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**Declaration:**

I, Muhammad Shahzad Hafeez, declare that this thesis is a result of my research investigations and findings. Sources of information other than my own have been acknowledged and a reference list has been appended. This work has not been previously submitted to any other university for award of any type of academic degree.

Signature.....

Date.....

## **Acknowledgements**

I am thankful to individuals and organizations which made completion of my thesis a success.

I am indebted to my supervisor, Jens Bernt Aune for giving me his time, fruitful guidance and suggestion on my work.

I am thankful to the officials from the Oslo Kommune and Lahore Waste management Company (LWMC) and library staff at the UMB for giving me insights into newer developments in the area of Solid Waste Management (SWM)

Finally I would like to indebted to my parents and family in supporting me in the academic endeavors

## **Abstract**

The research is devised on two themes as; describe and compare solid waste management practices in Lahore (Pakistan) and Oslo (Norway). Solid Waste Management (SWM) is an important technique in the present times which works on the philosophy of Reuse, Reduce and Recycle and helps in containment of various environmental problems.

In the developing countries waste contamination has become an important problem. My prime motive to select Lahore was due to the nature of environmental contamination leading to non-disposal of solid waste. The study is aimed to take cognizance of successful waste management practices in Oslo and its replication in Lahore. However, in Oslo solid waste management has been defined scientifically at three levels; generation; collection; treatment. Waste management has been practised in Oslo since a decade and has created a benchmark for other cities to follow. The methodology for research is premised on qualitative tools. The study is based on secondary sources, for example published government reports, data and other relevant information from official websites dealing with solid waste management. The secondary data sources in the case of SWM have been able to provide a better understanding in the case of Lahore and Oslo and provided us with a detailed insight into the progress and shortcoming in both cities. We may not be able to draw commonalities on the operational front between Oslo and Lahore, but Lahore has a lot to learn from the operations in Oslo. No doubt the number of population and quantity of waste generated in Oslo is far less than Lahore but Oslo is recycling 33% of total waste and strives to reach to more than 50 % until 2014. Besides, Lahore has recycled merely 21% of the total generated waste. This is due to lack of technological facilities around 50% waste left over in streets of Lahore, whereas Oslo solid waste management collection rate is almost 100%. In case of Lahore, bio-degradable waste from one town is processed to convert fertilizer compared to the rest of six towns, the rest of municipal waste is dumped in various dumping sites creating more havoc to the human as well as animal species and ultimately harming the environment. Besides in Oslo all municipal waste treated in an organized manner. In Oslo people feel confident to pay for waste facilities because of awareness and knowledge and also due to higher socio-economic norms, but in Lahore people are reluctant to accept rules because of poor knowledge, non-functional corrupt institutions. The technical advancement of Oslo is a learning experience for Lahore having said that the latter has to tread fathom miles in order to make their solid waste

management functional. There are plethora of regulations at the federal level which impact the management and disposal of municipal solid waste in Pakistan. But application of these laws is still far from becoming a reality for the country. The lack of interest from government and local bodies has hampered advancement of solid waste management as a practice. On the other side, in Norway central government provides general instructions for law enforcement and the people at municipality level are empowered to decide about making their surroundings a clean greener and healthy place to live. Meanwhile, in Pakistan there are best of legislation in place to devise mechanism for solid waste management but at the implementation stage across the country. Lahore needs to inculcate the idea of providing environmental education at school level so that when the young children grow up and enter local or federal decision making bodies they have sensitivity towards conservation and sustainability of the environment.

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## **1.0 Introduction**

The handling of waste in developing countries is becoming more and more challenging day by day, as most of the developing countries do not have the technological advancements to deal with this problem (Korhonen et al., 2004). On the other hand, developed countries have the most advanced technological alternatives to tackle this issue. Building system according to state-of-the-art within waste management requires stable economy (Liamsanguan et al., 2007).

Waste generation is essential due to discarding of un-wanted materials away for disposal. It is a continuous activity which is not very controllable. Huge quantities of municipal solid wastes are generated in all the cities of the world. The volume of municipal solid waste generated varies with the lifestyle of the people. In 2011, Americans generated about 250 million tons of trash and recycled and composted almost 87 million tons of this material, equivalent to a 34.7 percent recycling rate. Total MSW generation in 2011 was 250 million tons (US EPA, 2013).

Waste management was categorised in the past as an engineering operation. The flow of materials and the resulting waste generation is very complex. Sources of solid wastes in a community are, in general, related to land use. Although some classifications can be developed, the following categories have been found useful: residential, commercial, institutional, construction and demolition, municipal services, treatment plant sites, industrial, and agricultural (Tchobanoglous, 2003).

The management of collection waste is most difficult and complex in an urban environment because the generation of residential and commercial-industrial solid waste and recyclables takes place in every home, every apartment building, and every commercial and industrial facility, as well as in the streets, parks, and even vacant areas. As the total quantity of waste increases, the logistics of collection become more complex. Composition of wastes also differs from locality to locality. People in a particular locality often have similar background in terms of incomes, laws and expenditure. In Pakistan strategies are being developed to tackle solid waste management. A obstacles to this is financial resources. Technologies issues associated with the control of generation, handling, storage, collection, transfer, transportation, processing, and disposal of solid waste are other problems. All of these processes have to be carried out within existing legal and social guidelines that protect the public health and the environment and are

aesthetically and economically acceptable. Waste management is an interdisciplinary problem including administrative, financial, legal, architectural, planning, and engineering functions. All these disciplines must communicate and interact with each other in a positive interdisciplinary relationship for an integrated solid waste management plan to be successful (Eid, 2007).

In the last few decades, the population, urbanization and economic activities through industrialization are increasing in Pakistan. Lahore is a provisional capital of the province of Punjab. One of the biggest challenges Lahore is facing today is huge waste production and its final disposal. In the late 80's, the government of Pakistan introduced environmental legislation and since then environmental policies and new regulations have been implemented (EPA, 2007).

On December 31, 1983 under the Pakistan Protection Ordinance, provision was made for the establishment of provincial environmental protection agency. In 1985, the federal government was requested to delegate power of agency to the Housing Physical and Environmental Planning (HP& EP) department. On July 1 1987, Environmental Protection Agency (EPA), Punjab was formed. Punjab is the first province in Pakistan where an EPA was created in the best interest of citizens (EPD, 2013). On December 31, 1996, a separate administration unit, Environmental Protection Department was formed under the government of Punjab. On February 11, 1997 the federal government withdrew the Pakistan Environmental Protection Ordinance of 1983 and declared the Pakistan Environmental Protection Act 1997; the EPA Punjab then functioned as declared under this act (EPD, 2013).

During the current presidential period (2008 to 2013), the Chief Minister of Punjab managed to tackle the solid waste management in Lahore through cooperation with two Turkish companies Al Bayark and OzPak. These companies will help transform the waste management system in Lahore over the next seven years (Malik, 2012).

In 1981, Norway introduced a law reforming the waste management. The oil crisis of 1973 led to new international interest in renewable energy sources, both as a money-saving measure and out of concern for the environment. According to Asbjørn Vinjar, et al., (2008) following this trend, Norway started looking for renewable energy sources. New forms of renewable energy in Norway include wave power, wind power, heat pumps and new forms of bioenergy, such as different types of biomass for heat production and biofuels (bioethanol and biodiesel). Bio energy represents the oldest energy source in Norway, and firewood continues to serve as a

major source of energy for heating purposes. The production of garbage is increasing in every city of Norway. Through many years incineration was used to generate heat from waste. Norway advanced methods to collect waste from different sources (Aschehoug and Gyldendal, 2013).

The character of urban waste differs between developing and industrialised countries and between larger and smaller towns. Cointreau-Levine (1998) has estimated that in developing countries the extent of organic waste is relatively high, constituting between 40-70 percent of solid waste in developing countries. The increasing use of plastics as packaging material and other inorganic materials has caused the character of solid waste to change composition in recent years (Baud et al., 2004).

Pakistan is a developing country, and is different from Norway with regard to environmental, socio-economic and cultural. Pakistan began to tackle the waste problem recently, whereas, Norway has been working on it for a long time.

The various sources of waste generation, composition of solid waste and the need for designing a strategic plan for solid waste management is needed. Public involvement is important in Norway, and public awareness is growing in developing a waste management programme includes, techniques for the recovery, reuse or recycling of solid waste, techniques of composting, and how to manage special wastes such as bio-medical waste, plastic, and e-waste (Sasikumar et al., 2009).

This thesis will focus on two different systems of waste management, and the main objective of the study is to explain and compare the systems in the Lahore, Pakistani and Oslo, Norway. Methods for waste management in two different countries will be discussed and lastly, the problems and issues relating to waste management analyzed.

### **1.1 Aim of the Study**

The aim of this study is to present an indication of the different elements of municipal solid waste management (MSWM) in Oslo, Norway and Lahore, Pakistan and to find of possible solutions that can be implemented from the MSWM system in Oslo to help to develop an integrated waste management system (IWMS) in Lahore. Characteristic MSWM information of two cities will be presented to improve understanding of their attitude toward the waste. To facilitate the comparisons of waste management between two cities, the current solid waste

management systems will be described in terms of waste generation, its composition, collection methods, transportation, treatment, disposal, waste management plan and government laws, policies and regulations. The MSWM systems in Oslo and Lahore will then be presented and compared. It will also be discussed how the Lahore city of Pakistan can learn from the experiences in Norway

### **1.1.1 Research Questions**

1. To identify, what are the differences in types and composition of solid waste in two cities like Oslo, Norway and Lahore, Pakistan?
2. To see, how are the waste collection systems, waste transportation, waste treatment and waste disposal procedures in two cities operates?
3. To investigate, waste management plans, government laws, policies and regulations in the two cities?
4. To see, what are the social and economic difficulties of Pakistan in installing an advance system for solid waste management?
5. To identify and draw recommendations for Lahore city and learning experience from Oslo.

## **2.0 LITERATURE REVIEW**

### **2.1 Solid Waste Management in Lahore, Pakistan**

The solid waste management technique in Lahore is one of the best in the whole of Pakistan and is being replicated as a model for various other cities in the country. Waste management in Lahore was developed under the Lahore Urban development project (LUDP) established in 1978. LUDP has included the component of waste management. It is divided into two sites: Gujjarpura Site and Service Scheme, Walled City upgrading and Solid Waste Management (SWM). In November 1980, a pre-appraisal mission of the World Bank first addressed a Solid Waste Management project. Metropolitan Corporation of Lahore (MCL) was designed as its executing agency. Solid Waste Management Department of City District Govt. Lahore (CDGL) has been responsible for the collection, transportation and disposal of the solid waste within the limits of CDGL (Lahore Waste Management Company, 2013).

Lahore waste management company (LWMC) was set up to deal with solid waste management projects in the province of Punjab. Ever since its formation, it has taken new strides in dealing with waste management. In fact in 2011 the CDGL work was given to LWMC (Lahore Waste Management Company, 2013). In 2012, the LWMC has entered into a partnership with two Turkish companies for seven years to tackle waste in Lahore. These two companies are: Al Bayark and OzPak. Behri Kamal, project coordinator for OzPak, said that the Turkish companies were not just involved in the project for profit, but as a token of appreciation for the Khilafat Movement of the early 20th Century (Malik, 2012).

The city government has established this private initiative. LWMC has become a model for other cities like Rawalpindi. And The Indian city of Amritsar wants to implement LWMC and learn the tricks for waste management in its own country. Recently, in 2013, Indian Punjab provincial government representatives visited Lahore and met with LWMC officials to ape waste management models in the city of Amritsar (Malik , 2012).

On the other side we have the Saif Group, through Lahore Compost (Pvt.) Ltd, has set up its first composting plant at Mahmood Booti under an agreement with the City District Government Lahore (CDGL). The project has been setup on Build-Operate-Transfer basis, whereby the project will be transferred to CDGL after a period of 25 years. This is the first public-private project in Pakistan on such a large scale in the area of Municipal Solid Waste (MSW) recycling.

The company is registered as a CDM project with UNFCCC (Lahore Compost Private Limited, 2012). This is a public and private partnership helping to deal with the waste management. In Pakistan there have been economic and social constraints which have led the local governments to give up on waste management program and handed it over to private players: This may induce corruption and profit making (Lahore Compost Private Limited, 2012).

