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## CHAPTER II

### REVIEW OF LITERATURE

The review of literature concerning to the research entitled on “**DISSEMINATING KNOWLEDGE ON SOLID WASTE MANAGEMENT**” are categorized under the following sub headings,

#### 2.1. CONCEPT OF WASTE

#### 2.2. SOLID WASTE MANAGEMENT

#### 2.3. POLICIES AND PROGRAMMES ON SOLID WASTE MANAGEMENT

#### 2.4. RELATED RESEARCH STUDIES ON SOLID WASTE MANAGEMENT

### 2.1. CONCEPT OF WASTE

#### 2.1.1. Definitions of Waste

Waste refers to the range of garbage materials arising from animal and human activities that are discarded as unwanted and useless (**Rick Leblanc, 2020**).

**National Waste Report 2010**, waste is defined as any discarded, rejected, unwanted, surplus or abandoned matter; intended for recycling, re-processing, recovery, re-use, or purification by a separate operation from that which produced the matter, or for sale, whether of any value or not.

Waste is a term generally used to describe the materials we throw away. Waste may also be defined simply as left-over, or already used items waiting for reuse or disposal (**Audu, 2007**). Waste is any unwanted material intentionally thrown away for disposal (**Hoornweg, 1999**).

Waste is the useless by product of human activities which physically contains the same substance that are available in the useful product (**White et al, 1995**).

According to **Spanish Law**, Waste is all materials considered to be garbage and needs to be eliminated. The elimination is to avoid health or environmental problems but

also due to the shortage and depletion of raw materials, the recovery or recycling of waste is to be prioritized wherever feasible.

### **2.1.2. Classification of waste**

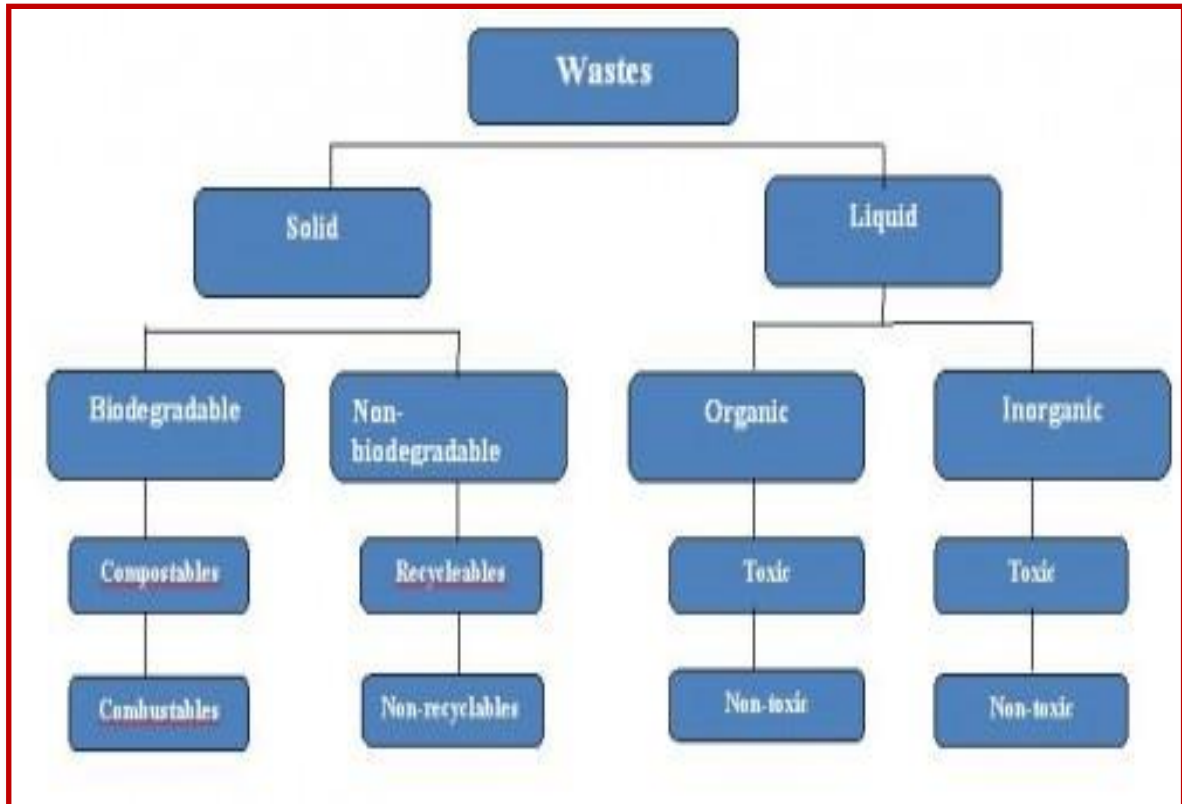
Classification of waste varies place to place and countries to countries. In Japan they divide in to combustible waste, incombustible waste and bulk waste (**Wen, 2014**). The classification of solid waste includes throwing, collecting, transporting and disposing also and it is most important process that all people can take participation in the environment protection (**Nie, 2018**). Combustible waste includes paper, Kitchen debris, textiles, wood and bamboo, as well as plastics and rubber. Incombustible waste includes metals, glass, pottery, and adulterated matters. Bulk waste includes furniture, bicycles, tatami mats, and kitchen appliances. Local municipal governments in Japan implement waste management and enforce the laws and rules (**Waste management and public cleansing law**). In United States, municipal waste is divided in to four types, containers and packaging boxes, bottles, beverages bottles, durable goods like furniture and electrical appliances, non-durable goods such as newspaper, clothes, and kitchen waste (**Park. S, 2018**).

Chinese Government report, Premier **Li Keqiang, 2017** proposed that China should begin to implement waste classification. In China, there are four types of municipal waste: Kitchen waste, hazardous waste, recyclable waste, and other waste. Kitchen waste includes leftover food, bones, vegetable roots and leaves, pericarp, and other food waste. Hazardous waste contains heavy metals, toxic substances that are harmful to human health, or wastes that cause realistic or potential harm to the environment, including batteries, fluorescent tubes, light bulbs, expired drugs, etc. Recyclable waste mainly includes five categories: Waste paper, plastic, glass, metal, and cloth. The other waste category includes toilet paper, brick and tile ceramics, drugs, tissue and other wastes that are difficult to recycle, such as dust, food bags, etc.

The waste is classified as Biodegradable and Non-biodegradable Waste. Biodegradable waste includes any organic matter in waste which can be broken down into carbon dioxide, waste, methane or simple organic molecules by microorganisms and other living things by composting, aerobic digestion or similar processes (**Recycling Council of British Columbia, 2008**).

Biodegradable waste can be found in municipal solid waste such as food waste, green waste, paper waste, animal waste, human waste, and waste from slaughter house.

Non-biodegradable wastes are waste that cannot decay or be broken down by living organisms. For examples water bottles, tin, glass, plastic bags, tires, and electronic items (**Craig Spelch, 2016**).The classification of waste presented in Figure I



**Fig I Classification of Waste**

### **2.1.3. Sources of waste**

The sources of waste can be broadly classified in to Municipal, commercial, Industrial, and agricultural.

#### **2.1.3.1. Municipal solid waste**

Wastes collected from the households, schools, colleges, hotels. Municipal solid waste mainly composed paper waste, plastic materials, glass, metals, food debris are the major waste seen in solid waste. Also which includes the construction wastes, electric bulbs, chemicals, parts of the automotive industries. Municipal solid waste may vary from city to city and country to country (**Barlaz M A et al., 1990**).

### **2.1.3.2. Industrial solid waste**

Industrial waste is the waste produced by industrial activity which includes any material that is rendered useless during a manufacturing process such as that of factories, industries, mills, and mining operations (**ChinazaGodswillAwuchi, 2017**). Industrial solid waste includes the paper, wooden materials used for packaging, straws, cloths, metals, glass, leather (**Ahsan N et al., 1999**).

### **2.1.3.3. Agricultural waste**

Agricultural wastes are defined as the residues from the growing and processing of raw agricultural products such as fruits, vegetables, meat, poultry, dairy products, and crops. They are the non-product outputs of production and processing of agricultural product. (**Obi, 2016**). Agricultural wastes are maximum lies under biodegradable wastes. Increased quantity of livestock waste, crops, and by-products of the agro based industries (**Rachel.G et al., 2007**).

### **2.1.3.4. Hazardous waste**

Hazardous waste is a waste with properties that make it dangerous or potentially harmful to human health or the environment. Hazardous waste in India is defined as “any substance, excluding domestic and radioactive wastes, which because of its quantity and/or corrosive, reactive, ignitable, toxic and infectious characteristics causes significant hazards to human health or environment when improperly treated, stored, transported and disposed” (**MoEF&CC (The Ministry of Environment, Forests and Climate Change, 2008)**). The waste from collected from industries, hospitals, are using thousands of toxic chemicals and produce large amount of hazardous waste, most of the wastes are from industries, healthcare and manufacturing processes.

Table I presents the types and the sources of waste.

**TABLE 1**  
**Types and sources of waste**

Source	Waste generators	Waste
<b>Residential</b>	Household activities	Food debris, paper, card board, plastics, wood, glass, metals, electronic items.
<b>Industrial</b>	Manufacturing units	Chemicals, hazardous waste, concrete materials, solvents
<b>Industrial</b>	Manufacturing units	Chemicals, , concrete materials, solvents
<b>Hazardous</b>	Hospitals	Old drugs, sharp needles, lancets, syringes
<b>Municipal</b>	Street cleaning, landscaping, parks, recreational areas.	Sludge, tree, food scraps, clothing, grass clippings
<b>Agricultural</b>	Crops, orchard, dairies, farm	Agricultural waste, harvest water, Slaughter waste, fertilizers
<b>Mining</b>	Open cast mining, underground mining	Inert materials

**Source: National environment report, 2012**

## 2.2. SOLID WASTE MANAGEMENT

### 2.2.1. Definitions of solid waste management

Solid waste management is a growing challenge to many rapidly urbanizing areas in Africa. It is currently estimated that the rate of urban solid waste growth is faster than that of urbanization (**AbdhalahK.Ziraba, 2016**).

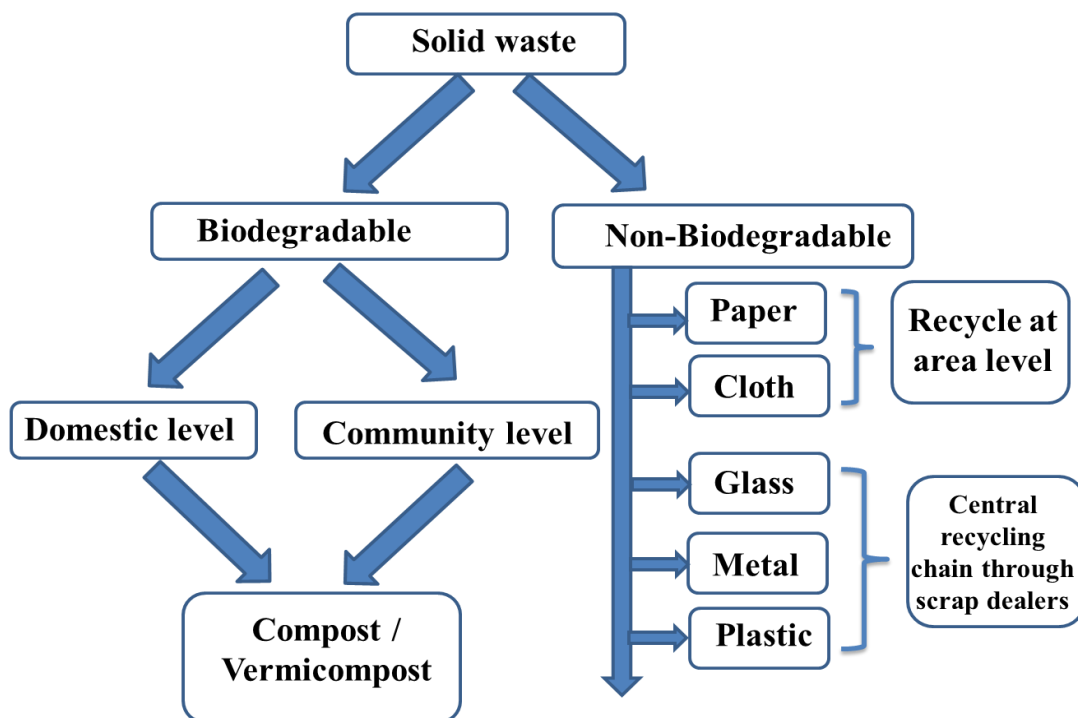
Solid waste management is a complex task that needs to be backed by information about changes in the consumption and the waste production patterns. It also requires technological support, organizational skills and leadership, and cooperation among the different stakeholders. Urban bodies face challenges of collection, transportation, treatment and disposal at the operational level. It leads to the question of whether private sector participation could be a welcome addition to the scenario (**Unnisa, 2014**).

