Historically, the problem of solid waste has been perceived by municipalities or local authorities from sanitation and public health point of view only. Thoughtlessly, the waste is being seen as something unwanted and which needs to be disposed. In many Indian cities, waste management is merely disposing or dumping waste in city’s outskirts. Through recycling, composting and incineration, the end of pipe interventions, some good can be done, but the potential has not been realized. Current practices of waste management have not solved the problem; but to an extent they are unfolding the hidden cost of waste accumulation; yet valuable potential resources remain untapped.

7.1 PRESENT PRACTICES OF RECYCLING AND WASTE DISPOSAL

In this section, the current scenario and existing practices of solid waste recycling and waste disposal that are being followed in India and in Bangalore city are presented.

7.1.1 Present Scenario in Urban India

The major mode of disposal of solid waste in class 1 cities (a total of 299 including 23 metro cities) is open land dumping which accounts for 94 % and only 6 % of the total solid waste generated has some kind of treatment i.e. 5 % by composting and 1% by others\(^1\). For land dumping, most of the cities have acquired land many years ago and now these sites are either over-used or got surrounded by residential areas due to expansion of cities. New sites acquisitions have become a tough task for authorities as
local residents oppose them and even the existing ones are eyesores and public health hazards.

7.1.1.1 **Dumping of Waste as Landfill**

The open dump approach is the primitive stage of landfill development and remains the predominant waste disposal option in most parts of the country. This usually involves indiscriminate disposal of waste and limited measures to control operations, including those related to the environmental aspects. Landfill is basically a structure designed and built either into or on top of the ground in which the solid wastes are isolated from the surrounding environment. The term ‘landfill disposal’ is highly general, vague and subjective. It ranges from uncontrolled open dumps to controlled dumps, engineered landfill and sanitary secured landfill with provision of gas recovery and leachate treatment. The waste, which is recommended to be landfilled includes:

i. Commingled waste not suitable for waste processing

ii. Pre-processing and post processing rejects from waste processing sites

iii. Non-hazardous waste not being processed or recycled

iv. Non-biodegradable material

True sanitary landfills for untreated mixed waste require impervious soil strata or liners at the bottom, plus bottom piping for collecting and pumping out leachate for treatment and recycling, along with piping arrangements to collect, extract and use part of methane gas generated in such anaerobic conditions. The waste is also to be covered daily by soil or inert material in scientifically managed cells. These precautions are expensive but necessary.
But, in practical, the waste is disposed of by open dumping in the name of landfill disposal without following the principles of sanitary and secured land filling. Wastes are carried to city outskirts and deposited in the low-lying areas without testing soil permeability. They remain uncovered and hence exposed, providing conducive climate for breeding flies, rodents and several other insects. The main environmental problem associated with landfill is pollution of ground water and the atmosphere. Studies have shown that the leachate from solid waste may have a pollution load up to 15 to 20 times higher than domestic wastewater.

7.1.1.2 Composting of Waste

Composting is a slow natural process in which mixed bacteria, fungi, insects and worms consume plant and animal waste and convert them slowly into a soil-like substance very beneficial to plant growth. Compost provides energy, minerals, nutrients and micro-nutrients, useful microbes and water-retaining humus to the soil. This improves the quality and pest-resistance of produce, makes crops drought-resistant and decreases irrigation water requirements. The use of compost to enrich the soil, along with chemical fertilizer in a balanced ratio, is therefore very necessary. The Government bodies as well as the fertilizer association for over a decade have repeatedly expressed this view. Compost can find a good market if properly promoted and made conveniently available to the farming community.

Composting can be done by aerobic and anaerobic processes. The aerobic wind-row process can be completed in 45-60 days, on any scale, even with mixed non-toxic waste, by repeated turning and aeration. Vermi-composting is a process in which earthworms consume decayed plant and animal waste with the help of bacteria in their
gut, to excrete fine-grained soil-like vermi-castings rich in minerals and microbes, very beneficial to plants and free of disease germs. Many other soil organisms assist in the breakdown and conversion of biodegradable waste. It is best suited to segregated biodegradable waste on a small scale in de-centralized locations. Anaerobic composting processes are very slow. They take about 180 days to produce compost in airless pits or trenches in the ground, and generate methane. Anaerobic composting can be accelerated in bio-gas digesters, where the harvested methane becomes a very useful fuel and the slurry produced is a useful organic manure.

In India, in few cities composting of solid waste is being done, but it is carried out in the most unscientific manner. The waste is just dumped into a pit which is partly covered, kept for atleast 3-6 months and sold out in a ‘as is where is’ basis at a throw away price. In some places vermin composting is done in small scales. In fact, the Municipal rules 2000 categorically recommended to compost organic waste of the city. The main concern of composting is the quality of the final output compost, which depends on the quality of segregated organic waste. The unsegregated waste yields poor compost. Ideal waste segregation is still a far cry in the country, but not an impossible if every-one is sensitized to the issue.

7.1.1.2.1 Decentralized Composting
Decentralized composting should be actively supported by urban local bodies (UBL) wherever and whenever possible, as it substantially eliminates the huge cost of secondary transport of waste from its source to a distant centralized processing site and also reduces vehicular pollution. It is ideal for smaller and less crowded cities.
But larger cities can also adopt decentralized composting where people are willing to support this in available spaces.

i. **Home or Backyard Composting:** Wet waste (approximately 0.5 kg per family per day) can be easily composted in a large clay pot or in a tiny corner of the yard or garden, watered daily with a glass of water. Each day’s wet garbage sinks lower and decomposes as new layers are added. Urban local bodies can encourage vermi-compost technology in areas where people are willing to do backyard composting.

ii. **Apartment and Colony Composting:** Groups of houses or a multi-story building can also do vermi-composting by identifying a small area on the terrace, along a wall or in one corner of its surrounding open area for composting wet waste collected from all residents.

iii. **Neighborhood Composting:** Segregated wet waste collected door-to-door in one lane, street, block or even ward, can be vermi-composted in a corner of a local civic amenity area or park or open site. Municipalities can help by granting rapid permission for use of space by such community efforts.

iv. **Garden, Park and Institutional Composting:** All biodegradable wastes generated in parks and gardens can be immediately composted on site and used as site soil conditioner or sold. Dry leaves collected during sweeping streets should also be composted in the nearest open spaces. Addition of water and cow dung or animal wastes or some kitchen waste speeds up the process.
v. Decentralized Vermi-Composting: Segregated wet waste, preferably vegetable / fruit market waste, after a week of accelerated aerobic (above ground) decomposition, can be fed to earthworms, whose excreted vermi-castings are fine–grained and full of useful microbes for plant growth. Vermi-composting can be done at any scale from household composting of food-waste in a large slotted plastic bin outside the kitchen window to city scale vermi-composting. Household level vermi-composting can easily be done on just 0.2 sq.metres for a family of five, whereas large scale vermi-composting requires 2.5 to 3 hectares of land for 100 tonnes per day of garbage to be treated. Unlike microbial composting, mixed waste cannot be used for vermi-composting, as toxic substances can kill the earthworms. Only segregated biodegradable food waste can be composted through this process.

