Review of Literature

CHAPTER-II

REVIEW OF LITERATURE

Solid waste management attracted the attention of various Environmentalist, Social Scientist, Engineers, Administrators and Academicians and researchers. This is a very interesting field of study where the researchers look upon solid waste from different perspectives. An attempt has been made to review the literature available related to solid waste management. The literature pertaining to the current study is classified under the following heads,

2.1 Studies related to those who create the waste

2.2 Studies related to sanitary workers

2.3 Studies related to waste disposal

2.4 Related studies

2.1 Studies Related to Those Who Create the Waste

Solid waste includes garbage, rubbish, refuse, sludge from waste water treatment plant, or air pollution control facility, and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, municipal, commercial, mining, and agricultural operations and from community and institutional activities. This section includes studies relates to the generation of waste, household solid waste management and willingness to pay for solid waste management.

Misra and Mani (1993) calculated the quantum of per capita waste generated at Colombo, Bangkok and Singapore as 0.42 kg, 0.45and 0.87 kg respectively. To Ward(1993**)** it was 1.51 kg for Kuwait , 1.51 kg for Germany ,0.8 kg for United Kingdom, 0.45 kg for Yeman ,1.98 kg for the United States of America and 0.41 kg for India. Another study by Qadis et.al (1996) found out that, on an average 1.76 kg of waste was generated per day in Abu Dhabi city.

Hingco (2000) estimated that, in 1993 Metro Manila of Philippines generated a total of 5440 tonnes of solid waste, which includes 0.69 kg waste generated per day and

the largest share of refuse comes from residential area. However SHARP (2005) has calculated waste management in Delhi and Toronto. Delhi has 0.45 kg and Toronto city of Canada generated 2.7 kg waste per day. The study suggested new initiatives to be formulated and implemented based on appropriate technical solutions with new forms of partnership between government, user and private sector was necessary to control the solid waste problem. Similarly SIIR (2005) reported that there is significant growth of MSW generation in India over the last few decades due to population explosion. The daily per capita generation of waste increased from 100 gms in small towns to 500 gms in large towns. Yedla and Kansal (2003) found out that of the 6256 tonnes of waste generated in Bombay every day, 17-20 percent is recyclable, but only a fraction of this is retrieved by rag-pickers. With the increasing demand for improved waste management, the authors suggested that private sector participation is essential and a Pigouvian tax is a necessary tool to make the private sector participation in solid waste management a success.

The Times of India (2006)reported that Delhi generated 8,000 metric tonnes of waste daily and 7,435 metric tonnes was put in to three landfill sites. By 2021, the waste will be three times more in quantity and require one hundred more landfill sites , unless the waste is disposed effectively.

Hoornweg and Tata (2012) made a global review of solid waste management , and reported that three billion residents generate 1.2 kg per person per day (1.3 billion tonnes per year). By 2025 this will likely increase to 4.3 billion urban residents generating about 1.42 kg/capita/day of municipal solid waste (2.2 billion tonnes per year).

Belel and Mahmoud (2013) found that average waste generation per household was found to be 0.65kg/capita/day in Nigeria. The composition shows that 67.6 percent biodegradable material and 32.4 percent were recyclable materials. Lack of adequate waste collection system and proximity to dumpsites was attributed to causing dumping by residents in drains/gutters.

Bichi and Amatobi (2013) found that 57.5 percent of the solid waste generated in Sabon-gari area of Kano in Northern Nigeria with 17.6 percent plastics and 3.0 percent metals. Per capita waste generated was 0.31kg/capita/day and the average bulk density of waste generated was 259kg/m3. The study recommended that a formal composting and recycling facilities be established within the community, and private firms can be involved for efficient and effective solid waste management in the area.

Singh et.al (2013) made a quantitative analysis of solid waste generation and revealed that 1.84 kg per capita per day and total solid waste generation was calculated as 3864kg per day. Per month and per year generation of solid waste was calculated as 115920 kg and 1110360 kg, respectively. Biodegradable solid waste accounted for 99.613 percent whereas non-biodegradable waste constitutes 0.371 percent of the total waste in Sunjwan village which is a rural area of Jammu district of Jammu and Kashmir State.

A study on the waste generated in municipality of Varanasi, Uttar Pradesh, India reported that solid waste includes food waste (31.9 percent) followed by plastic (22 percent), textile (10.6 percent), paper (9.6 percent), glass (6.7 percent), cardboard (6.2 percent), ash (5.3 percent), leather (5.7 percent) and minimum metals waste (2.8 percent). Surveys showed that per capita MSW waste generation rate is 800 MT per day, 0.217kg/person/day.(Srivastava 2014)

Sujauddin et.al (2008) found that 1.3 kg/household/day and 0.25 kg/person/day waste was generated in Rahman Nagar Residential Area, Chittagong, Bangladesh. The generation of household solid waste was positively correlated with family size ($rxy = 0.236$, $p < 0.05$), education level ($rxy = 0.244$, $p < 0.05$) and monthly income ($rxy = 0.671$, $p < 0.01$) of the households. Of the respondents, an impressive 44 percent were willing to pay US$0.3 to US$0.4 per month to waste collectors and it is recommended that service charge be based on the vol of waste generated by households. Almost a quarter (22.7 percent) of the respondents preferred 12–1 pm as the time period for their waste to be collected. This study adequately shows that household solid waste can be converted from burden to resource through segregation at the source, since people are aware of their role in this direction provided a

mechanism to assist them in this pursuit exists and the burden is distributed according to the amount of waste generated.

Monney et.al (2013) examined the characteristics and management of household solid waste in urban areas in Ghana. The study found approximately 2.3 tonnes of solid waste generated by 15 households in the study area over a 30-day period. Household solid waste is dominated by organic waste (48 percent) and inert materials (33 percent). Plastics/rubber and metals make up an average proportion of 5 percent each while textiles/fabric, paper/cardboard and miscellaneous constitute 4 percent, 3 percent and 2 percent respectively. The study recommends the pay-as-you-dump method as a cost recovery mechanism to offset waste collection costs.

Harider (2013) examined household solid waste generation in urban Pakistan. The total waste generated by household increased with household size. The state of solid waste collection was found to be poor across all income strata. The two low-income and one mid-income neighborhood did not have any municipal waste collection service. Fewer than 50 percent of the households in the high-income neighborhood reported access to municipal solid waste collection service. The rest self-disposed solid waste mostly in empty plots in the neighborhood. More than 65 percent of the households sold recyclables to waste collecting street hawkers, while another 25 percent handed recyclables to domestic workers, who in turn sold recyclables in the market.

An assessment of the municipal solid waste pollution problem Juba, South Sudan, was taken up by Loboka et.al (2014). The study revealed that average household municipal solid waste generated was 2.88 kg/day and the/capita/day was 0.38 kg. Thus, the entire city, with a population of about 231,776, generated approximately 667.5 tons/day. Plastic dominates the composition making up 72.75 percent, wood 19.98 percent, worn out textile 2.36 percent, metal 1.84 percent and organic (mostly food waste) 3.13 percent. Illegal dumping was also observed as well as open air burning. The wastes were disposed off in river bank/streambeds, especially at night and burnt on the Road sides, open spaces and near the houses. All these malpractices pose a serious health and environmental hazard to the water bodies. The

same water is being used for household purposes by the majority of the city's residents. The study also noticed that 69 percent of the wastes were disposed of randomly by the householders themselves, 22 percent by Juba city respective waste management units and nine percent by private companies. The conclusion of this assessment showed that the municipal solid waste pollution poses high risk to human health and the environment.

