand. This changed the view of the donor (CHF), who thought water supply would have priority. Its success is proven by the fact that the resulting community-based solid waste management project is now self-supporting.

2.1.2 Low willingness to participate in collection and recycling

Households often behave contrary to schedules and rules of effective solid waste management. Sometimes this is caused by a lack of facilities. If a transfer point or dumping site is more than 100 metres away from their house, people tend to throw their waste much more often in streets, open spaces and rivers (Panaji, India). More often, however, it is due to households lacking knowledge and incentives to keep to the rules of the collection system, and operators lacking sanctions and authority.

In Sri Lanka, people go to the main road with their bags of garbage to put it directly into the municipal truck instead of bringing it to communal containers. When the truck is not in time, they just leave their garbage bags in the street. There is little social control in the neighbourhood and the collecting crew lacks a certain understanding of the system. In Ivory Coast, something similar happened after a change in the municipal system. People used to bring their garbage to communal bins at a distance of less than 30 m from their house, for which they had to pay a fee. With the new system, a compactor truck that passed through the main road and then gave a signal, they had to walk to the main road and deliver their garbage to the truck for free. Due to this practice, the community-based solid waste collection through the communal bins collapsed. Later on people also stopped bringing their garbage to the truck,

because it was too time consuming for them. This had negative consequences for the cleanliness of the neighbourhood. In San José, Costa Rica, the micro-enterprise that collected wastes was confronted with uncontrolled behaviour of households who left their garbage everywhere and not in the containers as agreed upon.

Low willingness of households to participate in collection and recycling also depends on the perceived benefits and costs of the system. In India, 70 % of the people were against separation of waste at source, because it was considered inconvenient. In the GRASP project (India) some households do not want to participate in separation, because they say it is time consuming and dirty work. In some countries, notably in Asia, servants, caretakers and watchmen are important agents in waste handling: they bring the waste to communal bins, keep certain items apart, and so forth. These servants are known to be unwilling to cooperate in separation at source, either because they know the value of the recyclable or do not want to sell them to waste collectors or because they do not like the extra work (India).

A solution for this problem was tried in the Philippines (San Antonio Valley). Servants and watchmen were given a certain benefit and thus integrated into the system. The implementing NGO, a women's organization, tried to encourage housemaids to engage in recycling by giving them proceeds of the sales of recyclable materials. This is just one example of the provision of appropriate incentives to increase the participation of community members in a solid waste management system.

Other examples include City competitions as in Asian countries. Every year the cleanest city or town in many countries is awarded a special prize, shown on television and visited by high-level government officials. Competitions between households to win a prize for the cleanest house and immediate environment was also organized in Nepal by WE, a women's organization, when mere education failed. In China a system of points for cleanliness to be earned by households is used in some cities too.

Another option is to pay households for their participation or to provide them with discounts on certain valuable items, depending on their degree of participation. In the Philippines households receive a small amount of money from the waste collectors, depending on volume and quality of the garbage. In the SIRDO recycling projects in Mexico, participating members of households are paid according to work done and time spent. In one of those projects food-making women are involved. They separate their waste and in turn receive a discount when they buy vegetables. These vegetables are produced with the bio-fertilizer made from their wastes. Evaluation of these Mexican projects showed that economic benefits from a solid waste management system had more influence on proper behaviour of households (separation) than environmental education. According to their experience, education accounted only for 10 to 30% of change in user habits.

In Curitiba, Brazil, some interesting solutions are tried to encourage low-income households to participate in solid waste collection. First a massive education campaign, involving all media, promoted the separation of garbage at source (the "Garbage that isn't garbage" program). This program obtained a participation rate of 70% of all households, which can be qualified as quite successful. Another programme, the "Garbage purchase" project, was especially designed for unserved low-income areas. This programme was based on the exchange of garbage against free bus tickets and food parcels. A similar project, the "Green exchange" project, accepted only recyclable

garbage in exchange for food bags. This exchange took place at supermarkets, schools, factories and through neighbourhood associations.

2.1.3 Low willingness to keep public spaces clean

In several cases of countries like Indonesia, Cameroon and Chad it is mentioned that residents of a neighbourhood have a sense of responsibility for their home and immediate environment, but the public places such as streets and drains are considered the responsibility of the State. Often municipalities lack the money or manpower to fulfill this task and sometimes they think the neighbourhoods are responsible for this. This has negative consequences for the cleanliness of public places, and for the willingness to pay and the behaviour of households. Periodical clean-ups may have a temporary positive effect on the cleanliness of streets and public places. With a lack of social cohesion and control in a neighbourhood, this is not a sustainable solution. Especially in low-income neighbourhoods cooperation may be difficult because of the high mobility of households and the large amount of renting people. Moreover, urban problems are known to be personal and coping strategies individualistic. In Nepal, they organized a clean-up campaign for courtyards. The behaviour of the households did not change; afterwards they just put their waste in these courtyards again. But with the help of a large education campaign and the installation of small shrines in the courtyards, the project management achieved the necessary switch in the perception and behaviour of the people. The involvement of local administrative bodies (town Panchayats) in organization and education was responsible for this.

In Pakistan, the local women's organization, KAWWS had difficulties in persuading people to pay for street sweeping. A possible solution was to contract street sweepers as part of the solid waste collection system, but there was not enough money to implement this. In India experience exists with street-based organizations (Civic Exnora units), which organize regular street sweeping and clean-ups. They started with involvement of higher income communities who hired waste collectors and street sweepers to clean the streets. Later on activities were extended to the low-income areas, from where those waste pickers came.

A rather frequently returning problem is the fact that people throw the garbage next to the communal container or bin, causing an unhygienic situation. In Mali, waste transfer stations are owned by the District and they are kept in a bad condition. In Ujung Pandang, Indonesia, they developed a solution for this problem. A guard was employed by the local administrative body to keep the communal bins and their surroundings tidy.

Shared care taking systems are known from a low-income neighbourhood in Bangkok, Thailand. Residents living around a community kindergarten share the responsibility for keeping school surroundings clean with schoolteachers. In the same neighbourhood four women home workers have a schedule for keeping their street clean. Alternatively two of them feel responsible during two weeks for removal of litter, clearing of walkways, problems with stagnant water, noise and malodour. If they cannot solve these problems themselves, they report them to the community leader.

2.1.4 Low willingness to pay

Willingness to pay is a rather central point because it is important for the success of a community-based solid waste management project and it is related to many other aspects such as the motivation of operators and households and the reliability of the service. Community perception of fees and of the waste collection service is essential for its willingness to pay. If residents think they already pay for collection through taxes, or if they do not trust the service, they refuse to pay. For example in India some households are not willing to pay, because they think property rates should cover solid waste collection.

The service must be reliable to sustain willingness to pay. Payment according to achievement may be a solution, because households receive an observable benefit. In Ambassatna, Chad, willingness to pay declined because garbage collection became irregular. Residents had to pay per month, but later they started to pay per collection round.

A project in Ivory Coast also suffered from declining willingness to pay, because the service was offered to everybody, and because there were no sanctions in case of non-payment and no legal obligations to pay. They tried to increase cost recovery through offering additional services such as toilet and bathroom cleaning. But this did not increase willingness to pay of the community.

A change in the way of payment might improve willingness to pay. In Sudan different ways of payment were studied beforehand and one was selected -collection fees on top of the sugar price- and agreed upon by the community. In Bolivia the community was not consulted nor informed properly about a new system of collecting garbage fees with electricity bills, so it failed. In a project in Ujung Pandang, Indonesia, only 20% of households were willing to pay the sanitation fees. These fees were collected by officials from the local administrative body. Because of these payment problems the system was changed, so that fee collection became the responsibility of the municipal cleansing department. They started to collect fees through water bills. Another example from Surabaya, Indonesia shows waste collection fees that are part of a lumpsum for social welfare activities, collected during social meetings. This system is rather successful because people there prefer to pay a big sum now and then instead of many times a small amount. It can be concluded that willingness to pay has to be studied beforehand to conceive acceptable ways of payment and affordable fees.

Education about the benefits of the service and the financial obligations of the households may help to increase willingness to pay. But the earlier experiences of different countries shows that education alone is not enough to increase willingness to pay. A women's organization, started health and sanitation education campaigns with the idea of changing the view of households. They wanted to make them aware of the dangers of the absence of a garbage collection system, so that they would be willing to pay the fees. This was not successful, because people were too poor to afford the fees they asked. They had to obtain their funds from other sources.

As is pointed out by several projects, education campaigns as part of community-based solid waste management are both inadequate and inappropriate. Inadequate in the sense that before and during operation of the service education campaigns are often absent. Inappropriate because the contents of educational material is often not suited to the interests and priorities of the community. In Indonesia for example, too much emphasis in education was given to health and environmental benefits, while people used the solid waste collection service because of its convenience, its time and energy saving character. The SIRDO projects in Mexico indicate gender-specific interests. In these cases women appeared to be more interested in improvement of their physical environment than in economic benefits.

The experiences also prove that education is needed to maintain community participation to establish a 'spirit of responsibility' towards environmental problems and the most suitable ways of dealing with them (Guatemala). Moreover, it is necessary to inform households about the benefits and practice of separation at source, the benefits and schedule of collection, the tasks and responsibilities of households, time and place to deliver the garbage and the ways of payment.

The following table gives an overview of participation problems

Table 2.1 Overview of participation problems

Problems	Solutions	Effects
Low community priority for solid waste management	<ul style="list-style-type: none"> -education -provision of appropriate incentives -consultation with the community -give community a role in planning -community need assessment study 	<ul style="list-style-type: none"> -on its own inadequate to change priorities and needs -more appropriate system, based on real priorities and needs
Low willingness to participate in collection and recycling	<ul style="list-style-type: none"> -household and city competitions -pay households for their participation -give proceeds of recyclables to servants -education 	<ul style="list-style-type: none"> -effective -effective -effective -on its own inadequate to change behaviour
Low willingness to keep public spaces clean	<ul style="list-style-type: none"> -periodical clean-ups -education and make site valued -integrate street sweepers in solid waste management system 	<ul style="list-style-type: none"> -effective

	-guard at transfer station -shared care taking systems	
Low willingness to pay	-change way of payment -education	-way of payment with water bills-success unknown with electricity bills-- failed as a lump sum-successful -on its own inadequate to change willingness to pay

2.2 Management problems

2.2.1 Low willingness to manage

Management of community-based solid waste services is often a voluntary activity, mostly carried out by the more affluent residents, who are motivated by community benefits such as a cleaner environment, a better health of neighbourhood residents, status of the job, etc. Voluntary management is not necessarily a problem, as is shown in a successful project in Padang, Indonesia. In the long run, however, continuity of the service may not be secured. Also the area covered by the project may remain small. In Pakistan, the women's organization KAWWS, for example, did not have enough staff to increase its area of operation. In some projects, an individual from the neighbourhood had taken the initiative for a community-based solid waste collection system. In many cases this person also becomes the manager of the system. While motivated management is one of the success factors of community-based solid waste management project, exclusive dependence on one person who manages the operation of a solid waste service is considered undesirable, because accountability to the community and the continuity of the service may not be secured any more. Examples are the projects in Yogyakarta, Indonesia and in Surabaya, Indonesia. In these cases the wife of the local administrative body head financed the collection equipment herself, she is responsible for everything and she need not report to any person beside herself. On the other hand, she is able to use her personal influence to have rich people make extra contributions in case of maintenance problems.

It is not easy to find the right kind of remuneration to motivate managers of a community-based solid waste service system. In a SIRDO project in Mexico equal remuneration led to a declining motivation of the people working hardest. In Chad, young unpaid members of a sanitation committee preferred some kind of material benefit, better environmental conditions were not sufficient to sustain their motivation.

Experience from Chad shows that it is better to gather the most motivated volunteers in one committee instead of having ten less motivated committees. Sanitation committees were restructured after the Ambassatna pilot project. New committees that came into existence subsequently had to prove their viability for one year before

they received assistance from Oxfam, the implementing NGO. Another lesson from the same project in Chad was that training and exchange visits for management committees are highly positive in stimulating their motivation.

Another way to motivate managers is the explicit assistance (financial, technical) and moral support from the municipality. An interesting example is a composting project in Ecuador, where the municipality doubles the sales of recyclable to invest in local projects, which are selected by the community.

2.2.2 Lack of accountability to the community

Lack of accountability to the community depends on the management structure, the way of supervision and the links with the community. This is characteristic for the Indonesian projects, which are based on trust with little financial control and little performance control, which may result in an unreliable service.

A way to improve accountability to the community in general is to write down agreements on rights, responsibilities and obligations of the waste services system. Some micro-enterprises in Latin America are for example, contracted by the community or a community organization and can be controlled in that way. One-man contracts are used in South Africa. Written down rights and responsibilities are common practices in Sri Lanka, in the contacts of the National Housing Authority with communities in slum upgrading projects. Another way to improve accountability to the community, particularly with regard to financial matters is to define procedures of control. These may involve the obligation to report regularly to the neighbourhood committee or to community members (Indonesia), to a bulletin board about financial affairs (Ivory Coast) or by conducting meetings with neighbourhood committees about the quality of the service (Costa Rica). Yet another solution is used in Ivory Coast, i.e., the implementing NGO decided to share financial management to overcome political power constraints within the community.

2.2.3 Unrepresentative management

The accountability to the community of the managers of a solid waste service also depends on the composition of the management committee. Whether it is an elected body or appointed by the local government, whether it consists of traditional leaders or modern community organizations, or of influential individuals. This determines the degree of representation of different community interests in the management committee and its responsiveness to community needs. Representation of the interests of under-privileged groups or minorities is particularly important for women, youths and certain cultural or ethnic groups.

In Chad, for example, sanitation committees responsible for waste collection and management, which were set up by Oxfam, the implementing NGO had become mere figureheads. They consisted of influential persons who were not used to consulting the population and were only interested in the honorable position. Both women and youths were under represented in the management committees. Oxfam had encountered a lot of difficulties in finding appropriate women's groups to work with. In the project area women were used to operate on their own, for example in small beverages production or on the basis of personal relationships. They did not trust Oxfam, because

they associated them with the government who had always refused to give them small loans. Only the quarter heads were really interested in participation in the management committee because it reinforced their position.