7.1.1.3 Incineration of Waste

Incineration is a thermal process for burning the waste at a very high temperature. It requires high calorific value waste, which can burn without any external fuels. Incineration of Municipal Solid Waste (MSW) can theoretically reduce the waste upto 75 % by weight and 90 % by volume. The solid waste generated in India contains only 3 to 7 % of combustibles, paper and plastic by the time the waste reaches the disposal site\(^2\). This is principally because most of the burnable material is retrieved by rag pickers from the waste lying on the streets, dusts bins and dump yards. The calorific value of Indian waste at the dump yards is found to range from 800 to 1000 Kcal/ kg, which is very low. The system of incineration is therefore not suitable under Indian conditions. Besides, there are concerns regarding the potential human health hazards and ecological effects of poly chlorinated biphenyl’s (PCB’s) and dioxins
emitted from MSW incineration. The system of incineration is not suitable under Indian conditions for additional reasons:

i. High ash and dust contents of Indian waste

ii. The system is not environmental friendly

iii. High capital cost, especially for adequate control of emissions

iv. High operation cost and maintenance cost

v. System requires high technical skill to man it.

In India, incineration is recommended only for Bio-medical and hospital waste.

7.1.1.4 Waste Recycling

Recycling of municipal waste in India is carried out as an unorganized sector, which consists of waste pickers, itinerant buyers, dealers and wholesalers. Recycling system operates with a clear-cut chain of actors working in an economic chain and other dependencies. Starting at the bottom of the heap with the waste pickers, and moving upwards, the system engages waste collectors and distributors, while at the far-end small and tiny production units exist, running mostly on informal and self-employment basis. It is estimated that in India there are about 6,50,000 waste-pickers involved in the recycling sector and save about 20 % of the municipalities’ budget.

Waste pickers collect a substantial quantity of the waste from the streets, municipality bins and landfills. Waste pickers generally pick up papers, plastics, metals, glass rags, textiles, newspaper, etc. Besides the waste pickers, there are several waste purchasers who move from house to house for buying the reusable items. The rig-pickers manage to reduce the burden of municipalities to an extend of 10 and 15 %. Today recycling sector is facing many hurdles like mixed disposal leading to deterioration in their recyclability, handling of toxic, hazardous and unsafe material, risk of fire accidents,
poor product design, lack of market for recycled products, etc. Besides, the waste traders or dealers face the problems of police harassment on the pretext of buying stolen goods and operating the trade in the encroached land.

7.1.2 Scenario in Bangalore City

Bangalore City, popularly known as Garden city of India is on the brink of becoming a garbage city. Till yesteryears, known as pensioner’s paradise for its salubrious climate, greenery and gardens, Bangalore is today unfortunately losing its charm as a paradise and becoming an eyesore. During the decade (1991-2000), there was phenomenal growth of Information Technology (IT), Business Processing Outsourcing (BPO) and other software related industries in Bangalore, which earned the name ‘Silicon Valley of India’. This has resulted in unprecedented growth of population, high rate of migration, heavy business activities and increase in disposable income. The flip side of this growth resulted in vanishing of greenery, chopping of trees, unclean surroundings, heaps of solid waste and deteriorating environment. The evolution of Bangalore city from pensioner’s paradise to Silicon Valley of India has resulted at a cost of a heavy price.

Solid waste Management is emerging as a challenging task for local authorities. The complexity of the problem is increasing day-by-day imparting multidimensional threat on environmental, social and economic aspects of the society.

Like many other cities in India, the system of solid waste disposal in Bangalore is very poor and pathetic. Till recently, Municipal Corporation of Bangalore did not have any identified sites for the disposal of waste. In the absence of the landfill site
and proper arrangement for waste disposal, the waste was being disposed off along major arterial roads including Magadi road and Mysore road to the west of the city centre, Tumkur road and Hennur main road to the north, Airport road and Old Madras road to the east and Hosur and Kanakapura road to the south. All the waste collected in excess of the treatment capacity of the Karnataka Compost Development Corporation (KCDC) composting plant, Terra Firma composting plant, M/s Sunrays Compost Enterprises and few community based compost units, is disposed by open and uncontrolled dumping. About two-third of the waste arising in the city (about 1600 tonnes per day) is getting dumped in the city outskirts. The BMP along with Karnataka State Pollution Control Board (KSPCB) has identified 9 abandoned quarry sited to be developed as sanitary landfill around the city. Of these 9 proposed sites, the technical experts have selected only 3 sites after assessment of suitability viz. Narayanapura quarry site in Krishnarajapuram situated about 10 kms northeast of Bangalore city, Hennur quarry pit situated at a distance of about 9 kms north of Bangalore city and Devanachikkanahalli quarry site situated at a distance of about 10 kms to the southeast of Bangalore city. Dumping is also carried out illegally on private farmlands located in the city vicinity. Lack of available landfill space in the city and strong protests from the local residents at the proposed landfill site are further worsening the issue of solid waste disposal. The waste incinerated is mainly consisted of hazardous hospital waste. Some waste is also used to reclaim low-lying land or land affected by erosion. The practice is not sanctioned by the Bangalore Mahanagara Palike (BMP) but is undertaken by unofficial agreement between landowner and the vehicle driver.
7.1.2.1 Composting of Solid Waste in Bangalore city

There are three large scale commercial composting facilities operating in Bangalore with a total capacity of 35,000 tonnes per year, which are Karnataka Compost Development Corporation (KCDC), Terra Firma and Sunrays Composting. The KCDC plant was established in 1975 along with eleven others in India under a program funded by the World Health Organisation. The composting plant occupies almost 9ha of land and process around 150 tonnes of waste per day. It produces three grades of compost. The lowest grade is the basic compost and is called Bio-Agro. The second grade contains a natural pesticide extracted from the neem tree; this grade is called Bio- Agro Rich. The third grade, which is the highest grade called Bio-Agro Gold consist of organic matter in the form of decomposed sugarcane, rock phosphorus, poultry waste (to increase N, P and K levels) and micronutrients. KCDC plant presently produces between 10,000-15,000 tonnes of compost each year (i.e. 27-41 t/day) of which 70% is in the enriched form (i.e. Bio-Agro Rich or Bio-Agro Gold).

