GAP ANALYSIS IN EXISTING SOLID WASTE MANAGEMENT SYSTEM OF FAISALABAD

By

Muhammad Imran

Reg. # 39–FBAS/MSES/F08

Supervisor

Dr. Islam-ud-din

Assistant Professor

Department of Environmental Sciences

Faculty of Basic & Applied Sciences

INTERNATIONAL ISLAMIC UNIVERSITY

ISLAMABAD

2012

1- Waste management

2- Waste control

Gap Analysis in Existing Solid Waste Management System of Faisalabad

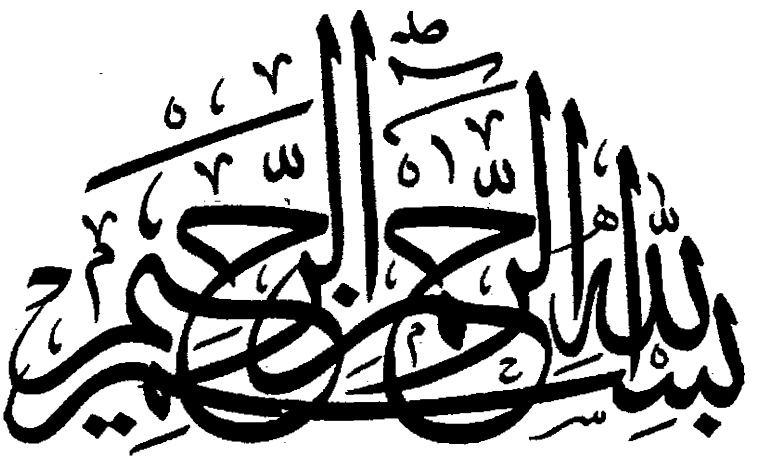
Muhammad Imran

Reg. # 39–FBAS/MSES/F08

Submitted in partial fulfillment of the requirement for the MS degree in Environmental Science at the Faculty of Basic & Applied Sciences, International Islamic University, Islamabad

Supervisor

Dr. Islam-ud-din
Assistant Professor



"In the name of Allah the most beneficial and merciful"

DEDICATED

I dedicate this document to my family and teachers. The endless support and affection of all of these people has resulted into the fruitfulness of my research work.

(Acceptance by the Viva Voce Committee)

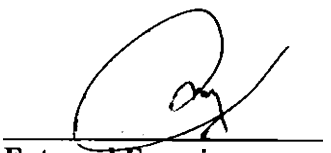
Title of the Thesis: Gap Analysis in Existing Solid Waste Management System of Faisalabad

Name of Student Muhammad Imran

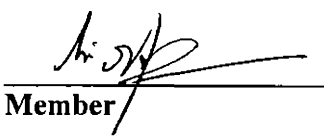
Registration No. 39-FBAS/MSES/F08

Accepted by the Department of Environmental Sciences/Faculty of Basic & Applied Sciences, International Islamic University, Islamabad, in partial fulfillment of the requirement for the MS degree in Environmental Sciences.

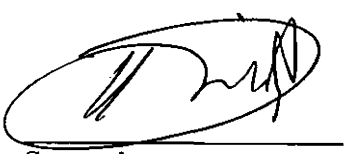
Viva Voce Committee



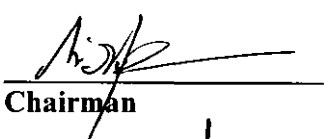
External Examiner



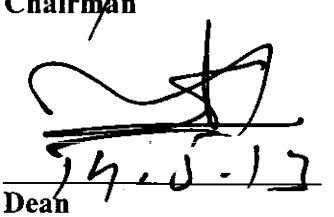
Member



Supervisor



Chairman



Dean

(26/04/ 2013)

DECLARATION

I, Muhammad Imran S/o Muhammad Hanif, Registration No. 39–FBAS/MSES/F08, a student of MS Environmental Science at the Department of Environmental Sciences, Faculty of Basic & Applied Sciences, International Islamic University Islamabad (IIUI) do hereby solemnly declare that the thesis entitled "Gap Analysis in Existing Solid Waste Management System of Faisalabad" submitted by me in partial fulfillment of the requirement for the MS degree in Environmental Science, is my original work, and has not been submitted or published earlier, and shall not in future be submitted by me for obtaining any degree from this or any other University or Institution.

Name: **MUHAMMAD IMRAN**

Signature: _____

Date: _____

FORWARDING SHEET

The thesis entitled "Gap Analysis in Existing Solid Waste Management System of Faisalabad" submitted by Muhammad Imran in partial fulfillment of MS degree in Environmental Science has been completed under my guidance and supervision. I am satisfied with the quality of student's research work and allow him to submit this thesis for further process of as per IIUI rules and regulations.

Date: _____ **Signature:** _____

Name: **Dr. Islam-ud-din**
Assistant Professor
DES, FBAS, IIUI

ABSTRACT

Solid waste management is considered as one of the major issues that need to be addressed in order to protect human beings. Increase in population and urban migration have created serious environmental issues due to inadequate solid waste management. The waste management is a matter of concern in Pakistan too. In this study, a descriptive research methodology was adopted to technically analyze and evaluate the existing solid waste management system of Faisalabad and gaps in it, considering the basic design parameters.

A representative sample was collected from eight union councils of the city and its physical analysis was carried out. The sample was categorized into organic (67.64%), textile (5.14%), papers (1.83%), plastics (8.08%), metals (0.18%), glass (0.73%), hazardous (1.28%) and other inorganic (15.07%) products. According to the CDGF data, bulk of the waste produced in the city was organic (41%), while 18.1% was recyclable. Further, 52.4 % of the total waste was valuable.

For waste management in the area, city district government Faisalabad (CDGF) was providing primary collection, transportation and street sweeping services; however, people were also getting private services in the city. The present communal waste collection system was inefficient. Due to unhygienic conditions and poor vehicular maintenance the ability of existing system had reduced to remove only 54% of the total generated waste. The uncollected solid waste was not only creating problems for inhabitants of Faisalabad but also found ways into drains, depressions and open plots/spaces etc. Gaps were identified in waste collection, hauling, storage, transportation, disposal, fleet maintenance and capacity building of the department. Door to door and point to point collection system was poor because of social hurdles and less materials recovery. 35% vehicles of solid waste management department Faisalabad (SWMDF) were off road. No waste transfer station and formal secondary collection points were present in the city. Inter-departmental communications were very poor. SWMDF was short of general manpower as well as technical staff. SWMDF, due to fewer resources, covered only 70% of the area. More than 89% of the budget was being allocated for employees related expenses. The SWMDF employees' ratio was 1.4 per 1000 persons and 197 Kg waste per employee was collected. An average of Rs. 1102.42 was being spent by CDGF for managing one ton of solid waste in the area. No other appropriate alternatives of waste management and viability of energy and resource recovery processes have been considered in the present system. The waste disposal system in Faisalabad was also very poor and not a single sanitary landfill site was present to dispose of solid waste in an environmental friendly manner.

Different design parameters i.e. strengthening institutional capacity, assistance of technical staff, financial increments, resources availability, mass awareness public campaign, efficient door step collection system, secondary collection points, transfer stations and modern transport fleets for collection and transportation services, have been proposed to fill the present gaps and improve the overall performance of SWMDF.

ACKNOWLEDGEMENTS

All Praises be to Almighty Allah, the Most Gracious, Most Merciful and the Most Beneficent who enabled me to complete this thesis. I present my esteem to the Holy Prophet (PBUH) who is the inspiration of clarification and the supreme benefactor, the mankind ever had.

I would like to express sincere and heartiest recognition to my research supervisor Dr. Islam-ud-din for his encouragement, guidance, valuable suggestions, endorsement, imperative and productive criticism and overall supervision.

I am pleased to express my thanks to Prof. Dr. Muhammad Irfan, Chairman, Department of Environmental Sciences, IIUI, Dr. Ashraf Bodla, Ex–Director (NDP–Urban Unit) Punjab, Dr. Aslam, Deputy Director SWMDF, Dr. Farrukh Pervez, Ernst & Young Pakistan and Miss Afia Hussain, IPDF Pakistan for cooperation and assistance in all manners.

I am also grateful to Sumeria Yousaf, EPD Punjab and Muhammad Khalid SWMDF for providing useful data and help regarding the survey of households. I would also like to extend my heartiest gratitude to representatives of City District Government Faisalabad (Management Authorities and Sanitation Staff) for their full support and cooperation during the research work.

In the end, I would like to express my sincere gratitude to my family members and friends, as without their incessant support and encouragement this work would not have been completed.

Muhammad Imran

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CDGF	City District Government Faisalabad
CM	Chief Minister
DCO	District Coordination Officer
EPA	Environmental Protection Agency
EPD	Environmental Protection Department
FY	Financial / Fiscal Year
GoP	Government of Pakistan
GoPu	Government of Punjab
HWMR	Hazardous Waste Management Rules
IIUI	International Islamic University Islamabad
IPDF	Infrastructure Project Development Facility
JICA	Japan International Cooperation Agency
KOICA	Korean International Cooperation Agency
ME	Masonry Enclosure
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NDP	National Drainage Program
P & R	Process & Recovery
PEPA	Pakistan Environmental Protection Act
PEPC	Pakistan Environmental Protection Council
PKR	Pakistan Rupee
PLGO	Pakistan Local Government Ordinance
PPP	Public Private Partnership
RDF	Refuse Derived Fuel
REF	Recovered Fuel
SWMR	Solid Waste Management Reforms
SWMDF	Solid Waste Management Department Faisalabad
SWMS	Solid Waste Management System
UC	Union Council
UN	United Nations
UNDP	United Nations Development Program
US EPA	United States Environmental Protection Agency
USA	United States of America
WASA	Water and Sanitation Authority
WB	World Bank

CHAPTER 1 INTRODUCTION

Generation of solid waste is a major problem in urban areas, thus its management is one of the important mandatory responsibility of local urban world. In Pakistan, urbanization and economic growth are regarded to have advanced drastically in recent decades (Batool et al., 2007). The increased urbanization and industrialization have resulted in tremendous buildup of solid waste in the urban and semi urban areas. (Zurbrugg, 2003; Idris et al., 2004; JICA, 2005; KOICA, 2007; GoP, 2007; Green, 2008; GoPu, 2009). Besides other challenges, solid waste management (SWM) is a big challenge to a growing new town (Van-Beukering et al., 2000). Poor solid waste management depletes natural resources and only to bury the waste underground is not environmental friendly option (Hossain et al., 2006).

Solid waste is the term used to describe non-liquid waste materials arising from domestic, trade, commercial, agricultural, industrial activities and from public services (Palnitkar, 2002). A type of waste mostly includes household waste with the occasional addition of commercial and industrial wastes (not the hazardous waste), collected by a municipality within its area, in either solid or semisolid form is called urban solid waste (JICA, 2005; GoPu 2007; KOICA, 2007; UNEP, 2008). Waste materials also exist in solid, gaseous and liquid states but the most direct and visual waste management problems in urban area are related to the solid ones (Dahlberg et al., 1993).

Solid waste generation in urban Pakistan is more than 55,000 tons per day, and waste collection in cities is only 50% of the total waste generated (EPMC, 1996; JICA, 2005). The amount of waste generated strongly depends on the level of consumption and lifestyle besides population. Average rate of waste generation from municipalities varies

from 0.283 to 0.613 kg / capita / day in Punjab and 0.55 kg / capita / day overall in Pakistan (KOICA, 2007).

Improper solid waste management is the most characteristic problem that constitutes a growing concern in Pakistan (Sharholy, et al., 2007; GoPu, 2009) as the basic services are not adequately available and accessible to the citizens (Murtaza and Rahman, 2000; GoPu 2007).

Municipal waste is generally composed of vegetable/putrescible, textile waste, paper and cardboard, glass and ceramics, plastics and rubber, wood, bones and metals etc. (GoPu 2007; KOICA, 2007).

To study a municipal solid waste management strategy and procedures, it is essential to know the composition of waste and thorough knowledge of collection and transportation (IGD, 1992; GVRD, 2005; Bandara et al., 2007; Hoornweg, 2008). The composition of solid waste varies mainly with the area in respect of life style, to some extent with the season and also with existing recycling activities (KOICA, 2007). There are clear differences in the nature of collected household waste, delivered household waste and commercial waste (Stardt and Schroll, 1999).

This study was mainly focused on the gap analysis of the existing waste management system of Faisalabad city in term of waste generation, collection, storage, transportation, disposal to the end point and associated key factor like management structure, financial matters, legal unsupported and risk involved with the present CDGF solid waste management system (SWMS).

Faisalabad city is located in the North East of Pakistan in the Punjab province. The City of Faisalabad is bound on the North by the Districts of Gujranwala and Sheikhupura, on the East by Sahiwal, on the South by Toba Tek Singh and on the West by Jhang and stands between longitude 73°74 East, latitude 30°31.5 North, with an

elevation of 184 meters above sea level. The city is at a road and railway junction, which has played an influential role in the development of Faisalabad's trade and economy. It is the largest industrial city of Pakistan and specializes in export oriented manufactured goods and the textile capital of the country.

The topography of the district is generally flat with alluvial type of soil. No major river cross the district, however, mostly district plain is canal feed and with high level of productivity. The climate of the district is hot and dry, though the temperature varies considerably from season to season. The maximum and minimum average temperatures in summer are 37 and 24 degree Celsius respectively, while in the winter the range is 24 and 08 degree Celsius. The highest temperature in summer may hit 50 degree Celsius, and the lowest in winter may fall below freezing point. Summer dust storms are frequent. The average rain fall in the district is about 27.5 cm/year (CDGF, 2006).