Solid waste management is a challenging task not only in developing countries but also developed countries. However, generation of municipal solid waste (MSW) is one of the important contemporary environmental problems in urban areas (**Pattnaik and Reddy, 2010**).

Solid waste management refers to collecting, treating, and disposing of solid materials that is discarded. Improper disposal of municipal solid waste leads to unsanitary conditions, which creates pollution to the environment (Jerry A. Nathanson, 2010).

**2.2.2. Basic principles of Solid waste management**

- Refuse: Avoid buying unwanted things
- Reduce: Altering lifestyle may results in minimal garbage generation.
- Reuse: Make best out of waste, do not waste things
- Recycle: recycle the wastes into fertilizers, manure with kitchen wastes.
- Segregation: The wastes should be segregated based on its nature like bio degradable or non-biodegradable in separate bins, which is easy to recycle the things.
- Treatments: Both physical and chemical treatments can be used for wastes for disposing based on its nature
- Treatment at nearest possible point: waste should be treated in a centralized manner preferably at the site of generation. Fig II shows the ideal sold waste management



**Figure 2 An Ideal solid waste management**

Source: Municipal solid waste management rule, 2000

### 2.2.3. Composition of solid waste

The composition of MSW varies significantly from one municipality to another and from country to country significantly. Such variation depends mainly on the life style, economic situation, waste management regulations and industrial structure. The quantity and the composition of the municipal solid waste are critical for the determination of the appropriate handling and management of wastes (**Hussein. I, 2018**).

MSW (Municipal solid waste) composition in India is approximately 60 per cent compostable, 30 per cent inert, and 30 per cent recyclable. According to the National Environmental Engineering Research Institute (NEERI), Indian waste consists of 0.8 per cent nitrogen, 0.15 per cent phosphorus, and 0.15 per cent potassium (Gupta et al, 2018).

The wastes generated in developed countries are mainly inorganic in nature, whereas organic contents form a large portion of waste in developing countries (**Hoornweg et al. 1999, Medina 2002, Zerboc 2003, and Zurbrugg 2003**).

India is developing countries and drawn the world’s attention due to high growth of industrialization, urbanization, growing population and higher economic development results in increased waste generation and ecological degradation and pollution. Fig III shows the composition on municipal solid waste in India.



Figure 3 Composition of municipal solid waste

Source: ICRIER, 2019 (**Indian council for research on international economic relations**)

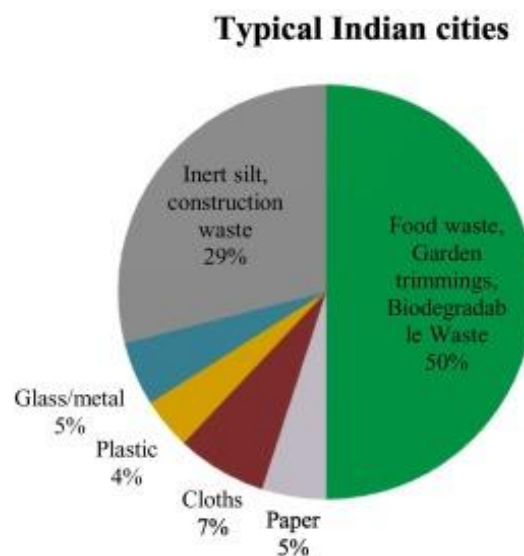
The Solid waste generation and composition influenced by other socioeconomic factors including the average family size, number of room(s), monthly income, and employment status (F.P. Sankoh, 2012).

Gidarakos E et.al (2006), have examined from the study municipal solid waste composition that there is a direct relation between the solid waste composition and the social activities in the community.

Sharholly et.al, (2008), examined the composition of municipal solid waste at generation sources and collection points was determined on a wet weight basis and it consists mainly of a large organic fraction (40%–60%), ash and fine earth (30%–40%), paper (3%–6%) and plastic, and glass and metals (each less than 1%). The ratio ranges between 800 and 1000 kcal/kg.

Abduli M.A., Samieifard, R & Jalili Ghazi Zade, M (2008) study conducted that solid waste management in Buserhr’s village. The waste generated in selected villages every day 646 grams of residential solid waste per capital. Waste composition in selected village is paper and cardboards 8.77 per cent, plastics 8.24 per cent, metal 6.08 per cent, rubber and leather 5.1 per cent and textile 4.83 per cent. The main obstacle to recycling program is the unbiased collection of waste in rural area.

The composition of solid waste in Indian cities is presented in Figure IV



**Figure 4 Composition of Solid waste**

Source Composition of solid waste, Ahluwalia and Patel, 2018

#### **2.2.4. Methods of solid waste disposal**

Landfill is still the main technological facility used to treat and dispose municipal solid waste (MSW) worldwide. In developing countries, final dumping is applied without environmental monitoring and soil protection since solid waste is mostly sent to open dump sites while in Europe, landfilling is considered as the last option since reverse logistic approaches or energy recovery are generally encouraged. However, many regions within the European Union continue to dispose of MSW to landfill, since modern facilities have not been introduced owing to unreliable regulations or financial sustainability. In this paper, final disposal activities and pre-treatment operations in an area in southern Italy are discussed, where final disposal is still the main option for treating MSW and the recycling rate is still low (**Ettore Trulli et.al, 2018**).

Composting is a safe method of waste management. Composting is an aerobic process where complex degradable materials are degraded and transformed by microorganisms into organic and inorganic byproducts (**Toledo. M et.al, 2018**).

The biodegradability, wastes can be classified into biodegradable, moderately degradable, and non-biodegradable. Aerobic and anaerobic organisms act on biodegradable wastes as a result of speeding up their degradability rate. Some agricultural wastes such as cow dungs, poultry droppings, etc. are examples of biodegradable wastes. While moderately degradable wastes are slowly degrading wastes. They have tough textured components. Examples of such wastes are wood and cardboards (**Bhat. R.A 2018**).

An appreciable amount of nitrogen, phosphorous, and potassium are lost to erosion. The use of surface-applied organic amendments has been reported to be very successful in combating erosion. Compost increases the water holding capacity, soil structure, and aggregate stability of the soil (**Gonawala, 2018**).

The composting process helps to protect underground water from becoming polluted compared to the landfilling method of waste disposal, which could pose a pollution threat to underground water. This is because there is a reduction of the microbes and chemical pollutants during composting. These are the pathogenic microbes present in waste which are harmful to humans. The application of composting increases agricultural productivity and organic matter content of the soil (**Luo. X et.al, 2017**).

Composting and anaerobic digestion of organic waste, such as food waste, garden (yard) and park waste and sludge, is common both in developed and developing countries. Advantages of the biological treatment include: reduced volume in the waste material, stabilization of the waste, destruction of pathogens in the waste material, and production of biogas for energy use. The end products of the biological treatment can, depending on its quality, be recycled as fertilizer and soil amendment (**RiittaPipatti, 2006**).

Composting is an aerobic process and a large fraction of the degradable organic carbon (DOC) in the waste material is converted into carbon dioxide (CO<sub>2</sub>). CH<sub>4</sub> is formed in anaerobic sections of the compost, but it is oxidised to a large extent in the aerobic sections of the compost. The estimated CH<sub>4</sub> released into the atmosphere ranges from less than 1 percent to a few per cent of the initial carbon content in the material (**Beck-Friis, 2001, Detzel et al., 2003, Arnold, 2005**).

Mechanical-biological (MB) treatment of waste is becoming popular in Europe. In MB treatment, the waste material undergoes a series of mechanical and biological operations that aim to reduce the volume of the waste as well as stabilize it to reduce emissions from final disposal. The operations vary by application. Typically, the mechanical operations separate the waste material into fractions that will undergo further treatment (composting, anaerobic digestion, combustion, recycling). These may include separation, shredding and crushing of the material. The biological operations include composting and anaerobic digestion. The composting can take place in heaps or in composting facilities with optimisation of the conditions of the process as well as filtering of the produced gas. The possibilities to reduce the amount of organic material to be disposed at landfills are large, 40 - 60 percent (**Kaartinen, 2004**).

Composting methods involves many types each type have its own advantages and disadvantages. Indian Bangalore composting was developed in Bangalore. The method is majorly recommended for the composting of night soil and refuse. The composting is carried out by digging trenches or pits about one meter deep where organic residues and night soil are put in alternate layers. The pit is finally covered with a 15–20 cm thick layer of refuse. The materials are left in the pit without turning or watering for three months. During this period, there is a reduction in the volume of the materials, and more night soil and refuse are placed on top in alternate layers and covered with mud or earth to prevent

loss of moisture and breeding of flies. This type of composting takes about six to eight months to obtain the finished product. This method is laborious and expensive to support **(Misra. R 2003)**.

Windrow composting is conducted by placing raw materials in long narrow piles or windrows, which are turned regularly. The mixing of the materials allows aeration into the setup. A typical windrow composting set up should start from 3 feet in height for dense materials like manures and 12 feet high for fluffy materials like leaves. It is difficult, and costly to support, but it is rapid and retains heat **(Gonawala S.S, 2018)**.

Vermicomposting is a type of composting in which certain species of earthworms are used to enhance the process of organic waste conversion and produce a better end-product. It is a mesophilic process utilizing microorganisms and earthworms. Earthworms feed the organic waste materials and pass it through their digestive system and give out in a granular form cocoons which is known as vermicompost **(Salman Zafar,2020)**.

Vermicomposting refers to the use of earthworms for composting degradable organic matters. Earthworms can degrade practically all kinds of organic matter by feeding on them. They can eat their body weight per day. For example, earthworms that weigh 0.1 kilogram can eat 0.1 kilogram of residue per day. The excreta of the worms termed “castings” are rich in nitrate, as well as available forms of phosphorus, potassium, calcium, and magnesium, which improve soil fertility. The existence of earthworms in the soil promotes bacterial and actinomycetes growth **(Bhat R.A. 2018)**.

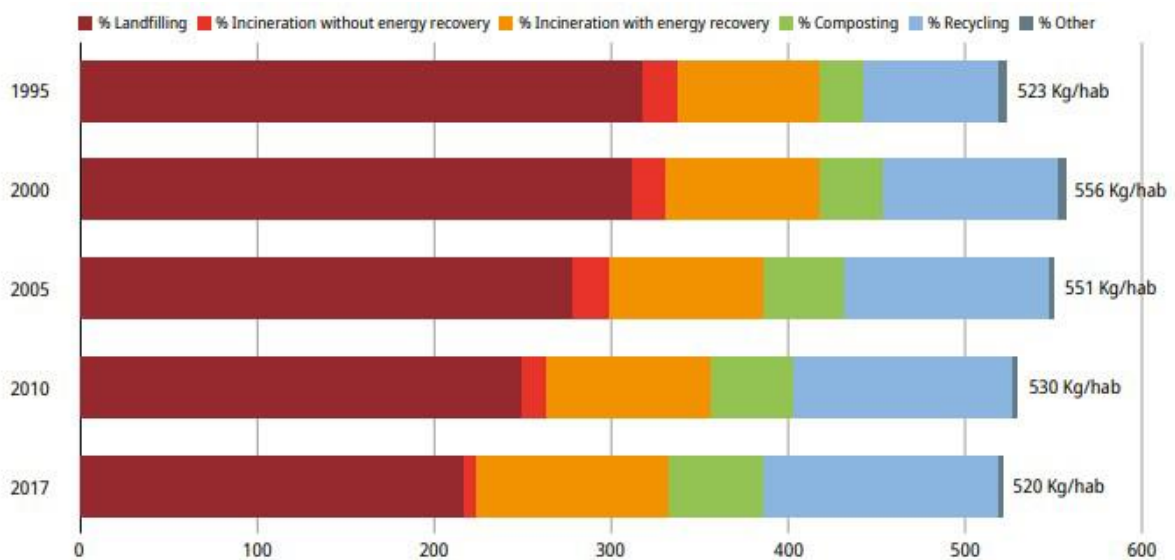
The vermicomposting in urban areas and municipalities also plays a vital role. In the villages farmers are maintaining vermicomposting beds, out of these only 60 per cent of the beds are maintained well and are producing good results. The remaining 40 per cent are just for record purpose only. Government fascination so many NGOs, organizations and individuals are interested on vermicomposting in the part of solid waste management. Vermicomposting is one of the eco-friendly process. Many organizations are showing interest towards vermicomposting **(GadeVenkatesham, 2009)**.