The compost is sold to Government Departments, Wholesalers and to farmers directly. KCDC also operates a small vermi-composting operation at the Bommanahalli facility. Terra Firma Biotechnologies Limited was started in 1995 and presently produces both compost and vermin-compost. The plant process between 150-200 tonnes of market wastes per day in dry season, however this reduces to 50-60 t/day in the rainy season. Rallis India Limited, a member of the TATA group of the companies, presently markets their products throughout India. Terra Firma claims that it produces 6,000 tonnes of vermin-compost and 4,000 tonnes of compost each year. Vermi-compost is sold in India under the name of Ralli Gold. Sunrays Compost was established in 1996 with a design capacity of 300 tonnes per day. This plant operates
only 200 days per year as it is closed in monsoon season. Typically it process 30,000 tonnes of waste producing 10,000 tonnes of compost.

7.1.2.2 Incineration of Solid Waste in Bangalore city

Incineration has not taken off in a substantial way. It is estimated in 1999 that only 0.3 tonnes per day of waste is incinerated. This waste is mainly hospital hazardous waste. Although most of the bigger hospitals claim that they have incinerators to dispose of infectious waste material, many of them are not functioning. Studies conducted by Tata Energy Research Institute and M.S. Ramaiah Medical College revealed that most medical institute in the Bangalore city tend to dump their biomedical waste with the rest of garbage.

7.1.2.3 Resource Recovery of Solid Waste in Bangalore city

Resource recovery means extraction of some economic benefit from the material, which has been regarded as waste. It includes reuse, recovery, recycling, conversion and energy recovery. Reuse means using again for the same purpose, such as refilling a soft drink bottle. Recovery means processing material so that it can be used again as the same material, such as processing of waste paper to make pulp and then new paper. Recycling means the process of transforming materials into raw materials for manufacturing new products, which may or may not be similar to the original product, such as recycling of plastics. Conversion means processing the material to make some thing different (producing compost from the food waste). Energy recovery- burning of waste, such as in incineration. The potential for resource recovery depends on the cost of separated material, its purity, quantity, its location, cost of storage and transport. The informal waste recycling sector in Bangalore, like many other cities of India, has
an extensive presence and plays a vital role in minimizing the quantity of waste requiring management by the formal sectors. People of low economic and social status perform this role. The Bangalore Mahanagara Palike (BMP) is presently not involved in the recovery and recycling of the waste materials. The following players are involved in resource recovery

7.1.2.3.1 Itinerant Buyers

Separation of waste at the household level is usually performed by householders and domestic servants to earn supplementary income. Households typically keep saleable items and sell them to door-to-door collectors or itinerant buyers. Some buyers collect cloth in exchange for aluminum vessels. Depending on the quantity of the waste produced factories and shops typically sell their process waste to itinerant waste buyers, dealers or repressors of waste.

7.1.2.3.2 Waste Pickers

People involved in the recovery of recyclable waste from the streets or from disposal facilities are commonly termed as waste pickers or rag pickers. It has been estimated in 2002 that there are 16,000 waste pickers in Bangalore city and are responsible for the disposal of 317 tonnes of waste per day (12.7% of total waste generated). A large number of private waste pickers exist at landfill sites where recyclable items are sorted. Most of the waste pickers are involved in this activity as a family profession and share the family income at the end of the day. Waste recovered by the waste pickers include any material of re-salable value and commonly include paper, cardboard, textile, glass and a wide range of plastics and ferrous and non-ferrous
metals. Sorting of the materials is usually performed immediately after collection. This task may be performed at home or in the street.

7.1.2.3.3 Dealers and Wholesalers

The material recovered by the itinerant buyers and waste pickers goes through several transactions before it ultimately reaches a reprocessor; the reasons being like the quantities collected may be too small for direct sale to the reprocessing industry, the waste may need to be graded, cleaned and treated before it can be reprocessed, the distance between the waste collectors and the processing industry may be significant, the waste collectors may not have the financial and physical means to store, clean and transport the waste.

There are approximately 600 dealers in Bangalore. The dealers typically employ between 10 and 15 waste pickers and operate from a small storage place equipped with little more than a set of scales. The quantity of waste purchased by dealers’ ranges considerably as, small dealer upto 500 kg/day; medium dealer 500-1,000 kg/day; large dealer 1 to 5 tonnes/day. Following sorting, the materials are periodically sold by the dealer to wholesalers, once every three days to once per week. On average, a dealer trades 2.5 tonnes of waste per month. The figure 7.1 gives an account of the waste recycling process in Bangalore city.

7.1.2.4 Voluntary Organisation in SWM in Bangalore City

Voluntary organisation includes Non-Government Organisation (NGOs), Community Based Organisation (CBOs) and Public-private partnership involved in solid waste
Figure 7.1 Summary of recycling sector in Bangalore

COLLECTION CIRCUIT: FACTORY STAFF, HOUSEHOLDERS, SHOPKEEPERS, ITINERANT WASTE BUYERS, SANITARY COLLECTORS AND WASTE PICKERS

DEALER (PLASTIC) → DEALER (ALL TYPES OF MATERIAL) → WHOLESALER (PAPER) → INPUT PRODUCER → END PRODUCT PROCESSOR (PIPES, BAGS, SHEET ETC)

DEALER (PAPER) → DEALER (ALL TYPES OF MATERIAL) → WHOLESALER (GLASS) → INPUT PRODUCER → END PRODUCT PROCESSOR (BOTTLES, GLASSES ETC)

DEALER (FERROUS METAL) → DEALER (ALL TYPES OF MATERIAL) → WHOLESALER (PAPER) → INPUT PRODUCER (FERROUS) → END PRODUCT PROCESSOR (VESSELS, DRUMS, ETC)

CONSUMER MARKET

Source: Report on Environmental sanitation by Bangalore Water supply and Sewerage Board-2001
management services. The role of voluntary organisation in solid waste management is gaining enormous significance as it is yielding good results. In general, solid waste management services are labour intensive. These services are becoming more expensive, as the wage structure and fringe benefits of Government and municipal employees are increasing. Due to low budget allocation, the efficiency, motivation and work performance of all employees is poor. This lead to weakening of institutional strength of municipalities, which necessitates the participation of voluntary organizations in solid waste management. Moreover, in creating public awareness and encouraging public participation, voluntary organisation can outperform the municipal or Government organizations. They play a crucial role in catalyzing community action.