A study was conducted in Dehradun city to find out the correlation among residential solid waste generation, family size and income. This study covered 100 houses with different socio-economic levels such as income level and family size. There were six components of solid waste; food waste, paper, polyethylene, plastic, glass and metal which were evaluated in this study. Based on monthly income, generation of food, paper, plastic and glass waste showed non-significant positive correlation while non-significant negative correlation was found with polyethylene waste. Further, residential waste generation such as food, paper, plastic and metal showed significant positive correlation with family size whereas generation of glass and polyethylene waste showed non-significant positive correlation with family size. (Grover and Singh, 2014)

An investigation on Household Preferences for Kerbside Recycling Services in London made by Karousakis and Birol (2006) used the choice experiment method to estimate households' valuation of recycling services in monetary terms. Conditional Logit (CL) Model, Random Parameter Logit (RPL) Model were used to analyze the data. The results indicate that on an average households were willing to pay (WTP) for an increase in the number of dry materials collected, as well as for compost collection. The study concludes that further research on economic and policy instruments to create incentives for recycling is also required. Only with the right economic incentives and efficiently designed recycling services can London meet its recycling targets.

A study on household's willingness to pay for improved solid waste management in Mekelle city of Ethiopia used Contingent valuation method (CVM) for valuation and Probit and Tobit models for empirical analysis. The results revealed that WTP of households for improved SWM are significantly related to income, awareness of environmental quality and age of the household head. The study can be used by policy

makers for decision making in determining the service fee for improved solid waste management. (Gebreegziabher et.al (2007)). Similarly Hagos et.al (2008) used Tobit and Probit models to determine the factors that influence households' WTP for improved solid waste management. Income and awareness of environmental quality are significantly related to WTP.

Informing efficient and effective solid waste management to improve local environmental quality and public health through the application of the Choice Experiment Method in West Bengal, India was done by Das et.al (2008). Data are analysed with conditional logit, random parameter logit and random parameter logit with interactions models. The best fitting random parameter logit with interactions model revealed that there is significant conditional and unconditional heterogeneity in residents' preferences for improvements in SWM services. The results reveals that on an average residents of these municipalities were WTP significant amounts, in terms of higher monthly municipality taxes, to increase the frequency of waste collection, and to ensure that the waste is collected by covered trucks. contrary to this by Niringiye and Omortor (2010) found that age of the household head is negatively associated with the willingness to pay for solid waste management.

Economic valuation of private sector waste management services and households' willingness to pay for private sector solid waste management services was examined by Ezebilo (2011). The data originated from a contingent valuation survey conducted in 224 households in Ilorin in southwest Nigeria was analyzed using Tobit and censored least absolute deviations models. The use of a robust and consistent estimator to model zero willingness to pay responses was discussed. The results showed that the respondents were willing to pay more than one percent of their household income per year, which was influenced by income, education, activities of sanitary inspectors, house type and occupation. The study suggested that government agencies should be actively involved in monitoring activities of private firms regarding provision of waste management services.

Amfo-Out et.al (2012) made a study on willingness to pay for solid waste collection in semi-rural Ghana. By employing the logistic regression model, study found

that variables like mode of collection, occupation and age are seen to have a significant effect on willingness to pay. It is recommended that the district authorities should consider the most affordable mode of collection in order to get the support from the members of the society. Vitor et.al (2013) pointed out that the amount of money the households are willing to pay was influenced by their income, quantity of waste generated, education, house ownership, and number of children.

According to Yusuf (2007) the mean willingness to pay for improved solid waste management is 240.92 per month in Nigeria. Similarly a study made by Lokina et.al (2011) estimated that mean willingness to pay for improved solid waste collection service was estimated to be USh (symbol of Uganda shilling) 2,439 per month in Kampala city. However Adepoju et.al (2012) argued that environmental quality value can be estimated from what people are willing to pay (WTP) to improve or to restore their environment, using valuation techniques which measure peoples' preferences. Primary data collected from 120 households in Osogbo metropolis, was analysed using descriptive statistics and logit regression model. About 37 percent of the households dispose their solid waste through burning, while 60 percent claim to dispose off their waste on a weekly basis. Irrespective of non-reliability of waste vendors, 52.5 percent of the respondents paid between 400- 600 monthly to dispose waste.

A study on willingness to pay for the treatment of environmental hazards in Peshawar was conducted by Khattak and Amin (2013). Binomial Logit Model was used for obtaining the estimation results. The study found that income of household, family disease history; education and size of households are the major factors which affect the household's decision regarding WTP. Majority of the respondents were willing that the service may be provided by the private sector.

Ojok et.al (2013) focused on households' willingness to pay for improved municipal solid waste management services in Kampala, Uganda and estimated the total revenue and cost recovery that accrued from WTP. The households in each division of Kampala were categorized into three income groups as low, middle and high using the quality of housing in the absence of any other formal way of stratification. A dichotomous choice contingent valuation technique was used to elicit households'

WTP, using the open ended survey format of contingent valuation method (CVM). The logit linear regression model was used to obtain the WTP of the households. The factors which influenced WTP significantly were gender, in which females were more willing to pay than males. Age, household size, education level, income level, marital status and migration status of household respondents are also influence the willingness to pay. However, period lived in the area did not affect the WTP for improved MSWM services significantly.

Subhan et.al (2014) made an assessment of public attitudes and behaviour towards the improvement of urban solid waste management offered by a municipality in Malaysia by looking at the people's willingness to pay (WTP) for the improved services. Contingent Valuation Method (CVM) was used for the quantitative data analysis. The study results indicated that the households are willing to pay for the improved services and a regression model was created to show the factors contributing to the willingness to pay. The results of regression model indicate that only age, race and income have significant relation to the willingness to pay for the improved services.

A study on household demand and willingness to pay for solid waste management service in Tuobodom in the Techiman-North District, Ghana examined whether respondents' demographic characteristics (sex, age, educational level, income and employment) could affect the willingness to pay for waste management services. The study observed illicit burning, open dumping of waste and lack of waste collection containers to receive refuse in the Tuobodom community which might be the reasons for their unwillingness to pay for improved waste management service. Probit analysis reveals that respondent's socio-economic characteristics such as age, education, income and employment has no significant influence in the respondent's willingness to pay for improved waste service. Based on the findings of this study, it is therefore recommended that the Techiman-North District Assembly should provide waste collection containers to receive waste generated to curb the menace of solid waste disposal that threatened the achievement of the seventh Millennium Development Goals (Seth 2014).