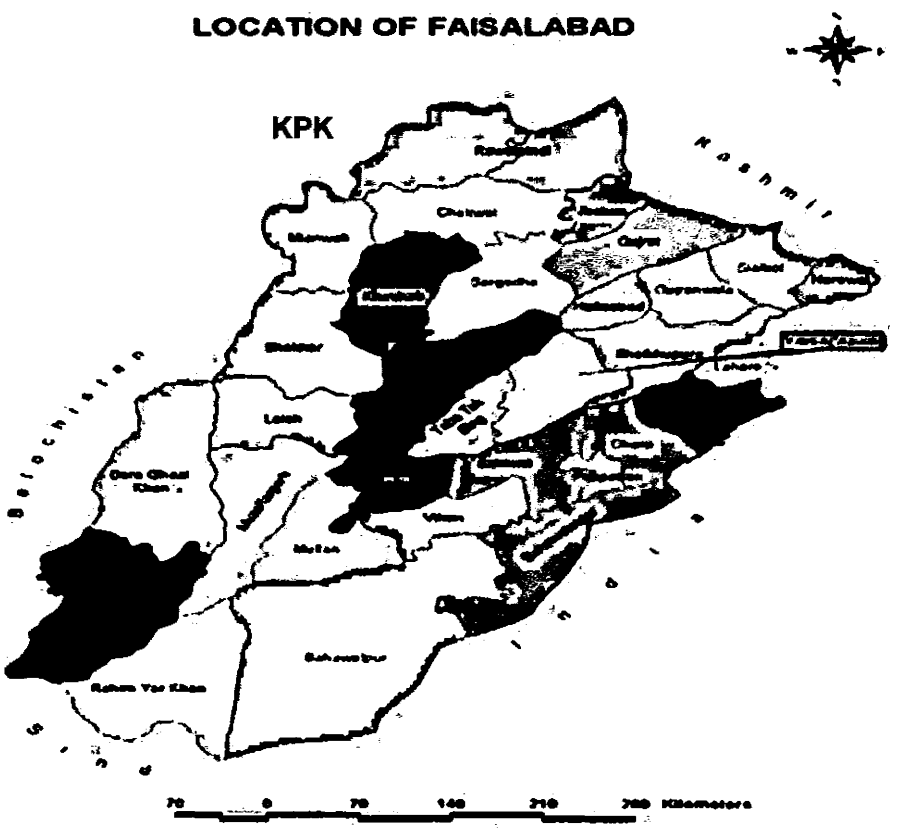


Figure 1. Map of Punjab showing Faisalabad District

Until year 2001, Faisalabad Tehsil Municipal Corporation (TMC) was the main official gateway in the city for each type of developmental and administrative works. After devolution under PLGO 2001, the City District Government Faisalabad (CDGF) is responsible and having power at local level, headed by a District Nazim. Now, a solid waste management department is working under CDGF organ flag. Table 1 shows Faisalabad District fact sheet.

Table 1. Faisalabad District Fact Sheet

Founding Year	1904
Total Area	5856 km^2
Total Population	5.42 millions
Population Density	927.2/km^2
Literacy Rate	60%
Total Housing Units	750975
Average Household Size	7.2
Average Annual Growth Rate	1.88*
No. of towns	08
Urban towns	04
Rural towns	04
No. of UCs	289
Urban UCs	113
Rural UCs	176
No. of villages	820
Rural to urban ratio	57:43
Male per 100 Female	109

Source: CDGF, *Punjab Development Statistics (2009)

1.1. Significance of the Study

In this study, the existing condition of waste management in Faisalabad city has been explained. As improper solid waste management is a big issue in all over Pakistan, it has

been tried to identify the reasons for solid waste mismanagement in CDGF area. The existing system was analyzed to find out gaps in it and to provide suggestions for an integrated waste management system in the city.

By applying and implementing the research outcomes and suggestions, the management of solid waste in Faisalabad urban area as well as other cities in Pakistan can be improved. This study tried to minimize the gaps and risks associated with the existing system, to improve the health and wellbeing of the people and the environment.

1.2. Objectives of the Study

- To study and analyze the existing practices and management approaches towards SWM in Faisalabad city.
- To find gaps in the SWM system of Faisalabad city
- To study the associated economic, environmental and public attitude for the present SWM system.
- To find out means and ways for better integrated waste management system.

CHAPTER 2 LITERATURE REVIEW

The solid wastes are, all wastes arising from human and animal activities that are normally solid and that are discarded as useless or unwanted (Grover et al., 2000) or waste is defined as unwanted material intentionally thrown away for disposal (Hoornweg, 2008).

The municipal solid waste includes wastes generated from residential, commercial, industrial, institutional, construction, demolition, process and municipal services (GoPu 2007; Hoornweg, 2008).

Haphazard dumping of solid waste remains highly visible in environment where we live and thus has great potential of adversely affecting public health as well as the quality of environment (Carra, 1982; Carbitt, 1999; Hoornweg, 2008). Common problems associated with improper management of solid waste includes contamination of surface and ground water through leachate, soil contamination through direct waste contact, air pollution by burning of wastes, spreading of diseases by direct vectors like birds, insects and rodents, aesthetic nuisance and economic losses (Zurbrugg, 2003; Cointreau, 2006; Rahman et al., 2008).

These problems arise due to several reasons including lack of comprehensive solid waste management system, lack of financial and human resources, insufficient legal and regulatory establishment, lack of awareness among residents, lack of research in solid waste sector and shortage of transportation arrangements (Nielsen and Exner, 1998; Zurbrugg, 2003; Kum et al., 2005; Batool et al., 2007; KOICA, 2007).

Integrated Waste Management (IWM) is the modern concept now a day which incorporates the waste management hierarchy (Turner and Powell, 1991) by considering direct impacts (transportation, collection, treatment and disposal of waste) and indirect

impacts (use of waste materials and energy outside the waste management system (Korhonen et al., 2004).

Urban Solid Waste Management (USWM) in developing countries comprises of formal and informal systems. The formal system consists of two actors: (i) the municipal body that is responsible for waste collection, transport and disposal (ii) private organizations interested in converting waste to marketable products such as compost or Refuse Derived Fuel (RDF) pellets and informal sector like scavengers (Sudhir et al., 1996).

Solid waste management is multi-disciplinary activity which deals with the control of generation, on-site storage, collection, transfer and transport, processing and recovery as well as final disposal of solid waste in accordance with the best principle of public health, economics, engineering, conservation, aesthetics and other environmental considerations (Tchobonoglous, 1990).

A typical waste management system in Asian countries can be described by the elements as street sweeping, techniques for waste reduction, storage, collection, transfer & transport and finally disposal (Snel and Ali, 1999; Zurbrugg, 2003; MSWM-Pu, 2007).

In most developing countries like India (Sharholy et al., 2007) and Pakistan (Batool et al., 2007) MSWM generally comprises primary and secondary collection and open dumping of more than 90% of the collected waste (Batool and Nawaz, 2009).

Primary collection involves sweeping the streets and collecting the waste placed in communal bins (Sudhir et al., 1996; Shimura et al., 2001; Sharholy et al., 2007). Collection and street sweeping together receive much attention and account for 70 – 90% cost of budget (Bartone, 1999; UNEP, 2008). A proper solid waste sweeping system helps to reduce street dirt and litter. In fact, in developing countries waste collection and

street sweeping are often highly inefficient; workers are often poorly motivated, untrained, under compensated and unnoticed. Mostly they are organized into a system of beats (Snel and Ali, 1999) and have old fashioned equipment. Many Collection activities involve the informal sector and poor man (UNEP, 2008). Street sweeping is carried out manually or mechanically. Manual method is suitable in congested areas. Workers collect waste from small heaps with the help of brooms (KOICA, 2007). Mechanical sweeping is carried out to increase the efficiency of the system and to overcome the shortage of labor and to clean main roads in the city (CDGF, 2006).

Waste reuse and recycling are desirable steps in waste management. Municipal waste reduction includes source reduction, source separation, waste recovery, reuse and recycling (Grover et al., 2000). Waste recovery is the procedure for obtaining materials / organics (by source separation or sorting out from mixed wastes) that can be reused or recycled (Tchobonoglous et al., 1990). Significant portion of the waste generated are recovered informally by scavengers (JICA, 2005). Composition of waste entering the municipal waste stream indicates that there is very little paper, plastic and glass, it is mainly silt and organic matter because mostly material recycle as an important resource (Snel and Ali, 1999).

After primary collection of the waste it is transferred to the communal storage point (Batool and Nawaz, 2009). A communal storage point consists of properly designed enclosure for placement of waste container. Waste enclosures have easy access and appropriate location for the staff and public (GoPu, 2009).

Many Asian countries do not have a formal house to house collection system. Householders either deposit their waste in a communal container or leave it in small piles outside the house. It is removed by sweepers (Snel and Ali, 1999). This improperly

stored refuse may attract insects, rodents, present a fire hazard & produce odors, litter & other unsightly conditions (Carbitt, 1999; McDougall et al., 2001).

Collection is a process in which solid waste is gathered from the storage points and hauled to a transfer station or dumping site (Sudhir, 1996; McDougall et al., 2001; Kaseva and Mbuligwe, 2005). It is then transferred, with or without compaction, to other vehicles for a longer haul to a disposal site (Cointreau, 1982). Vehicle availability is a very important factor in the collection of the waste and is directly related with performance of the system (Batool and Nawaz, 2009).

Available fleet for waste collection and transportation is composed of handcarts, donkey and bull carts for primary collection; open trucks, tractor trolley, arm roll for secondary collection (JICA, 2005; GoPu, 2009).

Transfer station is essential to transfer waste from smaller collection vehicles to larger transport vehicles for taking waste to a processing facility or a disposal site (GoPu, 2009; Batool and Nawaz, 2009). It also provides a point where recyclables are separated for recycling/reuse operations include sorting at a Material Recovery Facility (MRF) and to sort out mixed waste to produce RDF (Cointreau, 1982).

None of the municipalities in Pakistan have formal recycling system (JICA, 2005). Recycling and recovery is usually conducted by the informal sector on all levels of the waste management stream. Such work is done in a very labor intensive and unsafe way, and for very low incomes (Zurbrugg, 2003).

Recycling involves the transformation of a used product, via some process of grading and refinishing, to a new product of the same kind. Undoubtedly, recycling is at present the most constructive approach to alleviate the solid waste problem (Coomaren et al., 2000; GoPu, 2009).

Composting, biogas, incineration and Landfill facilities are waste treatment options (Ziekiene et al., 2005; GoPu, 2009).

Biological treatment is used to treat organic fraction of solid waste. There are various means for biological treatment. However, Composting is an excellent method of recycling biodegradable waste from an ecological point of view (McDougall, 2001). However composting schemes have failed because not enough attention was given to the marketing and the quality of the product (Zurbrugg, 2003). Composting involves aerobic degradation of putrescible organic components of the waste by microorganisms (Cointreau, 1982).

Thermal treatment includes processes of mass burn, RDF burn and paper and plastic fuel burn. Combustion of municipal solid waste reduces the weight (up to 75%) and volume (up to 90%) of solid waste, which can be valuable if landfill space is scarce. The generation of revenues from energy production, known as waste-to-energy incineration (McDougall, 2001).

Sanitary landfill is the most cost-effective system of solid waste disposal for most urban areas in developing countries (Marjorie et al., 1998). Other options such as biological or thermal treatment themselves produce waste residues that subsequently need to be land filled. The principal objective of land filling is the safe long-term disposal of solid waste (GoPu, 2009) but if it is not properly maintained greenhouse gases are generated from the decomposition of organic wastes in landfills and untreated leachate pollutes surrounding soil and water bodies (Hoornweg, 2008). In developing countries, the NIMBY (Not in my back yard) syndrome influences the location of waste management facilities such as disposal sites (Sudhir et al., 1996). Also the laws and regulations dealing with MSWM are outmoded and fragmented (Nielsen and Exner, 1998).

Damage to the environment due to poor waste management can be avoided by implementing environmentally sensitive waste management techniques, through the principle of the best practicable environmental option, whereby minimization, re-use, recycling and recovery techniques are employed, where feasible, in order to reduce the burden on the need for landfill (Marjorie, et al., 1998).

In primitive societies, small communities could bury solid waste just outside their settlement but as communities grew in size, a more organized form of waste management was needed to avoid odour and disease. For example in Mahenjo – Daro (Indus Valley) and Crete (Vesilund et al., 2002) health and safety issues dominated in waste management (Ponting, 1991). In order to deal with the problems of waste, it was necessary to enact some laws (Seadon, 2006).

The Pakistan Environmental Protection Agency (EPA) was established under section 5 of the Pakistan Environmental Protection Act (PEPA). The Power to make Rules is held by the Government e.g. the Hospital Waste Management Rules (HWMR) 2005, Hazardous Substances Rules (HSR) 2003, and National Environment Quality Standards (NEQS) Rules. The power to make Regulations in the cases appointed under Section 33 of the PEPA is held by the EPA but requires the approval of the Federal Government (FG). Such regulations may provide for: procedures for handling hazardous substances, guidelines for Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA), monitoring and measurement of discharges and emissions, etc. (GoPu 2007).2

On 2August 2001 the Pakistan Devolution Plan (PDP) came into effect. The scheme was to strengthen local control and accountability. According to Pakistan Local Government Ordinance (PLGO), Section 5, there are five types of local areas: the Union, the Tehsil, the Town, the District and the City District. The lowest tier of local

government is called Union. Each Union comprises a Union Administration (Union Nazim, Union Secretaries and Staff) and Union Council (PLGO Section 74 and 87) is headed by a Union Nazim (PLGO Section 75) (GoPu 2007).

According to PLGO, Section 40 (e), the Zila (District) Council in a City District shall review development of integrated system of solid waste disposal, sanitation and other municipal services. The City District Government may set up district municipal offices for integrated development and management of solid waste, treatment and disposal, including land fill sites and recycling plants (PLGO Schedule I Part D (iii) (GoPu 2007).

In 1994, Pakistan joined the Basel Convention on the Control of Trans Boundary Movements of Hazardous Waste and Their Disposal. A central goal of the Basel Convention is Environmentally Sound Management (ESM), the aim of which is to protect human health and the environment by minimizing hazardous waste production whenever and where able possible (GoPu 2007).

The Pakistan Environmental Protection Ordinance (PEPO), 1983, was the first specific governmental commitment to environmental improvement and to deal with the matter of waste. As federal legislation, the ordinance established the Pakistan Environmental Protection Council (PEPC), headed by the President of Pakistan. In 1997, the improved ordinance was enacted, after the approval from the Parliament, considered as an Executive Legislative Body in the country, the Pakistan Environmental Protection Act (PEPA) and then PEPC then revised, headed by the Prime Minister of Pakistan (PEPA) (GoPu 2007).

The PEPA defines waste as any substance or object which has been, is being or is intended to be, discarded or disposed of, and includes liquid waste, solid waste, waste gases, suspended waste, industrial waste agricultural waste, nuclear waste, municipal

waste, hospital waste, used polyethylene bags and residues from the incineration of all types of waste (PEPA Section 2 (xiv) (Punjab SW Reforms, 2007).

Major sources of this type of waste are hospitals, clinics, health centers and research laboratories etc (Marinkovic et al., 2007). The HWMR 2005 holds all health care institutions responsible for the proper management of the waste generated by them. Further it engages them to segregate, collect, transport, store and dispose of their waste in a given manner (Hospital Waste Management Rules Section 3) (GoPu 2007).

To achieve desire objectives require not only strengthening and enforcement but motivating the waste generators through campaign which leads to the development of pollution control technologies and strategies (Rahman et al., 2008).

A more comprehensive and culturally oriented educational media program should be adopted to increase public awareness regarding solid waste management and stimulate public participation (Agunwamba, 2003). Community education is a component of the solid waste management program in Karachi and Faisalabad, funded by the Asian Development Bank (ADB). Most public awareness efforts are directed to children, since they are responsive and easily accessible, and it is believed that they can influence adult attitudes (CDGF, 2006).

CHAPTER 3 MATERIALS AND METHODS

3.1. Study Area

Faisalabad city is located in the Punjab province, Pakistan. Formerly, it was known as Lyallpur. Faisalabad is the third largest city of Pakistan after Karachi and Lahore and is famous as "Manchester" of Pakistan. It is an important industrial center of Punjab province situated at a distance of 360 km to the south of Islamabad and 128 km from Lahore (GoPu, 2007).

Faisalabad district was previously divided into six Tehsils, but from October 2005, it has been declared as a City District under Pakistan Local Government Ordinance (PLGO) and divided into eight towns i.e., Lyallpur Town, Madina Town, Iqbal Town, Jinnah Town, Chak Jhumra Town, Jaranwala Town, Tandlianwala Town and Sumandri Town. The urban area comprises of four towns namely; Jinnah Town, Lyallpur Town, Iqbal Town and Madina Town. Faisalabad city has total 161 union councils (UCs) out of which 113 are urban and 48 are rural UCs. According to the Punjab Development Statistics Report (2009), the population of urban Faisalabad is 2.51 million. The average solid waste generation rate of Faisalabad city is estimated to be 0.5 kg/capita/day (CDGF, 2006). According to estimates, 1256 tons per day of solid waste is being generated in Faisalabad, out of which only 54% is collected, hauled and disposed of (GoPu, 2007).

Total 100 containers in residential areas and 100 pairs of dustbins in commercials areas are installed. There are 71 formal secondary storage points in the city. Two formal disposal/dumping sites at Chak Muhammad Wala and Khuddian Wariachian (Jaranwala Road) of 20 and 40 acres respectively, are in use since 1995 and are 19-25 km away from the city center. From the secondary storage point the waste is transported to the

final disposal site. Most of the waste is dumped in open spaces and undeveloped plots posing serious risk to public health through clogging drains, formation of stagnant ponds and making heaps of garbage providing breeding grounds for mosquitoes and flies with consequent spread of malaria and cholera (CDGF, 2006).

3.2. Selection of Area

There was two UCs from each urban town has been selected as Physical Pilot Area (PPA) for study, total eight UCs from the four urban towns of the city. The UCs from City District Government Faisalabad (CDGF) area was selected for visit and research work for the physical observing and sampling; door to door waste collection system, secondary storage points, placement of containers (5 m^3) at different places, installed colored dustbins for commercial areas, waste transport depot, and waste storage enclosure in area. Both UCs from each town have lower, middle and upper middle class with a commercial area, however middle class dominates mostly in the area.

3.3. Data Collection

During the study, two types of data were collected i.e. primary data and secondary data.

3.3.1. Primary data collection

Primary data was collected by visiting the sites, survey through questionnaires, focal interviews, sampling of waste and physical analysis. 50 waste pickers (scavengers) were randomly selected in the area for questionnaire survey. Hospitals and clinics were also visited for analysis of SWM System.

3.3.2. Secondary data collection

Published and unpublished data were collected from Solid Waste Management Department Faisalabad (SWMDF), Government of Punjab Urban Unit, Environmental Protection Department (EPD) Government of Punjab, Pakistan Environmental Protection Agency (Pak – EPA) Government of Pakistan, Planning and Urban Division

Government of Pakistan, Ministry of Environment (now Ministry of Climate Change) Government of Pakistan and Infrastructure Project Development Facility (IPDF) Division, Islamabad.

3.4. Sampling of Waste

A sample of 25 Kg from each UC was collected in accordance with the American Society for Testing and Materials (ASTM) Standards. Large sized shopping bags were used to store and weigh the waste samples collected from different points. The total sample was mixed and weighed.

3.5. Physical Analysis

After collection and mixing the waste was sorted and classified into different physical components including organic waste, textile, papers, plastics, metals, glass, household hazardous waste, dust and dirt (other inorganic) etc. The individual components were weighed again.

3.6. Quartering and conning of waste sample

Quartering and Conning of the sample was done. Samples were divided into two halves. Then one half was mixed and further divided into two halves. This process continued until a suitable sample by size and quality was obtained.

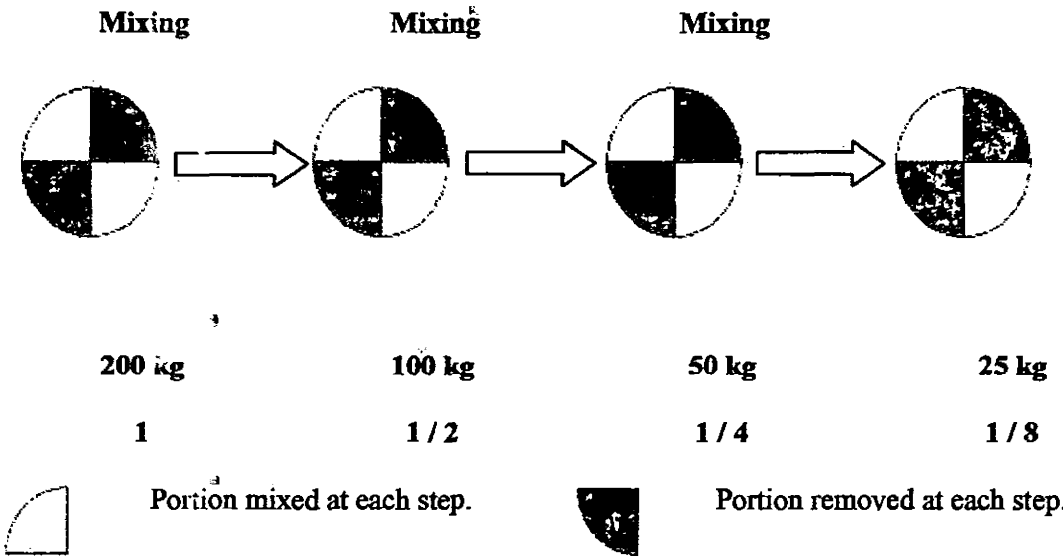


Figure 2 Sample bags of solid waste collected from different sites

Figure 3 Weighing of sample bag

CHAPTER 4 RESULTS AND DISCUSSION

4.1. Existing Solid Waste Management System in Faisalabad

Solid Waste Management System (SWMS) in Faisalabad city is of the oldest and most conventional type commonly found in rest of Pakistan and other developing countries. In Faisalabad city solid waste is being collected from secondary source points instead of door to door collection, then transported by conventional methods and finally disposed of without any precautionary measures. No treatment of wastes is carried out except for incidental recycling by scavengers. No system exists for the separate disposal of hazardous waste. No measures are being taken to minimize adverse environmental effects (CDGF, 2006).

4.1.1. Solid Waste Management Department Faisalabad (SWMDF)

SWMDF has been working under CDGF with the following objectives;

- To provide effective, efficient and economical means of collection, storage, transportation and disposal of solid wastes,
- To introduce separate disposal of hospital and slaughter house wastes in the designated cells at the landfill site,
- To collect data regarding quantity and quality of industrial wastes for future planning,
- To build up operational as well as institutional capacity of the CDGF by procuring new equipment/machinery and through training of existing staff as well as recruiting new technical human resources,
- To change human behavior towards solid waste management by launching comprehensive awareness campaigns, and;
- To improve living conditions of the inhabitants by providing clean and healthy

environment.

4.1.2. SWMDF organizational structure

As shown in Figure 4, the District Nazim CDGF heads the SWMDF.

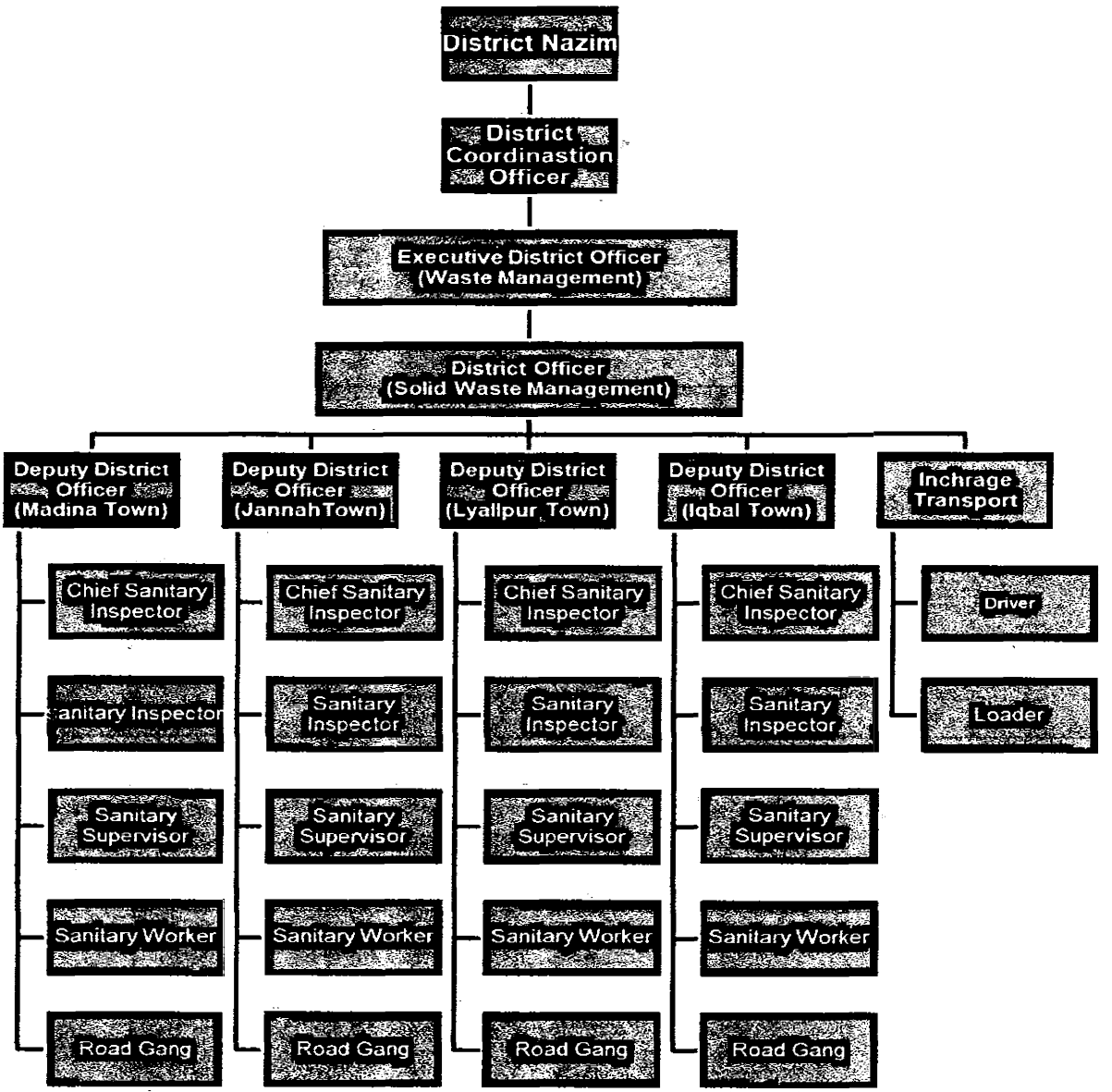


Figure 4 Organizational structure of SWMDF

4.1.3. Existing staff of SWMDF

SWMDF is run by a grade-18 equivalent district officer; assisted by one deputy district officer in each town. The SWMDF staff status is given in Table 2.

Table 2 Staff list of SWMDF

Man Power	Total sanctioned Posts	Filled	Vacant
Management staff	05	04	01
Administrative staff	67	63	04
Chief sanitary inspectors	13	11	02
Sanitary inspectors	30	23	07
Sanitary supervisors	72	69	03
Sanitary workers	3130	3064	66
Water carriers	156	129	27
Cleaners and loaders	91	88	03
Total	**3564**	**3451**	**113**

Source: CDGF (2009)

The SWMDF had about 3% vacant field formation seats, even though it was already short of man power (Figure 5).

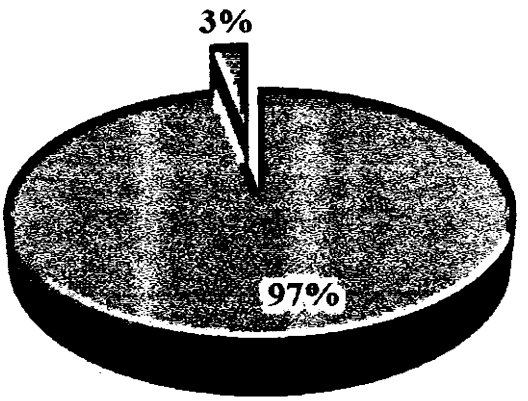


Figure 5 Percentage of man power shortage in SWMDF

4.1.4. Towns level staff of SWMDF

A list of workers deployed in each Town is given in Table 3 below:

Table 3 Deployment of sanitary staff at Town level

No.	Staff	Lyallpur Town	Madina Town	Iqbal Town	Jinnah Town	Total
1.	Chief sanitary inspectors	03	03	03	03	12
2.	Sanitary inspectors	07	08	07	07	29
3.	Sanitary supervisors	18	18	18	18	72
4.	Sanitary workers	789	833	712	782	3116
	Total	**817**	**862**	**740**	**810**	**3229**

Source: CDGF (2009)

4.1.5. Jurisdiction area of SWMDF

Presently only the urban UCs comes under SWMDF working jurisdiction for collection, storage, handling and transportation of solid waste (Table 4).