In Bangalore city, there are nearly eleven NGOs and CBOs, which are working in the area of solid waste management. Some of the voluntary organizations involved in solid waste management in the Bangalore city are Swachha Bangalore, Swabhiman, Waste Wise, Centre for Environmental Education (CEE) and community Associations like Kalyan Nagar Welfare Association, Bhuvanagiri (OMBR) Welfare Association, Rise (HAL 3rd Stage) and Nagapura (ward 14).

In April 2000, the Bangalore City Corporation (BCC) and Bangalore Agenda Task Force (BATF) launched a programme called “Swachha Bangalore” (meaning Clean Bangalore in local Kannada Language) by the then Government for infrastructure and service improvements, which also included door-to-door waste collection. However, the activities of Swachha Bangalore in the recent past have gradually slow down. Swabhimana (meaning self respect) was set up in 1995 by a group of active
environmental NGOs in the Bangalore. It consists of representatives of the municipality, Government agencies, several NGOs and CBOs. In the area of solid waste management, its objectives are to coordinate activities between various NGOs representing various stakeholder interests and the BCC to encourage partnerships at the neighborhoods level for environment friendly management of solid waste.

Waste Wise is a project initiated by Mythri Sarva Seva Samithi (Mythri) to achieve environmentally sound, socially responsible municipal solid waste management within the integration of informal sector. Mythri is an NGO primarily committed to the development of urban poor children. Waste Wise promotes decentralized models of waste treatment near the source with the participation of citizen groups. Centre for Environmental Education (CEE) is a NGO with a headquarter at Ahmedabad and having a south branch at Bangalore. It is pioneer organisation in the field of environmental education and solid waste management recognized by Ministry of Environment and Forest (MOEF).

7.2 Alternative Developments

The approach to waste management has to be changed from passive management (concern with final disposal only) to an active management of planning and integrating socio, economic and environmental concerns in the whole task of dealing with urban waste. Hence, instead of managing the waste, the time has come to put new insights into elimination of waste. The golden 3-R principle of waste management (i.e. Reduce, Re-use and Re-cycle) has to be coupled with new dimensions of 3-E (i.e. Efficiency, Economics and Ethics).
It is quite evident that the municipal bodies alone cannot solve this issue. In fact, there is a limit to what they can do at the back end of the problem, which are based on end of pipe interventions. New strategies and alternatives have to be explored which can tackle the issue from the front and involving all the stakeholders and provide clean environment and simultaneously relieving the stress on natural resources. The need of the hour is, therefore, not just development but sustainable development.

For effective and sound solid waste management system, it is essential to put forward new paradigms, which include zero waste concept, extended producer responsibility, environmental cost of product, legitimization of informal sector etc.

7.2.1 Zero Waste

Zero waste is a conceptual goal, which aims at elimination rather than managing waste. It is holistic system approach which visualizes that the material flow of production, industrial and economic systems are not one way or linear, but represent circular or web-like relationship resulting in no waste. It envisions industries and business to redesign their products and packages to zero waste, to extend producer responsibility, to end tax subsidies on polluting industries and waste generating activities and to invest in infrastructure which support re-use and recycle rather than in landfills and incinerators.

Zero waste is thus a logical planning approach incorporating principles of effective human and material resource utilization to avoid the conversion of discards into waste in a manner that revitalizes the local economy.
It is very important to note that zero waste should not be misinterpreted as no waste to be generated. Such an interpretation is neither feasible nor justifiable. The main theme of the philosophy of zero waste is to try first to minimize the waste generated as far as it is feasible, technically and economically and whatsoever little waste is generated should be put to some effective use.

Ideally, achieving zero waste is impossible, as no system is 100% efficient. A 100% efficient system is only hypothetical. But we can get ‘close’ to zero waste. In the process of achieving the target of zero waste, there can be continuous improvements, which can bring dramatic changes in a way the waste is perceived at present. The idea of adopting impossible target was accepted and proved successful by society and in business as well. The campaigns like zero emission, zero defects, zero accidents, and smoke free zones, litter-free zone, nuclear-free zone, etc are showing good results.

7.2.1.1 Global Initiatives in Zero Waste

The zero waste campaigns are being adopted worldwide in many countries. In the USA, zero waste targets have been adopted by Del Norte County, the City of Seattle, Santa Cruz County, San Luis Obispo County and Boulder city Colorado. The capital city of Australia, Canberra was the first city in the world to adopt zero waste vision of ‘No Waste by 2010’ in 1996. Zero waste campaigns are also operating in England, Wales, Ireland, Egypt and Philippines etc. There are many International Business companies and corporate worlds following the philosophy of zero waste principles, which includes DuPont Inc, Hewlett-Packard, Toyota, Bell Canada, Kimberley Clark, Ricoh group, IBM, Xerox Corp, Interface carpets and Honda Motor Corp.
7.2.1.2 Win-Win Solution

Zero waste is a win-win solution for every stakeholder and immensely benefits both the environment and economy. For example, Xerox, is one of the leading corporations that has announced a commitment to zero waste. Using a massive reverse distribution system, 95% of the returned material is either being reused or recycled. By adopting the zero waste policy, the company saved $76 million in production and avoided waste disposal cost. The company admitted that they went into this program for economic rather than environmental reasons. As of 2001, 40% of the municipalities in New Zealand have adopted zero waste goals. Most of them are targeting for total zero waste by 2015 and some by 2020.