Vermicomposting is also found to have positive effect on early as well as later stages of plant life cycle and positive influence towards the plant growth **(Arancon et. al, 2008)**.

Sheet composting release the benefit of decayed organic material without building a composting pile. In this method, organic matters such as leaves, garden debris, grass clippings, weeds, and vegetative food are thinly spread directly onto the soil as a mulch. The organic materials are then tilled in with a hoe, spade or garden fork and left to decay there, rather than in a heap or container. One or more layers of organic material(s) are spreads over the growing area, watered thoroughly and left to decompose until planting time. More layers of organic materials are placed at the bottom layers decompose thoroughly. The method is cheap and straightforward (Misra. R, 2003).

Recycling is the reprocessing of discarded materials into new useful product. The process of reusing of cans can save money. Recycling of paper will reduce of cutting of tress. Reuse of metals will reduce the mining activities. In India about 40-80 per cent of plastic waste is recycled compared to 10-15 per cent in the developed nations of the world. However the recovery rate of paper was 14 per cent of the total paper consumption in 1991, while the global recovery rate was higher at 37% (Pappu et al., 2007; CPCB, 2004).

The different types of waste management techniques are presented in Fig V



**Figure 5 Types of waste management techniques**

Source: OCED (2019), Waste: Municipal waste, OECD Environment Statistics (database)

**Hai, F. Ibney, (2005)**, study stated that generation rate and characteristics of solid waste generated by Dhaka city. The factor which effect on disposal due to composting and effect on transportation cost due to landfill site. The study analyzed that by considering 40-50% of collection efficiency area required for composting ranges from 167.11 acres to 96.97 acres and concluded that if dumping site is selected away from city due to unavailability of land or higher land price it will increase three times transportation cost than that of present.

According to **Majbar, et al.**, compost helps to improve soil fertility and plant yield. Supplement of compost with synthetic fertilizer can be another route of application of compost for plant growth. Erosion causes the soil to lose its fertility.

**Modupe Stella Ayilara, (2020)**, has concluded from study waste management through composting: challenges and potentials that improper waste management is a common practice which is not safe and can be replaced with safer waste management method such as composting. The world is tending towards improving environmental and human health. As a form of organic fertilizer, composting can play a significant role in achieving this goal. Focus on composting will cause a shift in the use of chemical fertilizer in favor of compost. This shift will invariably promote environmental and human health by reducing the number of toxic chemicals released into the environment. In the present state, a lot of awareness still needs to be done concerning the potentials of this technology for its full acceptance by farmers.

### **2.2.5. Importance of solid waste management**

**Jaspalsingh et.al, (2018)**, the degradation of valuable land resources and creation of long term environmental and human health problems, uncontrolled open dumping is still prevalent in most developing countries which indeed desperately need an immediate action due to associated harmful impacts. Emissions from incinerators are associated with respiratory sickness. Acute and chronic symptoms of respiratory failure are associated with incinerations.

**S.K.Maity, (2018)**, Modern civilization has brought a lot of luxuries and conveniences to our lives. However, with all of the amenities that modern life brings us, they also cause us to contribute to producing a large quantity of trash that needs to be

taken care of solid waste management that modern lives are enjoyable without the disturbance or refuse.

The unsanitary methods adopted for disposal of solid waste is a serious concern. The poor maintenance of landfill sites prone to ground water contamination because of leachate production. Open dumping of garbage leads to breeding places for vectors such as mosquitoes, rats, cockroaches, and pests (**Central Pollution Control Board, 2000**).

#### **2.2.6. Challenges in solid waste management (Ministry of urban development CPHEEO, 2013)**

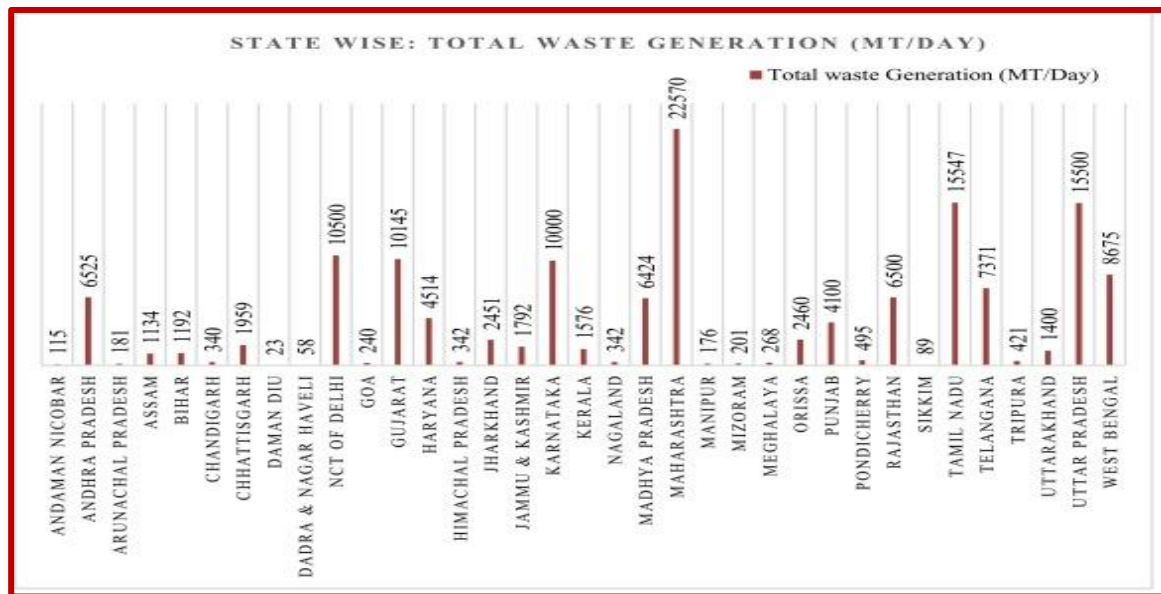
- Lack of segregation at source
- Lack of funds for waste management
- Lack of community participation towards the environmental condition and waste management.
- Lack of awareness towards solid waste management
- Lack in technical guidance in waste management.

#### **2.2.7. Solid Waste Management In Indian Scenario**

With this increasing population, municipal solid waste management (MSWM) in the country has emerged as a challenge not only because of the environmental and aesthetic concerns, but also because of the huge quantities of municipal solid waste (MSW) generated every day. According to **Central Pollution Control Board (CPCB)**, 1,43,449 tonnes per day (TPD) of MSW was generated in India during 2014- 2015, with an average waste of 0.11 kilogram (kg)/capita/day. Of the total MSW, approximately 1,17,644 TPD (80%) was collected, while only 32,871 TPD (22%) was processed or treated. Segregation at source, collection, transportation, treatment, and scientific disposal of waste was largely insufficient leading to degradation of the environment and poor quality of life.

The state wise total waste generation is presented in table II

**TABLE II**  
**STATE WISE TOTAL WASTE GENERATION**



Source :MNRE India, 2018

Waste is a burning issue in India as well as for the entire world. With the rapid urbanization and high population growth, the MSW quantities are increasing in India at the alarming rate. According to the census of India 2011, the population growth rate in India in the last decade was 17.6 per cent (Srivastava, 2014).

The unsorted solid waste at source, social taboo, citizen's attitude, poor assessment, inadequate potential strategies unorganised informal sector of waste, unplanned fiscal, and poor implementation of government policies. There is an urgent need for adequate treatment and recycling strategies required to be adopted as per the Indian solid waste composition. The appropriate implications of the potential solutions for MSW at the centralised and decentralised level need to be emphasised through various available of scientific treatment processes. Hence municipalities, along with the involvement of informal sectors, private agencies required to focus on creating potential opportunities and achieves the long term goal of the MSWM sustainability for Indian cities (Akilesh kumar , 2020).

The amount of municipal solid waste depends on living standards, geographical, commercial activity. As per the recent data from the ministry of new and renewable

energy (MNRE) report, India is generating approximately 145 million tonnes of waste per year and it is further expecting to reach up to 260 to 300 million tonnes per day in year 2047. As per CPCB report about 117,644 metric tonne of solid waste were collected and only 49,401 metric tonne only treated. (Central pollution control board, 2016) (**Ahluwalia and Patel, 2018**).

Solid waste generation has been found in 1995 was 0.64 kg in Kanpur, 0.52 kg in Lucknow, 0.4 kg in Varanasi, 0.59 kg in Ahemadabad and 0.44 kg in Mumbai. Currently total solid waste generated in India is around 42 million tons annually. Waste generation varies from 200-600 kg/capita/day and collection efficiency ranges from 50-90 % Population growth and solid waste generation in India has varying trend and correlation between population and solid waste generation of specific city is not necessary to be applicable. Population increased from 8.2 to 12.3 million in Mumbai during the period of Ten years (1981-97) at the rate of 49%. Similarly the population growth has been found to rise exponentially in other Indian cities; however, the growth rate may be varying. Trend of urbanization played significant role in enhancement of solid waste generation and in India it was 27.8% in 2001 and expected to reach 41% by 2021(**R.Rajput 2009**).

Solid waste management has become a major environmental issue in India. The per capita of MSW generated daily, in India ranges from about 100 g in small towns to 500 g in large towns. For example, the population of Mumbai grew from around 8.2 million in 1981 to 12.3 million in 1991, registering a growth of around 49 percent. On the other hand, MSW generated in the city increased from 3200 tons per day to 5355 tons per day in the same period registering a growth of around 67 percent (**Central Pollution Control Board, 2000**).

The total waste generation among the wards in India is presented in table III

**TABLE III**  
**TOTAL WASTE GENERATION AMONG THE WARDS IN INDIA**

State & UTs	Total wards	Total waste generation (MT/D)
Andhrapradesh	3,409	6,141
Andaman and Nicobar	24	90
Arunachal Pradesh	75	181
Assam	943	1,432
Bihar	3,377	2,272
Chandigarh	26	479
Chhattisgarh	3,217	1650
Daman and Diu	28	32
Delhi	294	10,500
Goa	217	250
Gujarat	1,427	10,274
Haryana	1,496	4,783
Karnataka	6,464	10,000
Kerala	3,536	2,696
Puducherry	122	415
Punjab	3,123	4,100
Rajasthan	5,389	6,500
Tamil Nadu	12,814	15,437
Telegana	2,112	8,634
Tripura	310	450
Uttar Pradesh	12,007	15,500
West Bengal	2,938	7,700

Source: Swachh Bharat Mission Report, 2020

The table IV presents the solid waste generation in major cities of Tamil Nadu

Table IV

## Solid waste generation in major cities of Tamil Nadu

Major Cities	Quantity of solid wastes generated in tonnes/day
Chennai	3500
Madurai	711
Coimbatore	710
Tiruchirapalli	408
Salem	330
Tirunelveli	210

Source: TNPCB report.

### 2.2.8. Existing practices of solid waste disposal in India

In India, waste dumping and open burning remain the primary methods of waste disposal. The majority of cities and towns dispose of their waste by dumping it in low-lying areas outside of town. **According to a 2014 Planning Commission survey**, over 80 per cent of waste collected in India is disposed of indiscriminately in dump yards in an unsanitary manner, resulting in health and environmental degradation. In India, the stench and unsightly sight of waste discarded on the roadside, often overflowing from drains or floating on the surface of rivers and it is not uncommon. In addition, with garbage clogging the drains, there is water logging and flooding of residential areas, highways, and even railway tracks during the rainy season, disrupting normal life. People often leave a lot of trash on the streets and in public areas (**Jagadish, 2017**).

A large portion of the collected waste is often dumped indiscriminately, clogging the drains and sewerage systems. These also become breeding grounds for rodents and insects, which are vectors of deadly diseases. According to a study released by ICRIER in January 2020, Delhi has the lowest collection of garbage of 39 percent while Ahmedabad has the highest of 95 percent (**Satpalsingh, 2020**). The local authority is affording for clean city, they are going fails into it mainly due to the lack of the Public Participation, the communication gap between local authority and Public (**Patel, 2016**).

Solid waste management likely associate it with garbage being dumped in landfills or incinerated. While such activities comprise an important part of the process, a variety of elements is involved in the creation of an optimal integrated solid waste management (ISWM) system, treatment techniques act to reduce the volume and toxicity of solid waste. These steps can transform it into a more convenient form for disposal. Waste treatment and disposal methods are selected and used based on the form, composition, and quantity of waste materials. Major waste treatment technology are thermal treatment, Dumps and landfills, Biological waste treatment (**Rick Leblanc, 2019**).

**Rouf Ahmad Bhat, Shabeer Ahmad Dar & Gowhar Hamid Dar, (2018)** conclude that current MSW generation and the possible problems associated with its management in India. The huge problem of India is responsible for mammoth generation MSW with daily rate of generation is 400g per captia. The quantity and characteristics of MSW is a growing challenge for the authority that has the mandate for MSWM. For managing the MSW, the authorities should endorse the collection, storage, segregation of waste in such a manner that they do not create any unhygienic and unhealthy conditions.

**HaritPriyadarshi& Ashish Jain, (2018)** study conducted in municipal solid waste management study in Aligarh city, Uttar Pradesh India. Aligarh Municipal Corporation on a BOOT basis for period of 30 years, 220 tons per day (TPD) of MSW. The organic content in the waste was found highest organic content (55.20 %), Paper (12.8 %), Plastic (4.5 %), clothes (2.8 %), wood (0.6 %) and others. MSWM in Aligarh city is unsatisfactory and thereby needs immediate attention. The solid waste management in Aligarh city has been significantly improved after the involvement of private sector.

Waste dumping and open burning continue to be the principal methods of waste disposal in India. Most of the cities and towns dispose of their waste by depositing it in low-lying areas outside the city. The report of the Planning Commission of 2014 found that over 80 percent of the waste collected in India is disposed of indiscriminately in dump yards in an unhygienic manner, leading to health and environmental degradation. “The stench and ugly sight of garbage dumped on the road side, sometimes overflowing from drains or floating on the surface of the rivers is not at all uncommon in India. Also, with clogging of the drains with garbage, there is water logging and flooding of residential

areas, roads and even railway tracks in the rainy season disrupting normal life. People also litter the streets and public places excessively (**Jagadish Chandra Mahanti, 2017**).

**Raj Parmar&ArtiPamnani, (2017)** study conducted on Municipal solid waste management in Indian cities and towns. Solid waste management is vast and complex area. In developed nation data on solid waste is proper and updated, while in developing nation data on solid waste is proper and updated while in nation data on solid waste is insufficient and need proper attention. In developed counties waste management is done by landfill, incineration, recycling and composting. In developing country like India waste management done by local bodies and municipalities and it has created great challenges for them. MSWM can be improved by increasing the source separation, installing decentralizes composting plant and involvement of NGO's in primary collection.

Waste collection and transport are essential elements of SWM. The MoEFCC estimates that only 75–80 percent of the total municipal waste gets collected and only 22–28 percent of this is processed and treated (Ministry of Environment, Forest and Climate Change, 2016).

**B.L. Chavan& N.S. Zambare, (2013)**, study conclude that municipal solid waste management facilities such as manpower resources and management systems in Sholapur city. The data has been collected from Municipal Corporation and other reliable sources. Total waste generated in Sholapur corporation area is 420MT/day. Sholapur city has 98 wards and divided into 6 zones. The total quantity of solid waste generation is 75,000 kg/d of which 50 per cent is biodegradable (dry), 25 per cent , recyclable 15.3 per cent green (wet) and 9.9 per cent debris and silt. The management and disposal of solid waste is not scientific and it creates serious problems. The combined effects of uncollected wastes, poor handling and inadequate disposal safeguards for municipal wastes always implications for public health leading to the chances of transmission of diseases.

**Rajkumar Joshi &Sirajuddin Ahmed, (2016)**, concluded that major parameters of MSWM, generation, its characterization, collection and treatment options as practiced in India. The initialization of decentralized solid waste processes units in metropolitan cities/towns and development of formal recycling industry sector in developing countries like India. The people should be educated to realize the importance of source segregation

at generation point as biodegradables, inert and recyclable material for proper waste management.

**Yuri Joelsson and Rebecca Lord (2016)**, study conclude that elements of municipal solid waste management system in the city of Mumbai and Navi Mumbai, India. The data for this study collected were gathered from literature studies and level stakeholders responsible for MSWM in Mumbai. The city generates about 7000 metric tons of MSW per day. The MSW generated Mumbai consisted according to data from the year 2004-2005 of 62% organic materials, 17% recyclable and 21% other materials. The waste collection in Mumbai is through a combination of community bins and door to door collection. Several rules and plans have been put to legal force accompanied by several initiatives with the intentions to improve solid waste management.

**Hina Zia and V. Devadas, (2016)**, study concludes that efficiency and the prospects for improvisation of the solid waste management system in Kanpur city. The data shows that transportation and open dumping are practiced in a non-technical manner. The study stated that management of solid wastes by the government organizations has not been successful municipal solid waste management, there is a need to systematically analyze the strength and weakness of the community as well as the Municipal Corporation, system can be evolved with the participation of various stakeholders in Kanpur city.

**M.S. Kadam and S.S. Sarawade, (2016)**, concluded from an analysis of solid waste management challenges and options for treatment that development and change of lifestyle of the urban people attract the rural people leading to generate village solid waste the high waste generation rate is due to rapid industrialization and technical societal developments. Waste to energy is the better option in these energy crises because 80 per cent of village solid waste is used as fuel for energy generations. Development of proto type model for treatment of village solid waste is necessary.

**Rishi Rana, Rajiv Ganguly & Ashok Kumar Gupta, (2015)**, study conducted in solid waste management in Chandigarh. Average of 370 tons/day of solid waste is generated in municipal area. The budget allocated for the financial year 2013-2014 to the municipal corporation for management of solid waste generated was INR 5737.49 crore.

An overall collection 90 per cent has been achieved in Chandigarh with collection efficiency of 60-70 for the registered households and 20% for the slums. Daily waste should be done in door to door. The main drawback is location of the bins. These drawbacks can be overcome using new equipment's and more rational methods for managing and collection of solid waste.

**Niyaz Ahmad Khan et al (2014)**, study that how Municipal Solid Waste Management carried out in the city of Srinagar in Jammu and Kashmir in India. The MSW generation in Srinagar has increased from 180 tons in 1981 to 530 tons in 2011. Capital rate waste generation rate vary from 100gms to 500gms. The collection system adopted that door to door collection and from street bin. Management collection efficiency lies between 65-70 per cent. Collected waste transported for dumping to open landfill site and remaining 30-35per cent of wastes is dumped into river embankments, unattended open spaces. They concluded that MSW shall be collected, stored, segregated, transported, demolition waste and bins or container should be cleaned before they overflowing.

**C R Mohmanty, (2014)**, the study is conducted in existing state of municipal solid waste management (MSWM) in Bhubaneswar city. Their aim was to identify the reason which causes obstructions in achieving good management system. They found that existing solid waste management system in the city is highly inefficient. Only primary and secondary collection of waste, transportation and open dumping was carried by the local authority. They found that of lack of human and financial resources, improper choice of SWM technology, inadequate coverage and lack of short and long term planning are responsible for the poor state of affairs. The city is facing these problems so there is a need to plan and adopt new solid waste management scheme which will improve the MSW condition of city and also helps to rise the living standard of people. They concluded that there is an urgent need to improvise the situation to stop further decay and deterioration of the city.

**SonamSahu, Dindhu J. Nair, (2014)**, study concluded that characteristics, generation, collection and transportation, disposal and treatment technologies of MSW practiced in India. Some effective measure can take lots of things should be done for the growth and development of the society such as proper recycling of waste, making goods from solid waste by proper treatment, which rise employment for unemployed peoples.

**Maryam Masood et.al, (2014)**, study conducted in solid waste management in Lahore, a metropolitan city of Pakistan, waste collection and transportation in the main focus. However the collection efficiency is only about 68%. Estimated that currently about 27 per cent of waste by weight is being recycled through the informal sector. In compost plant by using organic waste they produce 47,230 tons per year. They concluded that lack of planning and of both public and political will, are key barriers to improving SWM services in the city.

**Biubwa Ally et al, (2014)**, study carried out on various aspects of MSWM (municipal solid waste management) such as waste generation, its collection and disposal, recycling. Some study identified the main problem which becomes obstacles in improvement of municipal solid waste management and study found that collection of waste from Zanzibar municipality is very low which nearly about 50 per cent. Municipality collect waste in mixed condition and they dumped without any treatment. This shows the effect on environment and in human health. The main reasons are the municipal authority having limited budget, inadequate technical capacity, the absence of policy, lack of comprehensive legal and regulatory frame work and waste characteristics, poor urban planning and infrastructures.

**Javeriya Siddiqui, Govind Pandey & Sania Akhtar (2013)**, study concludes that waste collection scheme, present status of solid waste management and sanitary landfill in Mysore city. The data were collected in primary and secondary collection. 402 tons of waste generated per day. Mixed waste is collected and dumped in the landfills. The government need to take up a sustainable municipal solid waste management plan in Mysore city. Segregate the inert materials for dumping and plastic wastes for recycling while planning energy recovery from biodegradable waste. Ensure the success of municipal solid waste management strategies; people's participation must be encouraged.

**Chavan and Zambare, (2013)** stated that waste management has received worldwide attention of academicians as improperly stored waste can cause health, safety and economic problems. While reviewing the available literature in the area of waste management and disposal, it was observed that most studies focus on municipal solid waste management. The primary source of municipal solid waste generated in domestic, institutional commercial activities, garden and municipal services.

Waste segregation at household level can preserve the quality of recyclables, which will improve the accessibility to informal recycling sectors and help in overall reduction of waste for disposal. (**Matter ,Dietschi&zurbrugg, 2013**).

Kerala is generating 8300 tons of solid waste, in that 70-80 % of wastes are recyclable or biodegradable naturally. Many steps were taken to maintain the waste through Suchitwa mission which is a concern for solid waste management problem solving by treating the wastes, or improvement of solid waste into processing plants, steps for establishing modern waste treatment etc. in the year of 2012. Implementations of solid waste management in 27 municipalities were done to minimize the problems facing in disposal (**George Chakkancherry, 2012**).

Rapid urbanization and lifestyle changes are the major reasons for the waste management system. Generation of solid wastes in Kerala is reaching its height by polluting natural resources. This can be reduced by proper explanation of disposal methods like vermicomposting, incineration, gasification, composting etc. selecting the methods is based on the nature of the wastes. Over all concludes that composting and vermin-composting and biomethanation are the suitable techniques for soil waste disposal in Kerala (**Ajayakumar Varma, R. 2009**).

**Upendra Mani Pradhan, (2008)**, study stated that current solid waste management system and identified the strengths and the weakness of the system in Darjeeling. There is no provision for the segregation of waste. Town produces 50 metric tons of solid waste every day. On an average 62% of the waste is collected and disposed by municipality. The data were collected over direct observation. The current solid waste management system is unsustainable in the long run. The system depends on the numerous factors. People are willing to contribute positively and participate in a solid waste management system for development of sustainable solid waste management.

**MufeedSharholy A, Kafeel Ahmad, Gauhar Mahmood, R.C. Trivedi, (2007)**, have examined study topic Municipal solid waste management in Indian cities, explains that Municipal solid waste management (MSWM) is one of the major environmental problems of Indian cities. Improper management of municipal solid waste (MSW) causes hazards to inhabitants and from the study reveal that about 90 per cent of MSW is

disposed of unscientifically in open dumps and landfills, creating problems to public health and the environment. The study attributes, an attempt has been made to provide a comprehensive review of the characteristics, generation, collection and transportation, disposal and treatment technologies of MSW practiced in India. The study pertaining to MSWM for Indian cities has been carried out to evaluate the current status and identify the major problems. The treatment technologies for MSW are critically reviewed, along with their advantages and limitations.

**MufeedSharholy, kafeel Ahmad and R.C. Vaishya, (2006)**, study conducted that municipality waste management characteristics and management in Allahabad, India. The samples have been randomly collected from various locations and analyzed to determine characteristics of MSW. The total quantity of MSW has been reported as 500 ton/day and the average generation rate of MSW has been estimated at 0.39 kg/captia/day. The segregation waste at source and promotion of recycling and reduces of segregated materials reduces the quantity of waste and the burden on landfills, provides raw materials for manufactures. The composition of MSW shows mostly organic matter (45.3%), so composting is a good method for the treatment and production of soil amendment. The present MSWM system, which is required for the improvement of the existing system and for future planning.

Solid waste management in a developing country framework, it is to be noted that solutions which work for some countries or areas may not be appropriate or applicable for others. Specific issues, problems, environmental conditions and existing socio-economic framework will determine the appropriateness of various strategies and technologies in solving the problem of solid waste. However, various studies on solid waste issues bring about possibilities of certain approaches as being at least adaptable to many developing country scenarios. The main emphasis is on the four R"s – reduce, reuse, repair and recycle (creation of less waste and increased material recovery) and finding appropriate disposal options (**Medina 2002, Zerboc, 2003**).

### **2.2.9. Impact of improper disposal of solid waste**

Collection, discrimination, inadequate ground, dumping, ignorance, and so on are major issues and challenges in India. Dumping alone cannot mobilise financial capital for

costly technologies. A closer examination of the situation shows that waste must be handled holistically. Urban migration and population density will make WM a difficult problem in the future. Despite a number of policy responses to the issue, sustainable alternatives to either organic or inorganic waste remain unaddressed. Recycling is the most economically viable alternative for providing job opportunities to the urban poor. Critical topics such as industry responsibility, sustainable recycling, and catalysing waste reduction have received insufficient attention. In low-tech recycling, any type of packaging material cannot be recycled. Furthermore, the protection standards for waste pickers and staff are deplorable. The problem of urban waste can be solved using modern technology. Because of the high prices, developed countries are abandoning incinerators. However, developed countries have emerged as potential markets for the dumping of such technologies (Das, 2020).

**Olusegun Michael Ogundele, (2018)**, have examined and reveals that poor MSW (municipal solid waste) disposal methods and management constitute high risk factor to public health. Improper handling of waste- both liquid and solid especially from the ranks of waste collectors and scavengers increases the risk to human health. This study is a preliminary research on the community participation in waste disposal and its management.

Direct health risks concern mainly the workers in this field, who need to be protected, as far as possible, from contact with wastes. This further reveals other epidemiological studies that shows that a high percentage of workers who handle refuse, and of individuals who live near or on disposal sites, are infected with gastrointestinal parasites, worms and related organisms. Disease transmission by houseflies is greatest where inadequate refuse storage, collection and disposal is accompanied by inadequate sanitation (Olukanni and Akinyinka, 2012).

Environmental impacts of solid waste management in developing countries a case study of Rawalpindi city, that the major causes for the inefficient municipal solid waste management systems in Rawalpindi are the unintended invasion of the city, severe weather conditions, lack of social awareness and community involvement, improper resources including improper equipment and lack of funds. An inefficient municipal solid waste management system may create serious negative environmental impacts like

infectious diseases, land and water pollution, obstruction of drains and loss of biodiversity (N.Ejaz, 2010).

Waste management practices and their impact on human health comprised the recent data regarding waste and waste disposal techniques in the current scenario. It also emphasizes on the potential direct and indirect impact of waste management activities on human health. The outcomes have revealed that the general population living near landfill sites, incinerators, composting facilities, and nuclear installations were greatly affected by adverse health issues (Giusti, 2009).

Improper management of solid waste is one of the main reasons for environmental pollution and degradation in towns and cities, of the third world especially. Many of these cities do not have enforced solid waste regulations and proper solutions for disposal of waste, including for hazardous waste. The hazardous waste can bring several severe health effects to residents 'due to its characteristics as infectious, toxic or radioactive. Other environmental effects are destruction of the ecosystems through pollution of water, air, land and vegetation. This poor management of waste poses a great risk to public health. Skin disorders - fungal infection, allergic dermatitis, pruritis and skin cancer, respiratory abnormalities - bacterial upper respiratory tract infections (pharyngitis, laryngitis and rhinitis), chronic bronchitis and asthma, abdominal and Intestinal Problems – bacterial enteritis, helminthiasis, amoebiasis, liver cancer, kidney and renal failure, dental disorders – dental carries and dental pain, ear Infections – otitis media and bacterial infections, skeletal muscular systems – back pain, central nervous system – impairment of neurological development, peripheral nerve damage and headaches, blood disorders – Iron deficiency anemia UNEP, 2007 (united nation environmental protection).

Developing countries face several major problems as a result of solid waste such as, health hazards from uncollected waste, health hazards from collected but poorly disposed of waste, and economic burden of waste disposal on towns and cities (Pearce, 1994).

## **2.3. POLICIES AND PROGRAMMES ON SOLID WASTE MANAGEMENT**

### **2.3.1. Major initiatives from government on solid waste management**

The government play its part because urban solid waste management is the country's biggest challenge. The Indian Government assigns the role and duties of some

ministers, boards and civic authorities in handling MSW in India (**Reddy & Ram, 2019**). It is responsible for the general aspects of the MSW administration and for the planning and management of waste policy and regulations by the Ministry of Environment and Forestry. The Government of India has given the Urban Development Ministry and responsibility to prepare the Urban Local Body Municipal Solid Waste Management Manual to ensure quick and environmentally sustainable management of solid waste in the municipality.

**The Central Pollution Control Board (CPCB, 2000)** co-ordinates the (SPCB) State Pollution Control Board operations and provides technical advice and instruction to its employees, distributing information or directives on waste disposal, conducting governmental duties, etc. The State Pollution Control Board would create a robust mechanism to prevent and control air and water pollution. Local agencies are responsible for the distribution of services to urban solid waste management, including recycling at local level for the disposal, reuse and composting of solid waste from sources, road sweeping, transportation, storage and disposal. The Department of Fertilizer, Ministry of Chemicals and Fertilizer should help the urban compost e-market and encourage compost commercialisation in companies.

The Ministry of Agriculture will provide versatility in the regulation of fertilizers for the In the regulations for fertilisers for the production and selling of compost, the Ministry of agriculture will have flexibility for the distribution of compost usage in agriculture and the set-up of compost testing laboratories prepared for local authorities. The Ministry of Electricity must set the cost of electricity generated by solid waste in the power station and ensure that energy from the power stations is purchased. The ministry of new and renewable energies is responsible for promoting and offering subsidies or incentives to build waste-to - energy plant infrastructure.

Prime Minister Narendra Modi said all stakeholders should stick to the "golden rule" of the 3Rs- reduction, reuse and recycling, which will contribute significantly to waste management and sustainable development (**Reddy & Ram, 2019**) and (**Hardik & Hitesh, 2018**).

### **2.3.2. Government rules and policies on solid waste management**

The draft rule of 1999, objections, suggestions are reconsidered and framed rules based on the size and population the rules are implemented in all Municipal Corporation the all over the country. The rules in Municipal Solid Waste (Management and handling) are as follows,

- Avoid littering in public places, segregate the wastes into biodegradable and recycle waste and use separate bins accordingly
- Door to door collection of degradable and Non-biodegradable should be done in daily basis with the help of suitable transports like hand carts, tricycles, vans etc.
- Residential and commercial areas should sweep by covering all the area daily including Sundays and public holidays.
- Waste should be stored in closed container or closed environment, open storage should be avoided.
- While transporting the waste, vehicles should also be covered on daily basis.
- Treatment of biodegradable waste using composting or waste to energy technologies meeting the standards lay down.
- Waste can be minimized by using recycling the things. Try to throw only inert material and treatment plants to landfills as per the standards lay down in the rules.

### **2.3.3. Major programmes from government on solid waste management**

#### **2.3.3.1. Swachh Bharat Mission**

**The problem of improper disposal of waste in India is currently a major challenge of Municipal solid waste.** The Government of India, our Indian Prime Minister Shree Narendra bhai Modi launched “Swachh Bharat Mission” on 2<sup>nd</sup> October 2014 with the goal to make our country clean and open defecation free by 2<sup>nd</sup> October 2019 as a mark tribute to Mahatma Gandhi on his 150<sup>th</sup> birth anniversary. It is also the goal to achieve 100% scientific management of municipal solid waste by 2019. (Patel Hardik, 2018).

The sanitation and solid waste management are the two basic pillars of SBM (swachh Bharat Mission). The success of the mission will depend on the implementation of the regular monitoring and based on the monitoring results and the actions taken. (**Sadhan Kumar Ghosh, 2015**).

#### **2.3.3.2. Mahatma Gandhi Swachhata mission**

The government of Gujarat has launched Mahatma Gandhi Swachhata Mission. The goals and objectives which is same as the Swachh Baharat Abhiyan launched by Government of India. The dream of the Mahatma Gandhi was all the cities, towns and villages should be clean. Under the Mahatma Gandhi swachhata Mission, government released the Rs. 1 crore to all the Municipal corporations of Gujarat state. The Government has released this fund to initiate the mega cleanliness movement in the respected cities. The Government is also working in a full flag to achieve the goal of SBM with reference to municipal solid waste management (**Department of Urban Development & Urban Housing Development, 2014**).

#### **2.3.3.3. Swachhata Bharat app**

The Swachhata Bharat app has been launched by the Minister of state for culture & Tourism Mahesh Sharma. The main focus of the Swachhata Bharat app is to involve people actively to become part of the India movement. This app is initially launched in 4041 corporations, towns and cities of India. Anyone can download the app from the google play store. If he/she found dumped waste or overflowing dustbins or other cleanliness regarding problems and want to clear it, that person need to just click the picture and post it on the Swachhata app. Once a complaint has been posted, it will automatically forward to the concerned municipal authority. Action on the complaints may vary depending on the categories. The time is fixed for the various activities (**Gupta, M, 2016**).

#### **2.3.3.4. Swachhata Helpline**

The Swachhata helpline involves more citizens to reduce solid waste management or swachhata regarding issues through one call. The citizen can call **1969** and file the complaint, inquire about information of Swachh Bharat Mission in urban areas including the current status of their applications for construction of toilets (**swachh.city, 2018**).

### **2.3.3.5. SwachhSurvekshan**

The government of India to assess rural and urban areas for their levels of cleanliness and active implementation of Swachhata mission in innovative manner. Ministry of housing and urban affairs conducting the Swachhasurvekshan since 2016.

The objectives of survekshan are to encourage large level participation of citizens, to create awareness to the society. It is also encouraging a spirit to the cities and towns to improve their service for society to city clean. The Swachhata App is a fourth-generation smartphone and online programme introduced by the Ministry of Housing and Urban Affairs. Anyone can update the app and file reports about issues on the app if they notice discarded garbage or overflowing dustbins or other cleanliness. It would immediately forward the case to the local body concerned upon registering a case. The time had to be set for multiple tasks, such as overflowing dustbins, trash dumps and cleaning within 12 hours of submitting a complaint, in order to settle the grievances quickly. Both submitted reports will be updated and told of their case status on a daily basis. A web-based framework for reporting and tracking waste management in India was initiated by the Ministry of Environment, Forest and Climate Change (MoEFCC) in 2016. The ministry conducted “**Swachh Survekshan-2016**” for the rating of 73 cities in January 2016; “**Swachh Survekshan-2017**” for 434 cities in January-February 2017; “**Swachhsurvekshan-2018**” is schedules more than 4000+ cities or towns in January 2018 march. “**Swachh survekshan-2019**” covered 4237 cities in a record time of 28 day as, in a completely paperless, digital format for data collection (**Ministry of Housing and Urban Affairs, 2018**)

### **2.3.4. The landmarks by government of India on Solid waste management**

The table V represents the land marks on solid waste management for the past 40 years.