About 4500 tons/day of municipal solid waste out of a total 5800 tons/day is collected at five different landfill site of Lahore. Primarily business, household and commercial waste are collected and disposed of by burying in landfills site. Most of this waste is without any sorting (UK Essays, 2013).

Similar to other big cities in Pakistan, Lahore is expected to witness a continued rapid rise in population due to rural migration from surrounding areas and other parts of the country. This fast-paced urbanization, increasing population, a growing economy, and an increase in consumption patterns are exerting immense pressure on the social and physical infrastructure of the city, leading to various socioeconomic and environmental challenges (ESMAP 2010).

### **2.1.1 Types and Composition of Waste**

MSW generation rates vary widely in different areas of the country. Waste is categorized on the basis of source rather than type. Currently, there are no standardization laws covering solid waste collection and disposal. Between 40-65% of waste in Pakistan is composed of bio degradable material. Collection rates typically range between 30% in small towns to 70% in larger cities. Dumps of waste and litter on roads are a frequent sight (Masood, 2013). The generated rate of solid waste per day in Lahore is presented in Table 2.1, which is varying on the basis of socio-economic conditions of different towns (Khan, A. S., 2011).

On the basis of a waste generation rate of 0.75 kg/cap/ day, the annual waste generation in Lahore comes out to be 1.97million tons. The composition of solid waste in 2005 reveals that waste in Lahore contains 21.2% recyclables, such as plastic, paper, glass and metal. There is no regulation recycling in Pakistan, and the formal sector is not involved in recycling (Batool et al., 2008).



Table 2.1: Solid waste generation in tons per day from different 9 towns of Lahore in 2013 (Masood, 2013).

Towns	Population (Millions)	Waste Generation (tons/day)	Area (km <sup>2</sup> )
Allama Iqbal Town	1.00	710	513
Aziz Bhatti Town	0.69	485	68
DGB Town	1.00	702	30
Gulberg Town	0.80	563	43
Nishter Town	0.97	680	494
Ravi Town	1.04	727	31
Samanabad Town	1.02	712	37
Shalimar Town	0.88	619	24
Wahga Town	0.68	475	442

In Figure 2.1, waste include important components with over 60% of Biodegradable, Nylon component is 11.6 %. Textile wastes are 9.09% diaper, 3.11%, Paper-Cardboard 2.43%, Non-Combustibles 2.26%, and Combustibles 2.12 % of the total waste stream.

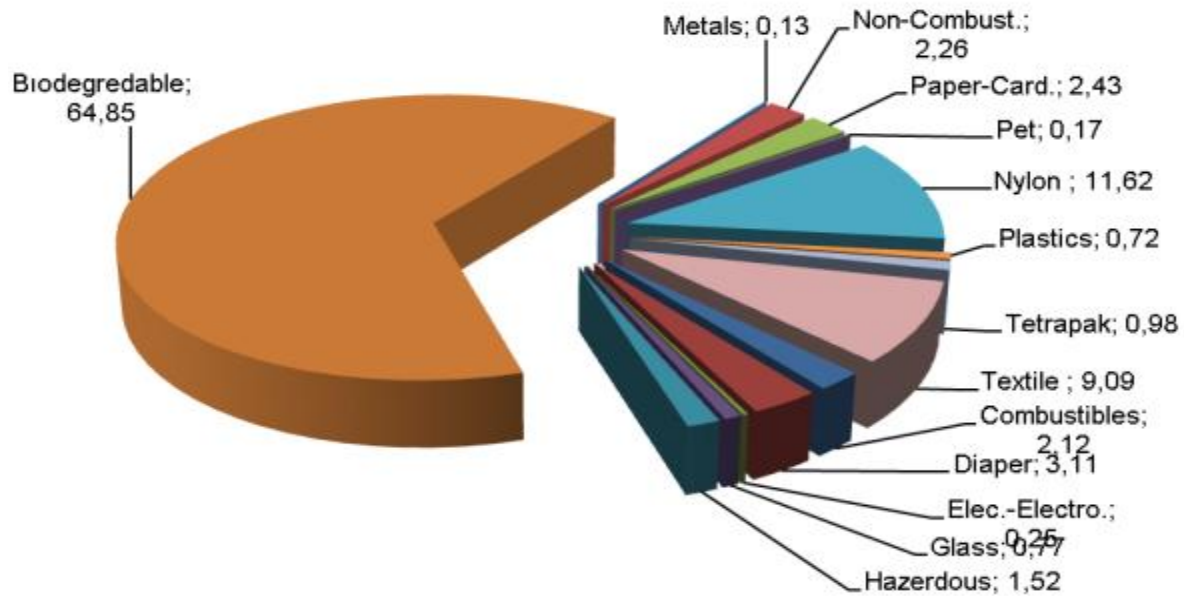


Figure 2.1: Waste stream characterization of Lahore in 2012 (Olmez et al., 2012).

### **2.1.2 Waste Generation, Collection and Treatment Systems**

Solid waste management as seen from the perspective of local authorities includes the activities of collection of domestic solid waste, either through door-to-door or neighbourhood collection, transportation and disposal of solid waste (usually in dumpsites) (Baud et al., 2004). However, solid waste is mainly collected by municipalities and waste collection efficiencies range from 0 percent in low-income rural areas to 90 percent in high income areas of large cities (Pak-EPA, 2005).

The solid waste management in urban areas of Pakistan, stated that solid waste management has not been carried out in proper manner and the condition is getting worse. The factors they include were rate of urbanization, composition of waste, scavenger role for recyclable separation and the capacities of existing municipalities for solid waste management (Mahar et al., 2007).

In Pakistan, it has been seen that, the local governments are major stakeholders in relation to solid waste collection and disposal. Due to the sheer volume of garbage which is produced each day, it becomes impossible for the local bodies to tackle the case of solid waste management. The Town Municipal administration assists the local municipal governments in tackling solid waste management. As per 2010 report carried out by the Pakistan government on “converting Waste Agricultural Biomass into Energy Legal Framework and Financing Mechanisms for Waste Agricultural Biomass (WAB)/Solid Waste in District Sanghar, Pakistan”. It has been concluded that a commission at the national level to oversee solid waste management procedures is need. There is a need for regulatory mechanism at town, district and provincial level (Converting Waste Agricultural Biomass into Energy, 2010).

More than 10,000 rag pickers in the city of Lahore are at the mercy of the middlemen who buy their stuff at low rates in the absence of any check on the trade by the City District Government Lahore (CDGL). Since the Afghans outnumbered the locals five year ago, the middlemen (kabarias) are also happy because of the availability of the ever increasing workforce, who usually never demands an increase in wages and work on their terms and conditions (Fig. 2.2). This is not surprising considering the ever increasing unemployment rate in the country. The Afghan influx increased in Lahore during the US invasion of Afghanistan in 2003. Between two and three rupees per kilogramme paper waste is usually paid to a rag picker. There are reports that it has not been revised for the last two years or so. Some well organised rag pickers has tried

to bypass the middlemen and offered direct supply to paper mills but by the end of the day they found that their lives were in danger. The kabarias have become a mafia and no one, even the government, dares to eliminate their role in the trade (Tahir, 2006).



Figure 2.2: Local picture waste management Lahore (World Bank Carbon Finance Unit, 2008).

As the country suffers, there is paucity of clean drinking water due to the presence of affluent from the industrial waste which not only pollutes the drinking water but causes various health problems for the people of the city. Poverty mixed with population explosion has contributed to falling of ecological standards of living in the city of Lahore (Hasan et al., 2011). Common problems arising from improper waste management includes poor sanitation conditions, disease, pollution of water bodies, and general environmental degradation (CPF, 2010).

#### **2.1.2.1 Solid Waste Treatment**

In Lahore, the Solid Waste Management Department (SWMD) of the City District Government Lahore (CDGL) is the sole authority responsible for the management of solid waste generated. Due to a variety of factors such as insufficient waste collection points, lack of equipment, unavailability of sanitary landfills, lack of resources, and communities' reluctance to pay for

collection fees waste management has become a major challenge for SWMD. Less than half of the 6,000 tons of municipal waste generated daily in Lahore is collected source, and even the collected waste is often improperly disposed. Waste is found along roadsides and close to dumping sites. Studies have shown there is an estimated organic content of over 50% in Lahore's solid waste source, presenting an opportunity to substantially reduce the waste for final disposal by engaging in large-scale composting. The Saif Group (Fig. 2.3), one of Pakistan's leading industrial and service conglomerates, formally established the Lahore Compost (Pvt.) Limited (LCL) as a private limited company to operate the composting facility in Lahore (LCL, 2010).



Figure 2.3: Local picture composting plant Lahore (LCL, 2010).

The Mehmood Boot (Fig. 2.4) dumpsite is located on the eastern bank of river Ravi in the city of Lahore. Under a contract, the city government's municipal body (CDGL-City District Government, Lahore) provided land for the composting plant and the Solid Waste Management Department was responsible for garbage collection and bringing it to the dumpsite. The equipment used for composting was imported from a Belgium company named Menart Compost Company. The project began first with 300 TPD of compost 2006 and scaled its operations to 750 TPD by April 2009. The plant converts organic waste into compost through a process lasting 70-90 days, using the "aerobic windrow" technology from Belgium. In this windrow composting, incoming garbage is weighed, inspected and sorted to remove large non-compostable items. Composting organic waste in a scientifically designed facility reduces the environmental and health hazards. This is an improvement compared with dumping of waste in

open dumpsites, the advantages of is rapidly converting the compost to fertilizer , less birds attracts to garbage places and also decrees the volume of total solid waste (Aslam et al., 2012).

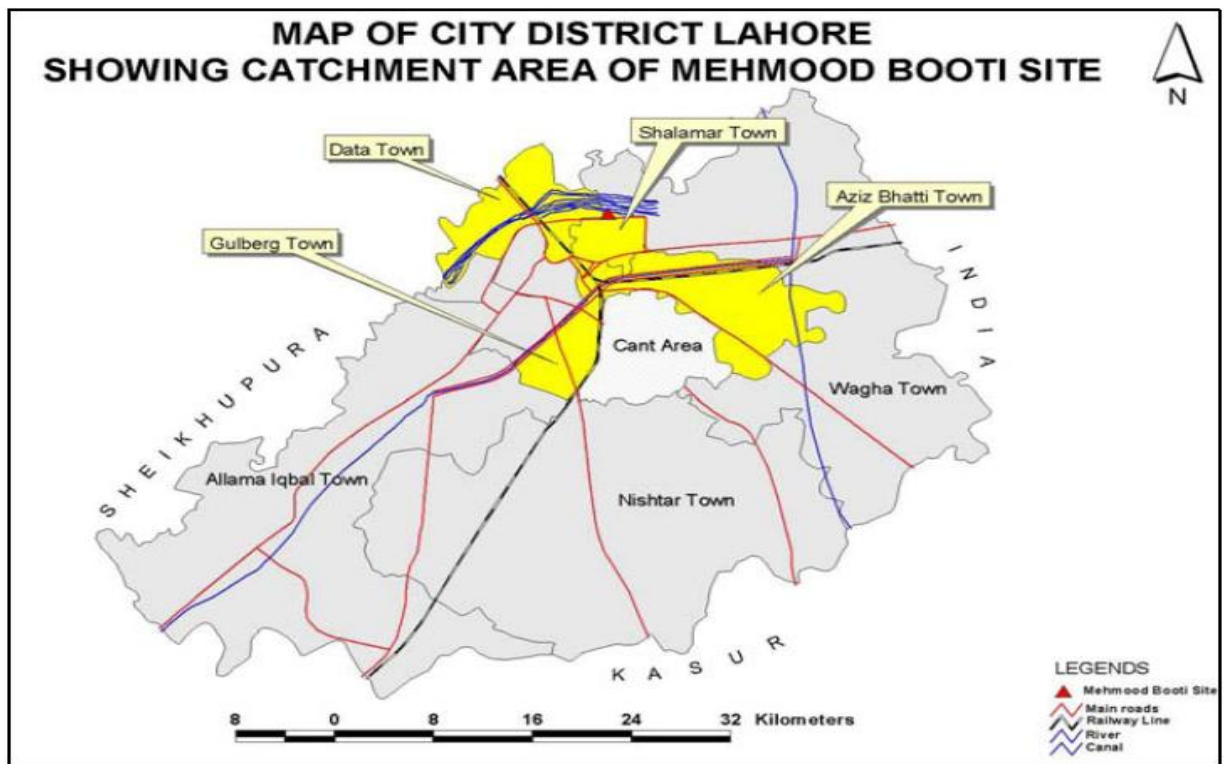


Figure 2.4: Local map for Mahmood Booti solid waste dumping site (Imtiaz, A., Ali, H. 2008).