However, from Indian perspective, with the existing socio-economic conditions, political negligence and public apathy on solid waste issues, achieving zero waste societies can be a distant dream. The lifestyle, culture, sense of responsibility, infrastructure, literacy, public participation and community involvement for social cause need a new orientation. The situations existing in the US or European countries are quite different from that of our country. Hence the ease with which the reforms can get implemented at New York or New Zealand and at New Delhi would not be the same. But excuses must be avoided. Adopting zero waste goals is necessary for our long-term survival.

7.2.1.3 Zero Waste Initiatives in India

The zero waste Kovalam project, in Kerala, is the first initiative towards zero waste in India. It is an ongoing programme of Thanal and is jointly supported by Greenpeace, GAIA (Global Alliance for Incineration Alternatives), KHRA (Kerala Hotels and
Restaurant Association)-Kovalam unit, the Department of tourism-Kerala and the Venganoor Gram Panchayat. It aims to tackle the waste issue through process of zero waste. It has established a zero waste center in 2003 and claims to be successful in creating about 100 jobs. Miranda House (MH) in Delhi has initiated a zero waste management project with active involvement of Toxic Links, an environmental NGO. Indian Tobacco Company (ITC), Bhadrachalam (A.P) has started zero waste initiatives in its official-cum-residential campus in 2000 in collaboration with Sukuki-Exnora. Large corporate campuses like ITC by adopting zero waste model are not only generating returns but also building the brand equity of the company by demonstrating its commitment to environmental concerns. Sarita Vihar, a residential colony in South Delhi has created a record as the first zero waste colony.

The successes of these little attempts are proving that zero waste is not a hopeless idealistic cause. They confirm that zero waste strategy can be a practical approach in India too. The success achieved and lessons learnt from such pilot projects need to be incorporated and replicated at wider areas.

Achieving a zero waste society or even getting close requires a mind shift. While it is simple in principle, the execution of these systems requires a lot of hard work, perseverance and creativity from the organizers in the community and in the industry. The co-operation from the local political representatives, manufacturing sectors, NGO’s, resident associations and municipal departments is crucial, along with ensuring high level of participation from the residents. To paraphrase, each stakeholder has to play its role effectively and sincerely and collectively contribute to fulfill the vision of zero waste society.
7.2.1.4 Role of Government in Achieving Zero Waste

The best way to start the zero waste programs is to adopt a zero waste goal as a local government policy with a target year. Forming legislation in support of zero waste can put a large conceptual umbrella, which can facilitate a series of practical steps towards implementation of zero waste society. The Central Government can initiate the action by forming a nodal agency of zero waste through which required funds can be allocated. The nodal agency can co-ordinate the networking of local authorities, community associations, recyclers, informal private sectors, industrial designers and manufacturers in creating vision towards zero waste society. Universities and colleges should teach zero waste principles as part of their basic curriculum and demonstrate their recycling unit at campus as models and first-hand experience. The general awareness should be promoted in community householders, schools, colleges and offices by preparing modules depicting how changes in behavioral and cultural aspects can influence in establishing zero waste society.

7.2.1.5 Role of Community / Householders / Individuals in Achieving Zero Waste

The earnest way through which the community or households or individuals can contribute to zero waste vision is by proper source segregation of their waste into dry, wet and recyclable. The discarded items can be further classified as avoidable, recyclable, compostable, reusable, toxic material and residuals (re-designable). After source separation, composting is the most important step in the community part of the zero waste strategy because it is the organic matter in the landfill that causes so many problems. Composting can be done on almost any scale. It can be done in the
backyard, in the basement, in the community or in a centralized facility. Thus, ban all the organic matter to landfill. The dry waste or recyclables can be sent to Resource Recovery Units (RRU). The toxic materials that can be neither recycled nor composted should be handled separately, or better if the Government can ban such items. As materials once considered as waste starts gaining value, zero waste principles will become more visible and local economies shall become more self-sufficient and create opportunities for increased civic participation and employment.

7.2.1.6 Role of Industrial and Business Sector in Achieving Zero Waste

The industries and manufacturing units can contribute significantly by not producing the goods and items, which cannot be recycled or reused or recovered or disposed off environment-friendly. Adopt Extended Producer Responsibility (EPR) for waste, which holds manufacturers, specifically brand owners, responsible for managing their product and packaging at the end of their useful life. Establishment of Resource Recovery Units (RRU) should be encouraged by industries or Government or private players or by joint collaborations. Resource Recovery Units (RRU) should be furnished with adequate infrastructure and appropriate techniques, which can facilitate the recoverable, recyclable, and reusable potential resources from the waste stream. Database of recovered materials can be linked from various RRU within the city and intercity through electronic system. Industries and Institutions can encourage waste audits in their organizations, which can identify areas where material input can be reduced and consequently lower the waste generation and also can gain financial savings.
7.2.2 Extended Producer Responsibility

The manufacturer’s responsibility on the product or good as per present expectations ends once the product is manufactured and released into the market. The manufacturers do not care for the disposal and its impact after the usage or end of product’s life cycle. The buck is passed on to the consumers, who in turn depend on the local government and ultimately the waste gets disposed off unscientifically. To overcome this, wherever possible, the manufacturers should be held responsible for the waste and the environmental impact of their products and packaging rather than passing that responsibility to the consumer as is being done in the case of Batteries, which was legislated through law (Management and Handling of Battery Rule-2000). This can prompt the manufacturer to look for novel methods in designing and redesigning products, which would involve planning in advance to limit the resource consumption, toxicity and waste. When brand owners have physical or financial responsibility for their product and packaging at the end of their life, they have a built in incentive to use less toxic, make more durable and recyclable products and reduce excessive packaging. Extended Producer Responsibility (EPR) was first mandated in Germany for packaging in 1991 and it is presently followed in most of the western countries. The Municipal Solid Waste Rules-2000 of India has missed out the Extended Producer Responsibility (EPR) in waste management. There is need to amend legislations or frame new laws to incorporate the concept of Extended Producer Responsibility (EPR). Once the disposal responsibility is vested with the manufacturer, the product will get pruned so as to be compatible to reuse, recycle and recover. By extending the responsibility of the producer, the quantum of dry waste gets substantially reduced and the segregation of domestic household waste becomes relatively easy. The manufacturers can tie up with other external recycling agencies
involved in recycling profession, thereby benefiting all the stakeholders. Thus the reverse distribution system can be developed to take back disposed waste into production rather than dumping as landfills or incinerating.