Longe (2009) made a study on people's perception on household solid waste Management in OJO local government area in Nigeria. It examined the structure of household waste management system, collection and disposal within the context of a wider research on integrated solid waste management in households. The results established waste management behaviours among the respondents on solid waste management system, services, patronage of services and cost recovery methods. Public opinion and perception on solid waste management system is characterized with irregularity and inefficient collection system; with poor monitoring of the private waste service providers by the local authority. Willingness to pay for waste management services provided by the private service providers, the Private Sector Participation operators is higher among the middle and high income socio-economic groups than in the low income group. However, with the application of sustainable environmental education greater success ratio could be achieved. The study advocates for improved solid waste management system through proper monitoring of the services of the Private Sector Participation operators by the Local Government Area for improved service efficiency. Finally the research suggests appropriate lines of action on sustainability of a private sector driven solid waste management scheme.

Ultra and Ultra (2013) explored on solid waste management practices of households in the University of Eastern Philippines (UEP) and identified the problems and solutions related to solid waste management. Study finds, kitchen wastes ranked first among the solid wastes generated by the sample households in UEP Zone 1 and II. This was followed by plastics, paper, bottles, and cans, mentioned in order of importance. It is evident that the type of waste generated by households differed by household size and income. Only few households in Barangay Zone II and Zone I practices burning of plastic wastes. In all the sample barangays, waste collection from households by garbage collectors was done on a regular basis. However, the schedule and the frequency of waste collection varied among the barangays. The problems encountered in solid waste management were frequent vehicle breakdown, which resulted in delays in waste collection and consequently, accumulation of waste; lack of knowledge of proper solid waste disposal practices; lack of cooperation among

households in practicing proper disposal of wastes; and low government budget for implementing solid waste management program.

Mukui (2013) conducted a study on factors influencing household solid waste management in urban Nyeri Municipality, Kenya. The study finds that, households were not using correct methods of waste management. The percentage of households where separation of solid waste was practiced was 24.6 percent; the 75.4 percent incorrect practice was associated with carelessness, socialization style and long distances to the nearest garbage chamber. The common correct methods of solid waste management were: use of a self-provided bin for storage, use of garbage chamber, compost pit and Kerbside services for household disposal.

The enormity of the quantity of waste generated is causing serious threat to the environment and to the people at large. The severity of the problem need to be examined and measures on a war footing need to be taken to overcome the problem.

2.2 Studies on Sanitary Workers

Rag pickers or sanitary workers are the people who are actually going through the garbage bins to pick out the ‘rags’. These rag pickers, women, children, and men from the lowest rung in the society, are a common sight in most cities and towns around the country. Rag picking is considered the most menial of all activities and it is people who have no other alternative jobs and thereby they are generally driven to it. Rag pickers contribute a great deal to the waste management as they scavenge the recyclable matter thereby saving the municipality of the cost and time of collecting and transporting this to the dumps. The rag picker has a special role to play in the segregation of waste in India. The studies related to the rag pickers mainly focused on the problems faced during the waste collection.

A study on the rag pickers in Delhi with focus on their socio-economic and occupational, health aspects was carried out by Sarkar (2003).The study gave the design of policy initiatives aimed at integrating waste collection and disposal by incorporating the employment needs of the urban poor and migrants, with adequate attention to the occupational health aspect of these people.

Devi et.al (2014) made a study on the rag pickers of Greater Hyderabad Municipal Corporation (GHMC) with focus on the socio-economic and occupational health aspects. The study makes use of a database, pertaining to the socio-economic profile of the rag pickers including the working conditions, and their problems and expectations. Study finds that many children begin working as rag pickers at the young age of five or six years. The study suggested following services to be provided for child rag pickers mainly, raise the minimum age for entry into hazardous work from ages 16 to 18 and finalize the list of hazardous work , legally define a child as any person under age 18 years so that all children are equally protected under the law, establish a compulsory education age for children, increase the number of labor inspectors responsible for child labor and devote more resources to enforcement of child labor laws, provide educational, prevocational, counseling, medical, recreation and entertainment activities.

Ray et.al (2005) attempted to examine the respiratory and general health of workers employed in a disposal and at an open landfill site in India. Ninety-six landfill workers of Okhla landfill site, Delhi, and 90 controls matched for age, sex, and socioeconomic conditions were enrolled. Health data was obtained from surveys, clinical examination and laboratory investigations. Landfill workers had significantly higher prevalences of both upper and lower respiratory symptoms, and they suffered more often from diarrhea, fungal infection and ulceration of the skin, burning sensation in the extremities, tingling or numbness, transient loss of memory, and depression.

Tiwari (2008) analysed the occupational health hazards of sewage and sanitary workers who are exposed to harmful gases such as methane and hydrogen sulfide, cardiovascular degeneration, musculoskeletal disorders like osteoarthritic changes and intervertebral dischernіation, infections like hepatitis, leptospirosis and helicobacter, skin problems, respiratory system problems and altered pulmonary function parameters. The study suggested engineering, medical and legislative measures will help in protecting the workers against exposures and early detection of the effects of these exposures.

Roopa et.al (2013) pointed out the respiratory functions of conservancy workers in solid waste management sector of Chennai, India. The pulmonary functions declined

with increasing years of working. Dhakal (2010) made a clarion call to integrate to them in the formal market economy and accept them as part of the society.

A study on the activities of waste-pickers and the composition of solid wastes in Nigeria, based on a literature review and field survey at Awotan Solid Wastes Dump Site (ASWDS) in South West Nigeria, was attempted by Awpoetu (2014). It is recommended that, waste pickers and their organizations should be formally integrated into the solid waste management system, landfills should be designed to enable safe rummage by waste-pickers through garbage before it is deposited and buried and basic education should be made accessible and affordable to the children of waste-pickers.

The waste collectors played a key role in the waste management process. From primary level of collecting wastes from different area, its transportation and finally its disposal are done by the sanitary workers. The sanitary workers are prone to various kinds of illness and their condition is deplorable.

2.3 Studies Related to Waste Disposal

Solid Waste Management System involves the selection and application of appropriate technologies, techniques, and management practices to design a program that achieves business goals and objectives, while minimizing operating costs and environmental harm (Tchobanoglous, Theisen, and Vigil, 1993). In most businesses, a single choice of method is frequently unsatisfactory, inadequate, and not economical. Use of an integrated approach to managing solid waste has evolved in response to the regulations developed to implement various approaches (Tchobanoglous et al., 1993). There are a number of examples from all over India and around the world where communities have practiced managing their waste locally and set up successful community-based waste management models. ISWMS consists of reducing the amount and toxicity of wastes at the source, recycling, reusing or composting as much of the waste as is economically reasonable, burning the waste that cannot be economically recycled to generate heat in waste-to energy facilities and finally land filling the residue left out on an environmentally acceptable manner. The approach is not a hierarchical scheme, but is synergistic in nature.

Akil and Ho (2014) assess the readiness of Iskandar Malaysia community to accept solid waste recycling. The finding estimated the households‟ knowledge towards the solid waste recycling” is good and positive. However, finding shows that respondents had incomprehensive knowledge on the method of disposal as more than 50 percent of householders only recycle papers and textiles. Most of the households agreed to participate in the activities of the separation of waste if the facility is made available at their kerbside. Therefore, study recommended the government to provide more in-depth knowledge by intensifying the awareness of the households in the recycling programs.