The Lahore Compost Project is one of the successful attempts made by private initiative to provide municipal services through solid waste. The commercial viability of the project was improved through sale of compost as a fertilizer (Fig. 2.5). The LCL project has all the three benefits, which include; environmental, economic and social benefits (Aslam et al., 2012).

The other two dumping sites are Saggian (Fig. 2.6) and Baggarian (Fig. 2.7) located in Lahore. Waste here is being dumped without proper precautions. This causes critical effect to the ground water and soil. It is said that 24 percent of the waste is littered on the road sides and pavements creating filthy conditions for urban livelihood. The composting of kitchen waste as it is being carried out in Lahore not only reduces the waste that enters the waste management but provides an end product that is fertilizer for plants and crops. Waste volume reduction has been reduced by 70 percent through the use of composting (Aslam et al., 2012).



Figure 2.5: Local picture composting plant Lahore (LCL, 2010).

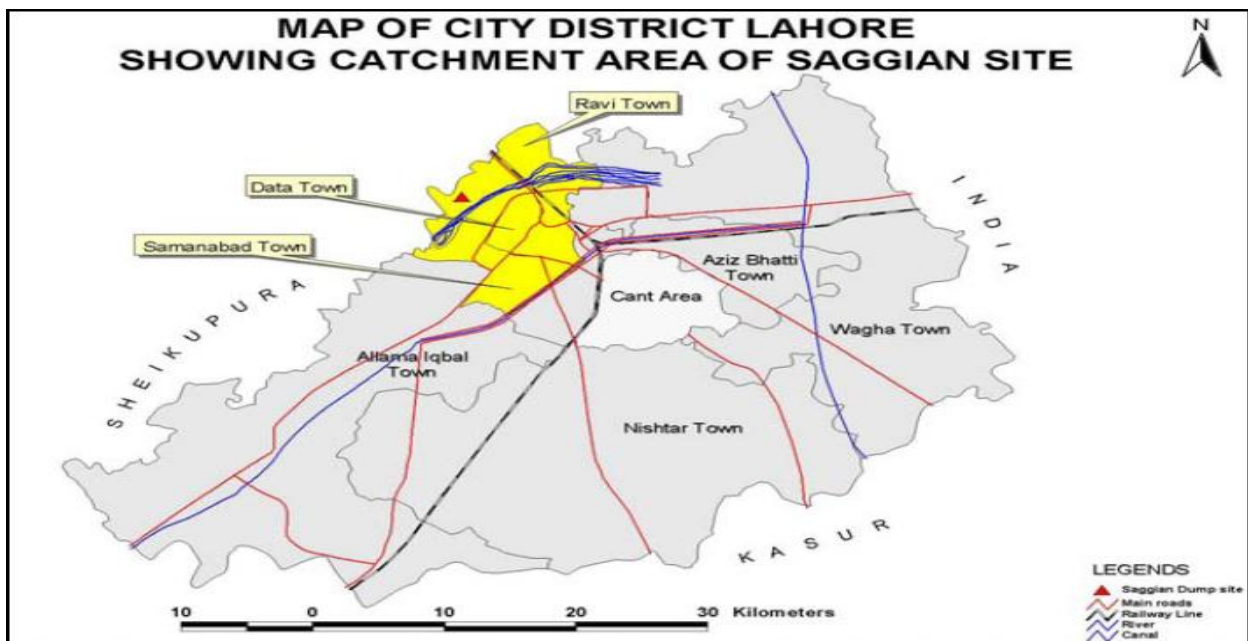


Figure 2.6: Local map for Saggian solid waste dumping site (Imtiaz, A. & Ali, H. 2008).

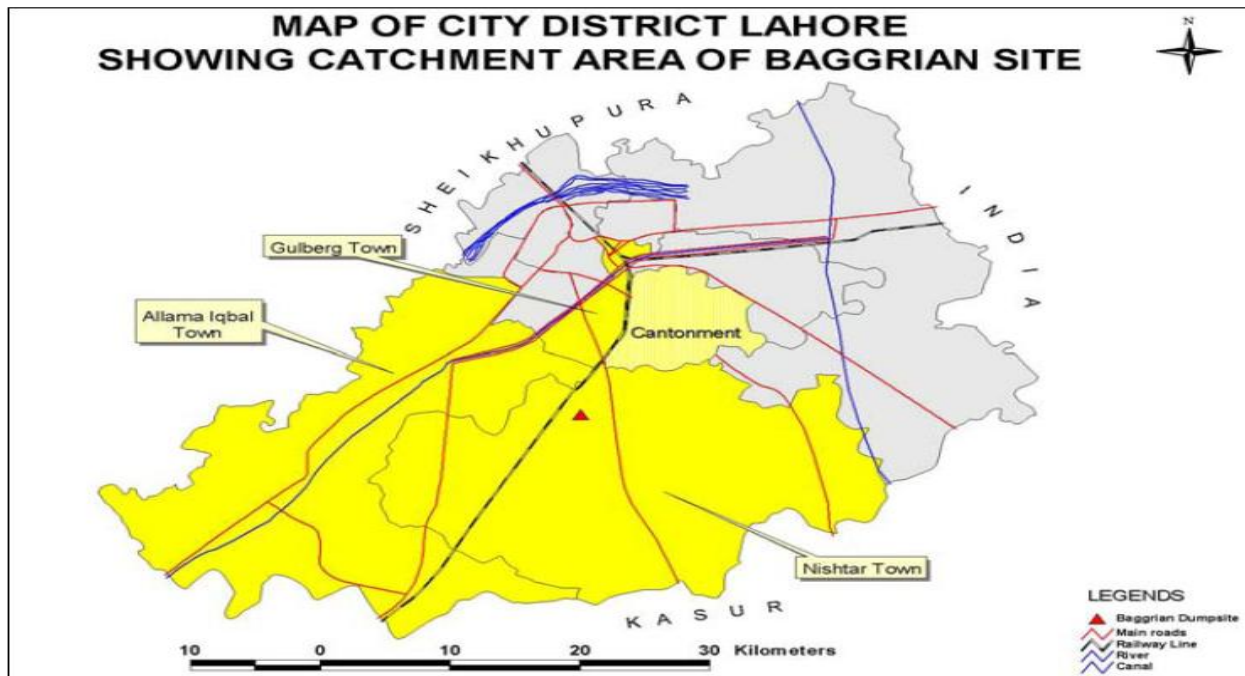


Figure 2.7: Local map for Baggrian solid waste dumping site (Imtiaz, A. & Ali, H. 2008).

A more environmentally oriented view of urban solid waste management includes reuse, recycling and recovery activities, and safe disposal of waste (Baud et al., 2004). Recycling can also cause problems if it is not done in an environmentally responsible manner. Examples include operations for news-print deinking, waste-oil recycling, solvent recycling, and metal recycling. In all of these processes, toxic contaminants that need to be properly managed are removed. Composting is another area of recycling that can cause problems if implemented without adequate location controls. For example, groundwater can be contaminated if grass clippings, leaves, or other yard wastes that contain pesticide or fertilizer residues are composted on sandy or other permeable soils. Air contamination by volatile substances can also result (Baud et al., 2004).

### 2.1.3 Regulations for the Management of Waste

There is a plethora of regulations at the federal level that impact the management and disposal of municipal solid waste in Pakistan which gives a direction in which future planning shall depend. Many of these regulations have been in effect for years and further updates will be needed (Baud et al., 2004).

Environmental legislation is still not well developed in Pakistan, especially in comparison to the developed world. For example there is no national quality standard for SWM. Presently, legal rules and regulations dealing with solid waste management in Pakistan are inadequate and outdated (EPD, 1997). There are Guidelines for Hospital Waste Management since 1998, giving detailed information and covering all aspects of safe hospital waste (Ministry of Health Pakistan, 2002). However, these guidelines are not implemented. There are no systematic approaches to medical waste disposal. Hospital wastes are simply mixed with the municipal waste in collecting bins at roadsides and disposed in a similar way. Some waste is simply buried without any appropriate measure. There is an urgent need to update laws. The laws should include activities concerned with the waste management. Factory or company should treat especially hazardous waste coming out from their polluting industrial units. Citizen, businessman, factory owner and even government should receive a penalty for violating the law of Solid Waste Management (Mahar et al., 2007).

Politically, planning and development division is responsible at federal level for development. At the provincial level the P&D department is responsible. The Ministry of Environment is responsible at the federal level for policies and programmes. PEPA (Pakistan Environmental Protection Agency) and Provincial EPA's are main regulatory bodies for implementation of Pakistan Environmental Protection Act 1997. The Tehsil (Local) Municipal administrations (TMAs) are responsible for solid waste collection, transportation and disposal. TMA's lack of funds, rules, standards, expertise, equipment and vehicles to collect waste (Malik, 2012).

There is limited focus on control mechanisms which are related safe handling of waste. For example if the industrial waste is dumped in land fill areas. This is a treat to the safety of the people (Cointreau, 1994). However, as Batley (1996) points out, private solutions can also include citizens mobilizing to solve problems of solid waste management themselves. Moreover, cooperation across the public private divide (Evans, 1996), between representatives of communities and governments were seen to reinforce and cement relationships founded on patronage and clientalism rather than to foster more inclusive forms of civic engagement (Beall, 1997)



#### **2.1.4 Social and Economic Constraints in Lahore for Waste Management**

The current state of solid waste management, water and sanitation, urban transport and health and education show the inability of the governments to cope with urbanization. Solid waste management constrained by financial, social, and economic factors. There is a need to formulate new SWM policies to cope with the growing needs of urban settlers (Khan, 2013).

Solid waste management has been one of the major barriers which lead to environmental decay. Inadequate waste collection system only exists for 51-69% of the total waste generated in a few major towns. Municipal collection of household waste is quite irregular and limited to high-income areas. Generally, inadequate disposal service and no weighing facilities are installed at most of the disposal sites. There is a poor management of hazardous waste and under the current disposal practice no proper method is being employed. The review of the legal framework indicates that there is a need for detailed and clear regulations dealing specifically with solid waste. In addition, promotion of public awareness, legislation, financial and economic calculations, strengthens institutional capacity and regulations enforcement and establishment of a proper sanitary landfill are considered to be principal remedial measures (Aman et al., 2007).

Scholars in seven municipalities like Karachi, Hyderabad, Lahore, Multan, Peshawar and Quetta were interrogated on the waste problem. Waste appear to be more visible in Peshawar than in Lahore and Karachi Improve the municipalities of Karachi and Lahore have less wastes presence as the waste is more effectively managed due to the more awareness for waste management and better collection systems than in Peshawar (Hasan et al., 2011) It was found out that municipalities with better socio-economic conditions are doing better with regard to waste management (Hasan et al., 2011).

#### **2.2 Solid Waste Management in Oslo, Norway**

The term “waste” is defined in the European Union legislation (Directive 75/442/EEC) as “any substance or object in the categories set out in Annex I which the holder discards or intends or is required to discard” (UN ESCAPE, 2000).

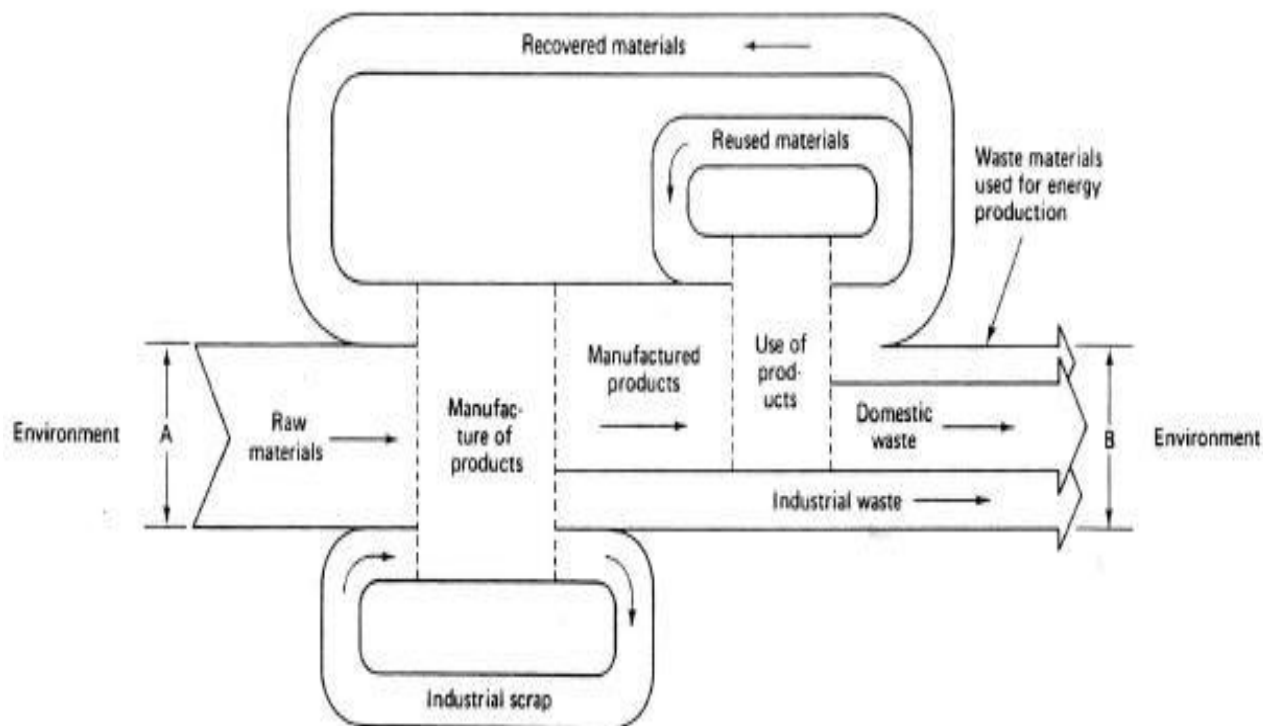


Figure 2.8: Flow of materials in society (UN ESCAPE, 2000).

Above figure (2.8) clearly gives us an understanding of the waste management processes in Oslo and manner in which raw materials are used. Waste is divided into domestic waste and Industrial waste. These waste materials are recycled and reused. As per the website information from the Oslo Kommune, solid waste management is done in a systematic manner. Food waste becomes bio fertilizer and fuel for cars and buses. The plastic packaging becomes new plastic products like toys, chairs and fleece jackets. Residual waste from the every household in Oslo is put in three different colour bags: white bag for residual waste; food waste goes in green bags; plastic waste in blue bags. And then the waste is collected in a container and put to recycle depending on the colour of the bags (C40 Cities, 2012).

According to the study carried out by Climate Leadership Group, the Waste Management Strategy (WMS) builds on national strategies and promotes the waste management hierarchy. The hierarchy says the priorities are:

1. Waste reduction - prevent production of waste
2. Re-use of objects

3. Recycling (Material recovery)
4. Incineration with energy recovery (Waste-to-Energy)
5. Landfill (for inert waste only)

Incineration and landfill are seen as the least desirable forms of waste management and represent the last resort within Oslo's strategy. As such, a large part of the WMS concentrates on the behavioural habits of citizens; an attitude change must take place, if citizens are to carry out waste reduction, reuse and recycling (C40 Cities, 2012).

### ***Future Planning***

The City Council's Climate and Energy Program from 2005, aims to reduce greenhouse gases and to encourage the use of more sustainable energy sources. One vision is that by the year 2030 Oslo's climate gas emissions will be reduced by 50 % compared to 1990. The Waste Management Strategy sets ambitious targets and will increase the percentage of recycling of household waste to a minimum of 50 % within year 2014. Citizens will be encouraged to sort food waste and plastic packaging for recycling, in order to achieve a target of 50 kg food waste and 10 kg plastic packaging per inhabitant per year in Oslo. Oslo's new bio gas facility will utilize thermal hydrolysis to treat 50,000 tonnes of food wastes each year. The plant will transform food wastes into green fuel for the city's buses, according to the Research Council of Norway (RCN). A new biogas plant will also supply nutrient-rich bio-fertiliser for agriculture. The RCN said that the new plant will have the capacity to process 50,000 tonnes of food waste each year, converting it into enough fuel to power 135 municipal buses as well as enough bio-fertiliser for roughly 100 medium-sized local farms. The biogas production processes were developed through long-term Norwegian research with funding from the RCN (C40 Cities, 2012).

Currently 65 buses are powered by biogas produced from sewage sludge in Oslo. When the new biogas plant reaches its full capacity in 2013, biogas will fuel at least 200 of the city's buses." Running on biogas will reduce emissions from public transport, which means less airborne particulate matter and thus improved air quality in Oslo (Petrol Plaza, 2012). In addition to this, improvement in the air quality will also be achieved. The RCN estimated that the plant will

produce energy equivalent of 4 million litres of diesel fuel valued at the very least at NOK 30 to 40 million (\$5-7 million) annually at current prices (Hinchey et al., 1985).

### 2.2.1 Types and Composition of Solid Waste

In Oslo, about 340 000 households generate annual waste of about 240 000 tonnes of this, about 114 000 tonnes of residual waste and 40 000 tonnes of paper is collected. In 2011, 392 kg of waste per person was produced, of which about 33 % was recycled. The city has a goal to increase the percentage of recycling (material recovery) to 50 % in 2014. Incineration with energy recovery was 60 % in 2011. Every week, the city empties about 130 000 bins 7 million per year (C40 Cities, 2012).

The amount of total municipal waste per capita was in 467 kg in 2007 as explained in Table 2.2 this number includes commercial waste 56kg per capita and household waste 413 kg per capita. Therefore, the amount of total household waste per capita increased from 407kg in 2004 to 413kg in 2007. In 2007 five percent of total household waste was sent to landfill (Table 2.3). From the municipal waste, the percentage of recycled waste in was 23% and from that 34% consisted with papers; in the form of cardboard, cartons and drink cartons and 66% was the garden waste. The garden waste produced is composted, sorted in fractions and sold at the recycling centers. The Oslo city has two incineration plants. The incineration capacity for both plants are 260 000 tons of waste per year. Together the two plants produce energy, heating and electricity, in total equaling the requirements of 10% of the households in the city. The Oslo city has closed the landfills within the city, and soil is accepted for covering (Richelsen, 2008).

Table 2.2: The connection between municipal waste and treatment in 2007 (Richelsen, 2008).

Type of Waste	Quantity of Waste (ton)	Treatment	Percent (%)
Garden Waste	2779	Material Recovery	23
Paper	4416		
Residual Waste	22077	Energy Recovery	72
Combustible	991		

Non-combustible	705		
Other	1064	Landfill	5

Table 2.3: The connection between household waste and treatment in 2007 (Richelsen, 2008).

Type of Waste	Quantity of Waste (ton)	Treatment	Percent (%)
Paper	41771	Material Recovery	29
Garden Waste	11405		
Glas/Metal	9360		
Residual Waste	125841	Energy Recovery	66
Combustible	21461		
Non-combustible	10548		
Other	6497	Landfill	5

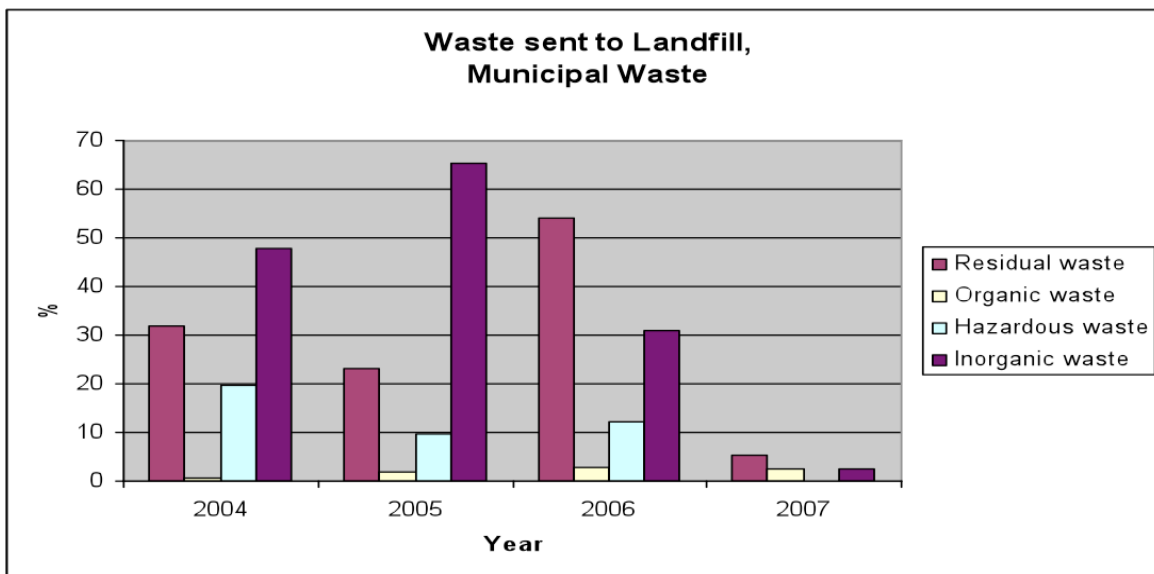


Figure 2.9: Municipal Waste sent to landfill (Richelsen, 2008).

In Fig 2.9, shows the non-combustible and inert waste (0.8% of total municipal waste) was sent to landfills outside the city. Therefore from 2008 large stems and roots are grinded and composted in bio filters and thereby no biodegradable waste was sent to landfill. However, from the household the recycled (Figure 2.10) waste in 2007 was 29% but Oslo has aim to recycle 50% of household waste within 2014, which is an increase from approximately 30% (Richelsen, 2008).

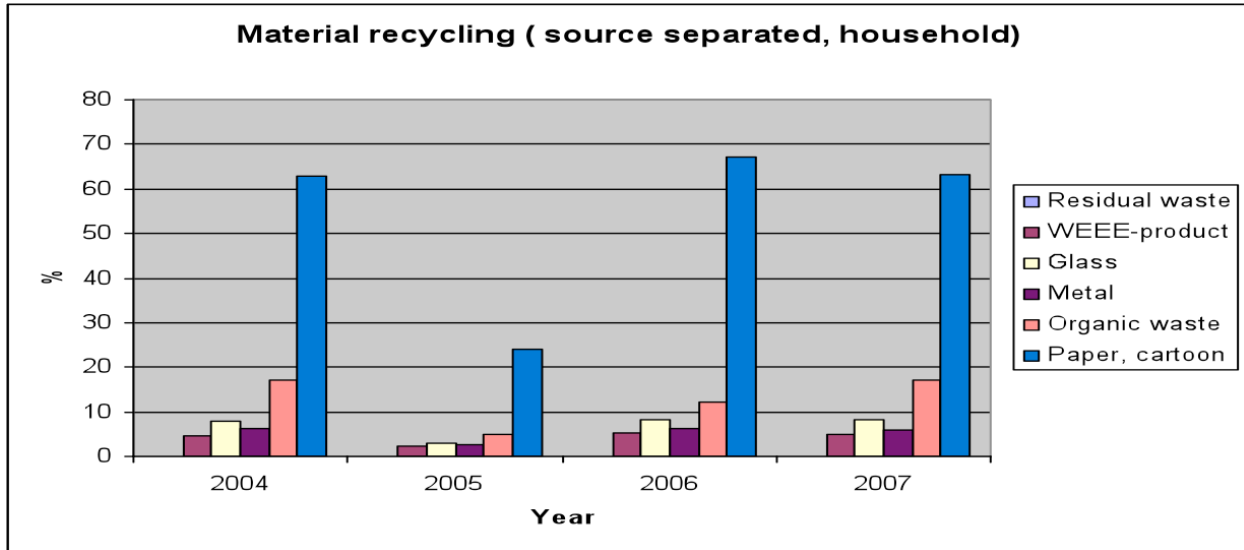


Figure 2.10: Material recycling of household waste in year 2004 to 2007 (Richelsen, 2008).