**TABLE V**  
**LANDMARKS ON SOLID WASTE MANAGEMENT**

Year	Rules
1989	The Hazardous Waste (M&H) rules
1994-1995	MSWM strategy paper by NEERI
1998	J.S. Bajaj committee (the high powered committee on Urban solid waste management)
1998	Bio-medical waste (M&H)rules
1998	Supreme court appointed barman committee
2000	MSW (M&H) rules
2000	CPHEED Manual on MSW
2005	Report of the Technology Advisory Group on SWM
2005	JNNURM (2005–2012)- 40 MSW projects costing Rs. 2,186 Cr sanctioned from a total of 65 cities covered
2005	12th Finance Commission (2005–2010)- Rs. 2,500 Cr for 423 Class I cities
2006	Strategy and Action Plan-Use of compost in cities
2007	11th Five-Year Plan (2007–2012)- Rs. 2,210 Cr for MSWM

Source: Solid waste management (2012) Jawaharlal Nehru national urban renewal mission

The Jawaharlal Nehru National Urban Renewal Mission (JNNURM) launched by the Government of India in 2005 further focused attention on the need to improve public service delivery in urban areas in general and solid waste management in particular and provided funds to support such activity. All the rules were revised and rules with many salient features were reframed by the government of India.

Solid waste management rules, (2016), the Union Ministry of Environment, Forests and Climate Change came up with the new Solid waste management rules (SWM) major highlights of SWM rule, 2016 are segregation at source, collection and disposal of sanitary waste like diapers, sanitary pads and other disposal items separately and not to dump with common waste, local bodies have been assigned responsibility of government

to ensure and utilize composting, user fees for collection, promoting use of compost, and promotion of waste to energy ( **Ministry of environment and forest, 2016a, The Gazette of India**).

**Plastic management rules, (2016)**,the Government has notified the Plastic Waste Management Rules, 2016, in suppression of the earlier Plastic Waste (Management and Handling) Rules, 2011.The aim of rule is to increase minimum thickness of carry bag from 40 to 50 microns. To promote use of plastic waste for road construction as per Indian Road Congress guidelines or energy recovery, or waste to oil etc. for gainful utilization of waste and also address the waste disposal issue; to entrust more responsibility on waste generators, namely payment of user charge as prescribed by local authority, collection and handing over of waste by the institutional generator, event organizers. Plastic products are left littered after the public events (marriage functions, religious gatherings, public meetings etc.) held in open spaces. First time, persons organising such events have been made responsible for management of waste generated from these events(**Ministry of environment and forest, 2016b, The Gazette of India**).

**E-waste management rule, 2016**, the roles of the State Government has been also introduced in the Rules in order to ensure safety, health and skill development of the workers involved in the dismantling and recycling operations. Liability for damages caused to the environment or third party due to improper management of e - waste including provision for levying financial penalty for violation of provisions of the Rules has also been introduced (**Ministry of environment and forest, 2016e, The Gazette of India**).

**Bio medical waste management rule, 2016**, some of the salient features are the ambit of the rules has been expanded to include vaccination camps, blood donation camps, surgical camps or any other healthcare activity, phase-out the use of chlorinated plastic bags, gloves and blood bags within two years, Provide training to all its health care workers and immunize all health workers regularly, state Government to provide land for setting up common bio-medical waste treatment and disposal facility (**Javadekar, 2016**).

**Hazardous and Other Wastes (Management & Trans boundary Movement) Rules, 2016** salient features include the following, waste Management hierarchy in the

sequence of priority of prevention, minimization, reuse, recycling, recovery, co-processing; and safe disposal has been incorporated, to set up/ allot industrial space or sheds for recycling, pre-processing and other utilization of hazardous or other waste, To register the workers involved in recycling, pre-processing and other utilization activities, to form groups of workers to facilitate setting up such facilities, to undertake industrial skill development activities and ensure safety and health of workers (**Ministry of environment and forest, 2016d, The Gazette of India**).

### **2.3.5. Role of government agencies on solid waste management**

In the year 2000, the Ministry of Environment and Forest (MoEF) of the Government of India released MSW (management and handling) rules for scientific MSWM, ensuring proper collection, segregation, transportation, refining, and disposal of MSW, and upgrading existing facilities to prevent soil and groundwater pollution. According to the clause, the CPCB has been tasked with monitoring the enforcement of these regulations, and municipalities will be expected to send annual reports to the CPCB on the status of MSW in their regions. These rules apply to any Municipal Authority in India that is in charge of MSWM. In addition, different states have Municipal Corporation Acts, such as the Delhi Municipal Corporation Act 1959, the Uttar Pradesh Municipal Corporation Act 1959, and the Karnataka Municipal Corporation Act 1976. These Acts also address environmental pollution caused by improper MSW disposal. For example, the Delhi Plastic Bag (Manufacture, Sales and Usage) and non-biodegradable garbage (control) Act, 2000, was enacted to prevent contamination of foodstuff carried in recycled plastic bags, to reduce the use of plastic bags, and to prohibit throwing or depositing non-biodegradable garbage in public drains, roads, and places of public assembly. Local governments often regard MSWM as a bad service in comparison to other basic utilities, owing to MSWM's inability to recover running costs. However, the majority of municipalities are unable to provide the desired degree of conservation services. They have not been very successful in terms of SWM services due to a variety of issues (Siddiqui et al., 2006; Kansal, 2002; MoEF, 2000; Gupta et al., 1998).

On World Environment Day, June 5, 2017, the Government of India declared a “National Strategy” to eradicate all types of single-use plastic by 2022, including not only plastic bags and bottles, but also plastic cutlery, straws, Styrofoam containers, and coffee

stirrers. According to a FICCI report, 43 percent of India's plastic is used to make disposable, single-use packaging, such as that used by e-commerce sites like Amazon and Flipkart (Isher and Ayush, 2019). A total of 18 states and UTs have imposed bans on plastic manufacture, stock, sale, or use of plastic carry bags, including Andhra Pradesh, Arunachal Pradesh, Assam, Chandigarh, Chhattisgarh, Delhi, Goa, Gujarat, Himachal Pradesh, Jammu & Kashmir, Karnataka, Maharashtra, Odisha, Sikkim, Tamil Nadu, Uttar Pradesh, Uttarakhand and West Bengal (Swachhata Sandesh Newsletter, 2019). However, due to a lack of state power, the bans have not been successfully implemented (Patel and Ahluwalia, 2018).

### **Role of non-government agencies on solid waste management**

Non-Governmental Organizations are identified as “classified organisations that conduct and pursue activities to alleviate poverty, support the interests of the poor, provide vital communal services, or undertake community development.” In a broader sense, the word NGO refers to any non-profit organisation that is not regulated by the government. Non-governmental organisations (NGOs) are value-based organisations that rely on charitable contributions and volunteer services. Though the Non-Governmental Organizations sector has become increasingly specialised over the last two decades, the ideologies of altruism and voluntarism continue to be key distinguishing characteristics. They have the specialised manpower and technological know-how to carry out their goals. As a result, they could be the best source for improving waste generation management. It is estimated that there are approximately 1.5 million non-governmental organisations (NGOs) in India working on various causes. As a result, the government of India has released its National Policy on Voluntary Sector, with the main goal of encouraging, enabling, and empowering an autonomous, innovative, and efficient voluntary sector to contribute to the social, cultural, and economic development of the people of India (Deepshikha, 2019). Non-Governmental Organizations (NGOs) are described by the World Bank as organisations that conduct activities to alleviate distress, support the interests of the underprivileged, protect the environment, provide basic societal services, or engage in community development (World Bank Operational Directive, 2008).

Many countries' public sectors are unable to provide adequate waste management systems, resulting in uncollected waste on roadsides and in other public areas. As a result,

there is a pressing need and potential to engage the private sector, civil society organisations, and communities in waste management. There is growing evidence of community and civil society groups successfully participating in MSW management. In India, nongovernmental organisations (NGOs) and other civil societies have recently begun to participate in developing waste management systems. NGOs can assist in the development of people's or community groups' capacity to play an active role in local SWM by raising their awareness of waste management issues (Deepshikha, 2019).

A large number of non-governmental organisations work in the field of solid waste management. Clean Ahmadabad Abhiyan in Ahmadabad, for example; Waste-Wise in Bangalore; Exnora in Chennai; Mumbai Environmental Action Group in Mumbai; Swabhiman in Bangalore, Vatavaran and Srishti in Delhi; CDC, Nagpur Vishal Protection Force in Old Faridabad, and so on (Deepshikha, 2019; Jayarama Reddy, 2011). These organisations are effectively raising citizens' consciousness of their rights and obligations about solid waste and the cleanliness of their community. These non-governmental organisations promote environmental education and awareness in schools and engage communities in solid waste management. Generally, the main programmes carried out by NGOs are as follows:

1. Raising public awareness and ensuring public engagement in the separation of recyclable materials and waste disposal at the source;
2. Creating jobs by coordinating door-to-door waste collection;
3. Organizing rag pickers into a skilled sanitation workforce;
4. Ensuring public involvement in a community-based primary collection system;
5. Encouraging waste minimization by in-house backyard composting, vermicomposting, and biogas generation;
6. Raising citizen consciousness of their right to live in a safe environment, as well as their duty to keep the environment clean.

### **Action enforced by Tamilnadu Pollution control board**

Municipal authorities as well as the District Collectors who are responsible for the implementation of the Municipal Solid Wastes Management and Handling Rules, 2000 have been instructed to identify a site away from habitations and water bodies for the

composting of compostable wastes and landfilling of inert waste. A private facility has also been issued authorisation at Madurai to process the municipal solid wastes generated from Madurai Corporation. The facility is yet to be commissioned. All other local bodies are in the process of identification of site for composting and secure landfill. All the Municipal commissioners have been instructed to take action to stop the disposal of unsegregated municipal solid wastes into low lying areas and water bodies in order to prevent water pollution. Municipalities have started the source segregation of municipal solid wastes generated in their limits partially or fully. Also Board has issued directions to the Commissioner,

- ✓ Corporation of Chennai to stop dumping of garbage at Kodungaiyur and Pallikaranai dump yards.
- ✓ Start segregation at the transfer points by using conveyor belt system.
- ✓ Take action to put up waste processing facilities at the earliest.

#### **2.4. RELATED RESEARCH STUDIES ON SOLID WASTE MANAGEMENT**

**Eshwari k. Shetty, (2019)** examined from the study Knowledge, attitude and practices towards household solid waste management among semi-urban residents-a community based cross sectional study from southern part of coastal Karnataka, India, the overall knowledge (60.3%), attitude (61.5%) and practices (72.8%) towards solid waste among the participants was near satisfactory. More than 90% were aware about the effects of inappropriate management of waste on health and environment. It was identified that having a better education and holding a skilled and professional jobs were the independent predictors of knowledge and attitude and the gaining momentum among public towards management of solid waste can be further strengthened by taking in to account the identified predictors like education and occupation of the residents.

A study was conducted to document the experiences and practices of household waste management of people in Manila, Philippines. A sample size of 300 was taken. The data were gathered through an interview with household members using open ended questions. Interviews were also conducted with garbage collectors as well as scavengers. Results showed that the households generated an average of 3.2 kg of solid waste per day, or 0.50 kg/capita/day. The types of wastes commonly generated are food/kitchen wastes,

papers, bottles, metals and cans, boxes/cartons, glass bottles, cellophane/plastics, and yard/garden wastes. Some household respondents said that it is possible that the dumping in certain areas caused the dengue fever suffered by some of their family members. Most of the respondents said that garbage collection and disposal is the responsibility of the government (<http://lib.bioinfo.pl/paper>, 1999)

**Mahmood Jamal Abdul Hasan, (2019)** viewed from the survey showed that 67% of respondents were dissatisfied with the current practice of solid waste management in their city. The results also showed that low-level of knowledge on relevant laws and regulations pertaining to solid waste was observed among respondents. Although half of the respondents were aware about the importance of managing solid waste, however, most of them failed to put their knowledge and awareness into practice. Therefore, extensive and continuous efforts by various stakeholders are urgently needed to enhance public awareness towards sustainable solid waste management in developing countries.