7.2.3 Environmental Cost of Product

The price of the product is generally calculated based on cost (which includes direct and indirect cost), demand and competition. The environment cost of the product is often ignored, which is of late, gaining significance. The costs associated with extraction of virgin depleting resources, processing which generates air and water pollution, transportation and final disposal of the product, which leads to environmental degradation and public health impact expenses, are not taken into account. Even while calculating the GDP for the national economy, the cost of degrading the environment, depleting forest cover, dwindling natural resources and non-renewable fossil fuels are not taken into account. Thus the price of the product does not reflect the true cost, as the burden on environment is invisible and sometimes non-quantifiable. In the pricing of a product, if the cost of environmental damage caused by that product during manufacturing and disposal is included, then the price of the product will be high. Thus the number of usage of environmental friendly products that are not only less damaging to the environment but are also cheaper, will go up.

7.2.4 Recycling the Recyclable Waste

The present production system is based on linear or one-way flow of virgin resources. Throw-away culture of society encourages the rapid conversion of natural resources into finished products. Almost all products in use today have a natural resource origin.
Exploiting nature's resources without reverse flow of material certainly diminishes the survival of human civilization forever. Hence recycling is a must to make the production system cyclic and thus closes the loop of material flow.

In India, the term ‘Recyclable Waste’ is often misused and misinterpreted. Theoretically, all recyclable waste can be recycled, but unless recycling is actually done, the term ‘Recycling’ is meaningless. The feasibility of recycling depends on profit opportunities, economic viability and return on investment. From an economic perspective recycling pays only when cost of collecting materials, sorting for recycling and marketing is substantially lower than the value of recycled product. But sometimes, due to unequal subsidies, the costs of recycled product are higher as compared to virgin material based products. To have a successful recycling sector, other issues to be addressed are better product design, toxic level, safety level of materials used, improvement in the working conditions of waste workers, social recognition to workers (as done in Pune) and Government support for adequate infrastructure.

7.3 Aspects of Development Alternatives of Solid Waste Disposal – Analysis based on opinion Survey

To study the aspects of Development Alternatives of Solid Waste Disposal, responses were collected on four categories of alternatives. The respondents were asked to express their opinion in order of disposition as high, medium and low. The four categories are:
1. **Production Oriented Alternatives**: The production oriented alternatives include the issues like extended producer responsibility, redesign product and packaging, increase the price of plastic bag, provision of subsidies to industries and societies and adoption of zero waste principles.

2. **Legal Oriented Alternatives**: The legal oriented alternatives include the issues like new legislations for reward and punish, mandatory community participation, and introduction of waste tax.

3. **Social Oriented Alternatives**: The social oriented alternatives include the issues like public awareness campaign, environmental cost of product, special attention to slum areas and provision of incentives and recognition to households.

4. **Novel and Economic Oriented Alternatives**: The novel and economic oriented alternatives include the issues like urban agriculture practice, marketing for compost manure and autonomous technology mission for SWM.

7.3.1 **Production Oriented Alternatives**

Under this category, five alternatives are studied. They are extended producer responsibility, redesign product and packaging, increase in the plastic bag price, provision of subsidies to Industries and societies for zero waste and adoption of zero waste principles.

7.3.1.2 **Extended Producer Responsibility**

Extended Producer Responsibility (EPR) for waste holds manufacturers responsible for the waste and the environmental impact of their products and packaging at the end of their useful life rather than passing that responsibility to the consumer. Once the disposal responsibility is vested with the manufacturer, the products will get pruned
so as to be compatible to reuse, recycle and recover. By extending the responsibility of the producer, the quantum of dry waste gets substantially reduced and the segregation of domestic household waste becomes relatively easy.

From the survey conducted, it is found that 63 percent of respondents checked ‘high’, 24 percent checked ‘medium’ and 13 percent of respondents checked ‘low’ for Extended Producer Responsibility (EPR) as an alternative measure of disposal of solid waste.

### 7.3.1.2 Redesign Product and Packaging

Redesigning products and packaging means planning in advance while designing the product and its packaging about the resource consumption, toxicity, waste quantum and compatibility for natural degradation of both the product and packaging material after its usage life. Product is designed to be eco-friendly and facilitating easy recycling / disposal.

From the survey conducted, it is found that 72 percent of respondents checked ‘high’, 20 percent checked ‘medium’ and 08 percent of respondents checked ‘low’ for Redesigning products and packaging as an alternative measure of disposal of solid waste.

### 7.3.1.3 Increase in the Plastic Bag Price

Plastic products are difficult to destroy and are non-biodegradable. The indiscriminate disposal of solid plastics wastes is of major concern as these wastes cause choking of municipal sewers and blockage of the storm water run-offs in drains particularly in hilly areas. Even death of many animals like cows which feed on the garbage food thrown in polythene bags takes place regularly. About 60 % of the plastic wastes
generated in India are recycled, which is the highest in the world. However the remaining 40% of the plastic wastes remains uncollected, unsegregated, strewn on the ground, littered around in open drains or in unmanaged garbage dumps. If the price of plastic bag increases the usage might be discouraged and this can also result in promotion of reuse.

However, from the study, it is found that only 24 percent of respondents checked 'high', 33 percent checked 'medium' and 43 percent of respondents checked 'low' for increase in price of plastic bag as an alternative measure of disposal of solid waste.

7.3.1.4 Provision of Subsidies to Industries and Societies for Zero Waste

For successful implementation of zero waste, it is essential to have subsidies for units like industries and societies. The local bodies have to provide subsidies for setting up of localized composting units, infrastructure, waste collecting bins, transportation vehicles, tax rebates, etc till the societies and industrial units become self sufficient in implementing zero waste.

The study revealed that 66 percent of respondents checked 'high', 20 percent checked 'medium' and 14 percent of respondents checked 'low' for provision of subsidies for units like industries and societies as an alternative measure of disposal of solid waste.