Open dumping is the most wide spread form of waste disposal, opined Joseph (2002). The possible reasons for poor implementation could be a combination of social, technical, institutional and financial issues. Public awareness, political will and public participation are essential for the successful implementation of the legal provisions and to have an integrated approach towards sustainable management of municipal solid wastes in the country.

An attempt has been made to study the physical and chemical characteristics of municipal solid waste in Coimbatore district with an objective of composting municipal solid waste and vegetable waste with distillery and dairy effluent. The results revealed that the waste can be disposed under favorable conditions which help to solve the solid waste problem in Coimbatore district. (Hema and Rajkumar, 2009)

Chakravarthy (1995) critically examined the conventional methods in disposal of waste like landfill, incineration and composting with their environmental cost. According to him anaerobic decomposition method is more suitable for urban areas as it may be useful for solving energy problems. However Singh (1998) has made a research on urban waste disposal in Delhi and Singapore. It was found that Singapore contain higher amount of recyclable waste while Delhi is dominated in organic garbage. Integrated waste management strategy, efficient administration, public education and high level of recycling are the hallmarks of the Singaporean model of SWM while on the other hand lack of resources and their unequal distribution lack of planning,

organizational and institutional constrains and lack of civic sense are the main problems hampering high class SWM service in Delhi.

The environmental impacts of a number of waste management scenarios were compared using a life cycle assessment (LCA) computer model, a case study area in a typical South Wales valley location was selected to model the environmental and economic impacts of a number of waste disposal scenarios. An interactive micro soft excel spreadsheet model was also developed to examine the costs, employment and recovery rates achieved using various waste recovery methods including kerbside recycling and incineration. The LCA analysis showed the incineration option to be more favourable than the landfill and recycling/composting options. However, the economic modelling results showed higher running costs and lower associated jobs when compared to the other options such as recycling. The study concludes by suggesting that integrated waste management will ultimately be the most efficient approach in terms of both economics and also environment benefits.(Emery,2007)

Erikssona (2005) compared different combinations of incineration, materials recycling of separated plastic and cardboard containers, and biological treatment (anaerobic digestion and composting) of biodegradable waste with landfilling. The evaluation covered use of energy resources, environmental impact and financial and environmental costs. In the study, a calculation model (ORWARE) based on methodology from life cycle assessment (LCA) was used. Case studies were performed in three Swedish municipalities: Uppsala, Stockholm, and Älvdalen. The study showed that reduced landfilling in favour of increased recycling of energy and materials lead to lower environmental impact, lower consumption of energy resources, and lower economic costs. Landfilling of energy-rich waste should be avoided as far as possible, partly because of the negative environmental impacts from landfilling, but mainly because of the low recovery of resources when landfilling.

Sanitary landfills offer a viable option for the Common Service Councils (CSCs) which are responsible for operation and management of disposal sites in the country, to deal with the environmental hazards caused by open dumps practice within its financial constraints. If sanitary landfills are conducted properly, the negative environmental

impacts can be kept to a minimum level. A study by Strathman et.al (1995) aimed to estimate the elasticity of demand for landfill using data from the Portland, Oregon metropolitan area. Municipalities finance solid waste services from general tax revenues, in which, waste generators effectively face zero marginal costs. Here, the efficiency losses are much larger, indicating that communities would benefit from introducing vol or weight-based pricing. Another study done by Aljaradin and Persson (2010) examined the design of sanitary landfills in Jordan for sustainable solid waste management. Majorities of landfills in Jordan are practicing open dumping and thus cause various environmental problems such as health hazards, surface water and ground water contamination, odors, etc. This study discussed about the environmental, economic and social opportunities of moving open dumps toward sanitary landfills, such a transfer is necessary and it could play important roles in tackling the pressing solid waste problems and a forward step for an approach for integrated solid waste management in the country.

Vermin composting as a sustainable option for solid waste management depends the present waste generation is either disposed of in an open dump in developing countries or in landfills in the developed ones. Landfilling as well as open dumping requires lot of land mass and could also result in several environmental problems. Land application of urban/municipal solid waste (MSW) can be carried out as it is rich in organic matter and contains significant amount of recyclable plant nutrients. The presence of heavy metals and different toxics substances restricts its land use without processing. Vermin composting of MSW, prior to land application may be a sustainable waste management option, as the vermin cast obtained at the end of vermin composting process is rich in plant nutrients and is devoid of pathogenic organism. The study done by Signh et.al, (2011) suggests that the utilization of vermin compost produced from urban/municipal solid waste in agriculture will facilitate in growth of countries economy by lowering the consumption of inorganic fertilizer and avoiding land degradation problem. Vermin composting of urban/MSW can be an excellent practice, as it will be helpful in recycling valuable plant nutrients.

Gaja And Abbasi (2008) analysed one of the most versatile and remunerative techniques for handling biodegradable solid waste is composting. Compost also has an inexhaustible market as a soil conditioner and fertilizer. Apart from being a source of nitrogen, phosphorus, potassium, and other nutrients for plants, compost is also believed to suppress soil-borne diseases in plants. These virtues make composting an ideal option for processing the enormous quantities of biodegradable solid wastes that are generated in the world.

Kaviraj and Sharma (2003) made a comparative study between exotic and local (epigeic-Eisenia fetida *and* anaecic-Lempito mauritii*,* respectively) species of earthworms for the evaluation of their efficacy in vermin composting of municipal solid waste (MSW). Vermin composting of MSW for 42 days resulted in significant difference between the two species in their performance measured as loss in total organic carbon, carbon–nitrogen ratio (C:N) and increase in total Kjeldahl nitrogen, electrical conductivity and total potassium and weight loss of MSW. Another study conducted by Garg et.al (2006) on vermin composting of different types of waste using Eisenia and foetida found that vermin composting (using E. foetida) was a suitable technology for the decomposition of different types of organic wastes (domestic as well as industrial) into value-added material. Similarly Ansari (2011) found that organic waste (grass clippings and water hyacinth) were successfully processed through partial biodung composting and vermin composting during the period of 60 days. This could lead to a suitable environment-friendly effort towards a balanced ecosystem. Suthar(2009) found that vermin composting can be an efficient technology to convert negligible vegetable-market solid wastes into nutrient-rich bio fertilizer. To Aalok et.al (2008) examined vermin composting is a better option for organic solid waste management. Epigeics like Eisenia foetida and Eudrilus euginiae were used in converting organic wastes (agro waste and domestic refuse) into vermin compost.

Chudhari et.al (2011) highlights the application of vermin composting for treatment of organic solid waste from urban residential area at Pune suggest that organic solid waste can be treated in a reasonable period of 32-34 days through vermin composting with around 60 percent reduction in the vol.

Kumar et.al (2010) made a study on management of municipal solid waste by Vermin compost a case study of Eluru. Landfills are the most common means of solid waste disposal. But, the increasing amount of solid waste is rapidly filling existing landfills, and new sites are difficult to establish. Incineration is most economical if it includes energy recovery from the waste. Energy can be recovered directly from waste by incineration or the waste can be processed to produce storable refuse derived fuel (RDF). If Municipal Corporation of Eluru (MCE) manages this wet waste an income of over rupees 0.89 crores per annum can be earned by MCE which is a considerable amount for providing of better services to public.

One of the effective ways of managing solid waste is to recover the potent energy from them through waste-to-energy (WTE) plants such as engineered landfilling and controlled incineration. Cost assessment of power generation based on MSW in Ghana showed that the average cost of electricity for landfill gas power plants with already existing closed engineered landfill emerged as the cheapest (USD 0.039/kWh) compared to landfilling without engineered sites and controlled incineration. Moreover, the average domestic employment per megawatt energy generated is higher at approximately 185 for existing engineered landfills compared to the other technologies. (Boateng et.al 2013)

Environmental groups rightly oppose the incineration of garbage because of toxic emissions and give preference to waste-to energy plant as the necessary pollution control equipment can capture most emissions and are less polluting than coal-fired plants. Environmental groups should favor such a facility because it is more environmentally friendly than the open dumping and burning procedures that are currently being used by the municipality reports by Bhada (2005)

Yedla (2005*)* analysed the energy generation and resource utilization with a case study of Mumbai municipal solid waste. It was found that the system with modified design could yield 0.157 million tons of landfill gas (0.145 million tons of coal equivalent) out of one year of solid waste generated over one year. Further, this could recover resource valued at US$2.49 million per year.

Eddine and Salah (2012) give an overview of waste to energy (WTE) technology, including conversion options and its useful products (such as electricity, heat and transportation fuel), and waste to energy-related environmental issues and its challenges. Study finds Solid waste can be used as an energy source in Algeria. However, the WTE facilities must operate under strict standards, which will minimize environmental impact and adhere to the precaution principle. Implementation of landfill disposal techniques should be encouraged for the valorization of biogas. Waste-to-energy and valorization of Algerian solid waste is a new subject that needs to be developed.

Shariar and Bustam (2012) made a study entitled “Waste to energy a new dimension in generating electricity in Bangladesh”. Bangladesh generates large quantities of solid waste, which can be used to our advantage to generate much needed electricity. The bulk of the solid waste is organic in nature. This is the part of the waste that undergoes the least amount of recycling, under the present municipal system. Recycling in Bangladesh may be seen to be expensive or cumbersome, but if the organic waste could be used to generate electricity, the process would become cost effective and popular. This is a very valuable fuel for electricity generation, while coming from an inexpensive source.

Barua and Deka (2010) analyzed electricity generation from bio waste based microbial fuel cells. In this study, it has been established that voltage generated in a microbial fuel cell decreases linearly with respect to time. In other words, the first order derivative of voltage generated with respect to time is a negative constant. Thus the rate of change of voltage generated with respect to time has been established to be independent of time. It has been found that a mixture of bio wastes can actually result in higher extractable current than any single component although this is not always true in general. Further, it has been found that when a component results in higher voltage production, it ends up reducing the cell life.

Edward and Kumar (2009) evaluated the situation of the municipal solid waste management in Trivandrum, with emphasis on unscientific landfills of solid waste. It also tried to find the challenges faced by the present system in the city. They suggested

proper management plan including mitigation measures and monitoring program to be implemented in the system to prevent or minimize the potential impact of landfills on the environment.

Sivaharsh et.al (2011) framed a model to integrate solid waste management and organic farming in a cost effective manner in the state of Kerala. A hub and spoke model for waste collection, processing and distribution of the processed manure to different farms around the processing center was designed. One of the key issues in organic farming is the difficulty in the procurement of organic manure and organic pesticides. The study concludes that integration of the two policies seems to be a viable option to solve the problems related to organic farming and solid waste problem.

The studies relates to the solid waste disposal suggest recycling, composting, landfilling and waste to energy are the best ways to reduce the effect of solid waste on environment. But these measures should be done in a proper way.

The literature relating to both generation collection and disposal is further enriched by few more studies, which had taken up both the activities relating to generation, collection and disposal. The following section deals with these activities.

To assess the generation and collection practices of organic Kitchen waste in households of Manipal, Simon et.al (2013) conducted a study. The general steps in waste management are generation, collection, sorting, separation, transfer, transport and disposal. This study was aimed at understanding the management practices at the first two steps only ie. generation and collection. The study brought out the various types of wastes generated the constituents and their quantum in organic kitchen wastes as well as the activities which happen at the generation and at the two waste collection points.

Visvanathan and Trankler (2003) made a comparative analysis on Municipal Solid Waste Management in Asia. The present scenario of municipal solid waste management (MSWM) in four countries of Asia – namely China, India, Sri Lanka and Thailand is highlighted comparing technical, economic, legal and, health issues The system adopted for collection, transportation and disposal is similar but unique to Asia,

unlike in the developed countries where the MSWM is formalized. This uniqueness is attributed to the waste composition, involvement of the informal sector, voluntary groups, private organizations, NGOs, and community based organizations (CBOs), and rapid privatization of collection, transportation and processing systems. Composting is seen as a major processing system for almost one half of the waste which is biodegradable and can be enhanced with economically friendly source separation techniques like in the developed countries.

Study on Municipal Solid Waste Management in Mysore City, was made with regard to the methods of practices associated with sources, quantity generated, collection, transportation, storage, treatment and disposal of Municipal solid waste in Mysore city. This study revealed that the present system of MSWM in Mysore city was not satisfactory based on Municipal Solid Waste (Management & Handling) Rules 2000. (Chandra and Devi 2009)

An exploratory study on municipal solid waste management system and energy recovery in Tiruvallur, India, includes review of the waste generation, characterization, collection, transportation, disposal of MSW, Government participation and available income to government through municipal solid wastes. This study recommends a better MSWM strategies and economical integrated SWM system. The proposed Municipal Solid Waste Management system provides better waste handling and processing and also provides various economic strategies from MSW. People lack knowledge about impact of MSW and hence they require awareness and training for their involvement to overcome various environment and health hazards due to improper disposal of waste. The government should undertake the SWM for better implementation to protect our environment and public health. It also found approximate available revenue to government of about Rs.13,81,842 from solid wastes. The possible electricity generation from Municipal Solid waste of five municipalities is found about 1.8 MW per day using RDF by Incineration process. Bio-gas can be obtained about 5040 m3, Organic Manure of about 25200 kg per day can be produced by various composting techniques. Rather than considering the municipal solid waste simply as residue to be thrown away, it should be recognized as resource materials for the production of

energy, compost and fuel depending upon the techno-economical viability, local condition and sustainability of the project on long term basis. (Arivukkarasu and Lakshmi 2014)

Nirgude (2014) find the mean per capita per day waste generation was 125 grams and majority of respondents i.e. 54.3 percent were having poor knowledge levels regarding segregation of solid waste. The most common problems for waste disposal reported were non availability of dust bin (36.2 percent) and municipal van (30.7 percent) for regular collection of solid waste.