From Sri Lanka it was also reported that community representatives, who were involved in all kinds of meetings with the municipality and other state agencies, got a feeling of officialdom, which was not always beneficial for the representation of community needs and problems. A possible solution used in Ivory Coast was the intervention of the implementing agency, a local NGO, against an unequal ethnic and gender representation in the local sanitation committee. Only men of the same tribal background were proposed as candidates for the management committee. The NGO rejected these candidates and succeeded in having the composition of the committee changed.

In Egypt a similar problem arose. The local development committee, the Gameyya, which had to supervise various activities aimed at improving the living conditions of the Zabbaleen, the informal waste collectors of Cairo, proved to be unrepresentative of the community of beneficiaries. The leading board members were non-Zabbaleen and they exhibited a paternalistic attitude towards the Zabbaleen. The degree of democracy in decision-making was very low and the poorest groups were neglected. The solution used here was to by-pass the existing committee and to design a new income generation or credit project for poor Zabbaleen women. A far higher degree of participation of the community of beneficiaries was reached in this way.

The following table gives an overview of the management problems.

Table 2.2 Overview of management problems

Problems	Solutions	Effects
Low willingness to manage	-restructure management committees -training and exchange visits for management committees -technical/financial/moral support from the municipality	
Lack of accountability	-define rights, responsibilities and obligations -establish procedures of control	-only successful if effectively enforced
Unrepresentative management	-intervention of implementing agency to adjust composition of committee -by pass existing committee/work directly with beneficiaries	-may adjust composition of committee -more effective participation

2.3 Social operation problems

2.3.1 Low salary of operators

There is a difference between remuneration of operation and of management of community-based solid waste management projects. Operational activities like collection of waste, sorting, recycling etc. are almost entirely done on the basis of profit, i.e. a personal salary, because work is hard and status is low. In Ghana, workers of a composting plant were first given 'food for work', but later on they received a salary, because otherwise the project staff could not attract enough workers.

The salary of operators of waste collection services is often low, because waste collectors derive their income from waste collection fees and from the sale of recyclables. Both do not yield much revenue in low-income neighbourhoods. Fee collection is not high, because households in low-income neighbourhoods are not able to pay high fees. The waste that remains to be collected is often worthless due to its high organic content. Another reason for the low salary of operators of waste collection services is the size of coverage areas, which is often too small to earn an adequate income.

Some projects have solved the problem of low salaries by employing people part time. This is the case in Cameroon, Indonesia and Ghana. This leads to a weak bargaining position for the manager(s) and to a less reliable service because waste collection as a side job will no longer be a priority for the people operating the service. On the other hand, it is clearly an incentive for operators that they can use their equipment and time for other activities.

Another possible solution, which is practised in some Indonesian projects, are cross-subsidies, either by serving different income groups or by serving different generators of wastes like households, industries, commercial business, institutions etc. Different groups can be asked for different fees. These increases in the coverage area and in the number of customers can provide the operators with extra income.

Recently the position of Zabbaleen women (Egypt) was improved and their economic independence increased through income-generating recycling projects such as rag weaving and patchwork manufacturing. In Mexico several productive activities evolved out of the SIRDO recycling systems, such as flower production for export, horticulture and plastic recycling. These economic benefits had a positive effect on the separation behaviour of participating households who cooperatively operate most systems.

Another incentive may be to provide a group of operators with a strong internal solidarity with special benefits. In Kenya, a special system exists. The youth sports teams can earn points in the league with neighbourhood cleaning activities. The whole operation is managed by neighbourhood officials and youth leaders together. This is a benefit that accrues to the team but which is quite effective in stimulating young individuals. Another example is from Indonesia where a youth group is involved in garbage collection. The profit of the waste collection service is used for youth group activities. An indirect measure is to decrease the costs of the service for operators. In Senegal, micro-enterprises involved in waste collection received an incentive from the municipality namely the exemption from certain municipal taxes.

2.3.2 Low status and bad working conditions

The low status of waste collectors in the society may be caused by their low salary, the nature of their work and sometimes by their waste-picker background. The nature of their work is often considered unpleasant and filthy, not only collection but also activities such as sorting of garbage at a composting plant. Especially in India some richer households have problems with waste collectors who have formerly been waste pickers. They are suspicious of them, sometimes accuse them of theft and do not agree that they have a legitimate role in their neighbourhood.

Solutions for the problem of low status tried in the GRASP project in India are education of households by volunteers from the area, promotion campaigns, a letter of authority from the municipality to the households, identity cards for collectors signed by GRASP which are given to the waste collectors. In the Waste Wise project (Bangalore, India), the waste collectors were provided with identity cards and they were officially introduced to the residents by the NGO. Besides, meetings with the community were organized to educate the residents. It was not clear from the literature whether this had the required results.

Another option is to improve the working conditions of operators by providing them with facilities as experiences from the Philippines and Senegal show. To involve the informal sector in solid waste collection in the Philippines, the following incentives were used. Provision of food, drink and free accommodation by junk dealers and provision with a painted pushcart and T-shirt by the implementing NGO. The local health committee, managing a solid waste management project in Senegal provided the operators and their families with medical assistance free of charge.

2.3.3 Unreliable service

An unreliable service, which does not arrive in time or is not carried out according to the expectations of the community, has consequences for the trust of the community for their participation and willingness to pay for the service. It may be caused by a lack of performance control, a lack of priority of the service when waste collection is carried out as a part time job. If operators have formerly been waste-pickers, they may cause additional reliability problems. These people used to the freedom of the street are sometimes difficult to train to perform a reliable service (India).

Involvement in decision-making appears to be an incentive for operators to perform better. In Bolivia, for example, members of micro-enterprises have a higher labour productivity and morale than the employees of municipal services, who collected garbage before, because they are owners-operators of the system and because they are paid according to achievement. A solution born out of necessity to improve the reliability of the service is to relate payment of operators more strictly to performance. This was applied in Chad, where households started to pay waste collector per round instead of per month. In Indonesia, the problem of reliability was solved by the division of collection areas and responsibilities. Before, one old waste collector had to operate the service under the supervision of the local administrative body. He could not perform a reliable service because the collection area was too large. It was then decided to split up the collection area in nine smaller areas and made the lower level

administrative bodies responsible for management of the service. These areas, however, appeared to be too small to be financially viable, so the motivation of the collectors declined.

2.3.4. Competition from private entrepreneurs

Some projects in India working with ex-waste pickers suffer from problems with their former employers, waste traders and with private waste collectors. In Pakistan, the new community-based waste collection system disrupted the sweeping areas of municipal sweepers who used to collect valuable garbage there in their leisure time. In Metro Manila, the Philippines, in the late 1970s a project was started by the government that totally bypassed the existing informal waste collection and recycling system. This project became a complete failure.

In the GRASP project in India, private collectors prevented waste pickers from collecting garbage. Private vermi-composters tried to drive them away from their vermi-composting plot. It was tried to integrate the waste pickers in the existing activities of vermi-composters but this was not successful. An attempt was made to solve the conflicts with private collectors through consultation with the municipal solid waste management agency, but this agency refused to intervene, probably because of political reasons. Then the project staff tried to convince households through education to deliver their waste only to 'official' waste collectors appointed by the project.

Integration into the project was successfully applied in the Philippines by the Women's Balikatan Movement. They involved junk dealers and waste pickers in their waste collection and recycling system.

2.3.5. Space problems

Space is an important constraint for all composting and sorting or recycling projects. A project in Vila Reis, Brazil, has temporarily stopped its activities because it has to arrange for a deposit site for recyclables in order to gather enough quantity to sell it. In some quarters there is no space for communal bins because of the high population density (Pakistan).

Consultation with local NGOs and opinion leaders to find sites for sorting and composting appeared to be an effective solution in Ghana and Cameroon. Next to negotiations with quarter heads, a massive media campaign with the help of local youth groups was used in Cameroon to solve this problem. In Mali delegates from the neighbourhood went to the municipality to lobby for space for a depot. The results are unknown.

The following table summarises the social operation problems of solid waste management.

Table 2.3 Overview of social operation problems

Problems	Solutions	Effects
Low salary of operators	<ul style="list-style-type: none"> -part time employment -cross-subsidies -add income generating recycling projects -provide group benefits -provide exemption from certain municipal taxes 	<ul style="list-style-type: none"> -less reliable service/poor bargaining position management -effective -effective
Low status and bad working conditions	<ul style="list-style-type: none"> -education/promotion campaigns -identity cards for collectors -municipal letter of authority -official introduction of collectors by NGO -provide operators with facilities 	
Unreliable service	<ul style="list-style-type: none"> -involve operators in decision-making -relate payment to performance -different division of collection areas and responsibilities 	<ul style="list-style-type: none"> -too small areas/too small returns
Competition of private entrepreneurs	<ul style="list-style-type: none"> -consultation with municipality/governmental agency -education of households -integrate private entrepreneurs into the project 	<ul style="list-style-type: none"> -no willingness to intervene -mixed results
Space problems	<ul style="list-style-type: none"> -consultation with local NGOs and opinion leaders -start a media campaign with the help of local youth groups -delegates from neighbourhood lobby municipality for space 	<ul style="list-style-type: none"> -effective -effective

2.4. Financial problems

2.4.1. Cost recovery problems

Cost recovery problems refer to a lack of funds to cover capital and recurrent costs of solid waste activities. Lack of funds can be caused by inadequate fee collection, too low fee rates, failing fund raising methods, low loan repayment, difficult access to credit and marketing problems. In many cases, fees for community-based waste services do not cover costs because they are fixed by the government and do not take into account costs and taxes that have to be paid by the community service. This is the case in Mali. Sometimes finding additional resources is a problem: both the successful projects in Kenya and the Balikpapan project in the Philippines suffer from financial

constraints, which hamper expansion. Other projects have problems with loans that are not paid back in time so that the fund cannot become revolving. This occurred in Cameroon, Egypt and Sudan. Others, especially recycling initiatives suffer from a lack of credit. In Mexico they wanted to enlarge the operation of their organic waste recycling activities but they use communally owned land that is not accepted as collateral (Mexico). Marketing problems mainly refer to composting and other recycling projects (examples Ghana and Cameroon).

Cost recovery may be improved by offering additional services. In Ivory Coast the solid waste collection service ran into financial difficulties because of low willingness to pay. They started offering extra services such as cleaning bathrooms and toilets. A possible solution to the repayment problem is tighter financial control, which includes effective bookkeeping practices. Some sense of responsibility towards the communal fund has to be established and some kind of sanction has to be thought of. In Egypt, for example, small credit groups of women who are responsible for repayment of each member of the group, give a high repayment rate through social control.

2.4.2. Inadequate fee collection

Fee collection for solid waste services appears to be influenced by willingness to pay, by the way of payment, by the availability of sanctions and by the persons collecting fees. If willingness to pay is low, fee collection will be low too. Lack of sanctions and a lack of legal obligations to pay are often the cause of fee collection problems (Ivory Coast, Bolivia). The way of payment, i.e. the way fees are collected, differs. Sometimes garbage collection fees are paid once a month or a week, sometimes per round. Fees can be collected by special persons, fee collectors, or by the garbage collectors, or during social meetings. Not only the type of persons collecting fees is important but also the way they are motivated for their job, their incentives. In Mali, fees are collected as part of taxes by the government, which in turn pays the micro-enterprise. The disadvantage of this system is the dependence on the efficiency of tax collection by the government that determines the payment of the micro-enterprise. The micro-enterprise itself cannot influence it and government officials may not have enough incentive to carry out fee collection effectively. A similar problem is known from micro-enterprises in Bolivia who were not paid for months, because the municipality had no financial resources.

Inadequate fee collection can have negative consequences for the motivation of garbage collectors and thus for the reliability of the service, if they depend directly on these fees for their income. Low reliability of the service can lead to low willingness to pay of households. It thus may become a vicious circle. One way to improve fee collection is to change the way of payment. In Gedaref, Sudan, garbage fees are paid on top of the sugar price, and are collected through sugar distribution. The community has been consulted upon and agreed with this way of payment. In La Paz, Bolivia, the municipality tried to collect garbage fees with electricity bills. This was not successful, because the people were not informed properly. It even came to boycott actions. Garbage fee collection together with water bills was tried in Ujung Pandang, Indonesia. In Surabaya, Indonesia, a minimum fee was set during a meeting with residents. This fee covers all social welfare activities in the neighbourhood and it is collected during monthly social meetings. This system is rather effective because people prefer to pay one lump sum instead

of many small amounts. Because success of a certain way of payment usually depends on the local context, community preferences have to be assessed. Another way to improve fee collection is to give fee collectors more personal benefit. In Padang, Indonesia, the young people collecting garbage fees received 10% of the collected fees. In Surabaya, Indonesia, local administrative bodies received 15% of the collected city-sanitation fee. In Ivory Coast, collection team members received 80% of the fees they themselves collect. First everybody received 80% of what the whole team collected, but that appeared to be not a high enough incentive.

A subject that is often neglected by community-based solid waste management projects is the possibility of sanctions for non-payment to increase fee collection. In Padang, Indonesia, it is practice to pay the solid waste fee directly to the garbage collectors in the beginning of the month. Otherwise one's garbage is not collected. In other Indonesian projects in Surabaya, the following sanctions were applied: denial of official documents, letters of approval, licenses, etc. These sanctions are possible as these projects are implemented by local administrative bodies.

As was made clear above, the persons collecting fees may influence the rate of fee collection. Fee collection by operators rather than government officials appears to be more effective. A different but equally effective option is fee collection by respected community members, as applied in Mali. Respected senior persons from each concession (group of households) hand over the money to the collection crew.