The two incineration plants produce energy to district heating and electricity. The Fig 2.11 shows the relation between the two fractions sent to landfill during the last 4 years, non-combustible on inert fraction. The 17045 ton was sent to landfill in 2007 (Richelsen, 2008).

The city of Oslo implemented separate collection for paper, drink cartons and cardboard as household service in 1997. The new service increased amount of this waste fraction with 23% from 28100 ton to 36500 tons (Richelsen, 2008).

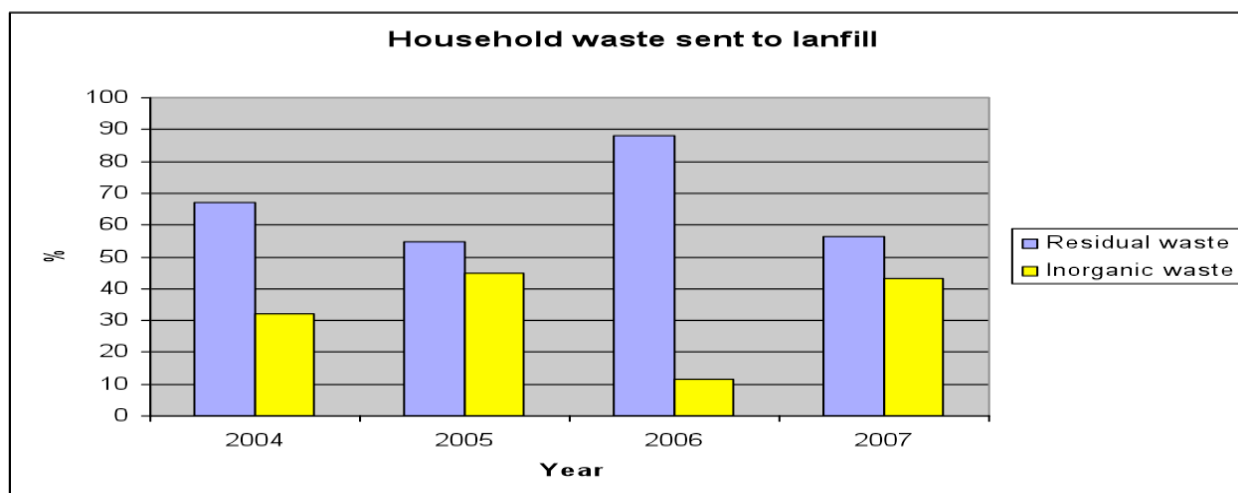


Figure: 2.11 House hold waste sent to landfill in year 2004 to 2007 (Richelsen, A 2008).

### 2.2.2 Waste Generation and Collection, Transportation and Treatment System

In 2011, about 240,000 tonnes household waste was collected and of this 1% was reused, 33% recycled, 60% energy recovered and only 6% went to landfill. The municipality has had sole responsibility for the collection of all household waste since 1932. Since 1993, this organization has outsourced services. Commercial waste operators carry out collection services on 5-year contracts. From 2006, the city has had a Waste Management Strategy that sets ambitious targets for sorting of plastic packaging and food waste. A minimum of 50 % of the household waste shall be recycled within 2014. All hazardous waste shall be collected and treated securely. This strategy aims to establish a “recycle and reuse” society (C40 Cities, 2012).

Sorting of materials must take place not only at recycling stations, but also in kitchens, living rooms and offices. Collaborations with voluntary organisations, awareness raising campaigns, all aim to enable citizens to implement the strategy. In addition, the city is encouraging developers to install pneumatic waste collection services and thus reduce the need for truck-based collections. The “producer pays” principle is also being promoted with regard to consumer packaging (C40 Cities, 2012).

To streamline the process of SWM the food waste and plastic packaging are done at source by 17,000 households in October, 2009. Other households have joined slowly after June 2012. Plastic packaging is deposited in blue bags while food waste goes in green bags. Residual waste is to be discarded in other plastic bags (from grocery stores etc.). All bags are discarded into the

same waste containers. The colored bags are separated from each other in optical sorting plants (C40 Cities, 2012).

In Oslo region a pilot project started in 2009 regarding sorting two new fractions in kitchen unit. Plastic packaging material and organic waste sorted in dedicated colored bags and put in bin together with the residual waste. These colored bags are later separated in the plants based on optical sorting, and organic waste is sent for biological treatment in a biogas power plant. Municipal waste is fed into hopper from the waste bunker, and as it moves through the combustion chamber on the grate, energy is recovered. Energy is distributed to 20000 homes (approximately 5GW) from the plant. By increasing the incineration capacity the amount of renewable energy increased by 13 % whereas the amount of waste sent to landfill was reduced based on strategy. Cinder produced by incineration was 1997 about 21 % and in 2003 it reduced by 16 %. This reduction is mainly due to the possibility to extract non magnetic metals in addition to magnetic from the cinder (C40 Cities, 2012).

#### **2.2.2.1 Treatment of Solid Waste**

There are three large MSW combustion plants in Oslo, which have permit under the Pollution Control Act for accepting waste for incineration. One of the plants is Haraldrud, completed in 1988. Haraldrud has two almost identical combustion lines which are operated by EGE. The energy produced by the combustion plant is mainly used in the district heating systems to heat up buildings in Oslo. 100.000 tons of waste is incinerated at the plant and 235.000 MW is sold to the district heating system each year. The main objectives for Haraldrud are to incinerate as much waste as possible with as little pollution as possible. It is therefore important to optimize the combustion process so the right amount of waste and air is supplied to the combustion (Gudim, 2011).

#### **A. Incineration of Waste**

Two waste-to-energy plants incinerate residual waste from the city, with a capacity of 410,000 tonnes of waste per year. The Klemetsrud plant was extended by a third incineration line in 2010. The energy is used for district heating (hot water) and electricity. The total energy production is about 840 GWh heat and 160 GWh electricity per year. The heat energy meets the need of about 84 000 households through the district heating system, while the produced electricity is delivered to the city schools. Norway has banned the deposition of biodegradable waste in landfills from



2009, yet in Oslo, this target was met in 2002. The city landfill site closed in 2007. Landfill gas from earlier deposits is collected and used for production of electric energy, delivered to the schools of Oslo (C40 Cities, 2012).

### **B. Waste Incineration to District Heating (EGE ,2012).**

District heating plant is, simply put, a centrally located heating plant supplying buildings or neighbourhoods with hot water for heating and tap water. The district heating production in Oslo is expanding. EGE delivers 50 percent of the current energy need in the district heating system (EGE, 2012).

The energy produced at the EGE plants is used to heat water which is sent into the district heating network owned by Hafslund. The water is transported in pipes to district heating customers in Oslo. Previously, Oslo used to have two separate district heating networks, but these are now connected with a 13.6 kilometer long transition pipe between Klemetsrud and the city centre. In order for an end-user to make use of district heating, the building or house needs to have pipes for water-based heating. The energy is transferred from the district heating water to the customer's heating system through recuperative heat exchangers. The district heating network in Oslo is continuously being expanded. In the years to come, there will be large expansion activities in the following city areas: Oppsal, Manglerud, Ammerud, Sagene/Torshov, Frogner/Majorstua and Ensjo (EGE, 2012).

### **Biological Treatment**

A new biological treatment plant is being constructed in Nes municipality, north-east of Oslo. The plant will produce both biogas and bio fertilizer from Oslo's food waste. The biogas will be used as a green fuel for buses and waste trucks, and the bio fertilizer will be used by local farmers. Until the new plant opens, the food waste is sent to biogas plants in Sweden. The biogas plant will have the capacity to handle 50 000 tonnes of food waste per year, which will make it possible to treat food waste from other municipalities, business and industry as well as from households in Oslo. Biogas from one kilo food waste equals about 0.13 L petrol, which means that a bus can drive about 500 meters on 2 kilos of food waste. The biogas plant will produce about 4,5 million Nm<sup>3</sup> upgraded biogas and 90 000 m<sup>3</sup> bio fertilizer (liquid) per year. These amounts will be enough to run about 150 buses on biogas and provide about 100 medium-sized farms with bio fertilizer yearly. Presently in public buses there have been advertisement's to

promote sorting of food waste from other waste for all the users. The big thing is that all the advertisements are in multi-lingual languages so that immigrant communities also understands the importance of recycling and acts accordingly (C40 Cities, 2012).

### **2.2.2.2 Solid Waste Collection Costs**

Household in Oslo paying a mandatory fee to finance the waste services. The size of the fee varies from 150 to 300 US\$ for waste services depends on living structure and the size of container. This fee cover all services regarding collection of residual waste and paper at the household, the use of recycling station and local recycling station , the hazard waste station, micro recycling centres, and incineration of residual waste. The reduction in fee may be achieved by reducing the volume of residual waste, by preventing production of waste, reuse more, increased recycling and home composting , home composting for both garden and food waste have been encouraged where possible and supported by waste authorities with reduced fee by waste reduction (Richelsen, 2008).

In 2011, the total cost was approximately US\$ 93.5 million. The corresponding income was in US\$ 111 million, of which approximately US\$ 7 million was related to external sales (metal, paper, electrical components etc.). The waste management is based on a “at cost” principle which in practice means that both surplus and deficit is transferred to a “waste fund” which is leveled out over time. In 2011, the average cost per inhabitant was US\$ 138. The average annual amount of waste per inhabitant was 392 kg. Investments in a new recycling station are planned at an estimated cost of US\$ 48 million. This comes in addition to the two existing recycling stations in Oslo (C40 Cities, 2012).

### **2.2.3 Solid Waste Management Regulations**

#### ***1. Legislation Overview***

This chapter provides a short overview on the Norwegian Pollution Control Act. It is the first law in Norway concerning pollution and waste issues. It was at that time a political goal to create a basic legal framework for all types of pollution and waste. The Pollution Control Act is a typical enabling act. The Act was established for the purpose of preventing and reducing harm and nuisance from pollution. This is reflected in the main rule of the act, which says that pollution is

forbidden, unless it is specifically permitted by law, regulations or individual permits (EIONET, 2012).

Section 1 of the Act states that the purpose of the Act is to protect the outdoor environment against pollution and to reduce existing pollution and waste. But environmental protection is not the only relevant consideration here. The act shall secure a satisfactory environmental quality based on a balance of interests, which includes costs associated with any measures and other economic considerations. Pollution is defined in section 6 of the Act. The definition has two aspects. In the first place, certain actions must be present. There has to be a discharge of solids, liquids or gases to air, water or ground. This discharge must be caused by human activity, not by nature itself. Secondly, there has to be a risk of adverse effects or impacts on the environment. The discharge has to affect the recipient. It is enough that the discharge may cause damage or nuisance to the environment. That is in accordance with the precautionary principle. Any damage or nuisance is relevant here, whether they affect humans, animals or nature itself. The Norwegian Pollution Control Act distinguishes between legal and illegal pollution. Section 7, first paragraph, states the basic principle and the main rule of the act: It is not allowed to possess, do, or initiate anything that may entail a risk of pollution, unless this is specifically permitted by law (EIONET, 2012).

Almost all pollution activity in Norway is based on individual permits or licenses issued by the Norwegian Pollution Control Authority or the county environmental agencies. Whether a permit is granted or not, depends on the professional judgment of the pollution control authorities.

In addition to the Ministry of Environment, Norway has three authority levels with regards to waste handling.

1. The Pollution Control Authority is responsible for following up firms that manage hazardous waste, which include both incinerators and landfills. The Authority also prepares suggestions for new waste regulations to the Ministry.
2. The County Governors are responsible for non-hazardous waste management, although they also follow up firms that handle some hazardous waste.

3. The Municipalities are responsible for following up collection and management of household waste. The municipalities are also responsible for local waste issues such as the ban on littering and open fire.