A study on municipal solid waste management practiced in the six major cities of Bangladesh, namely, Dhaka, Chittagong, Khulna, Rajshahi, Barisal, and Sylhet was conducted to identify the solid wastes management steps such as storage at source, separation, on-site storage, collection, transportation, treatment, reuse, recycling, and ultimate disposal. Study addresses the role of the city authority to meet the demand of the city dwellers in solving this emerging socio environmental issue and the initiatives taken by some nongovernmental organizations and community based organizations. The problems and constraints of the solid wastes management system are also identified to find a sustainable management concept for the urban areas of Bangladesh. Present situation of ultimate disposal sites (UDSs) requires improvement by providing a sanitary landfill mechanism in the existing sites. Recycling can be extended with wide varieties of articles both in the formal and informal sectors. Government support should be provided in composting, a prosperous sector for managing a huge amount of organic wastes in Bangladesh. Since there is no single solution, the proposed techniques can be used to select an integrated solid waste management system based on the local needs, socioeconomic settings, and technological capabilities to ensure the acceptability of the adopted system and the environmental sustainability.(Ahsan et.al,2014)

Choudhury and Choudhury (2014) made a study entitled trends of urban solid waste management India, gives an account of existing solid waste management process of Agartala city. There is a need to improvement of technical expertise and proper manpower management for solid waste management process because of huge

rise in waste generation per day and now it is exceeding 260MT per day. Though AMC under took a project for recycling of wastes but, only nearly 50 percent of total wastes can be used for this process because rest are either non bio-degradable or not suitable for recycling process. Thus wastes remains and accumulates gradually so, AMC have to take some advanced technical measure to handle this problem further. Probability of gas production from wastes of Agartala city was reported by FICCI (Federation of Indian Chambers of Commerce and Industry), (2009). Segregation of wastes is very important and need to take care during and before the collection time as it is observed there is no such measures adopted so far in this regard. AMC (Agartala Municipal Corporation) has taken many measures as per rule 2000 MSW and trying their best to tackle the solid waste management system and improving the situation.

Khan (2014) calculated MSW generation in Srinagar has increased tremendously from 180 tons in 1981 to 530 tons in 2011. The daily per capita generation of municipal solid waste in India ranges from about 100 gm in small towns to 500 gm in large towns and in Srinagar it is 271 gm. Currently 65-70 percent of municipal solid waste generated in Srinagar city is collected by door to door collection method and street bin systems and is transported for dumping to open landfill site which is at Syedpora Achan about 6 km from center of Srinagar city and the remaining 30-35 percent of waste is dumped illegally into depressions, river embankments, unattended open spaces or is locally burnt both by individuals or Safia Karamcharis creating nuisance for public as well as acting as breeding centers of some diseases. This study recommends and suggests that clear goals and timeframes need to be established, duties and responsibilities of local government, NGOs and Srinagar Municipal Authority and funding needs to be allocated in order to produce an effective waste management framework in the City.

2.5 Related Studies

The Urban Solid Waste Management System (USWMS) is intrinsically complex, because it involves different connected problems and must achieve objectives which are often in conflict. This study concerns the development of a location-allocation model for planning USWMS and some heuristic techniques for solving it. The results of the study identify the location of waste disposal plants, specifying the technology adopted,

the amount of waste processed and the service basin of each plant. Particular care is given to the case of the Italian region Lombardy: the regional USWMS law is in fact a useful stimulus for a constructive comparison between the actual system and possible alternatives. (Carusoet.al 1993)

Hong (1999) analyzed initial effects of adoption of a unit pricing system paired with aggressive recycling programmes appear to be substantial. Study explores the impact of price incentives under the unit pricing system on household solid waste generation and recycling in Korea. Simultaneous equation model considering the feedback effects between total waste generation and recycling. Estimation results using 3017 Korean household survey data indicate that a rise in waste collection fee induces households to recycle more wastes. However, this effect is partially offset by decrease in source-reduction efforts due to the feedback effects, resulting in relatively lower price elasticity of demand for solid waste collection services. This implies that household demand for solid waste collection services will not decrease much with additional increases in the collection fee, unless further recycling incentives such as more frequent recyclable pickup services are accompanied.

Life cycle assessment for integrated solid waste management was to be one of the holistic approaches to environmental and resource management which are emerging from applying the concept of sustainable development. Assessment of waste management options requires application of Life Cycle Assessment (LCA). Clift et.al (2000) suggested LCA of waste management is best seen as a way of structuring information to help decision processes. Similarly Solano (2002) examined integrated solid waste management (ISWM) model to assist in identifying alternative SWM strategies that meet cost, energy and environmental emissions. The model is flexible to allow representation of site-specific issues, including waste diversion targets, mass flow restrictions and requirements, and targets for the values of cost energy, and each emission. However Velumani and Meenakshi (2007) suggested Life cycle impact analysis should be carried out which helps the decision makers and planners to have integrated solid waste management for sustainable growth**.**

A study by Chatterjee (2010) mainly focuses on the issue of management of municipal solid waste in Kohima town and also describes its existing systems, the way of dealing with the present upcoming problems and also suggests new innovative approach for effective management of municipal solid waste in Kohima town. The surveys have shown that the collection process is deficient in terms of manpower and vehicle availability. Bin capacity provided is adequate but locations were found to be inappropriate, thus contributing to the inefficiency of the system. At this time, no treatment is provided to the waste and waste is dumped on open land after collection. The study found that, lack of suitable facilities (equipment and infrastructure) and underestimates of waste generation rates, inadequate management and technical skills, improper bin collection, and route planning are responsible for poor collection and transportation are the major issues of municipal solid waste management.

Sotamenou (2010) made a study on determinants of re-cycling and use of domestic waste in urban swamp areas of Yaounde in Cameroon. The study pointed out that the production of vegetables, the short distance between the house of the farmer and their farm, the use of recycled livestock wastes, the level of education and the surface of the farm have a positive effect on the decision to use domestic waste in the swamp areas. On the other hand, the age of farmers have a negative effect. In fact, the closer the farmers live to their farm, the more likely they will use recycled domestic wastes. To promote good management of domestic waste and safe urban and semi-urban agriculture in the swamp areas, the implementation of transfer station of waste collected, in or next to swamp areas, seems to be a solution.

To Balasubramanian and Birundha (2012) the number of trips made to dump site were statistically significant in determining the quantity of waste collected and disposed by the waste contractors.

Ansari (1999) suggested that for improvement in solid waste management in Delhi," polluter pays" principle should be used and heavy fines to be imposed for littering. He recommends Public private partnership as a good option in solid waste management of Delhi. Similarly Santosh and Namboodiri (2007) points out a major issue in waste collection is the resistance to change, at least in some sections of the

society, creating hurdles in adopting the concept of segregated storage and collection of wastes. Hence there is an urgent need to intensify extension activities so as to continuously motivate and educate the stakeholders. Buckens (1999) analysed that all the waste from society end up in one of three environmental depositories: air, water and land. Prevention, reduction ,reuse recycling of wastes are increasingly put forward as logical and cost effective ways of reducing waste streams.