7.3.1.5 Adoption of Zero Waste Principles

The concept of zero waste is evolving as a promising strategy for solid waste management in future. At present in India, with the existing socio-economic conditions, political negligence and public apathy on solid waste issues, achieving zero waste societies can be a distant dream. But it is necessary for our long-term survival and to avoid future crisis from unmanaged explosive rise in solid waste. The
main theme of the philosophy of zero waste is to try first to minimize the waste generated as far as it is feasible, technically and economically and whatsoever little waste is generated should be put to some effective use. Thus it is essential to initiate and adopt zero waste principles wherever applicable and as practiced elsewhere in the world.

From the survey conducted, it is found that 61 percent of respondents checked ‘high’, 27 percent checked ‘medium’ and 12 percent of respondents checked ‘low’ for adoption of zero waste principles as another alternative to the vexatious problem of waste disposal.

7.3.2 Legal Oriented Alternatives:
In this Category three alternatives are studied namely, new legislation for reward and penalize for resources, mandatory community participation and introduction of waste tax.

7.3.2.1 New legislations for Reward and Punishment
At present, there is neither reward for resource conserving practices nor any punishment for resource wasting activities. The implementation of carrot and stick approach for resource management can bring positive results in reduction of solid waste. Hence, new legislation with laws and rules to reward resource-conserving behavior and penalize resource-wasting behavior can be one of the legal oriented alternatives for better solid waste management.

From the study, it is found that this alternative approach has mixed responses. 47 percent of respondents checked ‘high’, 21 percent checked ‘medium’ and 32 percent
of respondents checked ‘low’ for new legislations for reward and punishment as an alternative measure of disposal of solid waste.

7.3.2.2 Mandatory Community Participation

The community participation in urban services is defined as “the sociological process by which residents organize themselves and become involved at the level of a living area or a neighborhood, to improve the conditions of daily life (water, sanitation, health and education etc.). In a broad sense, community participation entails neighborhood groups being aware of a project cycle and able to participate in various capacities as generators and managers of the waste. However, community participation itself is not an easy task. People are too preoccupied to bother about city cleanliness issues. Community participation has to be generated systematically and scientifically. Thus there is a need to strengthen laws and rules to incorporate community waste management participation as a mandatory and provide incentives and recognition.

From the survey conducted, it is found that 74 percent of respondents checked ‘high’, 19 percent checked ‘medium’ and 07 percent of respondents checked ‘low’ for mandatory community participation as an alternative to managing urban solid waste related problems.

7.3.2.3 Introduction of Waste tax

By collecting waste tax, fund can be created and utilized for providing better services. Some of the states in India have introduced solid waste tax as cess tax to augment the financial resources.
But, from the study, it is found that only 4 percent of respondents checked ‘high’, 8 percent checked ‘medium’ and 88 percent of respondents checked ‘low’ for introduction of waste tax as an alternative measure of disposal of solid waste.

7.3.3 Social Oriented Alternatives

Under this category, four alternatives are studied which are public awareness campaign, environmental cost of product, special attention to slum areas and provision of incentives and recognition to households to follow zero waste

7.3.3.1 Public Awareness Campaign

Public awareness campaign, when launched by popular personalities like film stars, sports persons and other well known artists as a social cause can have better impact than conventional campaign. It is common to observe that for many people the role model icons are from either film industry or sports. It is easy to influence the behavior of masses / public by creating awareness campaign through these popular personalities.

From the survey conducted, it is found that 68 percent of respondents checked ‘high’, 20 percent checked ‘medium’ and 12 percent of respondents checked ‘low’ for public awareness campaign as an alternative to managing urban solid waste related problems.

7.3.3.2 Environmental Cost of Product

The price of the product is generally calculated based on cost (which includes direct and indirect cost), demand and competition. The environment cost of product is often ignored which is of late quite significant. The cost associated with extraction of virgin
depleting resources, cost associated with air and water pollution caused by transportation, conversion, use and final disposal of the product. Cost associated with public health impact expenses are not taken into account. In the pricing of the product, if the cost of environmental damage caused by that product during manufacturing and disposal is included, then the price of the product will be high. Thus more environmental friendly products can become cheaper and be more in usage causing less threat.

From the study, it is found that 51 percent of respondents checked ‘high’, 29 percent checked ‘medium’ and 20 percent of respondents checked ‘low’ for environmental cost of product as an alternative measure of disposal of solid waste.

7.3.3.3 Special Attention to Slum Areas

Due to urbanization, there is a high rate of migration from rural areas to urban cities, resulting in increase of slum areas. Generally in all the cities, municipal authority while providing services neglects the slum areas. A special attention needs to be paid to slum and traditionally dirty areas of the city.

From the study, it is found that 78 percent of respondents checked ‘high’, 13 percent checked ‘medium’ and 09 percent of respondents checked ‘low’ for public awareness campaign as an alternative to managing urban solid waste related problems.

7.3.3.4 Provision of Incentives and Recognition to Households

Presently for households there are no incentives of any kind to motivate and encourage them to follow zero waste practices. The support from local body and recognition in any form can increase the morale of housewives and can facilitate forming zero waste societies and colonies. The earnest way through which the
community or households or individuals can contribute to zero waste vision is by proper source segregation of their waste into dry, wet and recyclable. The discarded items can be further classified as avoidable, recyclable, compostable, reusable, toxic material and residuals (re-designable). Hence, there is a need for providing incentives and recognition for households for following zero waste.

From the study, it is clear that 84 percent of respondents checked ‘high’, 13 percent checked ‘medium’ and 3 percent of respondents checked ‘low’ for provision of incentives and recognition to households as an alternative measure of disposal of solid waste.

7.3.4 Novel and Economic Oriented Alternatives:

Under this category, three alternatives are studied which are urban agricultural practices, marketing and subsidy for compost manure and autonomous technology mission.

7.3.4.1 Urban Agricultural Practices

Promoting Urban Agricultural Practices i.e. using vacant idle spaces within the city into green and productive spaces and converting discarded containers, roof tops, terrace into crop fields is suggested as an alternative. Urban agriculture creates green spaces in the city replacing vacant spaces and at the same time provide livelihood to the urban poor. Urban agriculture needs to be encouraged and products that are less suited for rural farming like mushrooms should be cultivated.