**Geetika Mishra &Mitali Yadav, (2019)** concluded that the various solid waste management initiative and challenges in managing municipal solid waste. Source segregation and collection, transportation of waste to the collection centers, financing issues and urbanization and lack of finance these are the challenges faced in India. Classification of waste at collection and disposal site should made by people. Awareness among the people about significance of source segregation at generation sites as biodegradables, inert and recyclable material and change in habits to store segregate and dispose of waste according to direction of municipal council for effective waste management. Government should take initiative to inspire institutions and universities to include waste management in their curriculum.

**Abdikadir Ahmed Omar, (2018)** have conclude from the study on knowledge, attitude and practices towards the solid waste management in karan district, Mogadishu Somali that findings revealed Karan district community have good level of knowledge as well as have positive attitude but their practice towards solid waste management was poor.

**K.G Kiran, Sanjay Kini& N. Udaya Kiran (2018)**study conducted among the households of Kuttar and Manjavadi villages and a sample of 120 households were studied. Majority had a good knowledge about the ill effects of improper solid waste

disposal and that 82.5% said collectively that it causes disease, unpleasant odour, unpleasant site and rodent nuisance. Majority have them positive attitude towards solid waste disposal and 98.3% felt that improper solid waste removal effects environment. Regarding attitude towards reducing household wastes 119 (99.1%) they are want reduce households wastes. In this study stated that communication strategies toward environmental protections becomes crucial. Solid waste management, turning intention to desirable behavior and creating favorable social and political environment not only be the concern of local officials but also of residents.

**AmbirmShahzadil, Muhammad Hussain, (2018)** study is concluded that knowledge, attitude and practices of people regarding household waste disposal among people in rural community of Lahore. Data was collected by pre-designed well adopted questionnaire, interview technique on different variables knowledge, attitude and practice among peoples of rural area. Majority of respondents were aware about the hazardous material and harmful effect of improper waste disposal. The attitude of community people was found good. Despite of having good knowledge the respondents were performing poor practices. Maximum respondents throw waste in open places.

**Laor P suma, (2018)** the study concluded from Knowledge, attitude and practice of that overall, 73 percent of respondents had high level of knowledge; 85 percent of respondents showed neutral attitude; and 59 percent of respondents performed moderate practice on MSW management. The results highlighted that age and education levels were statistically significant associated with KAP levels on MSW management at ( $p=0.05$ ).

**M.Anitha, (2017)** revealed from a Study on awareness of domestic solid waste management among high school students. Education has been used by mankind not only as a conserving agency and a mechanism of social control but also as a creative and regenerative influence to bring about positive changes in existing modes of thinking and living in belief's values, attitudes and customs. Environmental education is an integral process, which deals with man's interrelation ship with his natural and manmade surroundings including the relation of population growth, pollution, resources allocation and depletion, conservation, technology and urban and rural planning to the total human environment. Environmental education is intended to promote among citizens the

awareness and understanding of the environment, our relationship to it and the concern and responsible action necessary to assure our survival and to improve the quality of life.

**Indubala, (2017)** study conducted that knowledge and practices regarding waste disposal among people of rural community in Himachal Pradesh. The data were collected in 160 respondents from mucchali panchayat of Una district. Study stated that majority of the respondents were aware about the composting, recycling of waste and hazardous waste and harmful effect of open defecation. The practices of rural people regarding solid waste disposal was found substantially poor. Despite of having good knowledge the respondents were performing poor practices. Maximum respondents throw waste in open places or river. So that provision of sanitary measures like dustbins at the community level should be made available by Panchayats and concerned agencies for the proper disposal of solid wastes. Awareness and environmental sanitation promotion programs should be organized by local communities, NGOs, INGOs to aware the people about proper methods of waste disposal.

**Jose Nino A. Ramos, Elvira S. Pecajas, (2016)** the study conclude that knowledge, attitudes and practices of solid waste management of secondary schools in the division of Leyte. The respondents stored their waste in the containers with covers, in waste processing point out that waste minimization got the highest rank. The solid waste management practices are moderately and fairly practiced by the respondents which need more supervision by the school administrators. The attitude towards solid waste management is “moderately agree” and the practices towards solid waste management are “moderately practiced”.

**Qingbin Song et al., (2016)** have studied the residents’ attitude towards waste management and willingness to pay for better solid waste management in Macau. By applying logistic regression they found that education was the only factor significantly associated with the willingness to pay. The other explanatory variables used in the model were age, gender, family size and income which were insignificant in determining the willingness to pay for improved waste management.

**Niyati Mahajan (2016)** study concludes that solid waste management in Chennai through the awareness created by Exnora. Exnora has promoted communities being directly involved in a voluntary effort in waste collection, removal, recycling and applied

concepts such as the 3R (Reduce, Reuse, Recycle). Exorna performs an important role in mass awareness, environmental protection and empowerment of the disadvantaged. The current solid waste management system in Chennai mixes various types of waste, both formal (municipalities) and informal sector workers are operating without any coordination. Need to organize the household collection, separation and even management of the degradable wastes in their own neighbourhoods. The private companies are the suited for transport and disposal of bulk, recyclable and non-recyclable waste.

**Barloa, Lapie& de la Cruz, (2016)** conducted a study in Thailand to determine the attitude towards waste disposal. The data revealed that only 24% of publics are disposing wastes in open area nearby their house and half of the population is properly disposing the waste in separate dustbins. Where less than 10 % of the populations are not aware of waste disposal and over 90 % of peoples are really good in disposing waste in separate dustbins.

**Arkhamwahid, (2015)** examined from the study importance of awareness in solid waste management raising awareness about municipal solid waste management is an essential component of effective waste management. It is important for key stakeholders to be aware of a city's waste management activities and have a strong understanding of the benefits of proper solid waste management. Although, many challenges arise when raising awareness about solid waste management, a variety of communication techniques can be used to address them. Raising awareness about a city's municipal solid waste management activities and the benefits of proper solid waste management can result in increases in as follows,

- Use of city waste collection services by the public and private sectors.
- Funds for waste management from local elected peoples.
- Enforcement of local waste management policies.
- Support for local-level activities from national or provincial governments.
- Public participation in awareness programs which results in segregation at point source and reduction of waste.

**Rahmaddin et.al, (2015)** studied the KAP regarding waste management in communities near Martaputra River bank in Indonesia. The community's attitude was

deemed highly satisfactory also their knowledge, however the participants showed poor actions towards handling and management of river dumped wastes by non-participants.

**S.oduro-Kwarteng, K.P Anarfi (2015)** study concludes that the waste characteristics and separation efficiency of source separation of household waste in low and middle income communities in Kumasi metropolis, Ghana. A sample of 60 household survey, education on source separation and pilot source separation exercise. The solid waste was sorted into six fractions and three recycling categories (biodegradable, paper and plastic). Study stated that the source of separation program hinges on education and economic incentives. The sample size could be increased to enhance the accuracy of the data for prediction purpose. The public should be well educated on separation methodology in order to improve motivation and separation methodology in order to improve motivation and separation efficiencies.

Case study was conducted in Somalia to know the public attitude towards the waste disposal. 62 per cent of peoples are disposing their waste in nearby house or in open places. In that 32 per cent of peoples are aware of methods of disposing the waste, however many respondents showed poor attitude towards household waste disposal (**Azuike et al., 2015**).

**Ali akbar, (2015)** concluded from the study Household recycling knowledge, attitudes and practices towards solid waste management, that the KAP (knowledge, attitude, practices) of solid waste source separation and recycling was influenced by demographic factors of age, education level, gender and occupation. It was further found that education level and occupation were two significant factors affecting residents' WTP ( $\chi^2 = 24.083, p\text{-value} < 0.0001$ ) and concluded that study found that providing public with MSW infrastructures and improving citizens' awareness about SW source separation and recycling to training promote SW recycling programs hold great promise for developing effective public campaigns and behavior-changing interventions. This has important implications in that the usual KAP of public proved inadequate in the case of SW source separation and recycling. The implementation of needs-based training programmes considering females as one of the main audience groups and determination of municipality needs are thereby highly advocated.

The results of the research in Abadan indicated that their knowledge and attitude towards reduction, separation at source and recycling are good depending on age, gender and occupation but their performance is poor. Therefore, implementation of home waste management training programs as a necessity can play an important role in enhancing the practice of individuals (**Babaei et.al, 2015**).

**Rajesh et al. (2014)** stated that with the increase in population there is an exponential increase in the MSW generation, hence it is necessary to reduce either by disposing it or recycling periodically. Conducting awareness programs about waste generation and its effects on human health and sustainability for the people, proper planning in industries may create a healthy environment both for the humans and animals to live.

**C.D. Licy, (2013)** proved from the study that there is significant difference between awareness and practice. The study reveals the necessity of giving mass awareness to the impact of waste disposal practices from the beginning of school education. Committed environmental education will inculcate a proper and appropriate environmental culture in the students. As the study revealed awareness of e-waste disposal is lacking there is an urgent need to rectify this gap in knowledge and practice.

**Audu A. Jatau, (2013)** using a self-developed knowledge, attitude and practices questionnaire associated with waste management noted that respondents with higher level of education had correct level of knowledge of the impact of improper waste management on health than those with lower level of education. He also discovered that the level of education had a statistical significant influence on knowledge of waste management. He recommended promulgation and enforcement of waste management policies at all levels of government. They also recommended promotion of knowledge on waste management through workshop, seminars and conferences and sponsorship of individuals to undertake community based projects on knowledge, attitudes and practices associated with waste management.

**Banga, (2013)** reported from his study, household knowledge attitudes and practices in solid waste segregation and recycling-The Case of Urban Kampala. Zambia

Social Science, that participation in solid waste management activities depends on the level of awareness, household income, educational level and gender.

**B.C. Sarker, (2012)** the study showed that the extent of general concept of environmental awareness among the local people of the study areas was satisfactory although they had average ideas about solid waste, effect of solid wastes, solid waste management, and problems associated with solid waste management, the study also showed that there is a significant difference in awareness level. A large number of respondents suggest that, management of disposal facility should be increased to a satisfactory level and awareness must be developed among all people so that the negative consequences of wastes can be reduced at a large extent.

**Saungweme, (2012)** found out that most residence of Mbare in Harare were not aware of regulatory policies on waste management. People were just disposing the waste in convenient place, and also established that there was no coordination between residence and the municipality. The people played no role in waste management and the municipality. Education to the community that waste management starts at the source (household) where the 3Rs (reuse, recycle, and reduce) can be practiced.

**Vinod and Venugopal, (2010)** have also opined that quantity of solid waste grows faster than Population. The fact that some people are not aware of proper waste management strategies. As well as showing less concern to be involved in household waste management has resulted in the generation of large volume of waste in the city. The findings of the present study, shows that respondents were well aware of the importance and complications of waste management. But they are lacking in the practice of proper waste management.

**Bortoleto et.al, (2012)**believed that the knowledge of individuals is recognized as an important and influential factor in practices and to a large extent facilitates the implementation of recycling programs and ensures their success.

**Nag A, (2005)**stated thatcommunity counselling is a process used to build awareness that can change the attitudes and behaviors of a person or group of peoples. This strategy can be used to raise awareness about the environment. Someone who really

cares about the environment has the knowledge, attitude, and behavior necessary to create an alternative solution that involves both individuals and society.

One of the most important factors in the MSW is the public participation. Public participation is necessary for success of any health program, without which health will not have an enforceable guarantee (**Bertram et al., 2002**). The main way to exploring public interest and participation in the abovementioned issues is to study the knowledge, attitude and general opinions toward solid waste management and recycling (**Ghanbari et al., 2016**). In most developed and successful countries, such as Germany, the recycling program has started by educating and engaging people in the field of waste separation from origin; as 90% of the German population is active in the waste separation plan (**Schwarz-Herion et al., 2008**).