Table 4 Area under SWMDF's working jurisdiction

No	Name of Towns	Urban UCs	Rural UCs	Combined UCs
1.	Lyallpur Town	22	16	38
2.	Madina Town	33	08	41
3.	Iqbal Town	28	15	43
4.	Jinnah Town	30	09	39
	Total	**113**	**48**	**161**

Source: CDGF (2009)

Out of 161 UCs in the four towns, SWMDF only covered the 113 urban UCs. The remaining 48 rural UCs were not served due to shortage of funds and resources (Figure 6).

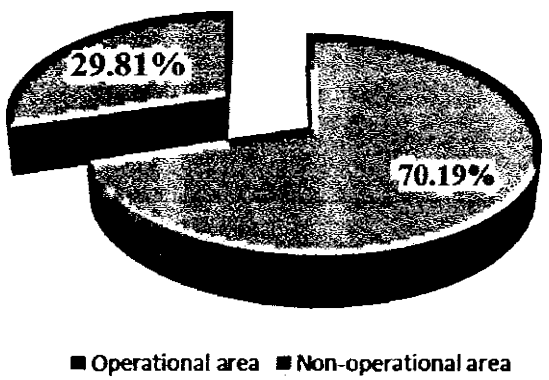


Figure 6 Ratio of SWMDF operational area

4.1.6. Population in SWMDF area

There are 113 urban and 48 rural UCs in the four towns having urban population of 2.51M in 2009 and growth rate of 1.88% (Table 5).

Table 5 Estimated population in SWMDF area

No.	Name of Towns	No. of Urban (UCs)	Population-1998 (x1000)	Population-2009 (x1000)
1.	Lyallpur Town	22	427.8	530.2
2.	Madina Town	33	578.0	691.2
3.	Iqbal Town	28	499.4	618.9
4.	Jinnah Town	30	541.7	671.3
	Total	**113**	**2046.9**	**2511.7**

Source: CDGF (2009)

Population projection was calculated by using the following formula,

$$P_I = P_o (1 + R / 100)\, T \text{ *}$$

Where,

P_I = Projected population of the current year (2009)

P_o = Population of the base year (1998)

R = Annual growth rate (1.88 *)

T = Time (intercensal interval)

**Source: Punjab Development Statistics (GoPu)*

4.1.7. Estimated waste generation

Waste generation is roughly calculated based on population and an estimated average generation rate of 0.5 kg/capita/day (KOICA, 2007; GoPu 2007) which comes out to be 1256 tons of solid waste per day in SWMDF area (Table 6).

Table 6 Estimated waste generation in SWMDF area

No.	Name of Towns	Solid waste Generation (2009) Tons / Day
1.	Lyallpur Town	265
2.	Madina Town	346
3.	Iqbal Town	309
4.	Jinnah Town	336
Total		**1256**

Source: CDGF (2009)

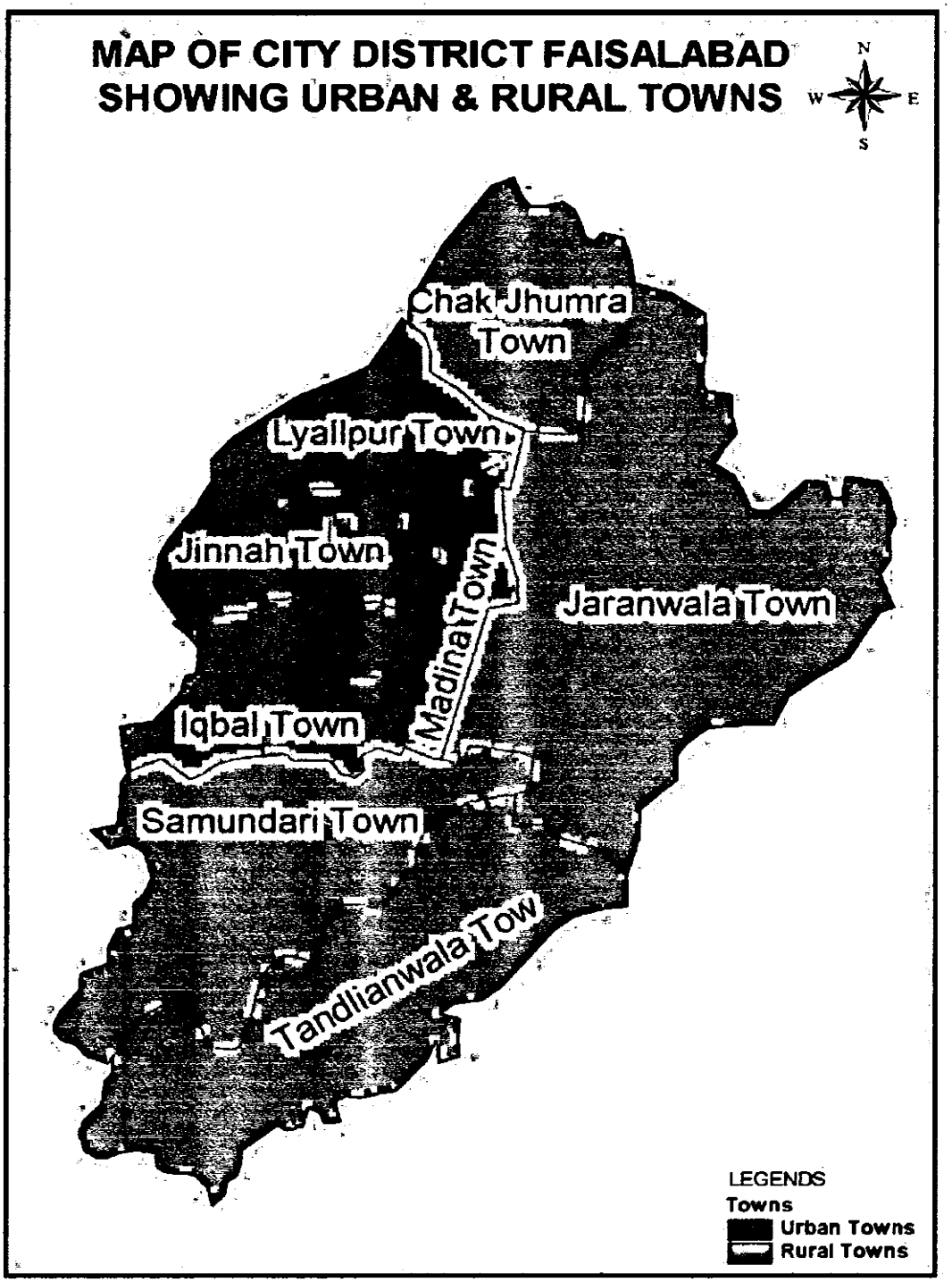


Figure 7 Map of CDGF showing jurisdiction area of SWMDF

4.1.8. Waste characterization

Solid waste generated in Faisalabad mainly composed of food waste, plastic and rubber, textile and garden wastes etc. According to the CDGF data, bulk of the waste (41%) was organic while18.1% was recyclable. Further, 52.4% of the waste generated was valuable. The waste generation and characterization data are essential to manage the waste and is the first step for proper SWMS (KOICA, 2007; CDGF, 2007: GoPu 2007) (Table 7).

Table 7 Composition of waste generated in Faisalabad

No.	Waste Component	No.	Waste Component
1.	Plastic and rubber	7.	Bone
2.	Metal (Iron)	8.	Food waste
3.	Paper	9.	Animal waste
4.	Cardboard	10.	Leaf, grass and straw
5.	Textile waste	11.	Wood and stone
6.	Glass ceramics	12.	Fines (dust, dirt, ash)

Source: KOICA, 2007

While according to the data from sampled waste analysis, greater proportion was consisted of organic materials which show that majority population of the city is dependent on traditional food like vegetables and cereals than on packed food. This is one of the most populous and congested areas but with low tendency towards packed material. Another reason for high organic waste was the winter season after Eid–ul–Azha during which people use more vegetables and pulpy food. Yard waste was also common due to the presence of green belts (Table 8).

Table 8 Composition of sample waste collected in Faisalabad

No.	Components	Percentage by Weight	Waste (Tons/Day)
1.	Organic	67.65	849.55
2.	Textile	5.15	64.684
3.	Paper	1.84	23.110
4.	Plastic	8.09	101.610
5.	Metals	0.18	2.261
6.	Glass	0.74	9.294
7.	Hazardous	1.29	16.202
8.	Others Inorganic	15.07	189.279
	Total	100.00	1256

4.1.9. Vehicles status of SWMDF

Vehicles used by SWMDF for waste collection, storage and transportation to main dumping site are Mazda Truck, Compactor, Arm Roll, Loader, Dumper, and Tractor with Trolley etc. (Table 9).

Table 9 Vehicles status of SWMDF

No.	Description	On road	Off road	Auction	Total
1.	HINO Roll on Roll off	18	-	-	18
2.	Hydraulic Tractor Trolleys	13	01	01	15
3.	Mechanical Loader	09	-	02	11
4.	Mechanical Road Sweeper	05	01	01	07
5.	Tractor with Blades	04	-	-	04
6.	Water Sprinkling Lories	03	01	-	04
7.	HINO Water Lorry	03	-	-	03
8.	Super Bedford (10 Tons)	02	01	-	03
9.	ERF Roll On/Roll Off	02	01	-	03
10.	Mazda Compactor (Japan)	02	-	-	02
11.	Isuzu Dumpers (5 Tons)	01	-	08	09
12.	Manual Tractor Trolleys	01	-	-	01
13.	Shovel	01	-	-	01
14.	DAF Dumpers (DFID)	-	05	-	05
15.	Mazda Dumper (3 Tons)	-	-	05	05
16.	Bedford Trucks (5 Tons)	-	-	03	03
17.	Bedford Dumpers	-	-	02	02
18.	Tractor (ford 3600) + (Massy 135)	-	-	02	02
	TOTAL	64	10	24	98

Source: CDGF (2009)

Out of total 98 vehicles, 10 were off road due to major repair and 24 were held for auction. 64 vehicles were available on road for waste management in the city (Figure 8)

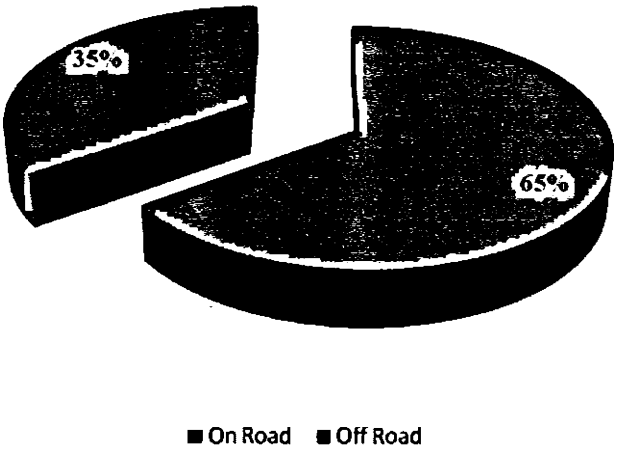


Figure 8 Percentage of On Road / Off Road Vehicle

4.1.10. SWMDF budget allocation

Capital and operational budget of SWMDF, City District Government Faisalabad was Rs. 505.39 million for fiscal year 2008-09. The allocation for solid waste management in annual budget of CDGF was based on the preceding year's actual expenditure adjusted by inflation. The year on year annual budget allocations for the last three years and the budget proposal for the financial year 2009-10 is summarized hereunder in Table 10.

Table 10 SWMDF Budget Allocation (in Rs.)

No.	Budget Allocation	FY 2006 – 07	FY 2007 – 08	FY 2008 – 09
1.	Employee related Expenses	284,117,622	334,565,084	445,119,254
2.	Travel & Transportation (POL)	32,000,419	39,017,840	51,169,598
3.	Other Operating Expenses	8,221,103	1,692,228	1,603,783
4.	Repair & Maintenances	7,504,800	8,010,000	5,000,000
5.	Capital Cost	9,800,000	1,200,000	2,500,000
	Total Budget	**341,643,944**	**384,484,153**	**505,392,635**
	Annual Increase (%age)	***N.A***	***12.5***	***31.4***

Source: CDGF (2009)

The volume of total budget proposal was Rs. 591 million, with an increase of 31.4% from budget of FY 2007-08. Out of the total budget, about 88% was allocated to employee related costs. Almost 10% was allocated for travel and transportation costs. Nominal amount has been allocated for vehicular maintenance and expenditure on capital asset (Figure 9).

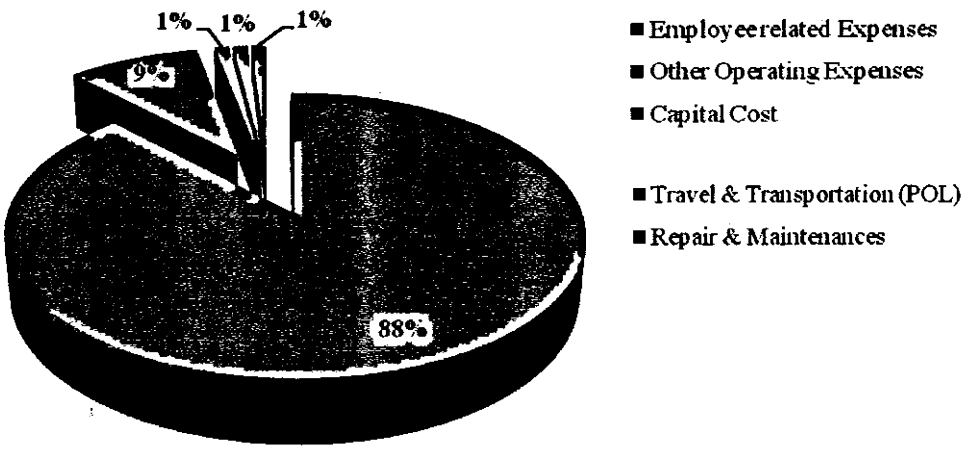


Figure 9 Analysis of budget allocation and expenses of SWMDF

4.2. Existing elements of solid waste management at Faisalabad

Elements of the Solid Waste Management (SWM) in existing system of Faisalabad district are as under:

- Generation of waste,
- Collection of waste and street sweeping,
- Storage of waste,
- Resource recovery,
- Transfer and hauling of the waste, and
- Disposal/open dumping

4.2.1. Wastes generation and their sources

The capacity of SWMS depends upon the waste quantity produced by community. Quantity of total waste generation is core information which determines the

number, types and capacities of collection vehicles and assesses the number, type and capacities of onsite or separate storage and communal storage bins, containers, skips and to estimate temporary storage arrangements etc., (CDGF, 2009).

Common sources of solid waste in SWMDF area are mostly households, commercial activities, hotels, hospitals, industries etc., (CDGF, 2009).

4.2.2. Collection of waste and street sweeping

Street sweeping is the most common method for collection of all types of wastes in Faisalabad by SWMDF. It is observed that not all roads and streets are swept on daily basis. There is no proper schedule for street sweeping. Some are swept on alternate days or twice a week and some are swept occasionally or not at all. In Faisalabad, road and street sweeping is partially carried out manually by sanitary workers and through mechanical sweeping. Manual sweeping is done with broom of approximately 1.25 m in length. Handcarts (two and three wheeled) as well as donkey carts are used to carry street waste to the designated containers and points. Usually the operational timing is from 6 to 8 hours a day. In the morning, sweeping work is carried out from 6:00 am to 11:00 am and in the afternoon from 2:00 pm to 5:00 pm but not in all UCs these timings are followed. Mechanical sweeping is carried out to increase efficiency and to overcome labor shortages but the use is very limited and restricted to certain roads due to lack of sufficient equipment/machinery. Total seven tractor sweepers with sprinklers were used by the department. The capacity of each mechanical sweeper was 5 km/hour. Mechanical sweepers were used only on level streets. Duty timing for mechanical sweepers were usually from midnight to 8:00 am.

4.2.3. Storage of waste

Solid waste is temporarily stored in dustbins, containers and skips before its collection by the SWMDF crew. In the city, the refuse is often discarded in streets, parks

and open places by the residents. Due to ignorance, they usually do not cooperate with the SWMDF crew. The crew collected the waste and taken to containers or filth depots. The Urban Unit, GoPu, had provided 100 containers (5 m^3 capacity each) to the CDGF under the Integrated Solid Waste Management Project (ISWMP) for the city and were placed at different locations in the city. Onsite waste storage points are as following:

- Dustbins / Box system
- Open dumps / Waste piles
- Containers (5 m^3)

The CDGF also introduced a system to use two different colours of bins (yellow color for organic waste and blue color for recyclable waste). This combination unit was installed at 100 locations along various roads' sides.

Containers are used for onsite storage of solid waste and are mechanically lifted and hauled to disposal site where they are emptied. Each container can store three to four tons of waste depending on the type of waste. Containers are compatible and easily lifted by the available Arm Roll collection vehicles.

The general practice is that most of the refuse generated in different areas of the city is dumped on the roadside, streets, walkways, vacant lots, storm water drains and open sewers. The CDGF has officially 71 storage points but 30 other unofficial points were also found in the city during the visit. List of the official waste storage points is enlisted in Appendix–A.

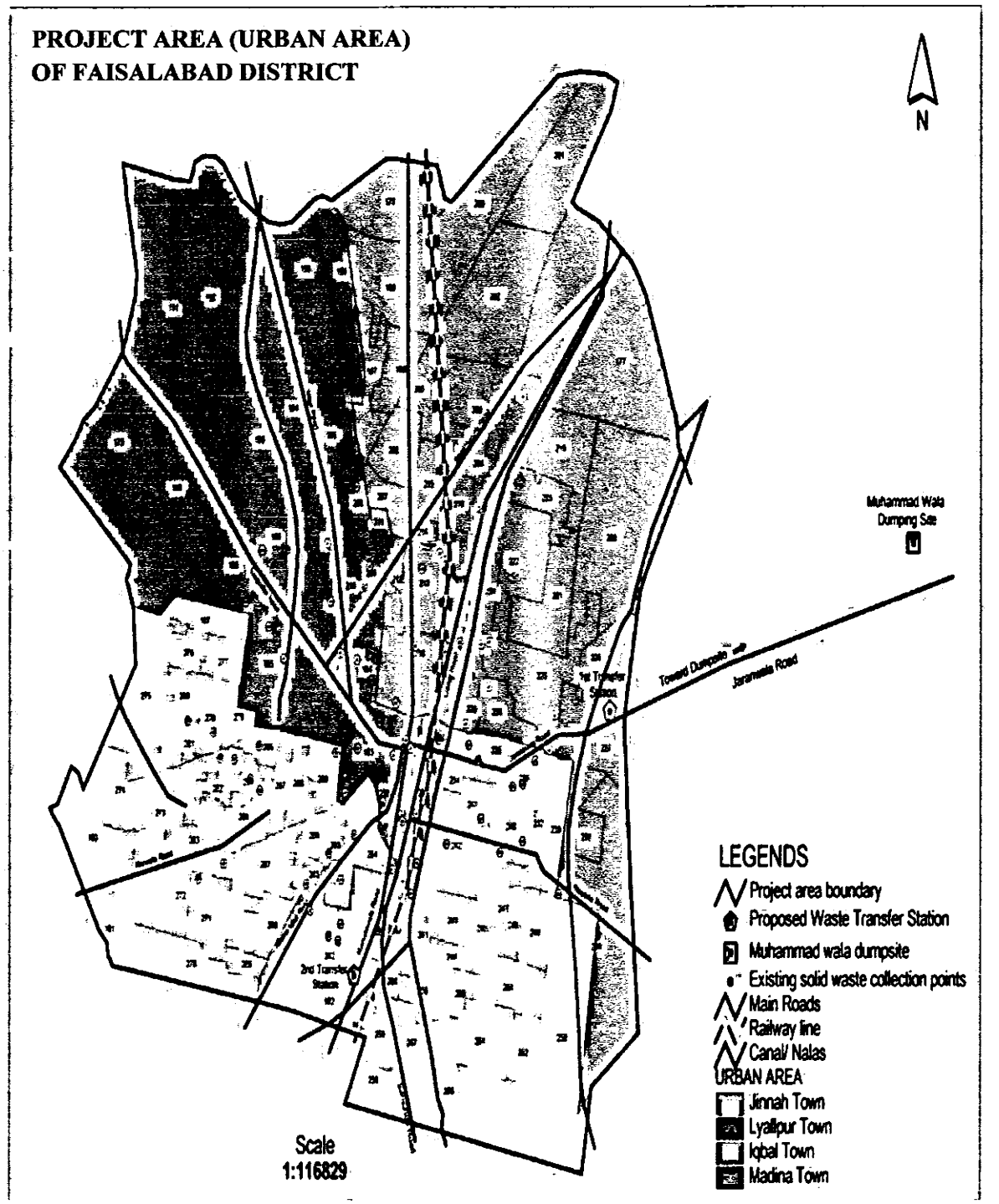


Figure 10 Location of waste storage points in Faisalabad

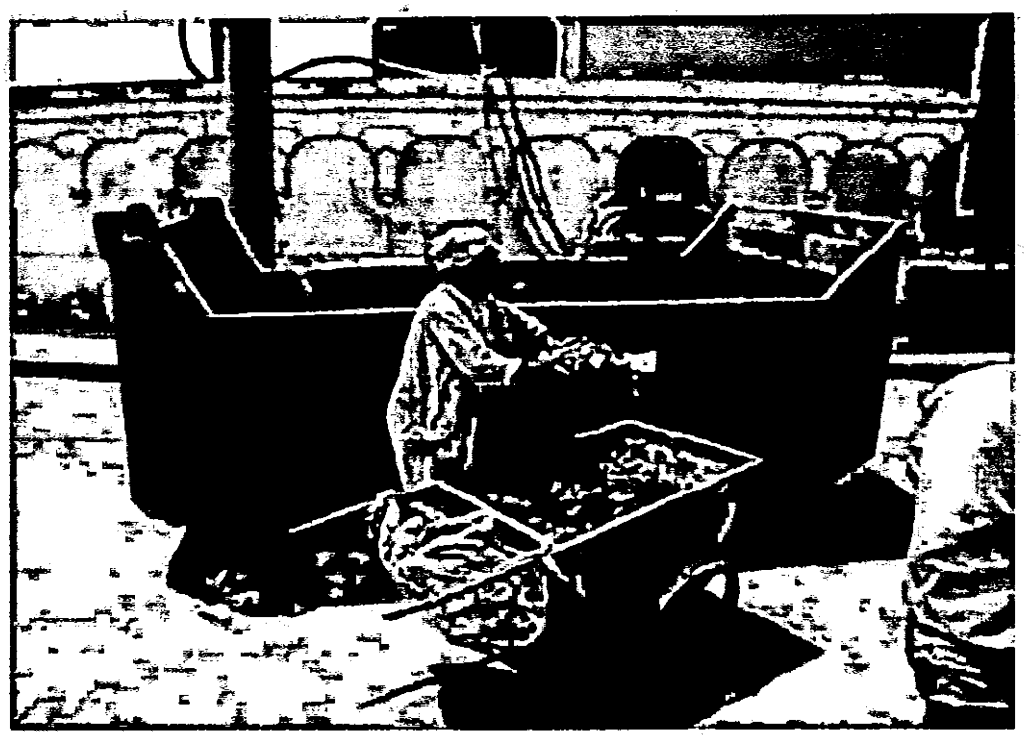


Figure 11 A simple process of transfer of waste from handcart to storage container

4.2.4. Collection and transportation

Solid waste was gathered from the storage points and hauled to waste transfer station or dumping sites (CDGF, 2009). Vehicles used for this purpose were Mazda Truck, Compactor, Arm Roll, Loader, Dumper, and Tractor trolley etc. The collection system consisted of stationary containers at the storage points which were moved to the disposal site after filling. According to the department, the waste was collected every day except Sunday.

Figure 12 Transportation of waste from secondary point to main dumping site

4.2.5. Recovery and processing

The waste generated is dumped at filth depots, collection points/enclosures through handcarts for further transport to the treatment or disposal sites. From these filth depots and disposal sites, the scavengers collect valuable materials (paper, metals, glass etc.) from waste and take to the recycling market. Their role in recovering materials is helpful in reducing waste.

The residents also sell such type of waste to the Street Hawkers (Raddhi walas). The street hawkers take and sell this waste to the junkshops (Kabadia). At junkshops, waste sorting is done, from where the waste goes to the warehouses that send it further for processing. After being processed, the waste goes to the recycling units where it may be re-manufactured and re-fabricated for recycle.

Figure 13 Informal resources recovery process at secondary collection point

4.2.6. Disposal of waste

Two official sites i.e. *Khuddian Wariachian* and *Chak No. 219 (Muhammad Wala) dumping site*s and several other unofficial sites are being utilized for solid waste final disposal in Faisalabad.

Khuddian Wariachian dumping site:

This site with an area of 40 acres is located about 16 km away from the city center on Jaranwala Road at Chak No. 237 RB Khuddian Wariachian. The site is a state property but transferred to department in 2002 to be used as a solid waste dumping site. The site is a plain land and on its northern side 800 meters long, 5 meters deep and 13 meters wide trench was dug and filled with waste. Rest of the land was in virgin state and was not in use since 2003. Access to the site is given from Jaranwala road and no electricity is provided to the site.

The nearby residents had strong resentment against the use of the land as a dumping site; hence the department is not using the site on regular basis. No

environmental study has been conducted on the site. Half of the waste in the trench is covered with earth and half lies on the surface. This area can be developed as a proper sanitary landfill site.

Chak No. 219 (Muhammad Wala) dumping site:

This site with an area of 20 acres is also situated on Jaranwala road at a distance of 19 km from the city center. The site is connected to main Jaranwala road through a small kacha road. The site is used by CDGF for the past 10 years. The waste is dumped at the site unsystematically along the depression areas. Neither electricity is there, nor is any weighing bridge installed at the site. There is no proper supervision of the site by the CDGF; hence no daily record of dumping is maintained.

No environmental study has been conducted on the site. Foul smelling, smoke and fire can be noticed at the site. Many types of birds and animals can be seen there. There is no leachate collection system at the site.

4.3. Initiatives taken by SWMDF

To improve the existing management condition the following initiatives were taken by the SWMDF;

- The supervision of daily working of sanitation staff will be ensured. The working time of sanitation staff is,

1st	Shift	06:00 am	to	11:00 am
2nd	Shift	01:00 pm	to	04:00 pm

- 22 sanitary workers in each union council were deployed,
- 590 Work charge sanitary workers were deployed for sweeping of the main roads,
- A Sanitary Supervisor for 1 to 3 UCs,
- A Sanitary Inspector for 5 to 6 UCs,

- A Chief Sanitary Inspector for 10 to 12 UCs,
- A Deputy District Officer at town level, and
- A District Officer at city level was deployed.
- Night sweeping was introduced at Clock Tower and eight bazars.
- 100 waste bins were fixed on main roads.
- Further planning was to fix such waste bins in educational and health institutions, public places and markets etc.
- Awareness campaign was completed in 08 modeled UCs and was being extended to other eight UCs. It was a door to door educational and awareness campaign through distribution of printed materials.
- Polythene bags were distributed to improve door to door waste collection.
- Qing-qi rickshaws and Suzuki pickups were introduced for the removal of sacrificed animals waste during Eid-ul-Azha and other special days.
- Reflected jackets were provided to the sanitary workers for better visibility and safety of the staff during work.
- Heaps of wastes were cleared off from 60 points in the city.
- One time cleaning operation was being implemented.

At the level of CDGF, District Officer Environment (DOE) is responsible for taking care of the environmental protection and other related issues. In Faisalabad, District Strategic Policy Unit (DSPU) has been constituted under the direct supervision of DCO. This unit in consultation with other departments of CDGF helps the City District Nazim (CDN) and DCO to make policies for the district including environmental protection.

An integrated solid waste management project (ISWMP) was launched from 2008 to 2010 for the capacity building of SWMDF through procurement of new

machinery and hiring of new staff under City Development Package (CDP). The Chief Minister announced Rs. 500 million for SWMDF. Planning Chart (PC – I) worth Rs. 600 million was approved on April 2007. Out of which Rs. 150 million were released for Part–1 of Phase–I in May 2007. Under this project, Arm rolls (15), containers (100), handcarts (550), mechanical sweepers (05), water sprinklers (03) and waste bins (100) were purchased. Two Awareness Officers and six Social Mobilizers (SMs) were recruited for awareness campaign regarding integrated solid waste management.

4.4. Performance analysis

A performance analysis has been carried out to assess technical suitability of the present SWM system.

Total waste collection by vehicles:

Out of total waste generated per day only 54% is collected by different vehicles while 42% remains uncollected (Table 11).

Table 11 Waste collection by vehicle per day

No.	Vehicle Type	On Road	Capacity (Tons)	Trips (Day)	Total (Tons/Day)
01.	HINO Roll on Roll off	18	2.5	05	225
02.	Super Bedford	02	09	03	54
03.	ERF Roll On/Roll Off	02	12	05	120
04.	Manual Tractor Trolleys	01	2.5	02	05
05.	Tractor Trolleys	13	06	03	234
06.	Tractor front Blade	04	2.5	02	20
07.	Compactor Manual Working	02	2.5	04	20
	Total	**42**	**37**	**24**	**678**

Source: CDGF (2009)

Total waste collected	=	678 Tons per day
Collection efficiency	=	(678/1256) x 100 = **54 %**

SWM staff and population ratio:

Total population of served area	=	2.5 million
Total SWM staff	=	3451
Staff per 1000 population	=	3451 / 2500
	=	**1.4 Employee / 1000 person**

SWM staff and waste collection ratio:

Total waste collected	=	678 Tons
Waste collected/staff member/day	=	678 / 3451
	=	0.197 Tons/Employee or
	=	**197 Kg / Employee**

Waste collection and budget allocation ratio:

Total waste generated per day	=	1256 Tons / Day
Total waste generated per year	=	(1256 * 365)
	=	458,440 Ton / Year
Annual budget allocation (FY 2008 – 09)	=	Rs. 505,392,635
Budget/waste ratio	=	505392635/ 458440
	=	**Rs. 1102.42/Ton**

4.5. Analysis of problems in SWMS of Faisalabad

Meetings were conducted with different focal groups of the community and many field visits were made to analyze the existing system of solid waste management in Faisalabad city and gaps were identified in the following areas.

- Collection,
- Storage,
- Transportation,
- Disposal,
- Capacity building of the department, and;
- Other SWM related Issues.

4.5.1 Gaps in collection services

No proper door step waste collection system was found in the area except for those houses that were paying for the door step waste collection to private workers. The sweepers do not consider door to door collection as their primary responsibility. Manual Street sweeping was carried out only in areas with better infrastructure. The situation is made worst by public attitudes. The waste is thrown carelessly outside their homes.

The CDGF declared two UCs from each town as Model UCs for a pilot project of SWMS, where sanitary workers were to collect waste from each and every house. But their efficiency was poor due to the insufficient and low quality equipment (personal protection, brooms and handcarts, two wheeled handcarts etc.) for the sweepers (Figure 14).

Figure 14 Two wheel handcart used by SWMDF.

New three wheeled handcarts were provided by the CDGF but it was very difficult to handle them esp. for female workers (Figure 15 & 16).

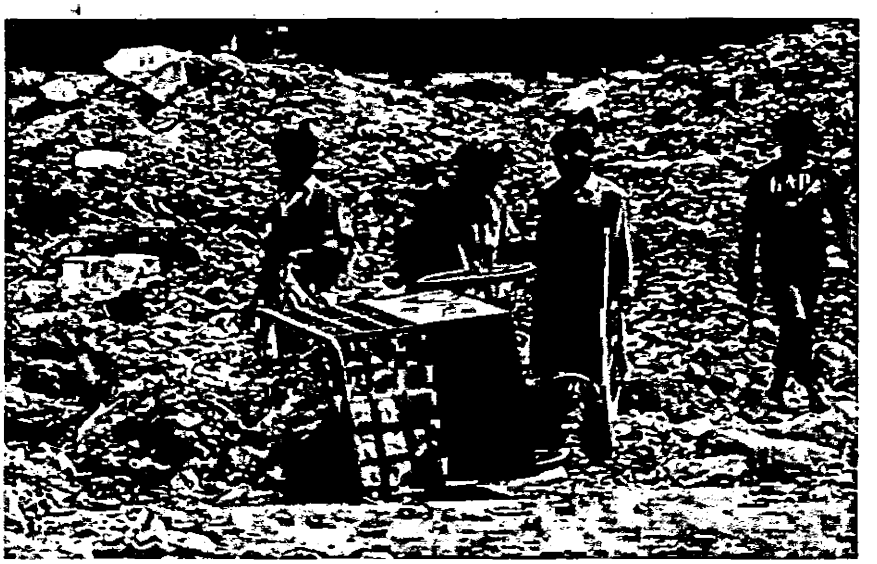


Figure 15 Problem associated with Three-wheeled handcart

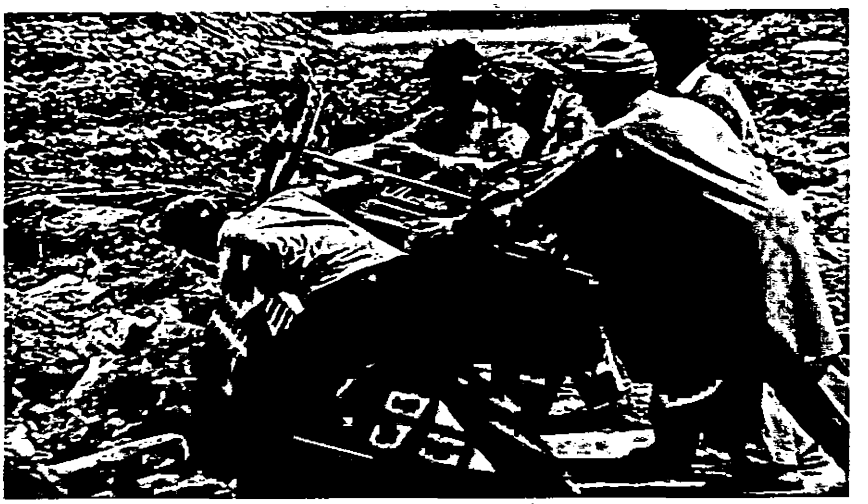


Figure 16 A pictorial view of transfer/unload of waste from Three-wheel handcart.

Most of the workers were using their own donkey carts and in case of any damage to their carts, no compensation was given to them (Figure 17).

Figure 17 Use of Donkey carts by SWMDF employee for collection of waste from houses

- In one beat list, 150 houses were allotted to one sanitary worker. In some areas with bigger houses 4 to 5 streets were covered while in others with smaller houses only one street was covered by 150 houses and served by a single worker.
- Animal waste could be found due to the animals used for dragging carts.
- Another major problem was the sanitary workers shortage. The apparent attendance list was showing all the workers but in reality the actual number of sanitary workers in the field was very less.
- No leave was allowed to workers on EID or other National festivals.
- For compensation an extra salary called 13th salary was announced by government for the workers but never given on due time.
- Sanitary workers were equally divided among union councils (22 workers for each UC) with different areas and population sizes.
- Generally, no supervision to check the performance of sweepers was found.
- Commercial and institutional waste collection was done by private workers. They were collecting waste from the shops and dumping in containers or sometimes in open on the road sides.
- Mechanical sweepers just cover the main roads of the city.
- A group of daily wages sanitary workers (Gang, 100 to 150 in number) was constituted for sweeping of main streets in the area. But still their actual number was far less than the provided list (Figure 18).

Figure 18 Road gang for sweeping of main streets

4.5.2 Improper waste storage facility

The sanitary workers were collecting the waste and transporting to the communal storage facility or other specified sites. The following gaps were found in the storage of waste.

- Number of formal collection bins i.e. filth depots and containers, were too less to accommodate waste generated in the area. As a result, large numbers of open dumps were found.
- Those collection points were not located according to the population and area requirements.
- Political interference was a major issue as many Nazims were not allowing containers in their respective areas due to aesthetic and smell problems. Therefore waste storage was a big problem for workers.
- Non availability of containers was badly affecting the hard work of sweeping staff.

- CDGF had established various wastes Masonry Enclosures for placement of containers but still were not completed. Those waste enclosures had design defects (Figure 19).

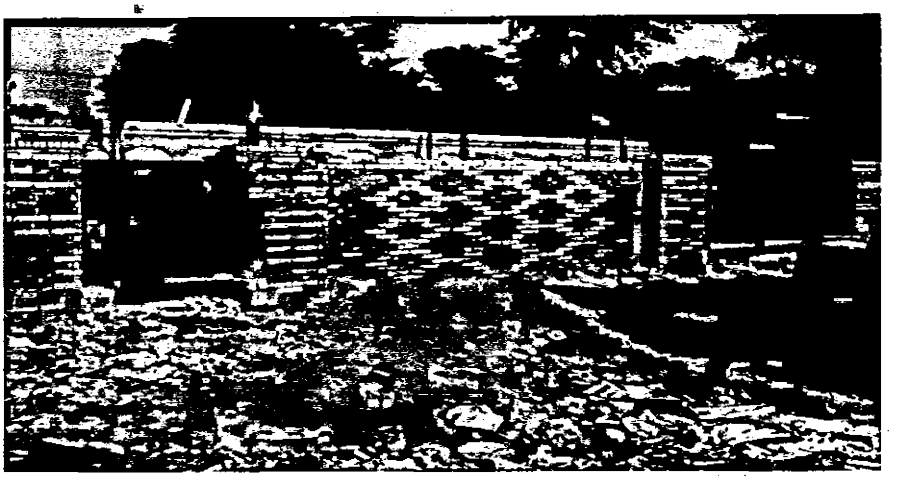


Figure 19 Waste masonry enclosure install under CM package

4.5.3 Waste transportation

Out of total 98 vehicles of SWMDF only 64 were available, out of which 18 were Hino Arm Rolls and 03 Hino water sprinklers vehicles newly purchased in year 2007 by CDGF. Most of the vehicles were in poor condition. Waste transportation by tractor trolleys was uneconomical. As a result, waste transportation was deficient of vehicles.

In addition to the above, the following gaps were identified in the waste transportation sector;

- The containers were not lifted regularly on time.
- Drivers were trying to unload containers on nearby unofficial sites to save petrol.
- Lifting of waste from small filth depots was problematic and the waste remained there for many days (Figure 20).
- The present system of waste transportation was labor intensive, time consuming and less productive.

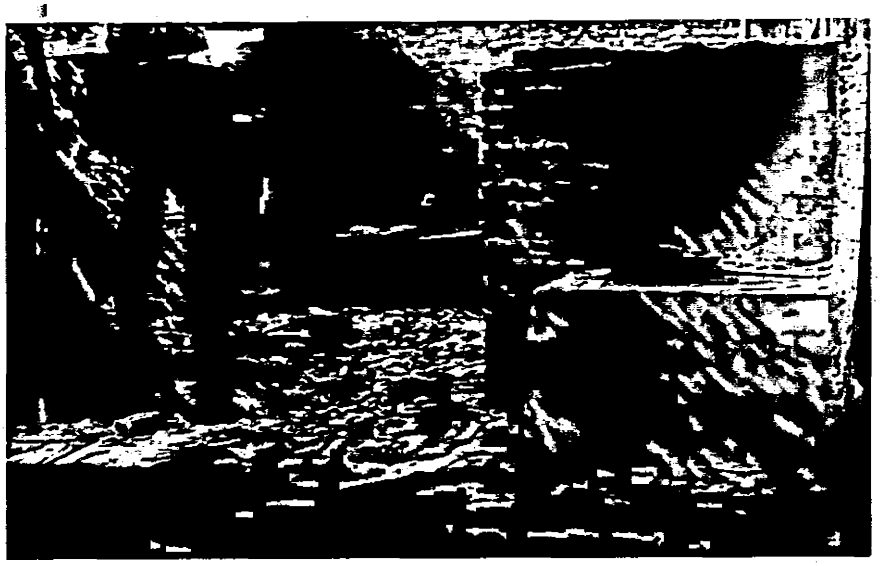


Figure 20 Small filth depot/secondary storage points in Faisalabad

4.5.4 Waste disposal

Out of the two waste disposal sites i.e., Chak No. 219 (Muhammad Wala) and Khuddian Wariachian dumping sites; the former was an active site for waste disposal. But no environmental study had been conducted for the site. Main drawbacks found were;

- Waste was openly dumped without any compaction and soil cover on the waste.
- No weighbridge was installed at the sites to keep records of the actual waste disposal.
- Proper infrastructure and equipment was not available on site.
- Scavenging activities were very common on the sites.
- Scavengers were collecting metals waste and burning the other waste.
- No waste treatment facilities were established by CDGF.
- Those open dumping practices were resulting in environmental degradation i.e., air, soil and ground water pollution.

4.5.5 Challenges pertaining to the presence of scavengers

Scavengers collect recyclables from different points e.g. containers and filth depot. One group of scavengers collects waste from typical points daily. Scavengers sell material to local Kabariyas. They normally earn 60 to 100 rupees daily. Their main living colonies are,

- Changar muhallah (UC 208).
- Ghula Muhammad Abad.
- Sumandri road near D – Type.
- Mai Di Jhugi.
- Judge Wala.

Waste pickers interfered in the collection and disposal operations in a number of ways. They lit fires, creating danger to the environment, employees and themselves. They were tearing off packed waste shoppers to collect desirable materials and were spreading waste everywhere causing nuisance. This way, they were significantly increasing the cost of existing collection system.