2.4.3. Low ability to pay

Low-income communities are often assumed to have a low ability to pay for services. Not all service levels are affordable and high fees cannot be charged. In Mali, they experienced this when the micro-enterprise wanted to collect cost covering fees from households. It appeared that they could not afford the required fees. In Panaji, India they solved this problem by introducing different fees and different collection systems for different generators of waste. Households pay a low fee and bring their garbage to communal bins, which are inexpensive to empty. Clinics, restaurants and hotels, etc. were charged a higher cost, covering fee for door-to-door collection. But it underlines the fact that it is necessary to study willingness to pay beforehand, as well as which system and rate of fees the community prefers.

Table 2.4 Overview of financial problems

Problems	Solutions	Effects
Cost recovery problems	-improve financial control -offer additional services -carry out a socio-economic feasibility study	
Inadequate fee collection	-change way of payment -give fee collectors more personal benefit -establish/enforce sanctions for non-	-mixed results -effective

	payment -fee collection by operators rather than government officials -fee collection by respected community members	-effective -effective
Low ability to pay	-different fees for different waste generators and levels of service -base fees on income level and/or amount of garbage produced	

Next to variable fees, cross-subsidies are ways of dealing with difficulties with ability to pay. In some Indonesian projects, fees are based on the amount of garbage or on the income level of the household. Cross-subsidies can be established by defining waste collection areas that are mixed in terms of income levels or waste generators. This may be a way to avoid political problems.

CHAPTER III

SOLID WASTE MANAGEMENT SCENARIO IN KERALA

In the context of epidemiological transition in Kerala, solid wastes pose a major concern. Though to some extent, there has been a tremendous improvement in the field of total sanitation, particularly household sanitation, which has contributed to the drastic decrease in the incidence of diarrhoeal diseases, the social sanitation including the waste disposal is a contributor to the emerging infectious and new diseases. When we consider the solid waste management scenario of Kerala, we can see that the exact quantity of waste generated in Kerala is not totally known except for certain micro level studies conducted in different towns and municipalities. The rapid urbanization and consumerism makes it a tedious process and due to this, the composition of wastes also varies. Even then, with the help of Kerala Research Programme on Local Level Development, few scientific and technical studies about solid waste management have been carried out in Palakkad, Kottayam, Thrissur and Thiruvananthapuram districts.

3.1 Quantity of waste generation

The total quantity of solid waste generated in Kerala is not estimated accurately. But the per capita generation of the waste and total quantity of waste of certain municipalities and corporations were studied in detail. The following table gives the details of per capita generation of waste in some municipalities/corporations/Panchayats in Kerala.

Table 3.1 Per capita generation of waste

SI. No	Corporation/Municipality/Panchayat	Per capita generation (gm)
1	Thiruvananthapuram	550
2	Kochi	530
3	Kozhikkode	549
4	Kollam	536
5	Kottayam	317
6	Perumbavoor	284
7	Manjeri	317
8	Aluva	454
9	Kayamkulam	104

3.1.1. City Corporations

The study conducted at Thiruvananthapuram City Corporation shows that a total of 290-300 tonnes of solid waste are generated per day from various sources. The sample survey conducted at 50 wards showed that among these 300 tonnes, 181 tonnes of solid waste are from households. The waste generated by shops and commercial establishments comes to about 13-15 tonnes per day. The study also revealed that about 55% of shops and other

establishments recover most of the recyclable materials from the waste before final disposal. The hotels and restaurants generate about 30 tonnes of degradable waste per day while markets produce about 40 tonnes of waste per day. The hospitals and clinical laboratories of the City generate both infectious and non-infectious wastes, which comes to about 2-3 tonnes per day. The other sources of waste generated in the City are offices, educational institutions, marriage halls, slaughterhouses etc.

A detailed study was also conducted on the informal sector involving collection of non-degradable waste like plastics, paper, metals and glasses. During the study we could identify more than 500 rag pickers that are involved in collection of non-degradable waste directly from the sources or from the waste dumps. They sell these wastes to the wholesale waste collectors who transport these materials to Salem and Coimbatore for recycling. The physical characteristics of the waste generated in Thiruvananthapuram City Corporation shows that 50% of the waste generated are organic substances, which are suitable for composting.

Thus from the detailed study and similar other studies in City Corporations, we can infer that a total of 280-350 tonnes of solid wastes are generated per day in almost all Corporation areas.

3.1.2 Large Municipalities

Quantity of waste generated in large municipalities of Kerala, like Alappuzha, Kannur shows that a total of 60-100 tonnes are generated per day. A detailed study conducted at Kottayam Municipality shows that a total of 52.3 tonnes of municipal solid wastes are generated per day. Among this, 14.4 tonnes are domestic wastes. This domestic waste includes 84% putrescible matter, 9% paper, 5% plastics and 2% other waste particles like metal pieces etc. The total quantity of waste generated from markets of Kottayam is 7.6 tonnes, while 30.6 tonnes of waste are generated from establishments like commercial bazaars, shops, institutions etc. Thus, when we consider the waste generation in other large municipalities, we can infer that a total of 60-100 tonnes of solid waste are generated per day.

3.1.3 Small Municipalities

The quantity of solid waste generated in small municipalities comes to about 5-15 tonnes per day. The total quantity of waste generated in Attingal Municipality comes to about 7-15 tonnes per day, while that of Chalakudy is 10-15 tonnes per day. Thus the total quantity of solid waste generated from small municipalities are 5-15 tonnes per day.

3.1.4 Panchayats

Only few studies have been carried out in Panchayats to quantify the total solid waste generated. As the urban-rural difference is not so distinct in Kerala, the quantity of waste generation and its management is also

causing a major problem to the Panchayat authorities. From the earlier studies, it was estimated that a total of 2-5 tonnes of solid wastes per day is generated in Panchayats.

Table 3.2 Quantity of solid waste generation in Kerala

Classification	Quantity (tpd)
City Corporations	280-350
Large Municipalities, Towns	60-100
Small Municipalities, Medium towns	5-15
Panchayats	2-5

Table 3.3 Waste generation rate from different sources

Type of waste	Corporation	Municipality	Panchayat
Household	1.5-2.5 kg/house	1.5-2.5 kg/house	1.5-2.5 kg/house
Shops	2-3 kg	2-3 kg	—
Hotel	25-30 Kg	20-25 kg	—
Market	15-20t	10-15t	—

3.2 Present Management Status

Except Thiruvananthapuram City Corporation, no other Corporation or Municipalities in Kerala have a centralised treatment plant for municipal solid waste management. In spite of the availability of a number of proven technologies, the local self-government institutions are not in a position to implement any, because of various socio-political and techno-economic issues. Hence, majorities of the Municipalities, Towns and Panchayats are still in need of small-scale waste treatment units. Solid waste management rose as a problem for public recently and before that no one considered this. The main constraints in implementing proper solid waste management programme are lack of political will and solid waste management was never given priority in the agenda of any political party. Difficulty in acquiring sites for waste management is another problem faced by many authorities and local self government institutions. Lack of faith in the success of the solid waste management programme was another problem and this still remains in Thiruvananthapuram Corporation even after the implementation of a centralised waste management plant.

Present system of waste management in Kerala, including large and small municipalities include depositing in Municipal waste bins or Dumper Placer Containers, dumping in open spaces and roadsides, burning, burying, dumping in the drainages, dumping in ponds and canals. Some quantity of the wastes generated are recycled and converted to manure. Only a few municipalities and Panchayats in Kerala have dump yards. Most of the dump yards are now have been converted into compost yards. The compost yard at North Paravoor is an example for this. Even land filling exists in certain parts of Kerala, but due to urbanisation, lack of space and as most of the low lying areas are converted to residential areas, land filling by authorities are negligible. Earlier days quarry sites were also used as land filling areas, but now a days they are also seen abandoned. Hence when we consider the present waste management system, open dumping in dump yards without any processing is followed in almost all areas, except Thiruvananthapuram Corporation and few municipalities.

3.2.1 Waste Management System in Thiruvananthapuram City

Thiruvananthapuram is the first Corporation of Kerala State, though now several have been added. It has a naturally undulated geographical feature and has highly urbanised spots on a serenely rural base. Once upon a time called the Cleanest City in India, Thiruvananthapuram is striving hard to emulate other cities in dirtiness. The blame squarely lies with the people, the authorities both political and official, the workers and the citizens themselves.

The existing arrangements for solid waste management in most of our urban centers are highly unsatisfactory and subject a considerable part of our population to serious health risk.

Thiruvananthapuram City Corporation, which had only 50 wards with an area of 74 Sq.km, has been expanded by including all the contiguous Panchayats and now has 81 wards with 141.74 Sq.km area. Consequent to the increase in the area, the population under it, has increased, and along with that the responsibilities of the Corporation authorities and the expectation of the citizens. Unless all who live in the City find-tune themselves to improve the upkeep of the City, there is no doubt that the City will wilt under the enormous pressure it is subjected to from all sides.

Solid waste is generated in each and every household, small and big establishments, hotels, market places, hospitals etc. The lifestyle of the people of Thiruvananthapuram has undergone an enormous change. The large open areas surrounding the houses are lost. Having houses at elevated places has been given up and living in multi-storied flats is well accepted. Hotels have mushroomed and patronized. Roadside eating places have increased in numbers. Markets have become big, crammed up and unsustainable. New and make shift unofficial markets have spread all along the urban as well as rural areas. Meat stalls and poultry have multiplied. Lodgings and hostels for men and women have increased. All these contribute a great deal to the quantity of solid waste generated. Thus disposal of solid waste is a major headache of Thiruvananthapuram Corporation.

There used to be a solid waste pit in every dwelling place and the compost thus formed was used for the plants, kitchen garden and coconut gardens. Such utilization is becoming increasingly impossible in the present situation, though certain persons continue to hold such point of view even now. Solid waste without plastics and glass when digested is a very good biofertilizer and the people who knew its value still go in for biocompost. In earlier days, small quantities of solid waste used to be collected in bullock carts and now huge lorries carrying a minimum of 4 tonnes are needed for transporting solid wastes. With nook and corners of the City occupied for residential and business purposes such places are essential by the public. But solid waste is continuing to be generated even by the resenting public. In such a situation, proper collection methodology and appropriate technology to dispose of the solid waste, fully understanding its fertilizer value will of the people involved namely the generators of the waste, the transporters, and personnel managing the storage yards, and the technologists who operate the plant should act in unison and dedication to achieve success.

During the last few years many good actions have been initiated by the City Corporation though found fault with by many. The installation of a solid waste processing plant at Vilappilsala is a commendable move and a great achievement. Collection of solid waste from Dumper Placer Container (DPC), transporting them to transit points and hence transporting to the processing plant is a major task. The waste collected from different streets are brought together and dumped along with the immense quantity of solid waste generated in four main markets in Thiruvananthapuram City, like Manacaud, Chalai, Palayam and Peroorkada. These market areas are the transit points for the transportation of the waste to the compost plant. The quality of this waste is such that it is wet and putrefies fast thus generating malodour and subhuman condition for handling.

It is a common sight in Thiruvananthapuram City that the people using DPC are seen tampering and even burning them when transportation is delayed. Since the waste is degradable, they decay fast and attracts flies and other vectors. On the part of the Corporation authorities unimaginative handling procedures and lack of duty consciousness is found. When the drainage channels are cleaned the solid waste are removed and kept on roadsides rather than dumping it into dustbins. These wastes again fill in the channel during the next rain.

On the whole the process started by the Corporation is on the right lines but needs to be thoroughly streamlined. Healthy Corporation should pour in from all quarters. Residents Associations can do immense help in managing solid waste disposal by educating, creating awareness among public and extending a helping hand to the public in stopping the unhealthy and indiscriminate practices of waste dumping which creates nuisance to all.

3.2.2 Present status of waste management in Thiruvananthapuram Corporation

Similar to other Municipalities and Corporation in Kerala, Thiruvananthapuram Corporation is also spending 30 to 50% of their total budget on solid waste management. Despite spending this money, they are unable to provide satisfactory solid waste management services. The common problems faced by these local bodies are infrequent waste removal, inadequate coverage of waste removal from all parts of the City, contamination and

health problems related to waste management, and above all flooding due to clogged drains. The traditional approaches to solve these problems have proved to be ineffective and non-sustainable. Hence a new technical involvement and concerted effort is needed for a proper and scientific waste management programme.

Unlike other Municipalities and Corporations in Kerala, the Thiruvananthapuram Corporation has established a centralised solid waste management plant for managing the garbage generated in Thiruvananthapuram City. The plant is situated at the outskirts of the City area and can manage 300 tonnes of waste per day. This compost plant is installed by the Poabsons's Private Limited (Private Company) and the technology that is using for garbage treatment is mechanical composting.

The City is divided into 16 health circles for the easy management and monitoring of the health and sanitation programmes. One Junior Health Inspector manages the corporation wards coming under one Health Circle. Area of garbage collection is determined in the early morning itself. One worker is posted for one garbage bin and he will be responsible for the cleaning surrounding the bin.

Garbage bins are placed at strategic points mainly in the old city area where the tractor for lifting is accessible. Bin removal is a fully mechanical procedure from the point of collection and disposal. There are 85 Garbage bins properly placed according to the needs of the public in the different parts of the City Corporation. Each garbage bin is numbered and a bin name is given and the unique numbering helps in identifying the bin properly during transportation and if there is any complaint.

Bin removal to temporary (transit) depot is done at late evening and night. At present 15 tractors are used for transporting the bin and 5 to 7 trips are operated by each vehicle to remove all the 85 bins a day. Any bin not removed at night is reported properly and removed in the next morning itself. Two standby tractors are ready to clear any bins not removed at night and to attend any complaint.

Supervision of movement of tractors and removal of bins are by the control of Mini Garage Supervisor under the control of one 1st Grade Junior Health Inspector and one Junior Health Inspector (JHI). They chart out a schedule and collect report from the night duty JHI posted in the dumping yard and from the drivers.

Garbage heaps in different parts of the City where bins are not placed and in the new city areas (Zonal) is a problem in collection and transportation. One fully covered vehicle each is given to 16 health circles daily in the early morning. Two to three trips from each circle are collected and dumped in the temporary depot. In the morning session, average 50 loads of garbage (120 tons) are removed. Additional vehicles are provided to the major health circles namely Secretariate and Chalai, where garbage accumulation is more.

In 4 major health circles (Nanthancode, Palayam, Fort, Chenthitta, Sreekanteswaram) afternoon section is operated by providing one vehicle to each health circle and two trips of garbage is disposed (30 tons).

One health squad is constituted with 3 Health Inspectors and workers under the control of one first grade Health Inspector. They inspect the entire city area randomly during day and night to impose spot fine when garbage is found dumped in open public places. Supervision of garbage collection in the old city area is by the Health Officer and the zonal area is Deputy Assistant Health Officer. The Health standing committee will monitor the overall garbage collection and disposal.

A weekly review meeting of Health Inspectors in the presence of Worshipful Mayor, Corporation Secretary, Health Standing Committee Members and Health Officers review the activities of the last week.

Table: 3.5 Some details of Thiruvananthapuram Corporation during 1999-2000.

Sl. No	Item	Details
1	Area	75.11 sq.km
2	Population	5,24,006
3	Population density	6594
4	Literacy rate	88.26%
5	No: of wards	50
6	No: of occupied residential houses	1,02,848
7	No: of health circles	16
8	No: of Corporation workers (staff and contingency workers)	2286
9	Total quantity of waste generated per day	300 (approx.)
10	Management (Disposal) site	Vilappilsala

The Thiruvananthapuram City Corporation is responsible for collection, transportation, management and disposal of the garbage generated within the city limits. For this, the authorities have provided a network of several Dumper Placer Containers in different parts of the city. Households and establishments including hospitals/ nursing homes, hotels, restaurants etc are required to deposit their waste in these bins, for subsequent collection and transportation to the compost plant at Vilappilsala, 15 kms away from city. A total of about 350 rag pickers make their livelihood by collection a variety of recyclable wastes from the bins and the open dumps. Silt from drains and construction wastes are collected along with the garbage for disposal.

Substantial quantities of wastes are also generated from the slaughterhouses and poultry farms. But no proper segregation, collection and disposal of these wastes are carried out in Thiruvananthapuram Corporation. Hence these wastes are also mixed along with the city waste and carried for disposal. Slaughterhouses, according to WHO norms were constructed at Kunnukuzhy, by the Corporation, which have a biogas plant constructed by the Khadi Board to process the waste. But unfortunately the biogas plant is not properly functioning and hence all the wastes are known to carry along with the other municipal solid wastes.

The Corporation of Thiruvananthapuram City has about 1300 staffs for solid waste management i.e. they are directly involved in the process of collection, transportation, and management of solid waste generated in the Corporation area. There are about 940 contingency workers and all these staff and workers are deployed in the 16 health circles of Corporation area. Each circle has one health Inspector and 2 Junior Health Inspectors. They are responsible for the waste management in their circle.

A total of 65 vehicles operate daily for the collection and transportation of municipal solid waste from Thiruvananthapuram Corporation. Among this, 39 vehicles are operating from Corporation garage and 26 from Corporation Main office at LMS, Palayam.

Table: 3.6 Transportation capacities available at Thiruvananthapuram City Corporation

Sl.No	Vehicle type	Model	No: of vehicles
1	A. Lorry	Leyland	3
	B. Lorry	Tata Benz	11
2	Tractor	HMT	25
3	Tipper	Tata	10
4	Dumper placer	Tata Benz	3
5	Compactor	Leyland	1
6	JCB and Mini JCB	----	3 and 1
7	Front loader	----	5
8	Vacuum emptier	HMT	3

The collection accessories available in Thiruvananthapuram City for waste collection are 300 containers placed at different places of the Corporation area. Among this 300, about 200 is only placed at various points for collection since rest are not suitable. These containers are burned at places where daily removal lacked. Hence a collection accessory has to be increased for proper collection and solid waste generated in the Thiruvananthapuram city Corporation.

The main failure for the proper waste management in Thiruvananthapuram Corporation is that due to the lack of proper collection system. The Dumper Placer Container is not emptied or removed daily and due to this problem, the functioning of compost plant is often affected. The current solid waste management practices in Thiruvananthapuram Corporation need substantial improvements, particularly in the areas of segregated collection system and safe disposal for infectious waste from hospitals, nursing homes, dispensaries etc. Improvements are also needed in the field of organisational reforms and optimal use of resources to maximise the manpower and vehicle productivity and improvement of overall coverage and service levels.

3.2.3 Solid waste Treatment plant at Vilappilsala

The solid waste treatment plant at Vilappilsala was commissioned during 1999-2000 and started functioning in the year 2000. The treatment plant occupies an area of 12.5 acres (1,20,000 sq.ft.) and for future development another 17 acres of land will be acquired. The plant can convert 300 tonnes of garbage per day and the technology

used for waste conversion is mechanical composting. The waste from the city is carried in closed lorries to the plant and is emptied at the site. This is then arranged in heaps or windrows.

Two-stage process is carried out at Vilappilsala compost plant. The first stage is known as “defouling” stage. During this stage, a microbial inoculum is sprayed above the unsegregated municipal waste. The purpose of spraying this inoculum is that it controls the foul smell, flies, mosquitoes etc and accelerates the decomposition rate. The microbial consortium contains bacteria that can disintegrate and degrade the waste materials fastly. They can reduce the production of noxious gases. The inoculum is available as either dry powder or colloidal emulsion. The second stage is the bioconversion of these wastes into compost. For this, windrows are made by heaping the waste. These heaps are turned for aeration periodically and the turning interval depends upon the composition of waste. Inoculum is sprayed on each turning. This process takes about 30-45 days. The decomposed wastes are then passed through rotary and vibratory screens to segregate the compost from plastics, stones and other inert matter. Thus collected non-compostables are disposed off as rejects in adjacent landfill sites.

The final product, the compost is then analysed in the chemical laboratory to estimate the nutritional value and standards of compost quality. A chemical laboratory has been set up in the treatment plant premises itself.

The compost plant at times becomes non-functional. This is mainly due to the improper collection system followed. That is required quantity of waste do not reach the plant daily. Only about 150-200 tonnes of waste reach the treatment plant and among this about 30-40% will be plastic carry bags. Segregation of waste at source is not practiced and hence all the waste from the city reaches the compost yard. It is reported that the households deposit the degradables in a plastic carry bag and dispose in municipal bins. These carry bags get in between the machines while functioning and causing major machine problems at plant. Plastic carry bags get in between the sieves and vibratory screens and cause machine inefficiency. Maintenance of these machines takes days and hence the plant cannot function properly. Hence segregation at source has to be strictly followed. The segregated plastics and other non-biodegradables in the treatment plant are used in land filling the adjacent areas of compost plant.

The barriers noted for better waste disposal in Thiruvananthapuram Corporation -are the low priority given by the Corporation decision makers, ie, apathy of the Corporation authority to the communities perceptions and needs, the lack of good examples of waste management techniques, use of inappropriate technologies for collection, transportation, treatment and disposal, lack of financial resources and the lack of trained personnel. Hence a concerted effort for proper scientific management of solid waste is essential. With this point of view the Centre for Environment and Development has proposed to study about the quality and quantity of solid waste generated in Thiruvananthapuram City, the problems of solid waste mismanagement, the technical options for solid waste management and also to study about the perception and attitude of the people towards solid waste

management in Thiruvananthapuram Corporation. The study was divided into two phases. The first phase included technical aspects and the second phase included social engineering aspects.

As the first phase programme, we conducted a detailed study on solid waste management and have prepared an action plan for implementation. Through this earlier study, the waste generated in Thiruvananthapuram City was quantified and characterised. We attempted to identify the various sources of waste generation, the facilities of solid waste management, the conventional and unconventional solid waste disposal practices and also various technological options. Based on this, pilot scale model building on solid waste management in selected locations were implemented. A detailed action plan for Solid Waste Management for Thiruvananthapuram City area was prepared. The organisational structure for implementing such a massive programme was also conceived.

The present study concentrated mainly on the attitude, view, ideas, concept and perception of people towards Solid Waste Management in Thiruvananthapuram City area. The present day waste disposal practices were analysed and its problems were also discussed. The study collected information about the willingness of the people to co-operate in a decentralised, action programme for segregation, collection and transportation of solid waste generated in their premises. The perception of Corporation authorities for such a programme was also discussed in detail.

3.3 Community involvement

People's participation in solid waste management depends on factors like including their interest in participation, economic and social objectives of participation and the importance and degrees of participation. People's interest in participation means that they are contributing to a collective action of common interest to their neighbourhood and also means that they join together in order to gain access to some financial resources. As the success of any programme depends greatly on public acceptance, the communities and the people concerned should be made aware and make them participate in the programs implemented. The community must be made aware about the programs, the processes, advantages and the disadvantages.

The failure of any waste management programme is that due to the lack of community involvement. The social engineering aspect is an important factor while planning a programme for community development.

3.4 Technologies used

3.4.1 *Windrow composting*

i) Chalakudy Municipality Waste Management Programme

Chalakydy Municipality consists of 30 wards with a population of 55,000 people spread over an area of 25.23 sq.km. The total quantity of waste generated in this municipality comes to about 10 – 15 tonnes per day. Out of this, 2 tonnes of municipal solid wastes are treated and disposed of to reduce the garbage menace of the municipality. This project was initiated as a model by the Integrated Rural Technology Centre (IRTC) in the year 2000. The maximum capacity of this plant is 2 tonnes per day, built and operated for initial 1 year by I R T C and now it is under the direct management of the municipality.

Table: 3.7 Chalakudy Waste Management at a Glance

Area	2 acres
Plant capacity	2 tonnes
Process adopted	Windrow Composting and Vermicomposting
Project started	3-07-1999
Waste Management started	20-01-2000
Plant Construction cost	21.6 lakhs
Recurring cost	4.8 lakhs
Project duration	1 year

A total of 10 workers (6 men and 4 women) and one Supervisor are employed by the municipality for the management of waste including segregation and composting of municipal garbage on delivery of waste in the plant premises. The work load has been divided between men and women workers in such a way that unloading of waste from municipal collection vehicle, arranging it into windrows, making cow dung slurry, covering the windrows with plastic tarpaulin sheets and turning the waste at pre - decided intervals are carried out by the men workers while the women workers concentrate mainly on segregation of digested waste, sieving the decomposed matter and packing of compost in 50 kg bags. The wages for men are Rs.115 per day and Rs.85 per day for women. The working hours is made into two shifts ie. from 8 am to 5 pm and second shift is from 5pm to 2 am. Only male workers are posted in second shift. Workers are supplied with hand gloves and gumboots. Monthly medical check up by doctors has been arranged for all the workers by the municipality.

a) Composting Yard

The composting yard has three long sheds, two of them are for windrow composting and the third for separation of undigested and digested waste by sieving and packing of compost. Each windrow compost shed is divided into 8 compartments and each compartment is again divided in to 3 sub compartments denoted as A, B & C with partition walls. Each sub compartment (A/B/C) is about 180 cm long, 3 meter wide and 85 cm high. Hence the total length of one compartment (width of the shed) is 540 cms. The third shed is without any partition, where sieves are installed, matured windrows are stacked for sieving and manure is stacked. In addition another small unit consisting of 12 compartments is used as Vermi culture nursery. Each compartment of this nursery is 1m x 1m x 0.55m.

As soon as the lorry or container carrying waste (usually 1 tonne or 1 $\frac{1}{2}$ tonnes) reaches the yard, it is loaded into the first compartment 'A'. While unloading from the container plastic carry bags, large bottles, plastic pieces, cardboard etc are separated manually by the workers. This enables partial removal of such refractory parts but a good portion still remains. The removed non degradables are at once packed and returned in the same empty lorry to the land filling site at Cosmos. The degradables are properly arranged in the compartment in three layers and cow dung slurry of 20% is added if the waste contains more vegetable matter. This 20% cow dung slurry is prepared by mixing 20 kg of cow dung in 100 litres of water. Similarly 40 % cow dung slurry is added if the waste contains more paper particles. Thus forming the first stage windrows for the process. It is then covered with tarpaulin sheet. It is understood that the municipal waste sometimes contains hospital waste. Dead and decayed animals are not carried to this compost yard.

The windrow is kept as such for 15 days. After 15 days, it is turned manually and shifted to compartment 'B' and covered with a tarpaulin sheet. The garbage is left undisturbed for further 15 days. The windrow that is 30 days old is turned second time and shifted to compartment 'C'. The windrow is kept in this compartment for next 15 days. ie, **A** (15 days) **B**(15 days) **C** (15 days). By this time major portion is digested.

Thus after a total of 45 days, the degraded matter is carried in wheelbarrow to the sieving shed. Here the degraded matter is segregated manually. Part of decomposable waste remaining undigested even after 45 days of decomposition are separated by hand picking. Non-degradables like syringe, glass pieces, small plastic pieces etc

are removed at this stage. This segregated compost is again arranged as windrows for next 10 days. This is for reducing the moisture content. No turning of the compost is done at the stage. After 10 days this compost is sieved using electrically operated rotating drum sieve of mesh size 1-cm in diameter. The fine compost particles that pass through the sieve is collected and packed in 50-kg packs and those retained in the sieve are collected, segregated and decomposable part is again used in windrows for composting. Then second round of processing is done using unsieved compost for further 25 days. This compost is again sieved and after that hardly 25% is retained which is used along with fresh waste.

The compost is usually collected in plastic bags containing approximately 50-kg manure and is sold at a rate of Rs 3/- per kg with 50% subsidy. This manure is labeled as second quality and is further sieved with finer sieve with an approximate mesh size of 78 mm². The compost that passes through this sieve is categorised as first quality and is priced at Rs.4/- per kg. Municipality allows 25% subsidy and Rs.3 is collected from the consumer.

B) Vermicomposting

In this plant, the compost that is produced after 45 days of windrow composting was used for Vermicomposting. The Vermicomposting bed is prepared by spreading one layer of coconut husk and above this the decomposed waste after 45 days is added. Vermicomposting is done in layers of 1 ½ m width at a height of 0.75 cms and length according to the space available. After adding the first layer of waste above the coconut husk, a thick layer of cow dung slurry is added. Above this coconut slurry waste is added for 30 cms height. Upto this 90 cms height wastes and cow dung slurry are added in alternate layers. The whole Vermicompost bed is covered with cow dung paste. Temperature of this Vermicompost heap is always monitored using a thermometer. When the temperature reaches and remains constant at 35^o C, earthworms in proper numbers are added. On the top, wet gunny bags are used as covering material. During sunny days water is sprinkled twice a day while once in rainy days. The waste heap reduces to 35 to 40 cms high after 30 days. It takes a total of 30 days for the completion of the Vermicomposting process. As the Vermicompost matures, sprinkling of water is stopped and allowed to dry. The worms then move down deep into the moist area and the compost from the top of the bed is collected with hand and packed in 50-kg bags. The Vermicompost is sold at a price of Rs.6 per kg without any subsidy.

c) Vermiculture nursery

Due to the high demand of Vermicompost, the Municipality has started a Vermiculture nursery in the yard itself. The Vermiculture nursery consists of 12 compartments and each compartment is of the size 1m x 1m x 0.55m. The Vermiculture bed is prepared using coconut husk for a height of 1 inch, plantain stem for 1 inch and cowdung for ½ inch. A total number of 250 worms are introduced in each compartment and is covered using coconut leaves. Daily monitoring is carried out for checking the temperature and moisture.

3.4.2. North Paravoor

North Paravoor of Ernakulam District is yet another model for municipal solid waste management. Similar to other Municipalities in Kerala, the major problem faced by the local authorities of North Paravoor is the heaps of garbage on streets. They had an open dump yard at Vedimara, a place 1 km away from the city. This dump yard has an area of 2¹/₂ acre and is filled with municipal garbage. The waste decay and the odour emanating from this spread to kilometers away from the dump yard. The people residing nearby complained and the authorities started to think about innovative ways for tackling this problem. As a result, based on the urban compost scheme, Paravoor started to collect money for converting this dump yard to a compost yard. Thus from the State Government based on urban compost scheme North Paravoor got 2¹/₂ lakhs, from People's Plan fund they got Rs1¹/₂ lakh and 3¹/₂ lakh rupees from Corporation / Municipalities fund. Thus a total of 7¹/₂ lakhs were collected for the collection, transportation and management of municipal solid waste.

With the support of Municipality, the Agricultural department is implementing and monitoring the solid waste management programme in North Paravoor. First they planned for composting alone, but now both Composting and Vermicomposting is carried out for managing the municipal garbage. The dump yard is now used as the treatment plant.

a) The treatment yard

The activities carried out for converting dump yard to compost yard were that they first burned all the combustible waste and the remaining was segregated for composting. A pit for burning combustibles was taken at a corner and the middle part of the yard is cleaned for dumping the daily waste. An area of ½ acre is cleared for segregation and the rest is for compost stock sheds and the office building.

Paravoor Municipality has one lorry and two trailers for transporting waste. Each vehicle daily carries 2 loads of waste to this dump yard. As soon as the waste reaches the dump yard, it is segregated and treated for further treatment disposal. Five lady workers are employed for segregating the waste. Manually they segregate the waste. Thus manual, handpicking method is employed for segregation. The combustibles thus segregated are burned in a pit, while compostables are removed to compost yard. Both composting and vermicomposting technologies are used for the municipal solid waste treatment. 2000 sq feet area is used for vermicomposting and this is divided into 15 compost yards. Each yard is 7.5 m long, 0.25m wide and .03 m high. The degradable wastes are daily fed into this bed and it takes 50-55 days for the composting process. Some times, if the waste in first bed is not completely converted to compost and the waste received is more, the wastes are dumped into a compost pit. This compost pit is 30m long, 10m wide and 2 m deep. Thus, composting and vermicomposting are simultaneously carried out in this yard. For vermicomposting, the African night crawler, *Eudrilus eugineae* worms are used and for each yard they supplied 3000 worms. The final products, compost and vermicompost are sieved and packed for sale. Each Kilogram of compost and vermicompost costs Rs.5/-. Thus Paravoor Municipality has succeeded in converting 'Trash to Cash'. Paravoor has become a model for other Municipalities also.

3.4.4 Biomethanation

a) Process

Another technology that is used for treating municipal solid waste is biomethanation, by using biogas plants. Biogas is produced by anaerobic decomposition of various organic materials like live stock wastes, urban wastes, agricultural wastes etc., in an oxygen deficient or chemically reducing environment.

When organic matter is digested in the absence of air, the degradation of the large molecules occurs in three stages. The first is known as liquefaction, the organic matter is usually in the solid form and in order to become available to the bacteria, it has to be broken up by external enzymes produced by the bacteria and dissolved in the water that surrounds them. It may be difficult to distinguish this stage from what is known as the acid forming stage.

In the second stage, ie. acidification or non-methanogenic phase, the bacteria reduces the soluble organic materials from the first step to soluble simple organic acids. In the third step ie. in Methanogenic stage, methane bacteria reduce the organic acids, primarily acetic acid and certain other oxidised compounds to methane and carbon dioxide.

Generally, the first and second stages are closely linked that they are often, considered together. During these stages decomposition of protein yields ammonia, which increases the pH of the medium and then creates favorable condition for methanogenic bacteria. Some of the ammonia evolved converts methyl carbon to methane and carbon dioxide (CO₂) is further reduced to methane.

i) Acidogenic phase

Acid phase fermentation is a key step in biogas production, since it results in the generation of acetate, which is the primary substrate for methane formation. The terminal end products of acid-phase fermentation are acetate, higher fatty acids, CO₂ and H₂. The formation of these products is mediated by a complicated network of enzymatic reaction chains. The polymeric carbohydrates contained in the complex organic wastes are hydrolysed by enzymes to simple soluble sugars and short-chain organic acids like acetic acid, propionic acid, lactic acid etc.

ii) Methanogenic phase

This involves the conversion of the intermediary products of the acetic phase to form methane. The main substrates for methanogenesis are acetic acid and hydrogen plus carbon dioxide. Acetic acid is usually regarded as the most important substrate.

The environmental factors which govern the process of methanogenesis and relevant to the technology of biomethanation are temperature, pH, anaerobiosis, C/N ratio, the necessity for micronutrients and the presence or absence of toxic materials in the substrate biomass.

b) Technology

It is a technology concerning microorganism. A waste treatment plant is a system comprising a gasholder and a fermentation chamber in which Biodegradable organic matter and other cellulosic waste materials can be treated anaerobically, which produces methane gas, otherwise called Biogas and Organic Manure.

Methane gas is a renewable source of energy, which is used for cooking, lighting, running diesel/petrol engine and for generation of electricity. Methane gas is a new source of fuel for mechanization of Agriculture and Small Scale Industries. The cost involved is low when compared to other fuels.

c) Organic Manure

Digested slurry can be used effectively in any type of soil and for any crop. In addition to providing microelements like iron, copper, boron etc. Bio manure improves the water retention capacity of the soil, because of the humus content in it. Moreover Bio manure buffers P^H change in the soil thereby maintaining the equilibrium and nutrient balance of the soil.

d) BIOTECH

BIOTECH, institutionalised in 1994, as a non-governmental organisation uses biomethanation technology for transforming biodegradable wastes to wealth. The bulk quantity of waste generated from Canteens, Marriage Halls, Hospitals, Markets, Hostels etc. and the public sites creating bulk wastes are ideal locations to establish biomethanation plants, in their own interest and interest of the community for managing the solid waste generated.

Models Used By Biotech are

- i) Fixed Doom Digester with separate gas collector
- ii) Floating Drum Type

Features of the biogas plants are low investment, factory assembled fibre glass modules, pre-conditioner to accelerate fermentation, fixed film reactor, simple operation and low maintenance, durable construction and compact design, designs for bio-solid and liquid, night soil treatment, low energy consumption and low sound pollution and above all eco-friendly and pollution free.

Biotech has installed more than 250 plants in Thiruvananthapuram district and in various other parts for waste management. Household level plants have been constructed even in rural areas for total environment management and sanitation.

CHAPTER IV

SUMMARY OF FINDINGS OF FIRST PHASE PROGRAMME AND OBJECTIVES OF PRESENT STUDY

The study about solid waste management in Thiruvananthapuram City was carried out in two phases. The first phase programme included collection of information on quantity and quality of wastes, different technological options for waste management, particularly degradable waste, and based on all these we prepared an action plan for solid waste management in Thiruvananthapuram Corporation area. The study also included a proposed plan for transportation of wastes from different locations to the compost plant at Vilappilsala.

The major objectives of the first phase study are

1. To prepare a comprehensive action plan for the management of Municipal Solid Waste of Thiruvananthapuram City.
2. To prepare a status report about the present quantity of waste generation, its physical and chemical characteristics, its management, infrastructural facilities available with the Corporation for Management etc.
3. To identify location specific appropriate technologies for each ward/waste collection circles and to find out various options for management.
4. To organize awareness programme to the people in the area selected for pilot scale studies.
5. To organize a pilot scale feasibility study on technologies to be used in one of the selected ward with the participation of local people and residents associations, voluntary groups and Corporation authorities.
6. To build up an Environmental Information System (ENVIS) on Waste Management using the GIS Software Package available with the Centre.

The first phase of the study aimed at preparing a status report on the management of solid waste with particular emphasis on finding out the nature, problems and constraints in solid waste management. The study attempted to find out the types and quantity of waste generated in each ward of Thiruvananthapuram City Corporation. Information was also collected on the present system and future technology options.

Technology optimization studies were also conducted at laboratory level and field level. Pilot scale models for solid waste management were implemented at two wards of Thiruvananthapuram Corporation and also at Centre for Development Studies (CDS) Campus. The sample survey conducted at 50 wards of Thiruvananthapuram City shows that a total of 290-300 tonnes of solid waste are generated per day out of which 181 tonnes are from households. The waste generated by shops and commercial establishments comes to about 13-15 tonnes per day. The study also revealed that about 55% of shops and other establishments recover most of

the recyclable materials from the waste before final disposal. The hotels and restaurants generate about 30 tonnes of degradable waste per day while markets produce about 40 tonnes of waste per day.

The hospitals and clinical laboratories of Thiruvananthapuram City generate both infectious and non-infectious wastes, which comes to about 2-3 tonnes per day. The other sources of waste generated in the City are offices, educational institutions, marriage halls, slaughterhouses etc.

Table: 5.1 Quantity of waste generated from each source

Source	Quantity (Tonnes)	Percent
Residential	181	60
Markets	40	13
Commercial area	15	5
Hospitals	2	1
Hotels/Restaurants	30	10
Marriage halls	18	6
Street sweepings	2	3
Constructional	10	1
Miscellaneous	2	1

A detailed study was also conducted on the informal sector involving collection of non-degradable waste like plastics, paper, metals and glasses. During the study we could identify more than 500 rag pickers who are involved in collection of non-degradable waste directly from the sources or from the waste dumps. They sell these wastes to the wholesale waste collectors who transport these materials to Salem and Coimbatore for recycling.

Technology optimization study conducted as part of the first phase of the project shows that composting is the most suitable method for waste management in the City, as majority of the waste generated are degradable in nature. The physical characteristics of the waste generated in the Thiruvananthapuram City Corporation shows that 50% of the waste generated are organic substances, which are suitable for composting. Our study also reveals that Biomethanation is another waste processing technology that can be tried for institutions, hotels and marriage halls.

The information collected through various surveys and pilot scale implementation studies has been utilized for formulating an action plan for the Thiruvananthapuram City.

The major aspects considered for the formulation of action plan are,

- i) Segregation and characterization of the wastes at the source itself whether it is household, market, institutions, hospitals etc.
- ii) Decentralised collection from the primary source and centralized collection from secondary sources. For example, the segregated wastes generated in each household, market etc., can be collected by persons appointed for this purpose by the residents associations. Shop owners can either empty the waste directly to the Dumper Placer Container (D.P.C) or to the small dustbins. From the dustbins/container a centralised collection system is more feasible.
- ii) Collection of non-degradable wastes from households/markets etc., by the rag pickers to supply to the recycling units. The existing system of collection by rag pickers has to be strengthened by providing proper training and assigning them responsibility of specific areas.
- iii) Processing of degradable wastes in each household/community itself as far as possible through Composting or Vermicomposting; and centralised processing system like Mechanical Composting for the market/institutional and other wastes and also the household wastes where household level composting is not possible.
- iv) Detailed transportation network planning for transfer and transport of the wastes, taking into consideration the shortest route from the collection centre to management site, traffic density, time of operation etc can be done using GIS.
- v) Establishing Common Facility for management of Hospital wastes/hazardous wastes either by the City Corporation or by the institution themselves.
- vi) Ward level as well as residential association level planning is essential for a sustainable waste management. Ward level planning can be organised under the leadership of Ward Sanitation Samithy.
- vii) An organisational set-up starting from the NHG/Residential Association to Ward Sanitation Samithy and Corporation level Public Health Committee has been suggested. The planning at the bottom level, implementation and monitoring etc can be carried out under this organisational set-up.
- viii) We have also suggested a few training programmes to various target groups to orient them in various activities to be carried out under this programme.
- ix) We have also worked out the approximate expenditure for a Waste Management Programme as suggested in this report.

x) One of the major aspects in any Waste Management Programme is its sustainability, which depends on the level of community participation. Here we suggest a high voltage campaign to involve the community in a participatory process of Waste Management.

xi) Finally, the process of Solid Waste Management in any City requires co-ordinated activities of various agencies i.e., local bodies, community groups, departments and other agencies. The City Corporation should initiate a dialogue with these agencies and community groups to implement a sustainable waste management programme.