Lah et.al (2002) made a critical review of the cost-benefit analysis in the literature on municipal solid waste management. A systematic measurement of environmental benefits of MSW management methods was not found and recycling may be cost-competitive depending on the situations. However, these circumstances are not clearly identified. These findings suggest that the subject of MSW management still lacks comprehensive and rigorous research that may guide both researchers and practitioners to the making of effective MSW management decisions.

Different methods of waste management emit a large number of substances, most in small quantities and at extremely low levels. Raised incidence of low birth weight is pronounced in residence near landfill sites, as has the occurrence of various congenital malformations. There is little evidence for an association with reproductive or developmental effects with proximity to incinerators. Studies of cancer incidence and mortality in populations around landfill sites or incinerators have been equivocal, with varying results for different cancer sites. The inherent latency of diseases and migration of population are often ignored. Waste management workers have been shown to have increased incidence of accidents and musculoskeletal problems. (Rushton, (2003)

Vulnerability of pollution of surface and groundwater is high because local authorities rarely considered environmental impact in sitting MSW disposal sites in Kenya. Illegal dumping of MSW on the river banks or on the Roadside poses environmental and economic threats on nearby properties. Poor servicing of MSW collection vehicles, poor state of infrastructure and the lack of adequate funding militate against optimization of MSW disposal service. Involvement of stakeholders is important to achieve any meaningful and sustainable MSWM. The role of the informal sector through community-based organizations (CBOs), Non-Governmental Organizations

(NGOs) and the private sector in offering solutions towards improvement of MSWM also is to be explored states Hentry (2006)

Harilal et.al (2007) made study on quantification, characterization and management of solid waste in Mahe, union territory of Pondicherry. Survey results indicate that Mahe municipality does not have an effective and sustainable solid waste management system. This is due to lack of operational disposal sites, adequate technology and infrastructure.

Norton (2007) examined the race, wealth, and solid waste facilities in north Carolina by using secondary data. Study pointed out that solid waste brings numerous public health concerns. In North Carolina solid waste facilities are disproportionately located in communities of low wealth. In the absence of action to promote environmental justice, there is continued need for new facilities to prevent harmful effects on health.

Geographic Information System (GIS) is a computer tool for capturing, storing, querying, analyzing and displaying spatial data from the real world for a particular set of purposes. This technique is used to generate optimal route for collecting solid waste. GIS is a tool that not only reduces time and cost of the site selection, but also provide a digital data bank for future monitoring program of the site. A study done by Ramachandra and Bachamanda (2007) by using GIS considered several factors in the sitting process including geology, water supply resources, land use, sensitive sites, air quality and groundwater quality. Weights were assigned to each criterion depending upon their relative importance and ratings in accordance with the relative magnitude of impact. The systems showed the effectiveness in the site selection process and identified areas with waste. Similarly Rahman et.al (2008) suggested that GIS can provide an opportunity to integrate field parameters with population and other relevant data or other associated features, which will help in selection of suitable disposal site to understand the practice and identify the lacunae. Studies on a similar vein were taken up by Thanh et.al (2009), Yahaya (2010), Anifowose (2011) and Hanbali (2011).

Optimal location and proximity distance of municipal solid waste collection bin using GIS was done in Coimbatore city. The proposed number of collection bins was assessed according to MSW generation in the ward. Then the optimal positions were found with reference to existing bin locations, Road network and population density. Moreover, based on the public preferable walking distance to drop the MSW to the collection bin, a model was developed. In this model, the three different proximity distances such as 50m, 75m and 100m around existing and proposed bins were generated and found the optimal distance. As a result, the entire area was covered by 75m distance around the collection bin with 99 percent. Nithya, (2012) suggested some modifications in existing system and recommend of this as a best possible collection service.

For the urban poor in developing countries, informal waste recycling is a common way to earn income. There are few reliable estimates of the number of people engaged in waste picking or of its economic and environmental impact. A study by Medina (2008) suggested that when organized and supported, waste picking can spur grassroot investment by poor people, create jobs, reduce poverty, save municipalities money, improve industrial competitiveness, conserve natural resources, and protect the environment.

Shakira et.al (2008) examined the solid waste management in Mettupalayam. The study focused on the quantity and compositions of MSW which vary from place to place, and bear a rather consistent correlation with the average standard of living. These shortcomings pertain mainly to inadequate manpower, financial resources, implements and machinery required for effectively carrying out various activities for MSWM. The study suggested that the integrated waste management will provide salubrious environment to the town making it green and clean town, environmental friendly, garbage and dust free, implement vision plan with 100 percent commitment.

Waste minimization in the form of proper waste segregation and utilization, the importance of pre-treatment of organic waste and combustible waste fraction does not only manage the waste but also generates products such as compost and renewable energy, says Visvanathan (2006).

Technical, economical, and environmental aspects of three SWM scenarios were investigated aiming to compare the scenarios and select the most appropriate one for implementation. Scenario 1 was to consider waste disposal into a sanitary landfill. Scenario 2 added waste transportation to transfer station before disposal to a sanitary landfill. Scenario 3 considered waste sorting, recycling and composting followed by landfill disposal in an integrated treatment disposal facility. The open dumping practice was considered as the baseline scenario. According to economic analysis, the benefits from the revenues of selling the produced recyclables and compost did not improve the ranking of scenario 3. However, scenario 3 has gained positive recognition due to the environmental benefits of waste recycling (Elagroudy et.al, 2011).

Taxila city is facing the worst solid waste management issues due to rapid urbanization, industrialization, insufficient funds and poor management notes Ejaz and Janjua (2012). Open dumps of municipal solid waste are causing serious negative environmental impacts in the area. Research findings are clearly indicating that due to rapid growth in population, increments in solid waste generation rate, poor management, non-implementation of solid waste legislation and lack of funding are responsible for the solid waste management crises in the Taxila city.

Decision support systems (DSS) are used to aid at solid waste management. The model, currently developed in MATLAB, is applied on recycling scenarios based on the degree of expansion of the different source collection schemes operating in Greece. Abeliotis e.tal (2012) points out that the existing schemes may not fulfill the recovery goals for packaging waste in Greece. Improved collection schemes are required, based on more pilot programs in order to investigate the optimum recycling strategy.

The main objective of the study of Annepu (2012) was to find ways in which the enormous quantity of solid wastes currently disposed off on land can be reduced by recovering materials and energy from wastes, in a cost effective and environmental friendly manner. Lack of data and inconsistency in existing data is a major hurdle while studying developing nations. This report attempted to fill this gap by tabulating the per capita waste generation rates and wastes generated in 366 Indian cities that in total represent 70 percent of India’s urban population. Estimations made by extrapolating this

data puts the total MSW generated in urban India at 68.8 million tons per year (TPY) or 188,500 tons per day (TPD). The data collected indicate a 50 percent increase in MSW generated within a decade since 2001. In a “business as usual scenario”, urban India will generate 160.5 million TPY (440,000 TPD) by 2041; in the next decade, urban India will generate a total of 920 million tons of municipal solid waste that needs to be properly managed in order to avoid further deterioration of public health, air, water and land resources, and the quality of life in Indian cities. In a “business as usual” scenario, India will not be able to dispose these wastes properly.