The Pollution Control Act regulates nearly all waste management activities. Specific requirements are given in Waste regulations under the Act. There are a number of waste regulations covering waste treatments such as land filling and incineration or waste management of specific waste streams (EIONET, 2012).

### ***1.1 National Acts***

The Pollution Control Act is from 1981. It is the first unified law in Norway concerning pollution and waste issues. It was at that time a political goal to create one basic legal framework for all types of pollution and waste. One whole chapter, chapter 5, concerns waste and waste management (EIONET, 2012).

### ***Waste Regulation (Avfallsforskriften, 2004)***

All the different regulations concerning waste and waste handling is gathered in on big regulation called “Avfallsforskriften”/Waste regulation. It contains 14 chapters, and regulates explicitly different waste categories such as:

- Waste electrical and electronic equipment (EE equipment).
- Handling of discarded refrigeration equipment containing CFC
- Batteries which are hazardous to the environment
- End-of-life vehicles
- Collection and recycling of discarded tyres
- Take-back systems for beverage packaging
- Refund of taxes paid on trichloroethyleneTRI ,
- and hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).
- Landfilling of waste
- Incineration of waste
- Hazardous waste
- Permits for transfrontier shipment of waste
- Discarded insulating glass units containing PCBs (EIONET, 2012).

## ***1.2 Regional Waste Acts***

Regional waste regulations in Norway cover responsibilities and fees in connection with collection and management of household waste. Municipalities also administer the ban on littering (EIONET, 2012).

## ***2. Waste Management National Plan***

The Norwegian Government issues a White Paper on the environment almost every second year. The White Paper outlines the national waste targets and the instruments on how to reach them. This is analogue to a national waste management plan, apart from it does not have a legal reference. The White Paper is a report on the state of the environment and a discussion on the government's future policy on this particular field (EIONET, 2012).

The Paper includes several waste targets for the coming years. The national targets aim to

- increase the percentage of waste being recycled to 75 in 2010 with an aspiration to reduce it further to 80%
- decouple the amounts of waste growth from growth in GNP,
- reduce the generation of hazardous waste by 2020 down to 2005-level.
- Secure safe treatment of hazardous waste

Further, the Paper describes new or revised instruments that the Government wants to put in place or have put in place to reach the targets:

- Implement requirements of compulsory waste plans in building- and construction matters at local governments
- Stimulate to increased energy utilization of organic waste
- Continue the work on the revised hazardous waste strategy to increase the collection and proper handling of hazardous waste which includes identifying potential new hazardous waste
- Increase research on how to secure safe use of compost and sludge and other waste products in farming (EIONET, 2012).

## ***2.1 Regional Plan***

County Governors have no mandatory waste management plans. Some municipalities have local waste management plans, but this is not compulsory either (EIONET, 2012).

## ***3.0 Waste Prevention for Norway***

### ***3.1 Targets***

- Norway has a target to recycle 75 % of all waste by 2010 with an aspiration to increase this to 80% after 2010.
- National target to reduce the generation of hazardous waste to 2005-level by 2020.
- Norway has passed a regulation on information on construction and demolition waste. This regulation is not a EU-based regulation. This new regulation requires 60% sorting of C&D-waste. This will be described further in chapter 6 (EIONET, 2012).

### ***3.2 Strategy***

Norway has introduced a financial support scheme to increase utilization of energy from waste treatment, in particular to address treatment of biodegradable waste. The scheme is handled through ENOVA which is an enterprise that was established to take a leading role in promoting environmentally friendly restructuring of energy consumption and energy generation in Norway. It is owned and financed by the Ministry of Petroleum and Energy (MPE) (EIONET, 2012).

## ***3.3 Policy Instruments***

### ***3.3.1 Information Based Instruments***

The Environmental Authorities carry out national and local information campaigns on waste issues every year. The last few years, these campaigns have been connected to landfilling of waste, hazardous waste, illegal export of waste and others. These campaigns are a mix of information and control of the regulations. This autumn (2009) there is a national campaign on the new Norwegian Regulation on C&D-waste (EIONET, 2012).

### 3.0 CONCEPTUAL FRAMEWORK

The integrated sustainable solid waste management (ISSWM ) approach is well known waste handling system. This approach has been developed in mid 1980s by a Dutch NGO called WASTE and latter further development occurred in 1990s by the Collaborative Working Group on Solid Waste Management in Low- and Middle-Income Countries (CWG), then it became as a norm (Khatib and kumar, 2011).

The ISSWM is a system approach is further subdivided into three main dimensions such as: stakeholders, elements, and aspects. These dimensions are presented in Figure 3.1.

- Stakeholders: The stakeholders consist with people or organizations participating in solid waste management. Therefore, it includes the following chain as; the waste generators, the service providers, the formal and informal private sector dealing with solid waste management, and other local or international institutions.
- Elements: The elements component consists of the technical components of the waste management system including the process from generation of solid waste followed by the collection, transfer and transportation of waste to treatment plant or to the dumpsites. However, the treatment factor ranges from reducing the size of the generated solid waste to recovery of the waste, especially the biodegradable waste component that consists of almost more than 60% of the total generated municipal solid waste in urban areas of the developing countries.
- Aspects: To achieve sustainable the integrated solid waste management it is necessary that all required aspects like; financial, social, institutional, political, environmental and legal issues are dealt with in a sustainable manner.

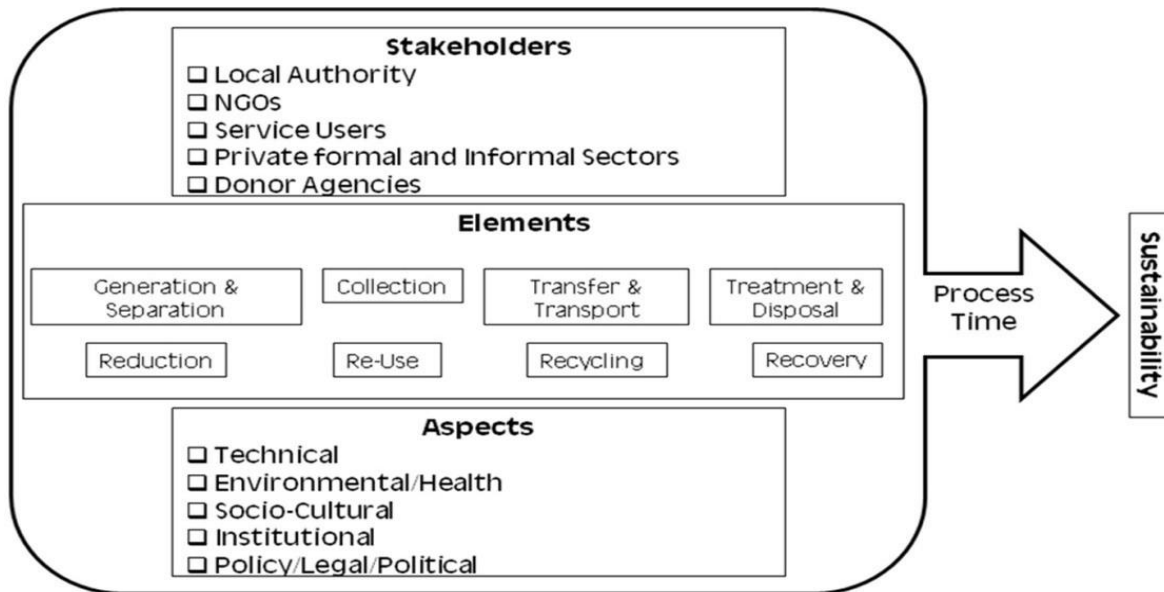


Figure 3.1 Integrated Solid Waste Management System (Khatib and Kumar, 2011).

According to Khatib and Kumar (2011), the major principles of ISSWM could be summarized according to the Figure 3.1 as follows:

- The technological and operational principals must be considered according to the physical setting, local environment, and land use, of the region. The environmental and health principles which ensure that any kind of operation is clean with minimal impact on the environment.
- The financial principles must be based on “all beneficiaries contribute principle”. Fees must be collected for the services and in return related government institution contributes by allocating revenues to municipal waste management (MSW). Cost recovery must also be taken into account.
- Stakeholders should be involved in the planning and implementation phase of the management processes.



## 4.0 MATERIALS AND METHODS

### 4.1 Description of the Study Area

#### 4.1.1 Lahore

Lahore is the capital and the largest city of the Punjab. The total area under this city is roughly 1772 square kilometre; with a population of about 8 million. It is situated beside river Ravi and borders India (Joeng et al., 2007). It is further subdivided into 9 towns for the management perspectives (Fig.4.1), such as, Iqbal, Gulberg, Samanabad, Data, Ravi, Shalamar, Aziz Bhatti, Wahga and Nishtar town (Naveed et al., 2009).

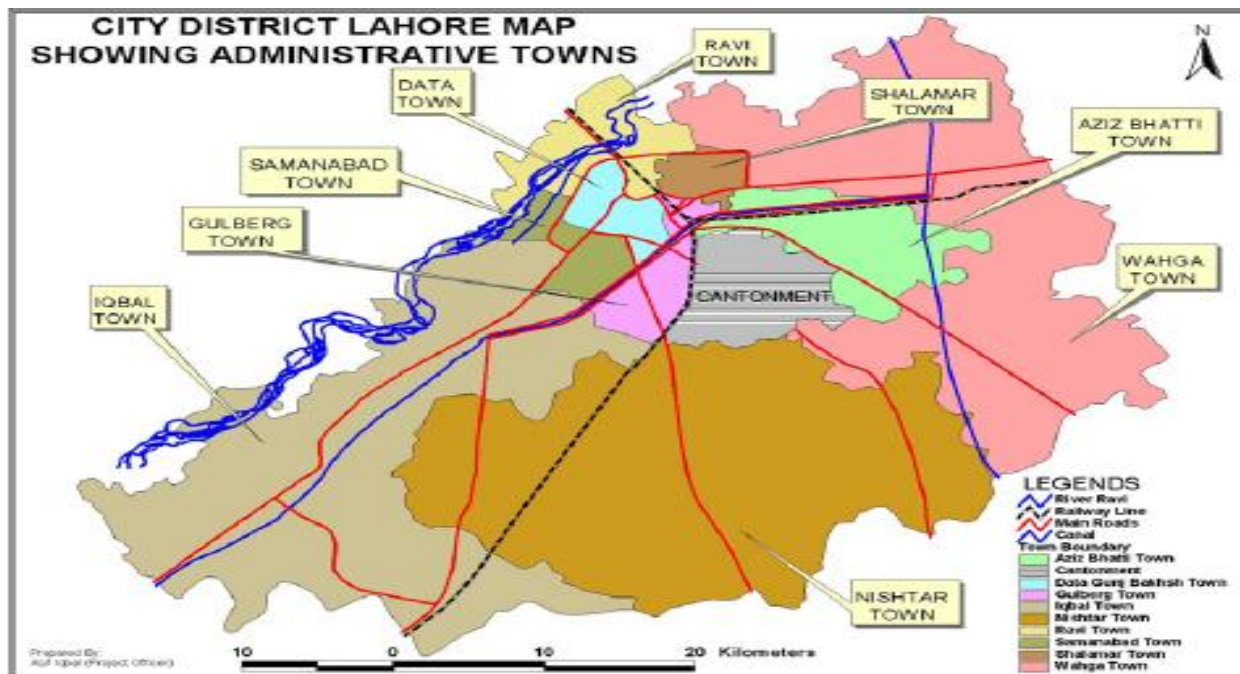


Figure 4.1: Local map for study area (Imtiaz and Ali, 2008).

The city is the centre of commerce, finance and transportation and is well known for its industries and their production systems like steel manufacturing, shoe making, rubber production and traditional metal craft. The wheat and cotton are the major crops whereas rice, sugarcane and millet are minor crops (Joeng et al., 2007).

Lahore has the most flourishing economy in Pakistan (GDP of US\$40 billion by purchasing power parity), contributing significantly to the national GDP of US\$395 billion. Central to

Lahore's economy is the Lahore Stock Exchange, government administrative bodies (namely the Water and Power Development Authority and Water and Sewage Authority), along with a strong industrial and services sector. A major industrial agglomeration with about 9,000 industrial plants, Lahore has been shifting in recent decades from the manufacturing to the services sector. Around 42% of its work force is employed in finance, banking, real estate, cultural, and social services sectors (ESMAP, 2010).