3.1 Major findings

The first phase study aimed at preparing a status report on the management of solid waste with particular emphasis on finding out the nature, problems and constraints in solid waste management. The study attempted to find out the types and quantity of waste generated in each ward of Thiruvananthapuram City Corporation. Information was also collected on the present system and future technology options.

3.2 The major objectives of the present study are

1. To collect information about the unconventional waste disposal methods adopted by households, institutions, commercial establishments hospitals, markets etc.
2. To collect and collate information about the local technologies adopted by the Resident Associations, local agencies and authorities.
3. To study the views, attitude and perceptions of the people about the Solid Waste problems and the plausible management options to tackle the problems.
4. To enquire about the willingness of the people to co-operate in a decentralized, location-specific management programme and also in a cost sharing for solid waste management.
5. To update and modify the Environmental Information System (ENVIS) which is prepared as part of 1st phase program on the basis of the second phase study.

CHAPTER V

METHODOLOGY AND TECHNICAL PROGRAMME

5.1 Survey in selected wards

Reliable data on quantity and quality of solid wastes are important for the planning and designing of optimal collection, transportation, management and disposal options. During the first phase program we carried out detailed field investigations in selected wards to measure the quantity and quality of waste generated by various sources and from this the physical and chemical properties of the waste was computed. This information was supplemented with the quantity of waste recycled by the informal sector.

The present study was started with a survey at 10 wards of Thiruvananthapuram Corporation. The survey covered 10 percent of households in each selected wards and the main objectives of this survey was to study the current practices of solid waste storage, the present waste management practices, to assess the community's perception on the existing collection and management system, to study the changed attitude of the community, to evaluate the peoples preferences and willingness to co-operate and pay for improved solid waste management practices and also to identify the new initiatives at local level for waste management. A detailed pretested survey format was used for this purpose. The format is appended. The survey samples were selected based on socio-economic criteria. The study samples were classified as low income, middle income and high -income groups.

Out of the 50 wards of Thiruvananthapuram Corporation, the survey was conducted in selected 10 wards to cover the households of different socio-economic categories, markets/commercial area, institutions etc. The 10 wards selected for the present study are Perumthanni, Shankhumugham (low income areas), Pettah, Palkulangara (middle income areas), Kannammoola, Pattom (high income area), Chalai, Palayam (market/commercial areas) and Thycaud and Kesavadasapuram (residential and institutional area). The survey result shows that 100 percent of the people in study area are aware about the present solid waste problems. This study reveals the fact that the people are really fed up with the present way of collection, transportation and management of solid waste by the Thiruvananthapuram Corporation.

5.1.1 Present system of waste storage at source

The survey was also aimed to study the present practices of waste storage and collection system. Storage of waste at the source of generation is the first and essential step towards solid waste

management. As per the Municipal Act, certain responsibilities have been laid down on the property owners and property holders to put their garbage in a standard bin and empty the same in community garbage bin or directly into the garbage collecting vehicles provided by the Municipality. Due to the lack of enforcement of the law, the garbage is thrown out to the roadsides by the waste producers. The waste should be stored at source of generation in two bins for degradable and non-degradable waste. This is two bin system and three bin system can be followed when waste such as batteries, chemicals, pesticides, expired medicines and other toxic type waste are produced.

The present survey at various households of Thiruvananthapuram area shows that most of the housewives of low-income groups are reluctant to store the garbage inside their house. They reported that this is mainly due to lack of space and lack of practice. They usually throw out the waste as soon as it is generated. The middle income and high-income people use bins, carry bags or buckets for the storage of degradable and non-degradable waste generated in their house.

Above 60 percent of the the middle and high-income groups in their houses before disposing it above 60 percent of people of low do not store the waste in their simply throw away. The rest of the dumps the wastes on roadsides, bins etc. In case of shops/stores and workshops highest percent of those who do waste but dispose it near the Roadside dumps are common in



households in store the waste in bins while income groups premises and community open dumps, establishments, account for the not store their roadsides. Chalai market

area. Those who store waste prefer plastic bins and finally dump it in nearby Dumper Placer Container. The buckets used by most of them are without lids and they are not suitable for storing of kitchen food waste for 24 hours in Indian condition, as garbage starts stinking very fast due to putrefaction. This stored waste is then emptied along the roadsides wherever they see waste dumps, usually near their residence. They never segregate the waste. Most of them reported that it is easy for them to collect the waste together than segregating even though they know that segregation promotes resource recovery. However while ascertaining the people's perceptions about source segregation of waste, it emerged that they are not willing to do any segregation except newspapers. They reported that they are not willing to segregate the waste because it is time wasting for them, since the Corporation workers carry all the waste together in a lorry to the composting yard. Even though the Corporation Dumper Placer Containers are designed in such a way to collect the wastes separately as degradables and non-degradables, the people dump all the waste together in it, since the

transportation of this waste is in a single lorry. About 50 percent of the population is non-vegetarian and use fish and meat regularly. Due to its perishable nature, people prefer not to store the fish, meat and bone wastes.

About 55 percent of the hotels and 60 percent of the shops, 80 percent of the and offices use plastic waste bins for storing. They usually deposit this stored waste in Placer Containers. They reported that they sweepers for cleaning their premises and them to dump the waste in Dumper Placer. But most of the sweepers we met replied that waste to nearby open dumps or roadsides or the Dumper Placer Containers. These not emptied daily and hence they dump the roadsides. Most of the shopkeepers in Chalai reported that they throw the waste on the the footpath or in open drain in front of their establishments. Only 24 percent of the bins had lids for covering the stored food waste.



restaurants, institutions their waste. Dumper keep strictly instruct Containers. they dump the even outside containers are waste on and Palayam streets or on restaurant

Over 80 percent of the hospitals, nursing homes and dispensaries in Thiruvananthapuram City store their waste at source without segregation and dump it in nearby Dumper Placer Containers or burn the waste in hospital premises. Only a few institutions take precautions for safe storage of this highly infectious waste. They collect all the waste together in one or two plastic bins. In some hospitals, especially private ones keep separate bins for waste collection in each ward while in some hospitals they keep 2 or 3 barrels for waste collection in their premises. In these barrels all the waste are collected together without segregation.

Construction wastes are seen indiscriminately thrown on the streets resulting in unsightly appearance and traffic problems in some areas. Broken pieces of bricks, glasses and wood containing nails are seen along with degradable waste dumps. In some places construction waste are seen dumped on footpath or at a public place without any consideration of the passersby. It is the waste producer's duty to dispose of the construction waste. This waste must be stored inside the waste producer's premises till it is disposed of by the producer.

The survey shows that the attitude and perception of the people have changed a lot during the last ten years. Household survey indicated that more people recycle the waste that is generated. About 55 percent of the households reduce, reuse and recycle the waste materials. For example, they separate newspaper, cardboard etc and sell it to rag pickers. They even reuse the broken buckets for storage purposes. They started reducing the number of plastic carry bags by reusing the old one for other purposes also.

5.1.2 Present system of waste management practices at source

The survey shows that most of the low income and middle-income houses burn 60% of the waste generated and sell the rest for a nominal rate. The common waste management practices of the low-income families are that they sell most of the non-degradables and burn the combustibles along with dried degradable wastes. In the case of low income families about 30% throw out the waste on soon as it generated, 48% burn the waste and about 16% simply bury the waste without any aim to convert it into manure. In case of middle income families about 40% throw away the waste in their premises itself and about 48% of them burn the waste in a pit and cover it with mud or control flies they reported. While 74% of families throw out the solid waste into Containers or open dumps, 19% burn the waste and 7% bury the waste in pits. The particularly in Chalai & Palayam market thrown out in open dumps. Now these points for waste collection and hence almost all the wastes from rest of the city area also reaches these Centres. Palayam market is worst in this matter as the fish waste also reaches the open dump. In Chalai most of the waste that reach the open dump is degradable and start stinking within a day. The survey in Thycaud and Kesavadasapuram areas (Institutional) showed that almost all the waste reach the open drains and open dumps. The waste from Institutions like Schools and Colleges are seen dumped on the sides of their front gates itself. Open dumps near the schools of Thycaud area is causing even troubles to the passer by. As authorities reported that they dump all the waste in pits constructed for the purpose in their campus itself and burn the combustibles, and as the open dumps near their premises are mainly due to the waste thrown out by the residents and nearby shops.



waste in a pit manure. In case throw away the 48% of them burn about 12% bury dried leaves to the high-income Dumper Placer the waste and 7% commercial areas, all the wastes are areas are transit

Table 6.1 Existing methods of waste disposal

Sources	Methods
Households	Dump on road sides, bury, burn, in municipal bins
Commercial establishments	Dump on roadside, drainage, in municipal bin
Markets	Dump on market premises, burn
Hospitals/Nursing homes	Dump in municipal bins, burn
Marriage halls	Dump in municipal bins, roadside, drainage, burn
Construction wastes	Dump on roadsides
Hotels/Restaurants	Dump in municipal bin, roadside, Burn Recycle for fuel

	for fuel
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5.1.3 Changed behavior and attitude of people

Earlier studies conducted by us in Thiruvananthapuram City Corporation shows that most of the people never took much interest in this subject. They thought that solid waste management is a program that should be carried out by the authorities- in- charge and they do not have any role to play. It is the duty of Corporation to manage all the waste generated by the community and for that the people are paying tax. The people also had a general apathy towards recycling waste materials and showed unwillingness to segregate waste at source. They even preferred Corporation/Municipality based service and were not able to accept the rag pickers as a link in the chain of solid waste management. They simply threw out the waste generated in their houses, some burn while some others simply bury the degradable waste. The coconut husk, shell etc were used as fuel by some of the houses. Earlier survey also revealed that segregated collection is not followed in any one of the houses. They never thought that they have to play an important role in proper, scientific solid waste management. But they showed willingness to participate in a waste management program if proper technical advises are given. Earlier study showed that proper awareness and education could bring out segregation, collection and management of degradable and non-degradable waste generated at the source itself. A system, which is properly sustained through a continuing public education program, will attain a growing rate of participation.

The present survey analysis shows that about 88 percent of people reported that they too have a major role to play in solid waste management as they form the first part of solid waste management programme as the generators of waste. This itself shows the change in attitude of people. They reported that even though there are few initiatives from various organizations in waste collection and management but are not successful. Every programme starts with new ideas and concepts, but fail soon due to the lack of monitoring and duty consciousness of people. So, they were first reluctant to accept such a programme in their locality.

5.1.4 New initiatives at local level

In Thiruvananthapuram City areas, particularly at Vazhuthacaud, Statue and Kesavadasapuram, a voluntary group has started door-to-door collection and transportation of domestic waste to Dumper Placer Container. For this, they collect Rs.25/- from each house. Some voluntary organizations functions with the help of Residence Associations while others work independently. Even though door-to-door collection and transportation takes places in these areas, some houses do not participate. This may be due to lack of awareness and reluctance to participate. Hence a co-ordinated action of Residence Associations, voluntary groups and households are necessary for waste management programmes.

It has been widely accepted that the success of development activities rests with the creative participation of communities. Community participation in Solid Waste Management, means involvement of the residents in planning, implementing, evaluating and continuous monitoring of the waste collection system and management at a local area where this activity is envisaged.

Our experience at Thiruvananthapuram Corporation wards, particularly at Pettah, Kannamoola and Thycaud, showed that urban communities become involve in constructive ways when they take part in decisions that affect them. We asked the people about their opinion about storage and collection system, taking into account the level of fees that they would be able to pay. They all at once replied for door to door collection system and we found that the residents are prepared to pay for the improved service of solid waste collection. Above all, people became more committed to the programme as their opinions are valued and accepted. This programme also helped in strengthening social relationships among the residents.

As part of the study we interviewed many officials, students, technologists, presidents and secretaries of residence associations, housewives and residents of Vilappilsala –where the compost plant of the City is situated. The opinion and perception of the people are summarised below.

5.1.5 Interview with the members of the Kerala State Pollution Control Board

Mr. Indulal, Member Secretary, State Pollution Control Board opined that the treatment system at Vilappilsala is well designed for the management of the degradable waste generated in the City. The most modern technology available is adopted for the smooth functioning of the plant. According to him auxiliary facilities and rectification of the defects should be made for the proper operation and the maintenance of the plant. Mr. Sudheer Babu, Environmental Engineer discussed with us about the inspection report of Pollution Control Board on waste treatment plant. The inspection was conducted in compliance with order-dated 7.11.2000 in E.M.P No. 53164/200 in O.P.No. 31284/2000. The committee inspected the Municipal Solid Waste Treatment Plant on 21-11-2000. Sri. S Mukundesh, the representative of the plant, the President and the ward member of the Grama Panchayat, Block Panchayat Member, residents and Health Officer of Trivandrum Corporation were present there during the inspection. This report points out the major defects observed during the inspection and suggest the remedial measures for rectifying those defects.

5.1.6 Impact of compost plant on the neighbouring population

According to S.S Mukundan, the president and the ward member of the Grama Panchayat opined that “ this invaded the households swarms and it is a total discrimination on the part of the corporation that the people of the rural area should suffer the waste products of the people of the urban area. Lot of people is suffering from allergies, infections and many other diseases”.

Lalitha, a housewife who stays in the locality showed her allergic skin reactions on her legs, which she claimed started appearing after the garbage processing began.

Somasekharan Pillai, an ex-military man residing near the plant alleged that his grand children of 3 years and 2 years are suffering from allergic infection and they found it difficult to life in the area due to fly menace following the disposal of the garbage.

Shiva Kumar, a coolie in that area complained about the uncovered lorries causing foul smell when the garbage is being transported. Ajayan, a jeep driver lights agarbathi to overcome the foul smell, he reported.

5.1.7 Findings from the survey conducted at Vilappilsala

About ninety percent of the people who participated in our survey at Vilappilsala area are of the opinion that the plant and its mode of working are not appropriate. The people alleged that plastic and inorganic waste is being burnt in the premises leading to toxic fumes.

The Panchayat member Mr.Stephen, who represents the Chovallor ward where the treatment plant is located, said that the wastewater from the plant is polluting drinking water sources in the area. The drinking water supply projects are located in the down stream. The plant employees claimed that the water used for processing the waste is being recycled.

The merit and demerits of the plant was also discussed by the people. The merits pointed out by them are the factory has a capacity to process 300 tones of garbage, a laboratory for chemical and microbiological analysis of the bio-manure is being set up at the plant site with support from Cochin University of Science and Technology and a process of recycling is being adopted.

The demerits are that there is spillage of garbage outside the processing yard. During rains these may be carried to nearby natural nullahs and thus spoils the surface water resources. Leachates from these wastes pollute the groundwater sources also. Larvae of flies are seen at some locations in the yard. Presence of flies was also noticed. On the eastern side of the plant, a small drum of about 200 litres capacity is placed to collect water leaching out. The pump kept there to pump it back to the yard is not in working condition. There is no permanent power supply to the pump and the nets provided around the yard are damaged at many places. Also there is gap all around between the roof and the net. There is a stench from the plant, which is more, pronounced during the periodic turning of the garbage. Plastics, tires and other rejects are kept in drums and on the floor outside the yard.

The plant representatives informed that the reject materials are removed for reuse every week. There is loud noise due to the operation of 125 KVA generators.

5.1.8 Observations

- When this factory was introduced there was a contract signed between the Corporation and the plant that the Corporation would supply 300 tonnes of waste per day. But we came to find out that only 150-200 tonnes is being supplied daily.
- The waste is supposed to be transported in covered tripper lorries, which is not the case.
- Due to insufficient number of trucks, the transportation of garbage is delayed for days.
- The corporation sprays inoculum on the temporary dumping yards to avoid foul smell and flies
- About 200m away from the plant, we could smell the stench emanated from the huge piles of garbage.
- The corporation claims that they provide necessary facilities to the employees and also provide medical reimbursement when needed.
- The plant employees reside within the compound has difficulties in leading a hygienic life, but they deny these facts.
- The corporation is planning to set up a contract for dumping garbage.
- We had a chance to make a conversation with the plant supervisor Mr. Murali. According to him everything possible is being done to protect the workers from disease and discomfort. When we asked about the measures taken to prevent flies, he replied that they spray pesticides everyday. According to him nets were provided to prevent flies, but we couldn't find any nets around there.

5.2 Formal and informal Interviews with various experts.

As part of the study, we also conducted formal and informal interviews with various experts to collect their opinion about the waste collection, transportation, treatment, disposal and health aspects of the people working in waste management sector.

5.2.1 Interview with Health Officer of Thiruvananthapuram Corporation

As part of this project, we conducted an interview with the health and project officer of Thiruvananthapuram Corporation, health inspectors of three waste management circles and the contingency workers of the Thiruvananthapuram Corporation area. Thiruvananthapuram Corporation health officer is the controlling authority of the corporation contingency workers. To the question regarding the law regulating the condition of service he replied that it is the wage board recommendations. He also said that on every 3 years gloves and gumboots are provided to the workers. Also masks are provided to the workers engaged in the mosquito control. He said that the workers are not willing to use these devices. Coal tar soaps are also given to the workers as disinfectants for

cleaning their body after work. He admitted that there may be delay in providing it due to the financial difficulty. He said that the workers handle all kinds of wastes except faecal matter waste. We asked him about the disposal of bio-medical wastes in public places by private hospitals and also the power of the corporation to take action against these hospitals. He answered that as per the rules incinerators should be used in every hospital and if the hospital disposes of the waste in public places the corporation can take action against the hospital according to Municipalities Act and Public Health Act. He also said that no medical check-up is provided to the workers but medical reimbursement facility is available.

5.2.2 Interview with health inspectors of three health circles

The health inspectors gave valuable information regarding the contingency workers. They said that as per the rules their working time is 7 am –11 am in the forenoon session and 3 pm – 5 pm in the afternoon session. But that later changed by an agreement between the corporation and the workers as 7 am – 1 pm. They said that the workers have to handle all kinds of wastes, domestic wastes, street wastes, market wastes, slaughterhouse wastes etc. They usually do not take bio medical wastes. One of the Health Inspectors revealed that though there is provision for gloves and gumboots but they don't give it to the workers. Soap is given to the workers. Technical training is given only to the workers engaged in mosquito control. One of the Health Inspectors said that there is periodical medical check-up for the workers at primary Health Centres. Another Health Inspector said that though according to law medical check-up is to be conducted once in a month actually it is not conducted. There is risk allowance and no insurance for them. All of them said that majority of the male workers are addicted to liquor.

5.2.3 Interview with workers of the corporation.

We conducted interviews with the contingency workers of three circles of Corporation. These workers sincerely co-operated with us. The workers include sanitation workers and sweepers. Sweepers are mainly female workers.

Majority of the workers is dissatisfied with their unhygienic working conditions. They have not even seen the protective equipments, which should be used during the course of their work even though there is provision for these equipments in the wage board recommendations. All the workers we met with are willing to use these equipments. Majority of the workers are affected by diseases of skin, stomach, lungs etc. The workers said that they handle all types of wastes. Though not legal they may have to take faecal matter. They said that they have to handle wastes from hotels, streets, factories etc. and these wastes contains various dangerous chemicals and gases, which are harmful to their body. Actually they are using their bare hands for removing these wastes. The contingency workers contented that though not legal they may even have to take bio-medical wastes disposed by the private hospitals in the public places. These bio-medical wastes contain syringes, dressing wastes, body parts, blood etc. Handling of these bio-medical wastes with bare hands and legs are seriously affecting their health. The workers said that the black powder disposed from the printing press, studios and Photostat machines are causing eye problems and skin problems such as itching.

The contingency workers told us that only slippers are given to them. But they contented that it is not enough for them since they have to stand in the wastes. From this interview we came to know that masks are given only to workers engaged in the mosquito control. The contingency workers said that they are in need of masks since the gas emanating from the decaying wastes causes serious lungs and eye problems. The sweepers also said that they are in need of masks since inhaling of dust during their work causes lung diseases like asthma. This disease affects majority of the workers we met with.

We asked them about the provision of disinfectants for cleaning their body after work. All of them said that they are provided with soaps but are not provided regularly. We also inquired them whether the corporation provides periodical medical check-up. We got negative answers to the question from all the workers. They said that only medical reimbursement is allowed. But they cannot use it properly due to administrative delay in getting the money reimbursed. They also held that they have to spend their own money even for accidents occurred during the course of work.

Another problem raised by these workers is exploitation by their authorities. They have to do overtime work without any extra allowance. Most of the workers are illiterate. They contended that in case of any complaint by them the authorities would punish them by giving overtime work.

Educational standard of the workers we interviewed with varies from illiteracy to graduation. The educated workers contended that they couldn't avail the benefit of the promotion.

5.2.4 Interview with some of the Residence Association Presidents, Secretaries and Experts.

As part of the survey, we also had formal and informal discussions with the residence association's authorities and experts. The following are the few excerpts from the collected opinion and perception of the people.

The president of Cosmopolitan residence association, Mr. John opined that most of the programmes on solid waste management are temporary. They are not sustainable due to the lack of strict monitoring and enforcement of law. Only the initial enthusiasm is seen and later all the leaders forget them purposefully. All the planning and implementation are for only 5 years and are not long term or sustainable.

Some of the members of the Thycaud residence association opined that reducing the waste stream is the most significant of all the options to manage waste. If we never generate the waste, then we never have to devise ways to dispose of it. To reduce the waste one produce usually means lifestyle changes. Reduce the amount one buy in the first place and purchase only the amount one need. By becoming better environmental shoppers one can also reduce the waste one generate, they opined.

In addition to this, some of the experts explained in detail, what one can do to reduce the waste one generates. For this one has to select products that are durable, easy to repair, have good warranties, energy efficient, functional, aesthetic and non-polluting in both manufacture and use. By analyzing what one throw away at home, they can easily cut short the quantity of waste generated by them. Each person adds to the waste management problem. If each household reduces its waste, the problem will be reduced. Each one of the community should think about the goods, services and activities one buy or support. In what ways they are contributing to the solid waste problem and how could they purchase and dispose of items in ways that generate less trash. What they can do to voice their opinion about solid waste issues in their community. For example, considering the aspects like

- buying goods in returnable and recyclable containers;
- learning where one can take items to be recycled then show their support by recycling;
- reading labels and learning more about contents in household products. Try not to purchase items with harmful ingredients;
- making suggestions to stores to offer paper bags in the produce section and to discontinue using plastic bags at the check-out line, except for special products or upon request;
- letting store managers and manufacturers who are making good environmental choices know you recognize and appreciate their efforts;
- requesting larger quantities and sizes of products by introducing a bulk buying section for grains, pasta and other dry goods;

- using consumer hotlines provided as a service by many food companies. Explain the need for environmental shopping and why you support it. Companies are very interested in how their products are perceived by consumers.

By asking manufacturers to consider these areas while designing packaging:

- plan for recyclability, both in design and material choice;
- eliminate excessive packaging;
- have more reusable or refillable packages;
- use creative thinking to find less wasteful solutions to theft prevention and shelf marketing;
- substitute non-toxic pigments and stabilizers;
- concentrate on the best and most efficient methods for minimizing the generation of waste;

These actions require cooperation among businesses, stockholders, government, employees, the general public, consumers and others. They also involve changes in lifestyles and values.

The president of the Moolavilakom Residence Association opined that the character of Thiruvananthapuram City is the cumulative result of all the actions of 5,24,006 people. Estimates are that these people generate 300 tonnes (approx.) of refuse per day. The City cannot move toward a more frugal use of its resources any faster than the people choose to move. The bottom line is that the waste the people generate does make a difference. If they generate less, that too, makes a difference.

5.3 Spot Visit

We visited Palayam market, Chalai market, Manacaud market and Thampanoor area to study the present waste management situation.

5.3.1 Palayam Market

Huge heaps of waste is accumulated in the Palayam market. It is remaining unremoved for about five months and is not covered. It contains all types of decayed organic waste. Due to foul smell it is impossible to stand around 300 Mts. Crows, eagles and other birds are seen flying around these wastes. Most of the passers by complained about the foul smell.

5.3.2 Chalai market

In the Chalai market we have seen contingency workers standing in the wastes with bare legs. They said that the empty plastic cans in the canal block it and they have to use their bare hands in clearing these blocks. Since the entire household wastes are dumped into the canal the water is highly polluted. The contingency workers are seen removing this dirty water to collect the wastes.

5.3.3 Thampanoor

In the Thampanoor area we saw the workers standing in the drainage canal with bare foot and collecting the wastes with spade. Bare hands were also used in the clearing process. They showed us wounds caused by the needles disposed from the "Women and Children Hospital", Thycaud.

5.4 Analysis

On analyzing the opinions of both the workers and also the circumstances, it is very clear that the present system of waste collection, transportation and management is unhygienic and causing several problems.

On analyzing the main problem regarding the health and hygienic working conditions of the contingency workers we realized that the main reason for their unhygienic condition is the lack or insufficiency of working equipments which also serves as protective devices of their body. The authorities claimed that on every three years gloves and gumboots are provided to the workers. But the contingency workers contended that they have not even seen these equipments in their lifetime. He also said that gloves and gumboots were given only to the permanent workers of N.S. depot during 1986-'87. Thus from our investigation we realized that the workers are not provided with gloves and gumboots. From this it is very clear that there is dereliction of duty on the part of the corporation.

From our investigation it became clear to us that only coal tar soaps are given to the workers as disinfectants for cleaning their body after work and are not provided regularly. But it is not enough since they handle all types of wastes. So in addition to soaps they are also in need of antiseptic germicides like dettol.

It is a fact that no technical training is given to the workers. Since the nature of wastes differed from that in the past technical training is essential for them. In addition to this 'Health, Sanitation and Hygiene' seminars, classes or training should also be conducted for them to make them aware of the consequences unhygienic working conditions.

Due to the downtrodden condition of the contingency workers they are treated as third grade citizens by the society. They are treated as slaves and the people do not co-operate with them. Citizens forget their duty and they dispose the wastes in the public. They also dispose plastic bags and cans along with other wastes in the public places. Private hospitals dispose the bio-medical wastes in the public places against the rules. So it is essential that rules regarding waste disposal should be made strict.

5.5 Pilot Scale models

Considering the preference of the people and to promote safe collection and transportation of waste, we have to have models developed so that it can be replicated in other wards of Corporation area. For this we selected two Residence Associations for pilot scale implementation of storage, collection and transportation of the waste to the Dumper Placer Container and finally to the compost plant at Vilappilsala. The selection was based on mainly the interest of the residents. After our survey, due to continued interactions, discussions, interviews, the residents showed interest in a proper and scientific waste collection and transportation programme and volunteered themselves to co-operate in such a programme. Thus the first area selected was Bhagath Singh Residents Association at Pettah ward. Pettah ward has 8-9 residence Associations. Among this the largest Residence Association with 210 houses was selected for the pilot scale implementation programme. The survey report showed that the people were ready to pay Rs. 25/- per month for the collection system of garbage. But we asked them to pay only Rs. 20/- since the number of houses is more. So after the compiling and computation of the survey results, we started our first programme at Bhagath Singh Residence Association.

5.5.1 Bhagat Singh Road Residence Association

As the first step towards this programme, we held a meeting with the Residents Association President, Secretary and members. The discussion was very active and interesting since they are very much positive in implementing this programme. So, the discussion was mainly focussed on the planning and implementation of storage and collection of solid waste from the houses in their Residents Association. First the programme was planned to include only few houses that showed interest and willingness to segregate the waste and storage. But as soon as the programme started all the households involved and hence we had to plan for all the 210 houses in this Residents Association. Door to door segregation of waste at source and collection was planned. This collected waste is then transported to nearly Dumper Placer Container, which has to be removed daily by the Corporation

workers. The association is in charge of all these activities. They formed subcommittee and included some members who showed greater interest for monitoring this programme. Some of the local resident members, who are concerned for the cleanliness of their surroundings has prepared to act as unofficial supervisors to check that their lanes are swept and the collection container (Dumper Placer Container) are emptied and removed daily.

There is no doubt that raising public awareness can have a powerful positive impact. The campaign that we arranged for the residents were carefully designed in such a way that the classes were mainly focussed for motivation rather than education. The messages that we passed on were very simple regarding practical actions related to solid waste management.

From the public opinion survey conducted in the City we concluded that the most beneficial results comes only when the Solid Waste Management programme covers all the households.

Discussions and classes separately for the Association residents. The housewives of each individually by the house-to-house discussions brought out many of the the community towards waste wastewaters from houses are environment problems in residential lectures were given to them about collection. First two days, they find segregation because they were not years. So when they asked to use food waste, vegetable waste etc covers and other non-degradables, for days. During morning when they were not able to put the waste lack of practice. But now, they keep two buckets or two plastic carry bags.



Inauguration of Waste Management Programme

were arranged authorities and house were met visit by us. Informal problems faced by management. Even causing areas. Special segregated waste it difficult for practicing this for two bins-one for and one for plastic they couldn't do it are busy cooking, separately due to waste separately in

The primary waste collection was the next step and for this, along with the help of Residence Association, Centre for Environment and Development had bought a trolley and two buckets of capacity of 100 litres each with lid. Based on the level of community participation, we arranged house-to-house primary collection. The collection time was fixed after consulting each house members and according to their convenience.

Two persons are involved in collection in the Bhagath Singh Association. They push the trolley and close as possible to the entrance of The trolley traces the pre-route at a pre-decided time. 6.30 time fixed for Bhagath Singh Road Association. The trolley declares by ringing a "bell" when the



Daily Waste collection

this waste Residents stops as each house. determined am is the Residents its arrival residents



bring their garbage either in plastic containers or plastic carry bags. The persons bringing plastic containers, empty the waste in bucket in the trolley while those bringing plastic carry bags deposit the degradables in one and carry bag in other bucket. This system is called 'bell ringing' system and is common in urban settlements. The trolley traces the route only once in a day at the fixed time. This system ensures proper collection of the garbage without littering and without any refuse containers. Roadside garbage heaps also vanished as this collection system started. Thus, this system of collection of garbage demands better time management. This trolley after collecting the wastes from all the houses empty it in Dumper Placer Container kept at Pettah market function. Here, still the problem exists. These separated wastes are dumped together in Dumper Placer Container. But one thing helps the collection people that they take the non-degradable collected waste bucket before emptying it in Dumper Placer Container and separate those wastes, which they can sell at nominal price. Usually broken glass, cardboard, gunny bags etc are collected by these people directly from households. They dump only the degradables in Dumper Placer Container.

This system is successfully going on in Bhagath Singh Residents Association. More people and more Residence Associations of the area have shown interest and come forward to take up such programmes in their area. Technical advices have been given to them for initiating such programmes. However, the house-to-house collection system demands regularity of services of the man and machinery. Proper monitoring and supervision helps to make their refuse collection system efficient.

Thus the programme implemented by Centre for Environment and Development in Bhagath Singh Road Residents Association is properly followed, it is hygienically very acceptable and house owners are not required to wait for the vehicle to come. The area once very unhygienic and open dumps were common is now perfectly clean and tidy. As the waste was collected, the people also thought of managing the wastewater coming from washbasins and bathrooms of their houses. They usually direct this wastewater to roadside or to the nearby open drain. After our classes and implementation of waste management programme, the changes are so visible that they directed this wastewater to soak pits built in their premises or to the drains hygienically. They daily clean the drains in their premises by pouring water and some reported that they use bleaching powder periodically for the cleaning of drains. Now a concept of total sanitation for total health was strongly imparted in the minds of people. This became possible only through the activities of Residents Associations. They played a very important role in bringing this message even to the common people. Almost all the members of this Bhagath Singh Road Residents Association is now aware about the problems as well as management options and above all their role of participation.

5.5.2 Moolavilakam Residence Association

The second Residents selected for implementation of collection of waste is Residents Association, a Association with 170 houses. Residents Association is a part of ward and covers only 170 houses mostly engaged in government They were looking forward to such and readily agreed to participate management programme in their after our survey, they called on a Residents Association and formed



Explaining the Programme to members of MRA

of 3 members. After the formation of the subcommittee they contacted us for the planning and implementation of waste management programme in their locality.

As a first step towards implementation we called a Residents Association meeting. There we presented the programme in detail. After that, we made house-to-house visit and conducted informal discussions and interviews about the time for collection, their attitude and perception and the way of waste segregation. Next stage was facility build up for segregation, collection and transportation. For this CED bought a trolley and two large buckets of 200 kg each for the collection of degradables and non-degradables. We took lecture classes on waste segregation and asked the people to follow two- bin system. Now they segregate the waste and keep in two plastic carry bags/two plastic containers or reuse the discarded metal bins for the storage of kitchen waste and non-degradables.

For the collection of waste from these houses, 2 persons are employed. Using the trolley, these persons reach each house at early morning hours. they declare their arrival by a “whistle”. whistle, the housewives bring the waste at leave, while other wait for the trolley to man pushes the trolley while the other the waste. This collection vehicle travels day to collect the waste generated in 170 They take approximately 2 1/2 hours to work. Once these narrow lanes were waste dumps. People used to quarrel with dumping their waste near the neighbour’s



Reusing waste bucket for household waste collection

they are fully satisfied with the way the collection system functions. The collected waste is then dumped at Dumper

Association storage and Moolavilakom Residents Moolavilakom Kannamoola with people and private jobs. a programme in solid waste area. Soon meeting of a subcommittee

At sharp 6.30 Hearing this gate side and come. One person collects only once in a houses. complete the crowded by neighbours for gate. But now

Placer Container placed near the junction. The non-degradables are either directly collected from the households or they take from non-degradables collected together and sell it to the middlemen, of recycling centre for nominal price. Thus they are getting monthly wages both from Residents Association and a low amount by selling non-degradables. Monthly these people are paid Rs.2000 each. Thus they are earning Rs.2000 per month only by waste collection. They work for 2 ½ hours per day and can go for other work during day hours.

The workers are provided with hand gloves, shoes and other protective equipments as they are working with the refuse generated by the residents. The workers are happy as they are receiving a fixed amount a month for working early hours a day and as they can earn by working on day hours. When we analyze the attitude of workers we can see that during earlier days people were reluctant to deal with the waste. But the awareness lectures and classes by us helped a lot in changing the perception and attitude of the people. But when we scrutinize the attitude and perception of the people for about 10 years, we can see that it changed a lot. Now people know that they have an important role to play in managing the waste generated by them.

Implementation of the waste collection and transportation of Solid Moolavilakom Residents Association Singh Residents Association became mainly due to the fact that this came as necessity from the society and they programme readily. Institutional co-operation from the Centre for and Development for promotion, monitoring of waste management was an essential and aided support.



storage, Waste in and Bhagath successful a need or accepted the support and Environment training and programme

In considering the cost effectiveness of this waste management programme, unquantifiable benefits to be gained from pollution control and public health improvement should be taken into account. The earlier programmes of planning and implementation of Solid Waste Management, the 'social factor' is often invoked to explain the failure. For making the total City clean, this programme should cover all the households, commercial institutions etc.

CHAPTER VI

Conclusion and Recommendations

The living environment is one of the important characters that determine the quality of life of mankind. The quality of life, to a large extent depends on the condition of surroundings of their houses and also its accessibility to various facilities including proper and scientific management of solid wastes. Rapid urbanization during recent decades in the country has given rise to a series of problems particularly overcrowding that affects the quality of life. Unsanitary conditions and lack of other facilities have made living conditions miserable in almost all large Cities.

The study carried out by Centre for Environment and Development, focused on the solid waste generation, collection, transportation, treatment, disposal, perception, attitude of people towards solid waste management and also various associated problems. This was carried out in two phases. The first phase included collection of information on quantity and quality of wastes, different technological options for treatment of waste and based on that an action plan was also prepared. The present study is the second phase which intended to study the current practices of waste storage, waste management practices by the households, commercial establishments etc. and to evaluate the peoples preferences and willingness to co-operate and pay for improved solid waste management practices.

The present study was started with a survey at 10 wards of Thiruvananthapuram Corporation and it covered 10 percent of households in each selected wards. The survey samples were selected based on socio-economic criteria and was classified as low income, middle income and high -income groups. Through this study at various households, we were able to identify that most of the houses of low- income group never store the waste in their premises. This was mainly due to lack of space and lack of practice. In case of establishments, stores, shops etc. also account for higher percentage that does not store waste. Not a single household of the study area segregate waste as degradable and non –degradables.

While ascertaining the people's perception about source segregation of waste, it emerged that generally people are not willing to do any segregation except newspapers. One of the major observations of this study is that, people are willing to co-operate with the solid waste management programme, if appropriate technology and technical support are provided. They are even willing to pay for proper services, especially for proper collection and management of waste is carried out. Generally the community is aware about the problems of solid waste mismanagement and are also very much concerned about the lack of proper system of collection, transportation and management of solid waste of Thiruvananthapuram city by the Corporation authorities. This shows that the attitude and perception of people have changed a lot during the last five years. The analysis of the present study shows that now most of the people think that they too have a major role to play in waste management programme, as they are the generators of waste. This itself shows the drastic change in the attitude of the people towards solid waste management as compared to the situation during the first phase of the study when most of the people were reluctant to accept their role.

As part of this study we tried to develop pilot scale models on waste segregation and collection under the leadership of Resident's Associations in the City , through door-to-door collection of household waste and transport this to Dumper Placer Containers. We collected opinion about segregated collection and transportation of solid waste, taking into account the level of fees that they would like to pay. We selected two Resident's Associations for the pilot scale study and implemented the programme and the programme is being successfully carried out for the last two years in Bhagat Singh Residents Association,Pettah and Moolavilakom Residents Association in Kannamoola. The experience and feedback from these programme shows that this can be extended to other wards also.

The major recommendations of the study are

- i) Awareness campaigns can bring about considerable changes in the attitude and perception of the people towards solid waste management.
- ii) Decentralized segregation and collection systems can be introduced in the City with the participation of the Residents Associations.
- iii) The Community is willing to share/ pay the expenses for a workable /proper management system for S W management or its various components.
- iv) Involvement of the community is essential for the sustenance of any system implemented
- v) Waste management activities can be a success only through an integrated and well-planned programme with the active participation of all the stakeholders.
- vi) Social Engineering through proper networking of the various stakeholders is an important factor for the success of any sanitation activity. The Residents Associations and the voluntary organizations can play a major role in this context
- vii) Proper Institutional structure is important for providing technological as well as social engineering support to the programme.

EXECUTIVE SUMMARY

The study about solid waste management in Thiruvananthapuram City was carried out in two phases. The first phase program included collection of information on quantity and quality of wastes, different technological options for waste management, particularly degradable waste, and based on all these an action plan for solid waste management was prepared for Thiruvananthapuram Corporation area. Information was also collected on the present system and future technology options. The study also included a proposed plan for transportation of wastes from different locations to the compost plant at Vilappilsala. Technology optimization study conducted as part of the first phase of the project shows that composting is the most suitable method for waste management in the City, as majority of the waste generated are degradable in nature.

Through the second phase we intended to study the current practices of solid waste storage, the present waste management practices, to assess the community's perception on the existing collection and management system, to study the changed attitude of the community, to evaluate the peoples preferences and willingness to cooperate and pay for improved solid waste management practices and also to identify the new initiatives at local level for waste management. The study samples were selected based on socio-economic criteria as low income, middle income and high -income groups.

The present study at various households of Thiruvananthapuram area shows that due to lack of space and lack of practice, wastes are not segregated and thrown out simply on roadsides. In case of establishments, shops/stores and workshops account for the highest percent of those who do not store their waste but dispose it near the roadsides. Those who store waste prefer plastic bins and finally dump it in nearby Dumper Placer Container. However while ascertaining the people's perceptions about source segregation of waste, it emerged that they are not willing to do any segregation except newspapers. About 55 percent of the hotels and restaurants, 60 percent of the shops, 80 percent of the institutions and offices use plastic waste bins for storing their waste. They usually deposit this stored waste in Dumper Placer Containers. Over 80 percent of the hospitals, nursing homes and dispensaries in Thiruvananthapuram City store their waste at source without segregation and dump it in nearby Dumper Placer Containers or burn the waste in hospital premises. Only a few institutions take precautions for safe storage of this highly infectious waste. Construction wastes are seen indiscriminately thrown on the streets resulting in unsightly appearance and traffic problems in some areas.

Household survey indicated that 55 percent of the households reduce, reuse and recycle the waste materials. Most of the low income and middle-income houses burn 60% of the waste generated and sell the rest for a nominal rate. The commercial areas, particularly in Chalai & Palayam market all the wastes are thrown out in open dumps. The waste from Institutions like Schools and Colleges are seen dumped on the sides of their front gates itself.

The survey analysis shows that about 88 percent of people reported that they too have a major role to play in solid waste management as they form the first part of solid waste management programme as the generators of waste. This shows the change in attitude of people towards solid waste management.

In Thiruvananthapuram City areas, voluntary groups have started door-to-door collection and transportation of domestic waste to DPC. Such new initiatives at local level for waste management are seen at other wards also. We collected people opinion about storage and collection system, taking into account the level of fees that they would be able to pay. They opted for door-to-door collection system and were prepared to pay for the improved service of solid waste collection. We selected two Residence Associations for pilot scale implementation of storage, collection and transportation of the waste to the Dumper Placer Container and finally to the compost plant at Vilappilsala. They are Bhagat Singh Road Residence Association of Pettah ward and Moolavilakom Residence Association of Kannamoola ward.

The present study shows that the attitude and perception of the people towards solid waste management have changed a lot during the last 5 years. Awareness campaigns in this direction can bring about many more changes.