Mojisola (2012) carried out a study in Ndola, the provincial capital of the Copperbelt province of Zambia with the aim of evaluating the methods of solid waste disposal, the level of access to solid waste management services, and Ndola residents’ attitudes towards solid waste management. Sixty households were randomly selected for the study. The results showed that there is an inadequate solid waste management facility in Ndola even though up to 80 percent of households in medium density areas indicated willingness to pay for waste collection and disposal services. The lack of environmentally friendly, sustainable and affordable waste management has led to the wide spread open dumping and open burning of solid waste. This calls for concerted efforts at increasing efforts towards waste minimization, utilization and management.

Data gathered within the past thirty years have revealed significant increases on waste quantity generated in Bahrain. The limited land area, characterised by Bahrain’s small geographical space, is the biggest factor that contributes to the problem of managing the increasing waste accumulation of the country and finding sustainable systems of waste management. Sustainable waste management systems through the adoption of Integrated Solid Waste Management (ISWM) is analyzed as a probable solution towards solving the hazards and complexities posed by current waste management problems. (Ansari, 2012)

Vasanta and Priyasauni (2013) analyzed the waste management strategies and the need of PPP model for Agra. Agra city approximately generates 2000-2500 tons of Solid Waste per day. The entire solid waste disposal is not an easy task. Therefore, there should be a mixed effort of the public and the private. A planned and concerted

effort is required to bring about awareness among the public and make them realize their responsibilities as individuals and as a community. The study finds, public awareness, community participation, transparent administration, accountability at all levels is the need of hour so as to ensure success of any MSW management plan. The solid waste management systems in the city would be set up on a public private partnership model. Fifty per cent of the cost will be borne by the Centre, 30 per cent by the municipal corporation and 20 per cent by the state government. The most important thing for success of PPP is that people would continue to pay if the system delivers in its performance. The prime reason for failure of PPP has been loud promises and assurances but unsatisfactory performance. NNA should see this as a very important strategy for fund raising and improving its user charges and ensure that people expectations are met by making the PPP arrangement strong and effective.

The study on the compositions of Bhopal municipality waste were estimated and analysis for better MSW management. Inappropriate bin locations and poorly designed community bins, collection vehicles that are in poor condition, inadequate labour for collection and transport of waste, and lack of waste treatment and disposal facilities were major problems in Bhopal. Thirteen samples were characterized and their promixate, ultimate analyses and calorific value were done in the laboratory. The average values of various parameters were density=314.9 kg/m3 , low and higher calorific values= 2244.2 and 2411.7 kcal/kg respectively, moisture content= 28.1 percent, ash= 15.6 percent, fixed carbon=9.5 percent, volatile matter= 46.6 percent, Carbon= 26.6 percent, Hydrogen=5.9 percent, Oxygen=47.7 percent, Nitrogen=1.1 percent, Sulphur=0.98 percent, Phosphorus= 0.84 percent, Potash=0.93 percent, C/N Ratio=26.6. Segregation helps in proper utilization of organic waste for composting. MSW in Bhopal has high moisture content and low calorific value, making aerobic composting the best treatment strategy. (Katiyar 2012)

Rapid urbanization and population growth of Bhubaneswar city is bound to bring an increase in the overall waste generation in the coming years. In the city, solid waste management falls short of the desired level as the systems adopted are out-dated and inefficient. Further institutional weakness, shortage of human and financial resources,

improper choice of technology, inadequate coverage and lack of short and long term planning are responsible for the poor state of affairs. The city is facing these deficiencies in varying degrees and there is a need to make substantial improvement in the MSW practices prevailing in the city to raise the standards of health, sanitation and urban environment keeping pace with the rapid urbanization and growing population. There is therefore, an urgent need to improvise the situation to stop further decay and deterioration of the city. Concerning the hierarchy of the principles and the methods for MSW management defined by the national legislation, Bhubaneswar has a long way to go and, therefore, there is a considerable amount of effort to be done in order to obtain real and significant positive evolution in MSW prevention, reduction and recovery.(Mohanty 2014)

Singh et.al (2014) emphasized on the adverse environmental impacts, health risks, poor waste management practices and also problems associated with the solid waste management system at the municipal level. The findings from this study indicates failure of the existing facilities due to apathy, high vol of waste generation, inadequate collection space, delayed sanctioning of new landfill sites and a number of open-dump sites which generate fires. An assessment of the public perception indicated that most people lack knowledge of the harmful effects of waste heaps including the fact that they are breeding grounds for flies, cockroaches, and mosquitoes and also large number of rodents which are responsible for transmission of germs and zoonotic infections to sanitary workers, rag-picking children as well as people living nearby.

A case study on Municipal solid waste characterization and it's assessment for potential compost production, in Zanjan city, Iran was conducted by Fathi et.al (2014). The samplings of MSW were performed in all four seasons during 2010 and the contents of its main components were determined. The qualitative and quantitative results indicated that the composting of MSW is feasible and can be adopted as a proper MSWM approach in the area. Recycling of paper, plastic and glass along with composting of MSW are highly recommended.

An attempt has been made to study the impact of increasing population on the amount of waste generation through System Dynamics (SD) Modeling on the basis of

which effective strategies could be developed for managing the same. With the increase in population one can observe that there is an exponential increase in the MSW generation. Hence, necessary action should be taken so as to reduce the waste either by disposing it or recycling periodically. The other way is to conduct awareness programs for the people in the cities regarding the waste generation and its effects on human health and sustainability. Proper planning should be followed by industries. By practicing this we can reduce the generation of some waste so that it creates a healthy environment both for the humans and the animals to live (Pai, 2014).

An attempt has been made to assess the existing solid waste management system, environmental concerns, and the future interventions with respect to environmental and social well being. Study of the Shimla urban local body, a civil society organization and increasing private sector participation in waste management arena highlights the issues of effectiveness, institutional weaknesses and relevant planning. Successful implementation of the door to door garbage collection in challenging terrains, optimized route planning, scientific treatment and disposal planning of inert on regional landfill model in Shimla city is documented. The user charges model with effective recovery mechanism is presented as a solution to the rising SWM associated costs. This study emphasizes the stringent enforcement of the Municipal Solid Waste Management and Handling Rules, 2000 through systematic planning process and emphasizes the need to take holistic view of state toward municipal solid waste management (Bharti, 2014).

2.5 Conclusion

The review of literature suggest that most of the studies have been done on issues related to generation of solid waste, collection of waste , disposal, problems of sanitary workers, other related areas like, GIS and private participation for waste management. Much work has not been done in India with regard to process of solid waste management. The earlier studies probed into these issues separately. In the field of waste generation, the quantity has increased in the recent years due to development activities. With regard to collection of waste it is not done in appropriate manner leading to environmental damage and health hazards. The workers need to be trained in

collection and transportation of waste. If vermin composting and electricity generation is attempted on a greater level the quantity of waste management and evil effect can be reduced and on the other hand it would create an option for electricity generation and also enhance organic farming. The present study intends to analyse the problem of those who creates (households) those who collects (sanitary workers) and those who dispose (recycling unit) and also suggest the suitable policy to improve the solid waste management in Coimbatore municipality.