#### **2.4.1. Success stories on solid waste management**

**2.4.1.1. Musiri Special Grade Town Panchayat, Trichy District** consists of population thirty thousand with 18 wards. Daily waste collected up to 6000kg per day and they have 11 transfer points with 10 additional people was employed for door to door collection. The following equipments 8 tricycles, 10 pushcarts, 1 power tiller and 2 tractors with trailers are available for waste management. In 2005, Musiri's 4 acre dump was filled to 70% of its capacity. Panchayat officials realized that they either had to find a new dump yard, or dramatically change the way that they manage the town's waste. They approached SCOPE, a Trichy-based NGO that specializes in sanitation, and requested help to develop a system to better manage the town's solid waste. SCOPE trained the residents of 6 wards to sort their waste at home, and accompanied Musiri officials on a tour to study solid waste management systems in Vellore and Bangalore. With Rs. 4 lakhs from the 12 Finance Commission, the town cleared 1.5 acres of its dump, and constructed a compost shed. Ten lakhs rupees of entertainment tax money is being used to build a concrete platform for vermicompost production. SCOPE designed and donated a machine for sieving the compost. The township received Rs. 1.5 lakhs from Exnora International and Rs. 3 lakhs from the DRDA to construct a decentralized wastewater treatment (DEWATS) facility for a community toilet in the compost yard. This facility treats 4,000 litres of water per day, which is sprayed on the compost windrows. House to house collection of waste has been

extended to all 18 wards. Musiri has sold over Rs. 70,000 worth of compost, and Rs. 40,000 of mixed plastic

**2.4.1.2. Mudichur Village Panchayat, Kanchipuram District** consists of population twenty thousand with 4 wards. Daily waste collected up to 2000kg per day and they have to transfer points with 30 people employed for door to door collection, street sweeping, waste sorting and compost production and 2 supervisors. The following equipments 16 tricycles, 1 power tiller and 1 tractors with trailers are available for waste management. In 2005, Mudichur Panchayat contacted Hand in Hand/SEED Trust, a Kanchipuram-based NGO, and negotiated a 4-year memorandum of understanding (MoU) by which the panchayat provides land and buildings for vermicompost production and waste sorting, and the NGO manages the waste collection and processing system. The Kanchipuram Collectorate provided Rs. 4.8 lakhs for the purchase of waste buckets and tricycles, and the construction of physical facilities. The NGO collects a monthly user fee of Rs. 20 from every household, and also earns revenue from the sale of compost and recyclable material. The panchayat officials were actively involved in raising public awareness about the new waste collection system, and painted 109 large yellow notices throughout the village. Waste is sorted into 15 categories before being sold to scrap merchants. The NGO earns Rs. 3,000 per month from the sale of vermicompost, and Rs. 6,500 per month from the sale of recyclable material. The NGO also collects Rs. 68,000 in user fees each month.

**2.4.1.3. Exnora Green Pammal** Pammal Municipality, Chennai with population 1 lakh with 21 wards, waste collected from area about 27,000kg per day and 159 people were employed with six supervisor and their work is to have door to door collection, street sweeping and segregating of waste and also the compost production. There are 150 tricycles, 45 pushcarts, 1 ox cart, 2 tractors with trailers, and 1 powertiller. The solid waste of Pammal Municipality is collected and processed by Exnora Green Pammal, an NGO that the municipality has contracted the work to. As per the terms of the contract, the municipality allocated land for the construction of a 1.1 acre waste processing and vermicomposting facility, and PepsiCo India sponsored the construction of the facility. The facility is equipped with 120 composting tanks of 1 ton capacity each, a cow shed, storage and sorting sheds, a training hall and a meeting room. The municipality also supplied collection carts, and pays Exnora Green Pammal a daily service charge of Rs.

0.95 per house that it serves. Sale of recyclable material earns between Rs. 10,000 and Rs. 15,000 per month, while vermicompost sales fluctuate according to seasonal demand, averaging 1,000 kg/month, at prices ranging between Rs. 3.8 and Rs. 10/kg.

#### **2.4.1.4. Gandhi Nagar Selection Grade Town Panchayat, Vellore District**

The Gandhi Nagar solid waste management system was inaugurated on 28 July, 2003 for population about 10,700 with 15 wards. The waste collected from the panchayat is about 1,600kg per day there were 6 people working with 1 supervisor with 8 tricycles, 2 tractors with trailers, 1 powertiller. Town panchayat officials, staff and residents were guided in establishing their system by a local Exnora affiliate. The panchayat constructed a 3,600 feet compost shed, a waste segregation cum tricycle parking shed, storage facilities, a cattle shed, and a vermicomposting shed with funding that they received from the 11th Finance Commission, the equalization fund, and the town's general funds. The panchayat officials motivated local businesses to sponsor the purchase of 8 tricycles, as well as red and green buckets for distribution to all households. In the financial year 2006-07, Gandhi Nagar sold recyclable materials worth Rs. 1,76,005, and compost worth Rs. 37,970, and collected user fees of Rs. 3,43,334.

#### **2.4.1.5. Melpattampakkam First Grade Town Panchayat, Cuddalore District**

House to house solid waste collection was initiated in Melpattampakkam in March, 2007, by the town chairperson, Mr. V. Jeyamurthy selected a 40 cent plot of government land on which he constructed 22 vermicomposting bins, a drying floor, a storeroom and a covered sorting area with 8000 population and 15 wards. He received Rs. 10 lakhs from the Commissioner of Town Panchayats to establish these facilities, and Rs. 2.6 lakhs from the 12th Finance Commission to purchase equipment. Operating costs are covered by funds received from the town's general fund, devolution grants, and by the revenue generated through vermicompost sales. He trained his staff in vermicomposting, and receives consultation from Eco-Pro, Auroville. He charges residents no monthly user fee for collection service. He earns Rs. 4,500/month from the sale of vermicompost, which he prices at Rs. 3/kg for bulk sales. He has not yet sold his recyclable materials, which he sorts into 15 categories.

#### **2.4.1.6. Ambikapur, Chhatisgarh State- TRASH TO TREASURE**

Ambikapur is a small town set in the northern hills of Chhattisgarh. It is the headquarters of the district Sarguja. Ambikapur town has a large number of settlers, mostly traders coming from various States. The municipal area of the city is divided into 48 wards.

This case study of effective management of solid waste covers Ambikapur's journey to becoming a landfill free city. The model adopted by Ambikapur is of scientific, sustainable and cost effective nature. Through sustained efforts the city is now successfully converting its trash to treasure. The SLRM model has also generated hundreds of green jobs without putting a financial burden on the state treasury.

Ambikapur's SLRM model is an excellent example of how we can protect our environment and generate livelihood opportunities with proper management and efficient use of resources. Ambikapur, like any other town in India faced the challenge of proper segregation, collection and disposal of solid waste. Waste disposal largely meant dumping waste on land, occasionally, the waste was also burnt on streets, either way, creating major environmental hazard.

Ambikapur has become a role model for all the urban local bodies (ULBs) in Chhattisgarh for its successful solid liquid resource management (SLRM). The landscape of the city has changed drastically in the last three years after the implementation of the project due to combined efforts from the government and the residents. The city has successfully become one of the few landfill free cities of India. Through the SLRM model, the city has also generated livelihood opportunities for 623 members of Self- help groups. Through sustained efforts, Ambikapur has now achieved 100% segregation of waste at source.

#### **2.4.1.7. Mysuru- Karnataka state- Pioneering Zero garbage centres.**

The historic settlement of Mysuru, is one of south India's most enchanting cities, famed for its glittering royal heritage and magnificent monuments and buildings. Mysuru is noted for its heritage structures and palaces, including the Mysuru Palace, and for the festivities that take place during the Dasara festival when the city receives a large number of tourists from around the world.

The city of Mysuru has been covered in this book for being one of the pioneering cities in providing sustainable solutions for waste management. The corporation has set up 9 Zero waste management units and 47 material recovery facilities in the city, which cater to 200 MT of waste generated, whereas the remaining 200 MT goes to a centralized waste treatment facility, which has a waste to compost plant for treating wet waste and a material recovery facility for recovery of recyclables.

With rapid urbanization and increase in tourism, Mysuru witnessed a surge in consumption which led to improper management of solid waste. From 280 MT per day a decade ago, the waste generation has now increased to 400 MT a day. The city had set up a waste to compost facility, way back in 2001, but the plant was not receiving segregated waste then. Unsegregated waste at source resulted in higher costs and inferior quality compost. To combat this problem, Mysuru started the campaign to segregate waste at source in a big way. This campaign also resulted in formation of Zero waste management units and Material recovery facilities in the city.

#### **2.4.1.8. Wonders with waste—A Kanpur success story**

The integrated solid waste management project in Kanpur offers hope. Located on the western bank of the Ganga, Kanpur is an important industrial city of Uttar Pradesh, the largest state of India. With a population of 36 lakh (3.6 million) and a total area of 260 sq km, the city is divided into 110 Municipal Wards. Kanpur has been home to textiles, leather, fertilisers and arms manufacturing, each with its capacity to pollute.

The state of solid waste management in Kanpur was no different from most other Indian cities until only a few years ago. Kanpur Nagar Nigam (KNN) had the responsibility for collecting, transporting and disposing of the solid waste generated in the city, estimated at about 1,500 tonnes per day. There were numerous collection centres in the city, more than 400 of which were open dumps. A fleet of 132 vehicles and 3,000 safaikarmacharis were supposed to collect and transport the city garbage and dump it at an authorised site a few kilometres away from the city. This they did at an annual cost of R42 crore, which has now come down to about half. Scientific disposal of the garbage was not even contemplated. The collection and transportation activity was financed out of grants from the State Finance Commission. A community of rag-pickers was involved in removing recyclable waste from the waste chain.

It is worth recalling that it was only in 2000 that the Government of India, exercising its powers under the Environment Protection Act of 1986, notified the Municipal Solid Waste (Management and Handling) Rules. The Supreme Court played an important role in nudging the Government of India to act in this area, which is otherwise the responsibility of the States. The Jawaharlal Nehru National Urban Renewal Mission (JNNURM) launched by the Government of India in 2005 further focused attention on the need to improve public service delivery in urban areas in general and solid waste management in particular and provided funds to support such activity.

Door-to-door collection of garbage is being done in bins attached to rickshaws by safaimitras using hand gloves and protective masks. The garbage is directly unloaded into refuse compactor trucks of varying capacity, which can typically take the load of 40-50 bins. This way, the garbage is compressed while being transported and more of it can be accommodated in the vehicle. There are still a few dumpsites on the streets, but they are on their way out. Each transport vehicle is equipped with GPS and every incidence of the compactor halt to collect garbage is monitored and recorded. This minimises the scope for deception and discourages fuel theft.

Monthly user charges have been set by KNN in the range of Rs. 30-50 for households, Rs1,000-6,000 for industry and Rs15 for the urban poor. These are collected by A2Z on behalf of KNN, and the monthly collection. To sensitise people to the benefits of door-to-door collection, there was no charge in the first three months. Mr Vikram Singh, former Municipal Commissioner of Kanpur and the promoter of this partnership says, there is scope to recover up to Rs1.5 crore from user charge collection. And rag-pickers have been given the opportunity of starting a new life.

The Kanpur Waste Management Plant is the largest producer of compost from organic waste; about 50% of the waste collected from Kanpur is biodegradable. The quality of the compost is enhanced by scientific inputs coming from the R&D lab at the plant. The premium quality organic fertilizer is sold through fertilizer marketing companies like KRIBHCO, IPL, Coromandel, Green Star, and also directly under their own brand Vasundhara. The plant is not able to meet the growing demand for organic fertilizer, thanks to the Fertilizer Control Order of 2010 that has defined the specifications

of the compost made from organic sources (including food components) and the scarcity of quality compost in the country.

**2.4.1.9. Solid waste management in Namakkal town – A Success story**

Namakkal has the distinction of becoming the only zero garbage town in the country. In order to achieve this they have practiced, door to door collection, introduced night sweeping, beautified parks and burial grounds, removed encroachments on all the roads and streets, prevent road side hotels and shops, green belt development on highways, levy charges for hotels, marriage halls, commercial complexes and garbage generating industries, and manufacturing of vermi-compost from organic waste. This experiment has been successful due to a holistic approach with all agencies cooperating together under the leadership of the District Collector.