4.5.6 Solid waste management related other issues

a. Construction materials

More or less in every street construction material was left, creating hurdles in street sweeping and collection of waste. It was producers' responsibility to lift the waste. Only construction waste near schools, hospitals and mosques was lifted and transported on request or on personal relation otherwise they were charging Rs. 500 per trolley on application by owner.

b. SWMDF's workshop

SWMDF's workshop was very poorly maintained and had no parking area. They could not purchase any spare part without the permission of DCO or Executive Authority

(EA). Vehicles and other machineries were repaired in private workshops. Two work charge employees were deputed at workshop for welding and vehicle puncture services. No technical staff was available.

c. Low level of public awareness

People were poorly motivated and they thought it was only SWMDF's or sanitary workers' responsibility to keep the streets clean. They were throwing waste out of their houses in streets or in front of neighbors' houses.

d. Water and sanitation authority (WASA)

The WASA workers were just cleaning the water drains and leaving all silt and waste on a sides to be removed by solid waste department.

e. Encroachment

Most of the shops were encroached upon to the streets and leaving little space for transportation and in turn created hurdles for sweeping.

f. Hospital waste

There are no separate collection and disposal arrangements for hospital waste. Allied Hospital Faisalabad (AHF) had facility for safe disposal of their waste through incineration, while other private hospitals and clinics did not have such like facility and their waste could be observed at municipal disposal sites (MDS) / Filth depots.

g. Poor institutional arrangements

Existing institutional arrangements for solid waste management were fragmented. Lack of supervisory staff at union council level, lack of financial resources to invest in solid waste management, inadequate sanctions, lack of technical knowledge toward waste management and corruption were the main hindrance in economically viable waste management system.

CHAPTER 5 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The solid waste function is preview of City District Government Faisalabad which includes four urban towns i.e., Lyallpur Town, Jinnah Town, Madina Town and Iqbal Town. Approximately 1256 tons per day of solid waste is being generated in Faisalabad City, having total population of 2,511,700 in 2009, and 54% (678 Tons) out of total waste generated (1256 Tons) is collected and disposed of daily by SWMDF.

A representative sample was collected from eight union councils of the city and its physical analysis was carried out. The sample was categorized into organic (67.64%), textile (5.14%), papers (1.83%), plastics (8.08%), metals (0.18%), glass (0.73%), hazardous (1.28%) and other inorganic (15.07%) products. According to the CDGF data, bulk of the waste produced in the city was organic (41%), while 18.1% was recyclable. Further, 52.4 % of the total waste was valuable.

The existing waste collection and transportation system is based on old traditional methods which is becoming difficult to collect waste properly.

- This under capacity waste collection system is responsible for littering of streets and roads.
- In addition to that, public behavior is very disappointing. They are very irresponsible and spread wastes everywhere carelessly. The municipal solid waste is not collected separately but it is mixed with other types of waste in the city.
- Street sweeping is not timely and properly done due to lack of supervision.
- Beat for the sanitary workers are not specifically defined by department.
- Communal storage for solid waste is masonry dustbins and enclosure, open heaps/ piles, skips and containers etc. It is very difficult for collection and hauling crew to collect the solid waste from the open heaps.

- Uncollected waste creates environmental degradation of the city.
- Manual collection and unloading is unhygienic along with wastage of time.
- Informal sector (scavengers) is involved for segregation of waste at waste storage points i.e., wastes collection points, waste enclosures and filth depots.
- Waste collection and unloading is found to take heavy proportion of time for compactor vehicles and tractor trolleys, which all use manual labor. These labor intensive practices reduce the collection efficiency of the system.
- Auto workshop lacks technical staff and required equipment/ facilities. Repair of the vehicles are done from market instead of authorized workshop.
- Large numbers of vehicles are off road and 24 vehicles are for auction.
- The practice of disposal is quite unplanned and without any environmental considerations. Waste is mostly dumped in and around the city in vacant lots and low laying areas.
- It is evident from data that 52.4 % of the total waste generated is valuable.
- Present communal collection system appears to be inefficient.
- Unhygienic conditions and poor maintenance of the vehicles have reduced the ability of the existing system to remove only 54% of the total waste generated.
- The uncollected solid waste creates problems not only for inhabitants of Faisalabad but also find ways in drains, depressions and open plots / spaces etc.
- Gaps are identified in waste collection, hauling, storage, transportation, disposal, fleet maintenance and capacity building of the department.
- Door to door and point to point collection system is poor because of social unacceptability and less materials recovery.
- There is none of waste transfer station and identified secondary collection points in the city.
- Interdepartmental linkages are on poor levels.
- SWMDF already faced shortage of manpower and technical staffs.

- SWMDF with low resources only covered 70% of the area.
- More than 89% of the budget has been allocated for employee related expenses.
- Presently there are 1.4 SWMDF employees for 1000 person in Faisalabad and 197 Kg per employee waste was collected with using all resources.
- There is none of other appropriate alternatives of waste management and viability of energy and resources recovery processes has been considered in present system.
- The waste disposal system in Faisalabad system is too poor and, there is not even a single sanitary landfill site to dispose of solid waste in an environment friendly manner.
- Citizens are not aware of the relationship between ways of disposing off waste and the resulting environmental and public health problems.

5.2 Recommendations

Following recommendations are derived from the present study of SWM of Faisalabad.

- A waste minimization strategy should be developed for the city.
- A Standard Operating Procedures (SOPs) document should be developed for efficient operations of SWMDF.
- All staff of SWMDF needs to be trained in their respective jobs. Refresh courses, seminars and workshops on various aspects of SWMS should be arranged.
- Door to door/point to point collection of the household waste should be introduced and where it is already in practice, enhance it for more effective results.
- Separate plan should be designed for shop to shop waste collection in commercial areas.

- Solid waste from house hold and commercial areas should be collected according to proper beat list allotted to sanitary workers on proper time and effective monitoring mechanism for this should be introduced.
- Mechanical sweeping of the main and allied roads can be enhanced by introducing new equipment and technologies, it can save time and increase cleanliness.
- Hand carts should be designed in a manner that they can be easily handled by the sanitary workers.
- Containers for collection of waste should be placed in community accessible locations and it can be done with two way discussions on gross root levels.
- Waste Transfer Stations (WTS) should be established to reduce hauling distance.
- Waste segregation, sorting of waste, material recovery and palatalization for RDF facilities should be provided at waste transfer stations in accordance of waste minimization strategy.
- A program should be started for refurbished of existing workshop, parking areas, offices, etc.
- Composting facility can preferably be provided near waste transfer stations.
- Establishment of training, technical and quality assurance support cell in the department will help to improve the capacity of the workers.
- Public private partnership can be developed for waste management, which is acceptable and convenient to local residents.
- Mass awareness should be developed in respect of waste management among community at every level. Health hazards risks associated with waste can be conveyed to people through print and electronic media.

- Waste bags should be introduced in those areas where the waste management at door to door level cannot be adopted by local residences. A comprehensive plan should be developed by SWMDF for collection of waste bags provided to the house holders on time.
- Separate bin system has been launched in city but firstly, the inhabitants should be motivated to separate the organic and inorganic waste through awareness.
- A proper monitoring system should be established to ensure optimal utilization of the available resources.
- Recycling should be considered as formal industry in SWMS, it can be generated revenue and to help reduce the waste at waste transfer stations.
- Improve the working conditions of the existing system because it will be improved the risk associated with the waste management system.
- Waste should be properly disposed of i.e. sanitary landfill should be constructed and properly operated. All necessary facilities should be provided on site like weighing facility. The landfill should be technically and environmentally safe.
- A separate plan should be launched for toxic and hazardous waste and it should be land filled separately and records be maintained.

So, it is concluded that the existing system can be improved with the involvement of the community and latest technology in the waste management. Now it becomes a need that the old system be replaced with the modern, more effective and efficient methods and system based on new technology, research and result oriented approaches. Furthermore, the existing system operates in a highly unsustainable manner without any focus on resource recovery, treatment and scientific disposal of solid waste.

REFERENCES

Agunwamba, J. C. (2003) Analysis of Scavengers Activities and Recycling in some Cities of Nigeria, Dept. of Civil Engineering University of Nigeria.

Bandara, N.J.G.J., Hettiaratchi, J.P.A., Pilapiiya, S., (2007) Relation of waste generation and composition to socio-economic factors.

Barres, (1990), Sanitary Landfilling in France. In: International Perspectives on Municipal Solid Wastes and Sanitary Landfilling, Eds. J.S. Carra and R. Cossu, Academic Press, London, pp. 78 – 93.

Bartone, C.R., (1999) Financing Solid Waste management projects in Developing Countries, lessons from a Decade of World Bank Lending. In: Proceedings of the Organic Recovery and Biological Treatment, ORBIT 99, Part 3, Rhombos, Berlin,pp. 757 – 765.

Batool, A., and Nawaz, C., (2009) Municipal Solid Waste Management in Lahore City District, Pakistan. The Pakistan Development Review, Volume 48, pp 136 – 141.

Batool, A., Nawaz, C., Majeed, K., (2007) Economic potential of Recycling Business in Lahore, Pakistan. The Pakistan Development Review, Volume 28, pp 294 – 298.

Beker, D., (1990) Sanitary Land Filling in the Netherlands. In: International Perspectives on Municipal Solid Waste and Sanitary Land filling, Eds. J.S. Carra and R. Cossu. Academic Press, London, pp. 139 – 155.

Carbitt, R.A., (1999) Standard Book of Environmental Engineering, 2nd edition McGraw Hill Publications.

CDGF (2006) Solid Waste Management Report by SWM Department, Faisalabad.

CDGF (2009) Solid Waste Management Report by SWM Department, Faisalabad.

Christensen, T.H., (1990), Sanitary Landfilling in Denmark. In: International Perspectives on Municipal Solid Waste and Sanitary Landfilling, Eds. J.S. Carra and R. Cossu. Academic Press, London, pp. 37 – 50.

Cointreau, S., (2006) Sustainable Solid Waste System in Developing Countries.

Cointreau, S.J., (1982) Environmental Management of Urban Solid Wastes in Developing Countries, Washington, D.C., A Projector Guide. Urban Development the World Bank: June 1982, p. 93.

Coomaren, P. V., Ohman, M., Brannstrom, T., (2000) A survey of recycling Behaviors in households in Kiruna, Sweden

Dahlberg, H., Johansson, M., Wennergren, U., (1993) Water Audit and Improved Solid Waste Management at Asian Institute of Technology Bangkok, Thailand, Masters thesis, Luleå University of Technology, Sweden.

EPMC (1996) National study on Privatization of Solid Waste Management in Eight Cities of Pakistan.

GoPu (2009), Punjab on Public Private Partnership Modality. Solid Waste Management Project in Faisalabad.

Green (2008) Solid Waste Management Programme in Faisalabad by Green Gold.

Grover, I. V., Guha, B.K., Hogland, W., McRae, G.S. (2000) Solid Waste Management, Oxford and IBH Publishing Co. (Pvt) Ltd., New Delhi.

GVRD (2005) Solid Waste Composition Study January 14.

Hoornweg, D., (2008) What a waste: Solid Waste Management in Asia

Hossain, Md. M., Coowanitwong, N., Shapkota, P., Pradhan, P., Nitivattananon, V., (editors) (2006) International Conference on Integrated Solid Waste Management in Southeast Asian Cities, July 5 – 7, 2005; Siem Reap, Cambodia, Asian Institute of Technology, Thailand.

Idris, A., Inane, B., Hassan, M.N., (2004) Overview of Waste Disposal and Landfills/dumps in Asian Countries. Journal of Material Cycles and Waste Management 6, 104 – 110.

IGD (1992) Sustainable Waste Management: The Adur Project. Report by the Institute for Grocery Distribution, Letchmore Health, Watford, UK, pp. 85.

JICA (2005) Japan International Cooperation Agency and Pak-EPA (Pakistan Environmental Protection Agency). Guidelines for Solid Waste Management, Pak-EPA, Pakistan.

Kaseva, M.E., Mbuligwe, S.E., (2005) Appraisal of Solid Waste Collection Following Private Sector Involvement in Dar es Salaam city, Tanzania, Habitat International, 29 (2), 353 – 366.

KOICA (2007) Joint Study on Solid Waste Management in Punjab, Pakistan.by Korea International Cooperation Agency and World Bank.

Korhonen, J., Okkonen, L., Niutanen, V., (2004) Industrial Ecosystems Indicators – Direct and Indirect Effects of Integrated Waste- and Byproduct Management and Energy Production. Clean Technologies and Environmental Policy 6 (3), 162 – 173.

Kum, V., Sharp, A., Harnpornchai, N., (2005) Improving the solid waste management in phnom Pench city: a strategic approach. Journal of Waste Management 25 (1).

Marinkovic, N., Vitale, K., Holser, N., Dzakula, A., Pavic, T., (2007) Management of Hazardous Medical Waste in Croatia.

Marjorie, J., Clarke, A., Adam, D., Read. B., Paul, S., Phillips, C., (1998) Integrated waste management planning and decision-making in New York City.

McDougall, F., White, P., Franke, M., Hindle, P., (2001) Integrated Solid Waste Management: A Life Cycle Inventory, second ed. Blackwell Science, Cornwall, p.3.

Murtaza, G., Rahman, A., (2000). Solid Waste Management in Khulana City and a Case Study of a CBO: Amader Paribartan. In: Maqsood Sinha, A.H.Md., Enayetullah, I.(Eds.), Community Based Solid Waste Management: The Asian Experience. Waste Concern, Dhaka, Bangladesh.

Nielson, P.H., and Exner, S. (1998) Product Specific Emissions from Municipal Solid Waste Landfills, Part 11: Presentation and Verification of the Computer Tool LCA-Land, International Journal of Life Cycle Assessment, Vol. 3 (4), pp. 225 – 236.

Palnitkar, S., (2002) Manual of Solid Waste Management, AIILSG, Mumbai. pp. 9.

Ponting, C., (1991) A Green History of the World. Sinclair-Stevenson, Great Britain.

MSWM-Pu (2007) Punjab MSWM Guidelines; Local Government and Community Development, Government of the Punjab, Published by The Urban Unit Sector, Policy and Management Unit, pp. 3 – 13.

GoPu, (2007). Punjab Solid Waste Management Reform, The World Bank Draft Final Report - August 22,

Rahman, M., Sultana, K.R., Hoque, A., (2008) Suitable Sites for Urban Waste Disposal using GIS Approach in Khulna City, Bangladesh.

Seadon, J.K., (2006) Integrated waste management – Looking Beyond the Solid Waste Horizon

Sharholy, M., Ahmad, K., Vaishya, R.C., Gupta, R.D., (2007) Municipal Solid Waste Characteristics and Management in Allahabad India. Waste Management 27, 490 –496.

Shimura, S., Yokota, I., Nitta, Y., (2001) Research for MSW on Analysis in Developing Nations. Journal of Material Cycles and Waste Management 3, 48 – 59.

Snel, M., and Ali, M., (1999) Stakeholder Analysis in Local Solid Waste Management Schemes.

Solid Waste Management Strategy (1999) for Dakahleya Governorate, March Section71.

Staudt, E. and Schroll, M. (1999) The German packaging Ordinance: the Questionable Effects of a Fragmentary Solid Waste Management Approach. J. Material Cycles Waste Management, Vol.1, No.1, pp. 17 – 24.

Stegmann, R. (1990), Sanitary Landfilling in the Federal Republic of Germany. In: International Perspectives on Municipal Solid Waste and Sanitary Landfilling, Eds. J.S. Carra and R. Cossu, Academic Press, London, pp. 51 – 66.

Sudhir, V., Muraleedharan, V.R., Srinivasan, G., (1996) Integrated Solid Waste Management in Urban India: A Critical Operational Research Framework

Tchobanoglous, G., Theisen, H., Vigil S.A., (1990) Integrated Solid Waste Management Engineering Principles and Management Issues, International Edition, McGraw Hill Publications.

Turner, R.K., Powell, J., (1991) Towards an Integrated Waste Management Strategy. Environmental Management and Health 2 (1), 6 –12.

UNEP (2002) "State of Waste Management in South-East Asia" by United Nations Environment Programme.

UNEP (2008) Division of Technology, Industry and Economics, United Nations Environment Programme.

Van Beukering, P., Gupta, J., (2000) Integrated solid waste management in developing countries. In: Grover, B.K., Guha, W.H., McRae, S.G. (Eds.), Solid Waste Management. A.A. Balkema, Rotterdam, pp. 3 – 20.

Vesilund, P.A., Worrell, W.A., Reinhart, D.R., (2002) Solid Waste Engineering. Brookes/Cole, California, United States of America.

Ziekiene, S., Trieys, V., Kovieriene, A., (2005) Municipal Solid Waste Management: Data Analysis and Management Options

Zurbrugg, C., (2003) Urban Solid Waste Management in Low Income Countries of Asia How to cope with the Garbage Crisis.

Appendix-A

Questionnaire / Interview Document for Research Thesis

Q 1: How is the working system of Waste Management in Faisalabad?

Q 2: How much area covered by CDGF for Waste Management?

Q 3: Is there any separate unit in CDGF for waste management, give detail of staff, working mode and methodology?

Q 4: What was the working strategy of SWM – CDGF?

Q 5: Which type of waste you collected mostly and what its percentage overall?

Q 6: What are the methods used by CDGF for waste collection?

Q 7: Which categories of waste do you have in the collection system?

Q 8: How does the system deal with this collected waste from different source?

Q 9: Is there any different methodology adopted for residential and commercial area by SWM – CDGF?

Q 10: Have you launched any public campaign to raise awareness among general public regarding to waste management in city?

Q 11: How many collection points, secondary collection points, transfer stations are designed in Faisalabad for waste collection?

Q 12: How is the waste carried to bins from the different source?

Q 13: How is the waste carried from Household to bins, bin to collection point/ containers and then finally to main point?

Q 14: Where is the main disposal site in Faisalabad?

Q 15: How many vehicles you have been allotted for SWM – CDGF?

Q 16: How many employees are there in SWM – CDGF?

Q 17: What types of vehicles are used in collection system?

Q 18: How many numbers of vehicles are there in all in CDGF waste management system?

Q 19: How much waste is collected per each day/ week/ month?

Q 20: Do you have any specific waste lifting pattern?

Q 21: What is the waste disposal techniques used?

Q 22: Could you tell me more about the disposal method used by SWM – CDGF?

Q 23: Is there any landfill site in Faisalabad or planned in future for system?

Q 24: What are the main problems you faced in present SWM system?

Q 25: What are the reasons behind this problem?

Q 26: Are the number of employees and vehicles sufficient to maintain waste in the areas allotted to you?

Q 27: Is there any other technique used for waste disposal?

Q 28: Is there any complaint registration system and of what type in SWM – CDGF?

Q 29: What is the feedback and public behavior?

APPENDIX –B

Secondary Location Points for Waste Collection and Transfer to Main Dumping Site

No.	Waste Storage Location	Container Size		Remarks (After Visit)
		Width (m)	Length (m)	
1	Jhung Road.	10	25	Along the road side opposite Ayub Research Institute Gate No. 1.
2	General Hospital.	20	30	It is located inside the boundary wall of General Hospital. It is a big area and small portion is used as collection centre.
3	Chuhar Mahajara opposite Darbar Mian Sb.	-	-	No specific collection center was found at the mentioned address.
4	Mainnarwala road Thana Gulberg.	26	70	The center is located on private land owned by University of Agriculture near Police Station Gulberg.
5	Chanab Club.	12.5	9.5	Proper Enclosure with gate.
6	Ganda Nala Ghulamabad Bhutto Chowk to Grave Yard Dera Sai.	-	-	It is an area of approximately 1 km long along with Ghulamabad Drain. Three main points located along with drain for collection center. No boundary walls available. Only one container with the capacity of 5 cu.m. was kept near Shubhan Masjid along with drain.
7	Gurunanak Pura Street No. 11.	-	-	Only one container of 5 cu.m. was kept outside the street.
8	Gurunanak Pura Street No. 15.	-	-	No container or specific boundary wall was seen for waste collection.
9	Gurunanak Pura Street No. 1.	-	-	Only one container of 5 cu.m. was kept outside the street.
10	Iqbal Town Main Road near Ghulamabad Ganda Nala.	18	20	It is a private open plot which is used as collection center.
11	Outside Jhang Bazar Near Pul Ghalla Mandi.	-	-	No specific collection center was found at the mentioned address.
12	Shadab Colony Mor Jhang Road.	40	30	It is a big private plot. The small portion of plot is being used as collection center. It is actually located near Jamia Masjid

No.	Waste Storage Location	Container Size		Remarks (After Visit)
		Width (m)	Length (m)	
				Chisty Noorani Jhang Road near Shadab Colony Mor.
13	Chank No. 279 Near Factory Nazam Sb.	10	45	It is a big private plot and one side is used as collection center. It is located at Nisar Akbar Road Chak No. 279.
14	Bismillah Park 279 Khurd.	16	19	Center is located on private plot near Government Boys High School.
15	Razaabad Bazar No 2 near Main Masjid.	-	-	Collection center was closed before two months and waste was disposed off at collection center near Police Station Gulberg
16	Ayyub Colony near Girls School.	07	09	Collection center located on private plot near Iqra Girls School owned by Mr. Fazal Hussain
17	Main Station Road.	2.5	25	No proper point. Only edge of road is utilizing as collection point.
18	Kabaria Searching Point.	05	15	Muhalla Karamatabad, Alshifa trust
19	Ejaz Hashmat Chowk opposite Kohinoor Plaza.	15.5	8.1	Complete Enclosure
20	Kohinoor Flat – 1, Jaranwala Road.	-	-	Only one container of 5 cu.m. was kept outside the street.
21	Kohinoor Flat – 2, Jaranwala Road.	-	-	Only one container of 5 cu.m. was kept outside the street.
22	Madina Town Flats – 1.	03	07	No container is available, waste is disposed off on the corners
23	Madina Town Flats – 2.	3.5	07	No container is available, waste is disposed off on the corners
24	Faizan Madina Masid.	05	12	-
25	Akbar Colony Kabristan Chak 214 near Al – Jannat Marbal Factory.	20	22	Private Land.
26	Nazd Makki Masjid Dhuddi Wala, Rasul Nagar.	-	-	Only one container of 5 cu.m.
27	Rajawa Town.	30	50	Open Private Plot in addition to one container of 5 cu.m.
28	Himmatpura Dhuddi Wala.	05	15	Near Govt. Primary Girls School Dhuddiwala.
29	Jhaal khanawala Opposite Fly Road.	25	75	Govt. Land (Plot plus two containers).

No.	Waste Storage Location	Container Size		Remarks (After Visit)
		Width (m)	Length (m)	
30	Old Workshop Office Near Work Shop.	15	25	Govt. Land open area.
31	Pul Galla Mandi.	-	-	On the edge drain and Jhang road.
32	Main Jhang Bazar.	-	-	One container In between drain and road.
33	Premier Mill.	08	50	On the edge of roads.
34	Rasala No. 12 – 1 Khajuran Wala Road.	08	75	Open disposal.
35	Rasala No. 12 – 2 Khajuran Wala Road, In front of Garden of Dates.	05	25	Open disposal.
36	Rasala No. 12 – 3 Khajuran Wala Road, In front of Garden of Dates.	05	25	Open disposal.
37	College Road Samanabad near Grave Yard.	10	15	On the edge of road towards railway line, one container.
38	Samanabad on the Edge of Railway Line.	-	-	Container only.
39	Nawalti Pul Samanabad	-	-	Open Govt. Land.
40	Dtype Colony Samundri Road.	08	15	In between Canal and Road, near Dtype Bridge.
41	Allama Iqbal Colony under Boundary Wall.	19	31	Govt. Land.
42	Aqab College near Iron Market Dtype Colony.	10	75	Along the boundary wall.
43	Waris Pura Chowk, Tanga Stand.	2.5	15	Disposal area with one container of 5 cu.m.
44	Disposal Works People's Colony No. 2.	31	60	Permanent Collection Point.
45	Raja Chowk People's Colony No.2.	06	20	Open disposal on private plot.
46	Civil Hospital.	-	-	Container only.
47	Tariqabad Down Side of Abdullan Pur, Bridge near Railway Station.	06	22	Open disposal on the edge of road plus one container of 5 cu.m.
48	Jhumra Road.	03	27	Open disposal on the edge of road.
49	Mansoorabad.	50	50	Open disposal on private plot.
50	Mian Pind Point – 1.	12	16.5	Open disposal on private plot.
51	Mian Pind Point – 2.	50	21	In between road and cultivation on the edge of the road.
52	204 Chak Manawala,	29	16.5	Disposal on the edge of the road.

No.	Waste Storage Location	Container Size		Remarks (After Visit)
		Width (m)	Length (m)	
	near Darbar and Grave Yard.			
53	Gulistan Colony near Grave Yard.	28	23	Broken boundary wall.
54	Iqbal Stadium.	27.5	25	Proper Enclosure with gate, in front of Aishah road Aishah Chowk.
55	Allied Hospital.	07	27	Disposal in between road edge and hospital wall.
56	Qaim Sain Road.	07	75	Disposal along the road in between university wall and road edge.
57	Sadhu Pura.	03	50	Disposal in between road edge and cultivation.
58	Same Nehr Bawa Chowk.	10	37	Disposal in between road edge and Canal.
59	Noor Pur Near Park.	-	-	Disposal in between road edge and Park wall – Container only.
60	Ashrafabad ahead is Ganda Nala in the boundary of School.	-	-	Two containers only.
61	Gogher oil mill road near Govt. dispensary.	08	23	-
62	Slaughter House.	-	-	Point is rarely used.
63	Bholay Di Chuggi.	5.2	6.6	Near WASA Tanki.
64	Hajweri Town area for school.	-	-	4 Kanal plot
65	Chabban road Hajweri Town disposal Khadija Memorial.	-	-	No size – private plot.
66	Railway Colony Bridge Tariqabad Masjid.	-	-	Three containers.
67	Zubair Colony Tethri Road.	2.5	40	Disposal on the edge of road along the wall.
68	Liaqatabad Main Bazar.	-	-	Street blocked with filth.
69	Yungwala No.1.	10.5	33	University Land.
70	Yungwala No.2.	07	20	University Land.
71	Fish Farm near King Basti Masjid.	23	24	Open plot – Private Land.

APPENDIX –C

Physical Waste Composition Determined in Faisalabad

No.	Waste Components	Waste Components Particulars	Total Waste Percentage
1.	**Organic**	Food Waste (All Food Waste Except Bones), Yard Waste (Leaves, Branches, Twinges, Grass, Plant Material), Diapers, Other organics / combustibles (Rubber, Leather).	**67.647**
2.	**Textile**	Textile, Carpet, Cotton, Carpet Padding and Others.	**5.147**
3.	**Paper**	Mixed Paper (High Grade Paper Like Computer Print. Office Paper, Magazine, Glossy Paper, and Waxed Paper), Box Board, Tissue, Envelops, Newspaper, Corrugated Paper (Cartons) and Others.	**1.838**
4.	**Plastic**	PET Bottles, Thin Film Plastic (Bread Cover, Surf Cover, Biscuit Covers, Chips Covers, Soap Cover, Medicine Packing, Oil Cover), High Density Poly Ethylene (Hard Plastic Clear), High Density Poly Ethylene (Hard Plastic Colored), Low Density Poly Ethylene and Other Plastic.	**8.088**
5.	**Metals**	Brass, Aluminum (Cans), Aluminum (Foil), Ferrous (Cans), Other Ferrous, Other Non Ferrous and Other Metal (Copper, Steel).	**0.183**
6.	**Glass**	Non Colored (Clear), Green Colored, Brown Colored and Other Glass.	**0.735**
7.	**Hazardous**	Cell, Latex Paint, Oil Paint, Pesticides / Fungicide / Fertilizer / Herbicide, Automotives oils, Sharps / Insect and Mercury.	**1.286**
8.	**Others Inorganic**	Rock, Sand, Dirt, Debris, Ceramics, Plaster and Bones.	**15.073**
Grand Total			**99.997**