#### **4.1.2 Oslo**

The City of Oslo is the capital of Norway and can trace its history back to around the year 1000 A.D. The City is situated at the northern end of the Oslo Fjord, and is surrounded by forests to the north and east. The City has ca. 550 000 inhabitants, and is growing fast. The Oslo region comprises ca. 1 million inhabitants. The Oslo Municipality area is 454 km<sup>2</sup>, of which 2/3 is covered by forest and lakes. The City has a parliamentary political system, and is ruled by a City Commission and a City Council. The Chief Commissioner is the highest ranking politician of Oslo (Carlson et al., 2008).

### **4.2 Methodology**

#### **4.2.1 Methods for Data Collection**

The in-depth study of the solid waste management systems of these two main cities (like Oslo, Norway and Lahore, Pakistan) was carried out by collection of information from published reports, documents from their official websites and authentic published reports.

- This research will be based on narrative literature or secondary sources collected from the library, internet, and online video clips. The literature including, journals and articles, books, and official websites of different institutions and the government of Norway and Pakistan.
- The Qualitative data analysis has been performed by comparing the different solid waste management activities from the two big cities of two different countries.

## **5.0 COMPARATIVE ANALYSIS**

### **5.1 Comparison of Type and Composition**

#### **5.1.1 Type and Composition of Waste in Lahore**

Composition of wastes also differs from locality to locality. People in a particular locality often have similar background in terms of incomes, laws and expenditure. Waste is categorized on the basis of source rather than type. Between 40-65% of waste in Pakistan is composed of bio degradable material. The composition of solid waste in 2005 reveals that waste in Lahore contains 21.2% recyclables, such as plastic, paper, glass and metal. There is no regulation on recyclables or recycling in Pakistan, and the formal sector is not actually involved in recycling (Batool et al., 2008).

According to Lahore waste management company report, waste characteristics study 2012, waste include important components vegetable and fruit dust, dirt, ashes, leaves, grasses and straw, The Organic components constitute 60% of Biodegradable. The Nylon component is 11.6%. Textile wastes are 9.09% diaper, 3.11%, Paper-Cardboard 2.43%, Non-Combustibles 2.26%, and Combustibles 2.12% of the total waste stream.

#### **5.1.2 Type and Composition Oslo**

Residual waste from the every household in Oslo is put in three different colour bags: white bag for residual waste; food waste goes in green bags; plastic waste in blue bags. And then the waste is collected in a container and put to recycle depending on the colour of the bags.

In Oslo, about 340 000 households generate annual waste of about 240 000 tones, of this about 114 000 tones of residual waste and 40 000 tonnes of paper is collected. In 2011, 392 kg of waste per person was produced, of which about 33% was recycled. The city has a goal to increase the percentage of recycling (material recovery) to 50% in 2014 (C40 cities, 2012).

The amount of total municipal waste per capita was in 467 kg in 2007 (do not correspond to the figure above); this number includes commercial waste 56kg per capita and household waste 413 kg per capita. Therefore, the amount of total household waste per capita increased from 407 kg in 2004 to 413kg in 2007. In 2007 five percent of total household waste was sent to landfill. The amount of biodegradable waste sent to landfill was 0.1% of total household waste (when). From the municipal waste, the percentage of recycled waste was 23% and from that 34% consisted of

papers; in the form of cardboard, cartons and drink cartons and 66% was the garden waste. The garden waste is composted, sorted in infractions and sold at the recycling centres (Oslo kommune, 2008).

### ***Summary***

However there are no doubts on the waste generation in Oslo as compared to Lahore is far superior in relation to colour coding which helps in sorting of waste, so the recycling process becomes smoother. On an average, Oslo recycles 33% of total waste and aims to reach 50% in coming decades. On the other side, in Lahore waste recycling is 21% and has lot more to achieve in terms of recycling of the waste.

## **5.2 Waste Collection, Waste Transportation, Waste Treatment and Waste Disposal Procedure.**

### **5.2.1 Lahore**

In 2012, the LWMC has entered into a partnership with two Turkish companies for seven years to tackle waste in Lahore. These two companies are: Al Bayark and OzPak. (The Express Tribune, 2012).

In Lahore Municipal solid waste is collected by the municipality. It concerns waste from households (82 % of total MSW), small business, office buildings and institutions such as schools, hospitals, government buildings, waste from parks and street cleaning (Eurostat et al., 2003, pp. 16). More than 10,000 rag pickers in the city of Lahore are at the mercy of the middlemen who buy their stuff at low rate. There no control of this business by the City District Government Lahore (CDGL). Since the Afghans outnumbered the locals five year ago, the middlemen (kabarias) are also happy because of increased availability of labour. This labour never demands an increase in wages and work on their middlemen terms and conditions. The Afghan influx increased in Lahore during the US invasion of Afghanistan in 2003. Between rupees 2 and 3 rupees per kilogramme paper waste is usually paid to a rag picker (Tahir, 2006).

Due to a variety of factors such as insufficient waste collection points, lack of equipment, unavailability of sanitary landfills, lack of resources, and communities' reluctance to pay for collection fees, waste management has become a major challenge and even the collected waste is often improperly disposed along roadsides and dumping sites.

Saif Group, with Lahore Compost (Pvt.) Ltd, has set up its first composting plant at Mahmood Booti under an agreement with the City District Government Lahore (CDGL). The project has been setup on a Build-Operate-Transfer basis, whereby the project will be transferred to CDGL after a period of 25 years (Lahore Compost Private Limited et. al 2012).

Studies have shown there is an estimated organic content of over 50% in Lahore's solid waste, presenting an opportunity to substantially reduce the waste. This represents an opportunity for composting. The equipment used for composting was imported from a Belgium company named Menart Compost Company. The project began first with 300 TPD of compost from the site in 2006 and increased its operations to 750 TPD by April 2009. The process of composting is to convert organic waste into compost through a process lasting 70-90 days, using the "aerobic windrow" technology from Belgium. In this windrow composting, incoming garbage is weighed, inspected and sorted to remove large non-compostable items. The composting of kitchen waste, as it is being carried out in Lahore, not only reduces the waste that enters the waste management but provides an end product that is fertilizer for plants and crops. Waste volume reduction has been reduced by 70 percent through the use of composting (Aslam et al., 2012)

The other two dumping sites are Saggian and Baggarian located in Lahore. Waste here is being dumped without proper handling.

### **5.2.2 Oslo**

In 2011, about 240,000 tonnes household waste was collected and of this 1% was reused, 33% recycled, 60% energy recovered and only 6% went to landfill.

In the Oslo region a pilot project started in 2009 to sort two fractions of kitchen waste. Plastic packaging material and organic waste were sorted in colored bags and put in bin together with the residual waste. These colored bags were later separated in the plants based on optical sorting, and organic waste was sent to biological treatment in a biogas power plant. Municipal waste is fed into hopper from the waste bunker, and it moves through the combustion chamber on the grate, energy recovered and distributed to 20000 homes (approximately 5GW). By increasing the incineration capacity the amount renewable energy increased by 13 % whereas the amount of waste sent to landfill was reduced based on strategy. Cinder produced by incineration was 1997 about 21 % and in 2003 it reduced by 16 % (C40 Cities, 2012).

There are three large MSW combustion plants in Oslo. One of the plants is Haraldrud, completed in 1988. The energy produced by the combustion plant is mainly used in the district heating systems to heat up buildings in Oslo. 100,000 tons of waste is incinerated at the plant and 235,000 MW is sold to the district heating system each year (C40 Cities, 2012).

Two waste-to-energy plants incinerate residual waste from the city, with a capacity of 410,000 tonnes of waste per year. The Klemetsrud plant was extended by a third incineration line in 2010. The total energy production is about 840 GWh heat and 160 GWh electricity per year. The heat energy meets the need of about 84 000 households through the district heating system. Norway has banned the deposition of biodegradable waste in landfills from 2009, yet in Oslo, this target was met in 2002. The city landfill site closed in 2007. Landfill gas from earlier deposits is collected and used for production of electric energy, delivered to the schools of Oslo. EGE delivers 50 percent of the current energy need in the district heating system. The energy produced at the EGE plants is used to heat water which is sent into the district heating network owned by Hafslund (EGE, 2012).

A new biological treatment plant is being constructed in Nes municipality, north-east of Oslo. The plant will produce both biogas and bio fertilizer from Oslo's food waste. The biogas will be used as a green fuel for buses and waste trucks, and the bio fertilizer will be used by local farmers. Until the new plant opens, the food waste is sent to biogas plants in Sweden. The biogas plant will have the capacity to handle 50 000 tonnes of food waste per year, The biogas plant will produce about 4,5 million Nm<sup>3</sup>. Upgraded biogas and 90 000 m<sup>3</sup> bio fertilizer (liquid) per year. These amounts will be enough to run about 150 buses on biogas and provide about 100 medium-sized farms with bio fertilizer yearly (C40 Cities, 2012).

### ***Summary***

The collection and treatment system for waste management in Lahore is not efficient enough to meet the current generation of waste as more than half of waste is left over in the streets, which pollutes the surface environment and ground water pollution, for this purpose few companies have been contacted but they don't have capacity to tackle it. Rag pickers are playing the key role for the collection and transportation of waste which can be recycled. Only one company operating for bio degradable waste which has for less capacity to deal with it, the major part of waste is dump into the landfill.

Therefore, in Oslo all the waste has relevant type of treatment, like bio degradable waste goes to bio plant combustible waste goes for incineration, where they are producing enough energy from the waste to meet the energy requirement in term of electricity and heating, and very minutes quantity of waste which is useless is dump in engineered land fill sites.

The study will utilize various perspectives to compare the systems in Oslo and Lahore. A special focus will be given to the reuse, recycling and recovery processes in Lahore and Oslo. This allows us to present alternative scenarios to policy makers, community-based organisations (CBOs), NGOs, and local public bodies and private enterprises,

Oslo too needs progress with regard to management of SWM. Biofuel production from waste should increase; this can have a positive effect on air quality in Oslo. Oslo also needs to continue the work on use of by-product from waste. For more general understanding of waste management is presented in tabulated form as in Table 5.1.

Table 5.1: Comparison of solid waste management in Oslo and Lahore.

<b>Oslo</b>	<b>Lahore</b>
1. Solid waste management is systematically sorted out with food waste going in green bags, other waste from the household in blue bags	1. Lahore there exists no mechanism for sorting out food waste from normal waste produced from households
2. Oslo methodology is Reduce, Reuse and Recycle	2. Lahore methodology has not yet implemented the principle of reduce, reuse and recycle.
3. The waste management strategy of 2006-2009 plans to contribute reduce CO2 emission	3. There no such policy document to reduce CO2levels in Lahore
4. Bio gas is being produced from sewage sludge in Oslo	4. Bio gas stage has not been reached in Lahore
5. Waste generate energy for winter months	5. Lahore has dumping sites, where solid waste is dumped in the land fill sites

for Oslo	causing major hazards to the environment
6. Civic institutions are stronger and work in tandem with private players	6. Civic institutions are not interested in issues of Solid waste management.

### **5.3 Laws and Regulations dealing with Solid Waste Management in Oslo and Lahore**

#### **5.3.1 Oslo Laws and Regulations**

According to Norway's national goal, growth in the total amount of waste shall be significantly lower than economic growth. The total quantity of waste increased by approximately 34 per cent between 1995 and 2010, while the gross domestic product (GDP) increased by 39 per cent in the same period (Statistisk Sentralbyrå, 2013).

#### ***A number of Instruments in Place***

Waste management is regulating in various ways, and there is interplay between regulation at central and local levels. The central government authorities set the general framework, leaving municipalities and industry with a relatively free hand to design local collection and treatment solutions (Environment Norway, 2012).

#### ***Important Waste Policy Instruments***

The authorities have put in place a number of instruments (e.g. legislation, taxes, and economic incentives) targeted at the municipalities, business and industry. The most important waste policy instruments are (Environment Norway, 2012):

- municipal responsibility for household waste
- business and industry responsibility for dealing with the waste they generate, including the collection and appropriate treatment of certain types of waste products, such as e-waste, packaging, cars, tyres, batteries, lubricant oil and PCB-windows
- regulation of landfilling and incineration according to EU legislation
- tax on final disposal of waste to landfills



- waste management plans as a mandatory element of all building projects, as part of municipal administrative procedures
- ban on landfilling of biodegradable waste from 1 July 2009

Otherwise, information regarding the Waste management comes as a part of the Pollution Control Act of Norway, under which there is a special provision on Waste Management (1981). The chapter concerning the regulations are as follows (Environment Norway, 2012):

All the different regulations concerning waste and waste handling is gathered in “Avfallsforskriften”/Waste regulation. It contains 14 chapters, and regulates explicitly different waste categories such as (EIONET, 2012).

- Waste electrical and electronic equipment (EE equipment).
- Handling of discarded refrigeration equipment containing CFC
- Batteries which are hazardous to the environment
- End-of-life vehicles
- Collection and recycling of discarded tyres
- Take-back systems for beverage packaging
- Refund of taxes paid on trichloroethyleneTRI ,
- and hydro fluorocarbons (HFCs) and perfluorocarbons (PFCs).
- Landfilling of waste
- Incineration of waste
- Hazardous waste
- Permits for trans-frontier shipment of waste
- Discarded insulating glass units containing PCBs

The Norwegian Government comes out with a White paper on environment every second year. This paper outlines the national waste targets and instruments which are needed to reach them. This paper may not have a legal reference but gives a state of environment and provides a discussion about government’s future policy.

The Paper includes waste targets for the coming years. The national targets aim to (EIONET, 2012).

- Reduce the generation of hazardous waste by 2020 down to 2005-level.

- Secure safe treatment of hazardous waste

Further, the Paper describes new or revised instruments that the Government wants to put in place or have put in place to reach the targets.

- Implement requirements of compulsory waste plans in building- and construction matters at local governments
- Stimulate to increased energy utilization of organic waste
- Continue the work on the revised hazardous waste strategy to increase the collection and proper handling of hazardous waste which includes identifying potential new hazardous waste
- Increase research on how to secure safe use of compost and sludge and other waste products in farming

A report submitted by the Ministry of Environment on Waste Management to the Norwegian Parliament in 2001, mentioned below are the extracts.

### ***Waste and Recycling***

Waste means any unwanted remains from production and consumption. Final treatment of waste, which means landfilling or incineration, results in emissions to air, soil and water and is a source of local and global environmental problems. Methane emissions from landfills are estimated to account for 7 per cent of Norway's total emissions of greenhouse gases (Environment Norway, 2013). In addition, waste treatment results in emissions of hazardous substances, dust, acidifying substances, heavy metals and nutrients, and results in littering. The extent of the environmental problems depends on the quantity and type of waste generated, the final treatment and on the standards at waste treatment facilities. These standards are regulated by licensing conditions.

### ***Goals***

As regards waste and recycling, the Government bases its efforts on the following goals (Environment Norway, 2013).

### ***Goals for Waste and Recycling***

*Strategic objective:*

Damage to people and the environment caused by waste is to be minimized. To achieve this, waste problems are to be solved by means of policy instruments that ensure a good socio-economic balance between the quantity of waste generated and the quantities recycled, incinerated or landfilled (Environment Norway, 2013).

*National targets:*

1. The growth in the quantity of waste generated shall be considerably lower than the rate of economic growth.
2. The quantity of waste delivered for final treatment is to be reduced to an appropriate level in economic and environmental terms. Using this as a basis, the target is for 25 per cent of the total quantity of waste generated to be delivered for final treatment in 2010.

Practically all hazardous waste is to be dealt with in an appropriate way; so that it is either recycled or sufficient treatment capacity is provided within Norway.

### **Policy Instruments and Measures**

*The Government will:*

- “Follow up the proposals for further development of waste management policy that were presented in Report No. 8 (1999-2000) to the Sorting and regularly evaluate the need to adjust waste policy instruments to make their application more efficient”,
- Consider proposals for amendments to the Pollution Control Act, including changes in the definitions of waste types, repealing the requirement for all municipalities to draw up waste management plans, measures to reduce the risk of littering, and funding for municipal control,
- Continue the agreements with branches of industry on packaging waste with some adjustments to ensure that a high proportion of the waste continues to be collected and recycled,
- Evaluate the need for changes in the fee for final waste treatment to ensure more correct pricing of emissions and provide a stronger incentive for energy recovery from waste,

- Issue regulations laying down stricter requirements for landfills, expand the list of hazardous waste categories, and consider appropriate adaptations to the EU arrangements for producer responsibility for end-of-life vehicles.

In Oslo SWM is mentioned under the Master plan of the Oslo kommune, 2008 which has a point 2.7 which deals with “the environment and sustainable use of natural resources”. In this it is pointed out that, “Energy for the district heating system is supplied by incineration of residual waste, thus reducing CO2 emissions from the combustion of oil and methane emissions from landfills (Oslo Kommune, 2008).

As per this plan, the city council plans to use the solid waste for heating in the city. This will be possible after the establishment of new bio fuel plant and new waste incineration facility in Oslo. One the vision of the Master plan is to, “promote urban development with focus on local community participation as well as high environmental standards, added to this an eco-efficient local transport system” (Oslo Kommune, 2008).

### **5.3.2 Lahore: Laws and Regulations**

In the case of Lahore there is no specific legislation which deals with Solid waste management. It is at the federal level under the Ministry of Environment that this matter is dealt with. Provincial agencies authorized by the federal government deal with waste management. Pakistan has an Environmental Protection Act 1997 (PEPA). This act came in force after Pakistan attended the Rio-De-Janeiro (Brazil) Earth summit. In the same year, Pakistan prepared the National Conservation Strategy to deal with all its environmental problems in the country (Azeem, 2013).

Section 13 of the PEPA deals with the prohibition to import hazardous waste to Pakistan. The Pakistan Environmental Protection Act, 1997 requires that no person import any hazardous substances of which chemical activity is toxic, explosive, flammable, corrosive, radioactive, cause directly or in combination with other matters, an adverse environmental effect (PEPA, 1997).

Section 26 of the act deals with delegation of powers to the provincial and local bodies in implementing environmental protection measures. Further the provincial bodies have delegated the powers to the local bodies to implement environment protection.

In the specific case of Punjab province of which Lahore city comes under is dealt by Environment Protection Agency (EPA) created by the Environment Protection Department. The EPA is responsible for the protection, conservation, rehabilitation and improvement of the environment; the prevention and control of pollution; and promotion of sustainable development in the province (PEPA, 1997).

The EPA deals with water, air, soil, noise pollution and have defined waste broadly and subdivided waste into hospital, municipal, agricultural waste.

The main composition of Solid waste as per EPA is as follows: The solid waste composition varies from region to region and time to time. There are following different types of waste.

- Biodegradable waste i.e. could be decomposed naturally such as food and kitchen waste, green waste, paper, etc.
- Recyclable material i.e. could be recycled again and again; such as paper, glass, bottles, cans, metals, certain plastics, fabrics, clothes, batteries etc.
- Inert waste i.e. not decomposable; such as construction and demolition waste, dirt, rocks, debris, etc.
- Electrical and electronic waste (WEEE); such as electrical appliances, TVs, computers, screens, etc.
- Composite wastes; such as waste clothing, Tetra Packs, waste plastic, etc.
- Domestic hazardous waste & toxic waste medication; such as paints, chemicals, light bulbs, fluorescent tubes, spray cans, fertilizer and pesticide containers, shoe polish, etc. (EPD, 2012)

### **Summary:**

As for waste management in Pakistan, PEPA 1997 was developed. Which dealt with waste management but does not include hazard waste. For Punjab environmental protection agency is responsible for the waste management and defining target for the waste management, these targets are not given importance because of enforcement concerns. The targets are limited to the paper work, not implemented on a practical level.

As compared to Lahore in Oslo waste regulation are made at centre and local level. Laws policies and regulation are well developed and implemented by the Oslo komune which sets targets to be achieved for the future. The federal government provides general instructions which may be followed by the local bodies.

#### **5.4 Socio-Economic Constrains Comparison**

The municipalities in developing countries typically lack the financial resources and skills needed to cope with this crisis. Several countries have realized that the way they manage their solid wastes does not satisfy the objectives of sustainable development. This raises the important issue of how to deliver quality service in the face of the financial and skill constraints of the public sector. Due to improper policies and legislation there is no fee applicable to every household to which pay for the waste management in the city. Therefore due to different socio economic status of within the towns on waste management leads to inequality in nature of waste management system. For example, in posh areas of the city waste management may be better compared to low income areas in the city. But overall waste management system is not effective due to social behaviour of local people as they are having less knowledge about how waste can be manage properly, due to their less knowledge and socio economic behaviour has given less impact to waste management.

Due to proper policies and legislation there is a mandatory fee for household, for the collection and transportation of waste. This fee is sufficient for the high income areas but in relation to the low income areas, a strategy of knowledge, social awareness about solid waste management needs to be inculcated.

## **6.0 Conclusion and Recommendations**

### **6.1 Conclusion**

It is extremely difficult to arrive at common ground in case of SWM due to following reasons: geographical, technological, political, socio-economic and managerial. The SWM has been dealt in a different way with regard to collection, sorting and technical knowhow which goes into the process of solid waste management. However during the research it has been found out that there is paucity of solid waste, this could become a win-win opportunity for both the cities if and when Lahore could utilise this to export solid waste to Oslo.

Then we have lack of awareness, planning as well as lesser political will responsible for poor waste management system in Lahore. There is inadequate resources and unskilled manpower which are too a barrier for development of a sustainable integrated waste management system. Added to this, there is unavailability of data on solid waste in Pakistan. Accurate data on waste generation, its characteristics and the environmental effects of its land disposal is the most important information required for future planning. The need is for apt policies combined with effectively implemented regulations which shall show a positive direction towards waste management. Then the improved waste management practices would provide stimulus towards environmental, social and financial benefits.

### **6.2 Recommendations**

Some of the recommendations for Lahore are as follows:

- Public education and awareness is very important for the change of attitude and behaviour of public. For this purpose we may use different strategies, e.g., education session for common man regarding disposal of garbage. By this way we can educate the common man regarding how they can play their role in solid waste management.
- The need of the hour is to revise the solid waste management law in Pakistan. The responsibilities of citizens, enterprises and the government must be clearly defined. After revision of legislature, the government must ensure proper monitoring, control and evaluation. Citizens, no matter how influential, should be punished for the violation of law and factories should be held accountable for the industrial waste they generate.

- Currently, individuals dispose of wastes by throwing away plastic bags, wrappers, fruit peels, cigarette butts, etc. in public places. Littering spreads pollution and ends up clogging drains and causing sanitation problems. This can be controlled by making roadside dustbins or proper disposal of waste at home.
- If proper waste management is practiced, this waste could be converted into useful products.
- The best way to reduce waste is not to produce it in the first place. Everyone should try to reduce his/her consumption of goods as much as possible. For example, choose products with minimum packaging and instead of accepting plastic bags when shopping, use cloth bags.
- Items should not just be thrown away after use if they can be used again. Doing this result in a reduction in waste and better conservation of resources. Items, which can be re-used, include glass jars and bottles, and plastic bags.
- Recycling means creating new things from used items. Almost 20-30 percent of MSW contains materials which could be recycled. For instance:
  - Paper can be re-pulped and reprocessed into recycled paper, cardboard and other paper products.
  - Broken glass can be crushed, re-melted and made into containers. Some forms of plastic can be re-melted and fabricated into carpet fiber or cloth
  - Food wastes and yard wastes can be composted to produce fertilizers and soil conditioners.
- Haraldrud and Klemetsrud plant can be models for waste management in Lahore. Oslo has a well established plan for waste management and politicians are engaged in waste management. Lahore could learn from the experiences in Oslo. Public-private partnership may become important in order to make waste management in Lahore more efficiently.
- Lahore needs to redefine the regulations dealing with waste management. There is here a lot to learn from the regulation in EU.
- In the study it was found out that there were major political and social differences which led to failure of SWM initiatives in the past in Lahore. Pakistan needs to learn from those experiences and develop a new policy on waste management.



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