From the study, it is found that 44 percent of respondents checked ‘high’, 31 percent checked ‘medium’ and 25 percent of respondents checked ‘low’ for urban agricultural practices as an alternative to managing urban solid waste related problems.
7.3.4.2 Marketing and Subsidy for Compost Manure

There is a tendency among the farmers that the manure produced from the compost of organic solid waste is of same second grade quality when compared with other chemical manure. The quality of the compost can be improved by proper segregation of solid waste. Presence of toxic metal and other inorganic matter reduce the quality of compost and also poses threat for earthworms in vermi-composting. So the organic waste using for compost has to be ensured that it is totally devoid of other materials by proper segregation. The Government should initiate measures to develop the market for compost manure by providing subsidies and concession to withstand the competition from other chemical manures and it should stop providing subsidy to other chemical manure which are environmental unfriendly.

From the study, it is clear that 76 percent of respondents checked ‘high’, 17 percent checked ‘medium’ and 07 percent of respondents checked ‘low’ for provision of marketing and providing subsidy for compost manure as an alternative measure of disposal of solid waste.

7.3.4.3 Autonomous Technology Mission for SWM

The Municipal Rules have not achieved the desired results. There is a need to set up an effective and functional Technology Mission for improving solid waste management practices in the country. The role of the mission should be to monitor the performance of various local bodies in the implementation of municipal rules, to provide technical assistance to the local bodies, to develop ICE (Information, Communication, Education) material and awareness Programmes and disseminate the
same through mass media. All Government grants and loans to the urban local bodies for SWM related matter should be routed through the mission.

From the study, it is found that 64 percent of respondents checked ‘high’, 25 percent checked ‘medium’ and 11 percent of respondents checked ‘low’ for setting up of autonomous Technology Mission for SWM as an alternative to managing urban solid waste related problems.

7.4 Overall Evaluation of Alternatives

The ranking of the 15 alternatives under the four categories is presented in table 7.1. Respondents were asked to express the preference on each alternative / issue in the order of disposition as high, medium and low. For ‘high’, ‘medium’ and ‘low’ responses of respondents for each alternative, marks were awarded as 3, 2 and 1 respectively. On the basis of cumulative marks for each alternative, a total score was obtained and ranking is done based on total score. Table 7.1 shows the total score of each factor in all the four categories of alternatives.

Table 7.1: Score and Rank of Alternatives

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Alternatives</th>
<th>Total Score Obtained</th>
<th>Mean Score</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Production Oriented Alternatives</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 Extended Producer Responsibility</td>
<td>250</td>
<td>2.5</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>2 Redesign Product and Packaging</td>
<td>264</td>
<td>2.64</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>3 Increase the Price of Plastic bag</td>
<td>181</td>
<td>1.81</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>4 Provision of subsidies to Industries and societies</td>
<td>252</td>
<td>2.52</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>5 Adoption of Zero Waste Principles</td>
<td>249</td>
<td>2.49</td>
<td>10</td>
</tr>
<tr>
<td>B</td>
<td>Legal Oriented Alternatives</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 7.1 shows that majority of respondents agreed that the “Provision of incentives and positive recognition for units like households and industries for following zero waste”, as the best development alternative of solid waste disposal with a score of 281 followed by “Special attention to be paid to slum and traditionally dirty areas of city” with a score of 269. The measure, Government to initiative to develop market for compost manure by providing subsidies and concession for farmers is coming with a score of 269. This yet another one of the best alternatives. The least preferred
alternatives were introduction of waste tax with a score of 116 and increase the price of plastic bags to discourage its use with a score of 181.

### 7.5.1 Test of Hypothesis of Equality of Mean Scores of different classes of Alternatives

The four different classes of alternatives are tested to verify whether the mean scores of different categories of alternatives for recycling and disposal are same. Table 7.2 shows the distribution of data for one-way ANOVA.

**Table: 7.2 One way ANOVA.**

<table>
<thead>
<tr>
<th></th>
<th>Product Oriented Alternatives</th>
<th>Legal Oriented Alternatives</th>
<th>Social Oriented Alternatives</th>
<th>Novel and Economic Alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scores</td>
<td>250</td>
<td>215</td>
<td>256</td>
<td>219</td>
</tr>
<tr>
<td></td>
<td>264</td>
<td>267</td>
<td>231</td>
<td>269</td>
</tr>
<tr>
<td></td>
<td>181</td>
<td>116</td>
<td>269</td>
<td>253</td>
</tr>
<tr>
<td></td>
<td>252</td>
<td></td>
<td>281</td>
<td></td>
</tr>
<tr>
<td></td>
<td>249</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Score</td>
<td>1196</td>
<td>598</td>
<td>1037</td>
<td>741</td>
</tr>
<tr>
<td>Mean Score</td>
<td>239.2</td>
<td>199.3</td>
<td>259.3</td>
<td>247</td>
</tr>
</tbody>
</table>

Source: Primary Data

Null Hypotheses $H_0$: The mean scores of different categories of alternatives for recycling and disposal are same.

**Calculations**

\[
T = \text{Sum of all the Observations} = 3572
\]

\[
TSS = \text{Sum of the squares of all the observations} = T^2 / N = 24687.74
\]

\[
SSC = 6541.52, SSE = TSS - SSC = 18146.22
\]

\[
MSC = SSC / (K-1) = 2180.50, MSE = SSE / (N-K) = 1649.65
\]
### Source of Variation: Sum of Squares

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degree of Freedom</th>
<th>Mean Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Samples</td>
<td>SSC = 6541.52</td>
<td>K-1 = 3</td>
<td>MSC = 2180.50</td>
</tr>
<tr>
<td>Within Samples</td>
<td>SSE = 18146.22</td>
<td>N-K = 11</td>
<td>MSE = 1649.65</td>
</tr>
<tr>
<td>Total</td>
<td>TSS = 24687.74</td>
<td>N-1 = 14</td>
<td></td>
</tr>
</tbody>
</table>

\[ F = \frac{MSC}{MSE} = 1.32 \]

Table value of F at 5% level of significance for (3, 11) degrees of freedom is 3.59.

Table value: 3.59 \hspace{1cm} Calculated value: 1.32

Calculated value of F is less than table value of F, hence null hypothesis is accepted.

Thus the mean score of different categories of alternatives for recycling and disposal are same. That is all the four classes of alternative are equally important and tried with equal commitment to solve the problem of urban solid waste.

### REFERENCES:


