THE UNIVERSITY OF HULL

Municipal solid waste management and institutions in Tripoli, Libya: applying the Environmentally Sound Technologies (ESTs) concept

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By

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Abstract

Solid waste management systems in developed countries are undergoing a transformation to a resource recovery-based model. Conversely, in many developing countries waste management is still inadequate in terms of environmental and public health. The environmentally sound technology (EST) concept, which emerged from the United Nations in the 1990s, has been suggested as a useful means to identify sustainable solid waste management systems for developing countries. The international community has promoted ESTs in an attempt to clarify the concept and facilitate their selection and use. However, in developing countries, understanding of the EST concept and technology transfer mechanisms remains elusive.

The aim of this research is to investigate context-appropriate technologies for solid waste management in Libya. The research investigates the usefulness of the concept of Environmentally Sound Technologies in the Libyan context using the capital, Tripoli, as a case study. Institutional capacity theories and basic principles of ESTs transfer and adoption were employed to investigate the factors that hinder use of ESTs in the study area. A mixed methodology combining semi-structured interviews, a questionnaire survey, field observation and document analysis was used to analyse the current practices, the institutional framework, and interaction between the service users and providers.

The finding indicate that the national and local institutions in the city are failing to carry out sound practices. Deficiencies were recorded in the organisational and legal framework, as well as in the financial system. Moreover the assessment of city residents towards most of the current practices was negative, and their role and contribution towards current practices were very limited. The deficiencies identified that related how the MSWM institutions interact with each other and with the service users would require substantial review in order to carry out system reform. Certain of changes are identified to influence the institutions' capacity to accommodate ESTs at the municipality level.

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List of Abbreviations

BMW	Biodegradable Municipal Waste
C&D	Construction and Demolition
CBOs	Community Based Organizations
DTIE	Division of Technology, Industry and Economy
EGA	Environmental General Authority for Libya
ENSAPAFRICA	Environmental Assessment Capacity Building Programme for Africa
EOP	End-of-Pipe
EPI	The Environment Performance Index
ESOs	Environmental Sanitation Offices
ESOT	Environmental Sanitation Office /Tripoli
EST	Environmentally Sound Technology
ET	Environmental Technology
EU	European Union
GDP	Gross Domestic Product
GIA	General Information Authority
GPC	General People's Congress
IETC	International Environmental Technology Centre
ISWM	Integrated Solid Waste Management
LD	Landfill Directive
MDGs	The Millennium Development Goals
MENA	The Middle East and North Africa
METAP	Mediterranean Environmental Technical Assistance Programme
MHPU	Ministry of Housing and Public Utility
MHU	Ministry of Housing and Utility
MSWC	Municipal Solid Waste Compost

MSWM	Municipal Solid Waste Management
MUCT	Municipality Utility Control Tripoli
NGO's	Non Govewrnmental Organisations
NPES	National Programme for Environmental Sanitation
OECD	Organisation for Economic Cooperation and Development
PCTCs	Private Collection & Transport Companies
SWM	Solid Waste Management
TPSC	Tripoli Public Service Company
Ts	Transfer station
UN	United Nations
UNDP	United Nations Development Programme
UNED	United Nations Environmental Programme
UNEP	United Nations for Environmental Programme
UNES	United Nations Earth Summit

CHAPTER ONE: INTRODUCTION

1 Introduction

Human processes and activities such as the extraction of natural resources, and the production and consumption of goods, produce solid wastes. The transition of humans from nomadic to sedentary lifestyles coupled with the development of towns and cities made it overwhelmingly important to formalise solid waste management (SWM) (Nordone *et al*. 2004). A rapid increase in development in different sectors, especially in developing oil producing countries like Libya during the last three decades, has affected environmental and public health, for example by increasing the generation of solid waste (Asherani, 2003).

Decision makers and relevant authorities in developing countries are seeking to adopt suitable technologies to deal with this waste and they need to assess how the specific, prevailing background conditions constrain the choices available (UNEP/DTIE/IETC, 1996; Puustjarvi *et al*. 2003). Determining suitable technologies in a given area depends on how local conditions influence environmental, economic, social, and political issues. There are examples of solid waste investments that have failed, not because the technology was at fault, but for lack of consideration of compatibility with local circumstances (Van de Klundert and Anschutz, J. 1999; Puustjarvi *et al*. 2003). Acknowledging the challenges inherent in technology transfer from developed to developing countries (UNEP/DTIE/IETC, 1996) the United Nations Earth Summit (UNCED) introduced the concept of Environmentally Sound Technologies (ESTs). In the Agenda 21, the concept of ESTs was addressed to simplify the complex relationship between development and the environment. Technology in this context provides a link between human action and natural resources. Therefore, ESTs have become crucial for both development and the environment. Technology itself cannot compensate for or mitigate the deep-rooted social causes of environmental problems. Therefore, selection and adoption of ESTs requires both human resources development and local capacity duilding aspects of technology choices.

Libya in this context has experienced economic and social development during recent decades as a result of oil discovery. Although the population increase has been

accompanied by economic growth, expansion in urban areas, rapid industrial development and rising standards of living, Libya has not accomplished a compatible improvement in solid waste management. As in many other developing countries, traditional final disposal methods are the dominant option of solid waste disposal; 90% of solid waste collected is disposed of in open dumps (Almabrouk and Fonass, 2003).

Libya, in recent decades, was one of the few countries in North Africa that has had laws in the area of environmental protection. However, despite development in various sectors, the government has not made satisfactory adaptation of these laws to keep pace with subsequent economic and social growth or devised a suitable action plan for implementation (Faras, 2000; EGA, 2007). As well, it is observed that very few academic studies on municipal solid waste have been conducted in Libya. Furthermore, there is a lack of expertise in the field of solid waste management (EGA, 2002; Sawalem *et al*. 2009). This affects the possibility of building a sustainable SWM strategy for Libyan municipalities.

1.1 Research background (Overview of research and context)

The research is restricted to the solid waste that is collected by or on behalf of local authorities and was known as municipal waste in the UK "Environmental Protection Act , (EPA, 1990), and so classified in UN-HABITAT (Scheinberg , *et al*. 2010: 6).). Hazardous waste is another issue in terms of toxicity, which needs a different stream of management as it has different environmental regulations and organisation. Therefore this research focuses on how to adopt sound practices in the municipal solid waste management system, given that developing countries still confront difficulty in receiving appropriate technologies that can operate based on their local social, economic and political conditions. In Libya, where there is a rapid growth of population, unsustainable SWM practices have burdened the country’s cities with health and environmental problems and there has been significant expenditure in the sector without return. In particular, the cities are confronted by accumulation of wastes in streets and in open areas near houses and ineffective treatment and disposal due to inappropriate technologies used. In this context and to achieve the objectives of the research, the EST definition was identified based on the

Libyan context as a developing country that relies heavily on foreign technologies for development.

This research was started in July 2009, when the national government including the Environmental General Authority (EGA) realised that the five-year plan of the National Programme for Environmental Sanitation (NPES) had failed. Within this period, there were some shortcomings in the SWM system, such as increase of waste burning at landfill sites and decrease of production of compost, as a result of deficiency in organisational arrangements that led to the weakening power of actors such as EGA and participation of the private sector. Apparently, there is an urgent need to reform the current SWM system, especially after the 17 February revolution, where many systems need to be reformed including municipal solid waste management (MSWM). Additionally, with Libya being an upper-middle income country, there appears to be a financial opportunity to improve existing practices and increase investment in collection and treatment technologies. For this reason, any means of technology that realises one or more of the following benefits is to be welcomed:

- Improve the efficiency of MSWM services performance and treatment facilities. Attain modifications and development in the current used system through adoption of assessment criteria for decision makers to evaluate alternatives and the background conditions that affect what makes something a sound practice (Rosario, 2004; Bartone *et al*. 1990).
- Increase resource recovery, in order to provide an alternative to mass landfilling which is no longer environmentally or financially sustainable, and as a commitment to reducing future environmental impact (Henry *et al*. 2006).
- Decrease emission of ozone depleting gases, to contribute to international efforts to overcome the problem of climate change. All states have obligations to reduce the greenhouse gases (GHG) that cause climate change, especially from MSW, which is a significant contributor to GHG emissions (Zaïri *et al*. 2004).

In this research, in order to contribute to the building of a future sustainable SWM in Libya, analysis of existing practices was undertaken to understand to what extent ESTs are applied and to identify the potential of institutional capacity to select lessons learnt as basic principles to reform current SWM system. In this regard, the

potential for use of ESTs was identified through discussions and deliberation with the stakeholders (national and local government and householders) taking into consideration the political, social, economic, public and biophysical factors present in Libya as well as analysing the experience of SWM in developed and developing countries. For this purpose interviews, a questionnaire, site visits and literature review from scientific and trade journals, proceedings and consultants, were employed

1.2 Research justification

With fast-growing waste production and the increasing diversity of its components, management of solid waste is becoming an increasingly difficult problem for the municipalities in Libya. No one denies the importance of using modern technologies to manage waste in a sustainable manner. Many of these modern technologies in different waste management streams are applied in many areas of the world, such as sanitary landfill, mechanical biological treatment, and incineration. However, to take a decision on applying sustainable waste management systems it is necessary to consider not only technical aspects but also other factors related to selection and use of technology. In the Libyan context, there have been efforts by the national and/or local government to introduce some technologies to improve the quality of service and way of treatment. However, such attempts have not been able to enhance the effectiveness of the current system, due to the lack of coordination among stakeholders whether at governmental and non-governmental organisations levels or with the local community. Moreover, no evaluation and assessment studies were carried out to ensure system success. Thus, the efforts made have not been effectively exploited; consequently there was no improvement in the service provided.

Failure to comply with the sustainability criteria contributed to the aggravation of the SWM situation. Consequently, those interested in the field of public health and environment, such as national and local government bodies and other relevant authorities have expressed their concern about the unacceptable solid waste situation in cities of the country. These concerns were clearly defined in reports of ministerial meetings and/or performance evaluation reports. On the other side, members of the community have also expressed dissatisfaction with SWM services. They demanded

reforms and modification of the system through various national and local media such as newspapers, TV and radio.

Based on Law No 15 for 2003, EGA as the entity responsible for supervision of environmental pollution control considers that the solid waste situation in Libyan cities requires research attention to shed more light on the issue and pave the way for a solution. In this regard, this study was requested and funded by EGA in order to contribute to development of appropriate solutions for MSWM practices. Options for these are limited in developing countries, basically due to the lack of studies on the issue of ESTs, in particular in MSWM, and issues related to institutional capacities to create an adequate understanding of the problem.

This study aims to further increase understanding of the solid waste management practices affecting Tripoli cities and the role of institutional capacity in adopting ESTs based on local conditions. This will provide a useful starting point for addressing an otherwise intractable problem. In general, the study also contributes to both the theory and practice of adopting ESTs in the SWM sector in developing countries.

1.3 Research motivation

Increasing waste generation and diversity of its components as well as resource conservation? issues reflect the need to adopt sound technologies to solve health and environmental problems. In this context, developed countries, especially, members of the European Union (EU) have taken the lead, when they built their administration and financial institutions and set up strategies and policies based on their capacities. In developing countries, however, the situation is different, and the improvement in their SWM systems is negligible, even in middle income countries like Libya, where financial resources are available that could be used to facilitate ESTs transfer and adoption. However, low priority has been given to modernising SWM institutions and institutional arrangements. Thus, Tripoli and other cities in Libya are suffering from a lack of suitable technological facilities. The result is inappropriate practices such as failure to collect significant amounts of waste, and heavy reliance on open dumps.

The researcher was conscious of the situation of SWM as a member of the EGA with experience of many SWM projects, and most recently (in 2007) as the representative of the EGA in a SWM project in cooperation with UNDP. This also afforded an opportunity of access to policy papers and other documents to which some of the public do not have access. These papers reflect the existing SWM situation in Libya. This position has helped in facilitating the process of choosing the research methodology. In addition, the researcher had good access to data as he was backed by the EGA, which was the funding body for this research. Moreover, there was a common consensus that the motivation of this study was driven by the strategic challenges confronting solid waste policy-makers and managers in Libya, the recognition of the urgent need to fundamentally rethink SWM, and the lacuna in the literature about MSWM in the region.

1.4 Research aims and questions

The specific aim of the study is to investigate the current practices of municipal solid waste management system in Tripoli city and critically focus on how local institutional capacities are important as an issue that recognises the current system situation. Also it evaluates existing conditions and progress made in adopting ESTs, whether in terms of storage, collection, transport, treatment and final disposal, and analyses the ESTs principles for sustainable transition of the MSWM system. The findings are expected to assist the decision-making process in formulating policy and strategy for the SWM sector in the study area of Tripoli city.

To achieve the main purpose of this research, the thesis was guided by the following four objectives;

- To analyse the current MSWM practices in Tripoli city and their regulatory context;
- To assess the institutional procedures regulating MSWM practices;
- To explore the interaction between the service providers and service users;
- To explore how MSWM system reform could be carried out to employ the EST concept in the study area.

This research focuses on understanding the main factors affecting the adoption of ESTs through analysing the current waste management practices in Tripoli, Libya, with a view to recommending more sustainable practices and analysing the usefulness of the concept of environmentally sound technologies for the improvement of waste management practises. In this regard, the researcher proposes four key research questions to fulfil the research aim:

1. What is the current state of MSWM in Tripoli?
    a. To what extent could the existing practices be considered ESTs?
2. What are the institutional procedures that regulate MSWM practices in Tripoli city?
    a. How do institutional considerations affect the selection and use of ESTs?
3. What is the interaction between service providers and service users in the adoption and use of ESTs?
    a. What is the service users' opinion of current practices and what role do they play?
    b. How do the service providers respond to the service users' reactions?
4. What are applications for adoption of ESTs?
    a. How suitable is the ESTs concept for reform of the MSWM in Tripoli?

1.5 Research structure

The thesis is structured in nine chapters. The chapters are arranged to be consistent with each other to ensure that each research question is answered and the objective is achieved on the one hand and for the reader's convenience on the other. Each chapter is outlined below:

In **Chapter One**, the research problem and the research context are outlined. An overview of the research problem is introduced, and issues of research background, justification, motivation, aims, objectives and questions are covered. In **Chapter Two**, the literature that covers related research contextual issues is reviewed. These themes are organised in three sections; controversial issues related to building SWM policies and strategies in developed and developing countries are addressed in the first section. Section two highlights the emergence and development of Environmentally Sound Technologies, while section three discuses ESTs uptake factors, and institution and institutional capacity as a theoretical framework is

reviewed. In **Chapter Three,** the key features of the context of the study are reviewed and the key factors that influence the sustainability of the solid waste management system in Libya are identified. The chapter covers two main themes; the geographical, social and economic characteristics, and the political and administrative system in Libya on the one hand, and the key environmental issues in Libya, benchmarking of Libya's environmental performance and the challenges facing Libya's institutions, on the other. The chapter concludes by describing the city of Tripoli in terms of physical, human, economic and environmental characteristics. **Chapter Four** describes and rationalises the use of mixed methods in this study. It outlines the method used to collect the necessary data to answer the research questions. The methodological issues in this chapter are organised to cover three aspects; the research approach, area and population, research data collection and analysis and the researcher's positionality and ethics.

Chapter Five is the first of three empirical chapters. In this chapter, the current situation of MSWM in the study area is analysed. The analysis covers three MSWM issues: the legal framework; MSWM generation and composition; and flow of the municipal solid waste and current waste practices, including waste storage, collection, transfer, composting, recycling and final disposal. **Chapter Six** analyses the institutional framework and its interactions to understand the factors that inhibit uptake of ESTs within the MSWM system. The analysis in this chapter is based on the perceptions of the national and local government institutions, and it includes the organisational framework, environmental policy and financial system of MSWM. In **Chapter Seven** the analysis is focused on the interaction between the service users and service providers. In this chapter, in addition to the perception of the national and local government institutions towards service users, the opinions of the householders towards current practices and their role are analysed.

Chapter Eight presents a discussion of the research findings, organised according to the four research objectives. **Chapter Nine** draws conclusion from the research findings. It sets out the theoretical implications and also highlights the research contribution, generalizability and strengths and limitations, as well as suggestions for future study.

Summary

The municipal solid waste management sector is becoming a strong focus of policy attention for many countries, especially for developing countries (Shekdar. 2009). Rapid economic and social growth on the one hand and the need for sustainable development on the other, mean there is a discrepancy between the demand for technology to provide waste service and treatment and capacity to meet this demand. Promoting understanding of the EST concept is one of the most important options for addressing this issue. In developed countries, to a great extent ESTs are adopted, while in many developing countries doing so is still a challenge. In this study, the concept of ESTs will be critically analysed in order to explore the way in which the MSWM institutions in Tripoli can be sustainably reformed.

The results of the study, therefore, would contribute to understanding the factors that need to be reformed to adopt sound practices at local level. System reform in such a case may be imperative for developing countries to achieve development and sustainability.

CHAPTER TWO: SOLID WASTE MANAGEMENT AND ENVIRONMENTALLY SOUND TECHNOLOGIES

2 Introduction

This chapter contains three sections presenting the literature on municipal solid waste management (MSWM) as a theoretical framework for the study. The first part considers the principles of sustainable solid waste management, drawing on recent experience in the EU. In addition, I provide a brief characterisation of waste management practices in developing countries, especially in the Arab region. Second, the chapter introduces the concept of environmentally sound technology (ESTs) as an approach that international agencies have promoted to selecting and adapting developed country technology for use in developing country contexts. Finally, this chapter provides a critique of the EST concept.

Section One

2.1 Sustainable SWM

For more than three decades, the international community has been advocating building a sustainable future. In 1992, the United Nations Conference on Environment and Development (UNCED) was held in Rio de Janeiro, Brazil. Almost all countries of the world (178 out of 193) admitted that there is a need to establish the concept of sustainability in municipal solid waste management among all nations. Within Agenda 21, the Rio Declaration on Environment and Development, chapter 21, summarises the environmentally sound management of solid wastes, which includes maximising waste re-use and recycling. Policies for sustainable development should be formulated based on the definition of the World Commission on Environment and Development, which is to ensure access to the needs of the present generations without compromising the future needs of the coming generations (WCED, 1987). Accordingly, the SWM strategies in the EU and other developed countries in the last three decades have been shifting from traditional waste collection and disposal to building a policy for sustainable solid waste management (Hansen *et al*. 2002). Sustainable SWM is modelled on the so-called waste hierarchy, which presents reduction, reuse, recovery and environmentally sound final disposal as the order of priority in waste management decision making,

though cognisant of local conditions (Waste Framework Directive, 2008). The EU is promoting a transition to sustainable SWM by setting time-bound targets. For example, in the UK, the target was 25% and 30% of household waste must be recycled by 2005 and 2010 respectively (DETR, 2000). Policies aiming to implement sustainable waste strategies have recognised to the need to engage householders and other stakeholders in behavioural changes (e.g., Tonglet *et al*. 2004; Phillips *et al*. 2011).

In general, achievement of sustainable development can only be measured by the extent to which the economic, social, environment and institutional aspects are integrated witheach other (Spangenberg, 2004)**.** In terms of SWM, understanding of factors that influence SWM and how each factor is associated with the dimensions of the sustainability is an important issue to select and adopt sound practices (Troschinetz and Mihelcic, 2009). Selection and adoption of technologies should not only be a response to local and national targets, but also international goals should be included, such as technology that leads to decrease of ozone depletion gases. Within the EU, the Landfill and Incineration Directives responds to such demands (Vehlow *et al*. 2007). However, the experience of implementing environmental protection projects in practice still varies considerably within the EU and in particular in developing countries, which requires further actions to apply the concept of sustainability.

2.2 Trends in solid waste strategies and outcomes in developed countries

Developed countries are the most industrialised and technologically advanced countries, which are characterised by high per capita income levels, high human development and a stable political situation (World Bank, 2008; UNDP, 2010, 2011). I will focus on the European Union (EU), where, it can be argued, a sustainability transition in waste management has occurred over the last 40 years, since the first Waste Framework Directive in 1975. The EU waste policy mandates stringent procedures to ameliorate the environmental consequences of waste. In addition, targets have been set conscious of waste as a resource. However, since the accession of Eastern European and other new member states comprising EU-27 in 2007, social, economic, political and environmental disparities within the EU have increased

markedly (Pries *et al*. 2011). As will be shown, the extent to which SWM systems have achieved a transition to sustainable practices (as envisaged in EU policies) also varies considerably between EU members. Thus, the EU provides examples both of the high standards of waste management that are technically possible, and of the challenges which can be faced in meeting those standards.

2.2.1 The EU Waste policy and strategy

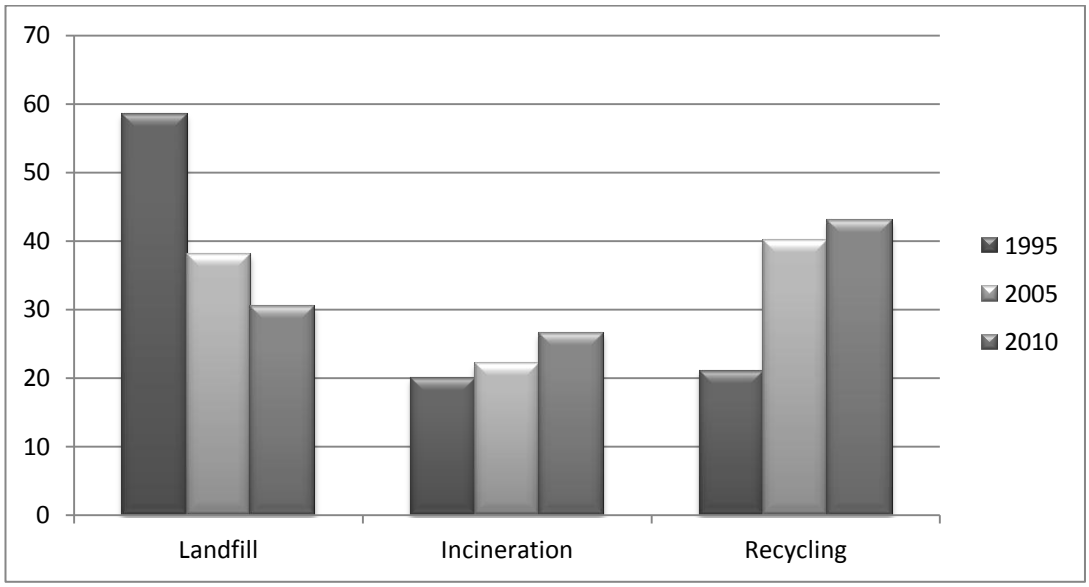
In 1975 EU developed a strategy set out in the Waste Framework Directive to establish integrated solid waste management. Waste policies in the EU are part of a broader agenda of sustainable development. For example, immediately after releasing Agenda 21, the EU adopted its first sustainable development strategy, which aims to increase capacities for continuous improvement to ensure a better life for the present and future (Hawkins and Shaw, 2004). Waste policy at EU level is focused on adopting the waste hierarchy. For example, mechanisms for complying with the Landfill Directive vary from one country to another. Many countries rely on economic instruments such as the Pay-As-You-Throw principle and Landfill Allowance Trading System (LATS) in their effort to decrease the amount of biodegradable municipal waste sent to landfill (Defra, 2005).

Figure 2.1 illustrates the outcomes of solid waste management strategy in the EU between1995-2010. In general, SWM strategies have been transformed to a recovery-based model by increasing the rate of recycling and composting, which has achieved a decrease in waste disposed to landfill (Skovgaard *et al*. 2008). In the UK, for example, the recovery model is based on the concept of waste sorting at source, mechanical collection techniques and raising public awareness of waste as a resource (Bulkeley *et al*. 2007).

Environmental impacts of waste depend largely on the amount and characteristics of the waste as well as its management (WRAP, 2010). For example, life-cycle analyses have shown that adoption of recycling technologies has overall environmental benefits over landfilling for many waste types (WRAP, 2010). Nevertheless, waste collection, treatment and disposal cause serious environmental pressures such as greenhouse gases generated from several solid waste practices (Skovgaard *et al*. 2008). Thus, a strong regulatory approach is needed to ensure that

regulations on paper are enforced effectively in practice (Van de Klundert and Anschutz, 1999). Thus the EU has formulated multiple Directives (see Table 2.1) that seek to enhance member states' capacity for sustainable waste management to promote internally favourable institutional structures and arrangements, financial schemes and mechanisms, technologies selection and adoption and involvement of stakeholders (Pires *et al*. 2011).

Figure 2-1: Municipal solid waste management in the EU-15 in percent of weight, 1995-2010



Source: Calculated based on Skovgaard *et al*. 2008 and RAPID Press Release March, 2012)

The Waste Framework Directive (2008) reinforces the waste hierarchy and mandates the separate collection of different materials to promote recycling and recovery. In this regard, in many EU countries, different materials are segregated into well-defined waste streams, such as packaging waste, plastic bottles and glass (Pires *et al*. 2011). The duty to manage these waste streams lies with different authorities based on local regulations.

In addition, since the 1990s, significant attention has been given to increasing the responsibility of waste producers (Cahill *et al*. 2011; Calliafas *et al*. 2012). In this context, for example the UK launched its producer responsibility regimes that derived from four separate EU Directives covering waste packaging, batteries, waste electrical and electronic equipment (WEEE) and end of life vehicles (ELVs) (see Environmental Agency home page). These instruments obligate the producers to

separate the waste they generate at source, and impose full responsibility to manage packaging materials, and handling waste electrical and electronic equipment. Such measures are designed mainly to decrease the financial burden on local authorities (Khetriwal *et al*. 2011) and to encourage the producers to reduce the waste they generate, albeit the targets are set in terms of waste diversion (Deutz, 2009).

Table 2-1: The main directives regulating solid waste and its aims in EU

	Directive	Aim
Reduction/ recovery directives	Waste Directive, 1975 (75/442/EEC)	To set out controls for waste to prevent or reduce waste production and its harmful effects
	Directive 99/31/EEC- Landfill	To prevent or reduce negative impacts of landfilling on the environment and health risks
	Directive 94/62/EEC- Packaging and packaging waste	To extende the Producer Responsibility principle
	WDF, 2008/98/EC	To set basic waste management principles, to extend the Producer Responsibility principle, and introduce the polluter pays principle
	DIRECTIVE 2002/96/EC- WEEE	To extended Producer Responsibility principle
	Directive EEC/259/93 and 94/721/EEC- Waste transport	To regulate imports and exports of waste inside and outside the EU reduce conflict between Extended Producer Liability and the Waste
Pollution control	Directive 99/31/EEC- Landfill	To reduce the potential environmental impact of pollution
	Directive 89/369/EEC and 89/429/EEC- Incineration	To reduce pollution of air, water, soil and damage to human health by incineration
	Directive 94/31/EEC- Hazardous waste	To include of hazardous wastes within the scope of waste management strategies and plans

Source: Adapted by the author

The EU established a number of support institutions, such as Eurostat, EIONET, and ReportNet in order to deliver necessary and adequate information to members

through networks that process and publish statistical information, indicators and other relevant information used for future planning (EIONET; Eurostat; ReportNet) home page.

2.2.2 Disparities in the transposing of the EU Waste Framework Directive

As is well known, EU-level waste regulations have to be transposed into national laws and implemented by individual member states. In spite of the improvement in the EU as a whole over the last decade, there are significant variations between EU countries in compliance with EU waste Directives (Skovgaard *et al*. 2008). In particular, while the Landfill Directive (LD) has clearly been a driver for closing landfills and increasing alternative waste management technologies, there are clear differences between countries (Skovgaard *et al*. 2008). For example in 2010 Germany and the Netherlands recycled 62 and 61 per cent of their waste, and 25 and 33 per cent of their waste was incinerated, respectively. Conversely, other countries still rely on landfill. For example Greece, Cyprus, Malta and Poland dispose around 80 per cent, and Italy, UK and Spain around 50 per cent of their waste to landfill (Skovgaard *et al*. 2008). These northern Mediterranean countries, such as Greece, have the lowest recycling rates compared with the other countries. However, there has been an improvement in MSWM systems in Mediterranean countries. For example in Italy and Greece, the percentage of materials recycled increased to about 33% and 15% respectively between 1995 and 2005 (Skovgaard *et al.* 2008).

Many EU member states have changed their policy and institutional context, building their strategy on other treatment technologies rather than landfill, facilitated by new institutional powers and responsibilities. As a good example, Davoudi (2000; 2006) and Bulkeley *et al* (2007) explain the UK experience in this context, and how the local regions reshaped their institutional relationships based on their local capacities. In this regard, at country level, new institutional, legal and financial structures were developed as a new government technology to improve performance of local councils (Bulkeley *et al*. 2007). Local councils have had the option to choose the technologies for SWM and build its institutions according to how they plan to manage their waste (Davoudi, 2000).

Efforts made across the EU reflect the fact that countries were under pressure from the EU waste policy, and were required to implement these specific policies within a given time. Some countries have derogation periods and still need especially to reduce landfill of biodegradable municipal waste substantially in order to meet the target (EEA, 2010). According to Lasaridi (2009) Greece was unable to fulfil many of the requirements to improve its SWM system, for example, training for local staff, involving all stakeholders and raising public awareness. Some countries face special challenges in the area of waste (EEA, 2010). The EEA summarises the reasons for non-compliance as follows:

- Insufficient coverage of the population by waste collection services remains one of the most important waste problems, especially in rural areas;
- Some fractions within municipal waste need more attention because they pose a threat to the environment, such as pharmaceutical and medical waste;
- Low opportunities of recycling and recovery of non-hazardous construction and demolition waste.

The difficulties identified by the EEA (2010) reflect the costs of both environmentally sound waste disposal and waste recovery technologies, which are disproportionately problematic for lower income EU countries, compared to their wealthier counterparts (Mazzanti *et al*. 2009; De Tilly, 2004). In addition, in some cases national governments do not appear to have the authority to enforce the implementation of policies at the local scale, in the absence of a shared commitment to those policies from relevant local authorities (Mazzanti and Zoboli, 2008).

Notwithstanding the strong policy drive to waste recovery at the EU scale, there are significant variations in the success of policy implementation among member states. These variations reflect economic and social variations within the EU, with southern and eastern members typically lagging behind northern and western member states in waste recovery rates and other relevant measures.

2.3 Trends in solid waste strategies and outcomes in developing countries

Developing countries are categorised as consumers of technology originating elsewhere; economically they are classified as low and middle-income (World Bank,

2008). The common features of developing countries are high population growth, imperfect markets and incomplete information (UNDP, 2010; 2011). In this section I will highlight the MSWM in developing countries overall in the first part, then I will focus on the Arab countries in the second part.

Developing countries are characterised by low solid waste generation per capita compared with developed countries (Scheinberg *et al*. 2010). However, this is a sign of lower income and therefore lower consumption rather than more advanced waste reduction than developed countries. Developing countries are still struggling to collect solid waste from all city residents. Wilson *et al* (2012) reported that between 30-60% of urban solid waste in developing countries is not collected and less than 50% of the residents are served. A contributing factor is difficulty in servicing collection vehicles (Coffey and Coad, 2010). A wide range of treatment and disposal, technology is applied, from state-of-the-art sanitary landfill to illegal sea, river banks or open air dumping, burning and burying of waste, which are common methods in many cities in these countries (Scheinberg *et al*. 2010; UNDESA, 2010). However, landfill is the common method of final disposal of solid waste used by developing countries (Mosler *et al.* 2006). Guerrero *et al* (2013) present the results of a study of 36 cities across the world discussing factors that affect SWM system performance. They found that the relevant authorities at local level in most of the cities studied disposal of their solid waste in open dumps, where there are no facilities that protect the land, water and air from pollutants released from waste. In terms of financial system, they recorded that in many developing countries there is a low rate of service users who pay collection fees compared with developed countries.

In the African context, there are few countries have been able to establish sustainable municipal SWM (Achankeng, 2004). Responsible authorities in Africa have imported inappropriate strategies and technologies. Imported technologies in the field of solid waste will not successfully solve the problem of MSWM in a sound manner, without increasing capacities, cooperation and coordination among stakeholders including implementing and supervisory bodies with other related relevant authorities (Achankeng, 2004). Over several decades developing countries have received support from international agencies and developed countries to adopt SWM practices that have already succeeded in advanced countries. However, many

of those projects could not support themselves or expand further when the external agencies discontinued their support (Ogawa, 2002). Ogawa (2002) suggested that technical, financial institutional and social factors can all be constraints on improvement solid waste management in developing countries.

In the Arab region, municipal solid waste is increasing in quantity as in other developing countries, as a result of population increase, economic progress and rising standards of living. It comprises a relatively high percentage of organic matter and less of other non-organic materials such as paper, glass, plastics (Abou-Elseoud, 2008; 114). The proportion of organic waste to total waste ranges between 35% in Bahrain and 63% in Jordan (Table 2.2). Organic components represent a source of compost material in some Arab countries, for the improvement of soil properties or for the production of electricity (Cherif *et al*. 2009; Alhumoud, 2005). In this instance, selection of treatment option and technologies is to a high degree dependent on the type and percentage of waste components.

Table 2-2: Municipal solid waste components in some Arab countries

Country	Organic materials %	Paper %	Plastic %	Minerals %	Glass %
Egypt	50-60	10-25	3-12	1.5-7.0	1.0-5.0
Jordan	63.0	11.0	16.8	2.1	2.1
Syria	62.0	4.0	7.0	6.0	4.0
Yemen	55.0	14.0	13.0	2.0	1.5
Saudi	37.0	28.5	5.2	8.3	4.6
Kuwait	50.0	20.0	12.6	2.6	3.3
Qatar	45.0	18.0	15.0	4.0	10.0
Bahrain	35.0	28.0	6.0	12.0	5.0

Source: Abou-Elseoud (2008)

Access to waste collection in the Arab region seems to be high compared with other developing countries. For example; the proportion of people with access to waste collection and street sweeping is 100% in Bahrain Al Sabbagh *et al* (2012), 95% in Tunisia and Jordan, 80% in Syria and 65% in Egypt (Abou-Elseoud, 2008;

117). However, source segregation is rarely practised. The storage system, which is a basic element of the MSWM sector, still relies on one container to handle all types of municipal solid waste components. For example, in Bahrain the service provider delivers a communal container to collect different types of solid waste from clients (Al Sabbagh *et al*. 2012), while in Qatar, service users use plastic bags to handle their waste before it is transferred to a medium-sized container (Al-Maaded *et al.* 2012).

Although the economic level of the majority of the Arab countries is categorised as upper-middle and high income (World Bank, 2008), support to carry out research in the field of environmental protection is very limited. There are very few SWM papers on Arab countries in academic literature (Al Sabbagh *et al.* 2012; Abdrabo, 2008; Henry *et al.* 2006). In terms of final municipal waste treatments and disposal, the practices of MSWM in Arab countries are not very different from each other (Table 2.3). However, landfilling is overwhelmingly the most common waste management practice, because of its practicality, simplicity, effectiveness and economic favourability. According to Abou-Elseoud (2008), countries in the Arab region treat very little of the waste they generate; he estimated that they treat less than 20 % and recycle less than 5%.

Table 2-3: Municipal solid waste practices in some Arab cities

City	Landfilling	Composting	Recycling	Incineration
Tunis	Y	P	P	N
Cairo	Y	P	P	P
Amman	Y	N	P	P
Aleppo	Y	N	P	N
Riyadh	Y	P	P	P
Kuwait	Y	P	P	P
Bahrain	Y	N	P	P
Aden	Y	N	P	N

*Y: Practised, N.: Not Practised, and P: Partially Practised

Source: Al-Yousfi (2004)

Uncontrolled dumping is common in the Arab region (Al-Yousfi, 2004). Based on countries' reports, Al-Yousfi (2004) summarises the main difficulties facing Arab countries in their endeavours to develop and implement sound practices (see Table 2.4). Al-Yousfi (2004) suggests the reasons for such difficulties are basically attributable to weak institutional capacity in these countries to strengthen the economic/financial, political and social aspects.

However, Abou-Elseoud (2008) notes that there is a change in the methods of MSWM disposal used in Arab countries as a result of a considerable increase in costs and opening-up to private operators. In Cairo, for example, the tax collected by the authorities for household waste only covers collection costs. In Beirut the capital city of Lebanon, nowadays, private companies manage some sanitary landfills. Although there have been difficulties, many Arab countries since the mid-1990s have started to improve MSWM system and clean up the main hot spots and are attempting to implement policies for recovery and recycling. For example, large numbers of open dumps were closed in Tunisia, Egypt and Lebanon and replaced by sanitary landfills and composting plants.

Table 2-4: Major difficulties facing MSWM in the Arab region

City / Difficulty	T*	C*	Am*	Al*	R*	K*	B*	Ad
Scarcity & conflict of information	x	x	x	x	x	x		x
Diversity of operating agencies	x	x						
Lack & inefficient equipment	x	x		x				x
Lack of finance		x	x	x				x
Lack of legislation & planning		x	x	x	x	x	x	x
Lack of technical staff & labour	x	x	x	x	x	x	x	x
Lack of training and capacity	x	x	x	x	x	x	x	x
Inefficient management processes	x	x	x	x	x	x	x	x
Lack of public awareness &	x	x	x	x	x	x	x	x

* T: Tunis, C: Cairo, Am: Amman, Al: Aleppo, R: Riyadh, K: Kuwait, B: Bahrain, Ad: Aden

** x: Yes the difficulties exist.

Source:Al-Yousfi (2004)

In general, it is observed that the major barrier to efficient and effective SWM in developing countries is the overlap of institutional bodies responsible for the planning and implementation of MSWM as well as the duplication of efforts (Henry *et al.* 2006; Wilson, 2007; Zarate *et al.* 2008). This of course has direct financial consequences with a high cost involved, for this duplication of efforts means wasting the scarce human, material and technical resources which exist. Moreover, this duplication means a very inefficient use of the scarce resource of the existing management capacity available for MSWM. Moreover, tasks are often divided over several departments, which often leads to conflicts as the MSWM employees have two different «bosses», and to a lack of cost effectiveness, when there is a separation between the municipal cleansing department responsible for implementing solid waste activities, which has no knowledge of its budget, expenditures or accounting, and the city council that manages its budget. Such shortcomings in MSWM systems appear everywhere.

Summary

The literature review illustrates that there is a significant variation in the shaping of MSWM policies and strategies and technologies adoption between developed and developing countries, especially in terms of their commitment to implementation. This is certainly attributable to availability of institutional capacities at local level capable of tracking what is essential. This variability is clear even between EU member states, which are all governed by the same policy framework.

In developing countries, there are many issues that need to be addressed in order to build a sustainable system for SWM sector. However, applying MSWM in a sustainable manner is still subject to the country's ability to embrace these technologies with similar efficiency. In this regard, Libya could learn from such obstacles faced by its neighbours and/or EU countries, especially those least compliant with EU regulations, and could benefit from the lessons from successful projects that adopted appropriate technologies. At the same time, Libya ccoul also benefit from the technological expertise and institutional structures of countries that have achieved a transition to a SWM system designed to promote sustainability. Therefore, in the light of such difficulties in improving service provision, the principle of ESTs is designed to identify solutions that would work locally, through

understanding factors that lead to transfer and adopt of ESTs practices based on local social, economic and political developments.

Section Two

2.4 Emergence and development of Environmentally Sound Technologies (ESTs)

This section will review the concept of ESTs, which is defined by a number of international organisations such as The United Nations Conference on Environment and Development **(**UNCED), International Environmental Technology Centre (IETC) of the United Nations Environmental Protection agency (UNEP). According to scholars and researchers, EST is not based on technical aspects only but decision-makers in SWM authorities should also look at incorporating other aspects such as legal and institutional frameworks and local capacity-building etc. Therefore, the ESTs concept will include these aspects to facilitate distinction from other technologies.

2.4.1 ESTs concept

Historically, the United Nations has taken a leading role in identifying ESTs, both in conceptualising these technologies and organising institutional mechanisms for their transfer (Muchie, 2000). In 1992 the United Nations Earth Summit (UNES), defined ESTs in Agenda 21 Chapter 34; this is the most widely used and broadest definition (Puustjarvi *et al.* 2003). They described ESTs as a total system of technology that includes not only technical aspects and related know-how but also the organizational and managerial procedures.

Agenda 21 defines ESTs in three different ways as shown in Table 2.5. The most sensible way to define ESTs, which corresponds to the objectives of this research is as new technological paradigms or revolutions, promoting sustainable development, due to an opportunity that can be obtained from using and/or replacing sound technology, incorporating old and/or new technologies which are available around the world and in line (integrated) with local factors, which guarantees success as it is compatible with the entire system (UNEP-IETC, 2003). However, the definition of ESTs has been the subject of discussion, and part of the problem is the intrinsic variability of what is to be considered as environmentally appropriate technologies,

such as scale, time, location, duration of use, institutional, and cultural contexts (Muchie, 2000; Puustjarvi *et al.* 2003). ESTs are very difficult therefore to identify, requiring detailed knowledge of both the technology and the setting in which it applies. In this regard, within the United Nations Environmental Programme (UNEP) offices, many activities have been carried out to facilitate understanding of ESTs concept and transferred mechanisms. For example, as in 1996 they published a book used as a guide for decision-makers of developing countries to assess ESTs for municipal solid waste, and in 2009 they carried out pilot projects in India, China and Lesotho for learning lessons on ESTs implementation in the solid waste sector (United Nations Environmental Programme, 2009).

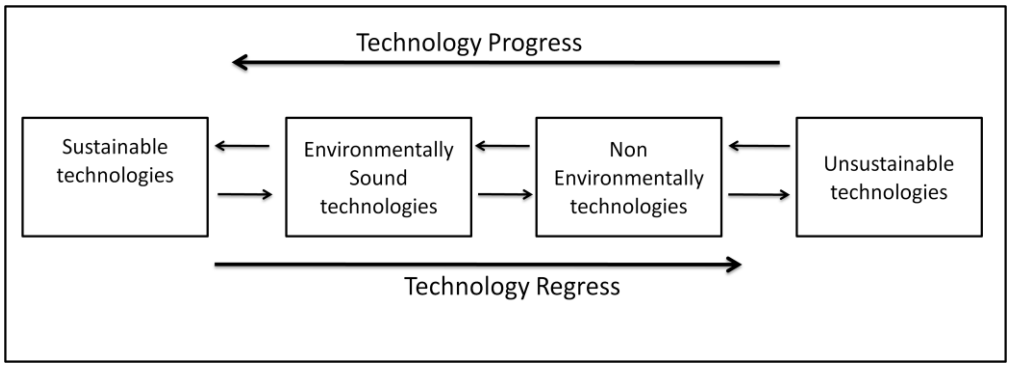
Table 2-5: The three main functional categories of EST

ESTs	Definition
Processes and products technology	Neutralize or reduce harmful effects on the environment without necessarily introducing fundamental changes in the original
Technological systems	Process modifications or changes in the raw materials to eliminate or reduce their negative environmental impacts.
New technological paradigms or revolutions	Novel and/or traditional technologies which are inherently sounder from the environmental point of view than the technologies for which they were

Source: derived from the United Nations Conference on Environment and Development, Agenda 21, Rio De junior (1992)

The definition of ESTs covers the comprehensive concept of production and consumption technologies that are more environmentally sound and sustainable than the technologies for which they are substitutes. Figure 2.2 conceptualises the transition from technologies that are unsustainable to those which are environmentally sound and sustainable. However, in practice this may not be a linear or un-directional practice, as it involves not only a changes of technology, but also fundamental changes in whole system, such as changes in the production, organisation or even changes in social customs and norms (Kemp, 1994).

Figure 2-2: The transition of technology towards sustainability



Source: UNEP (2003)

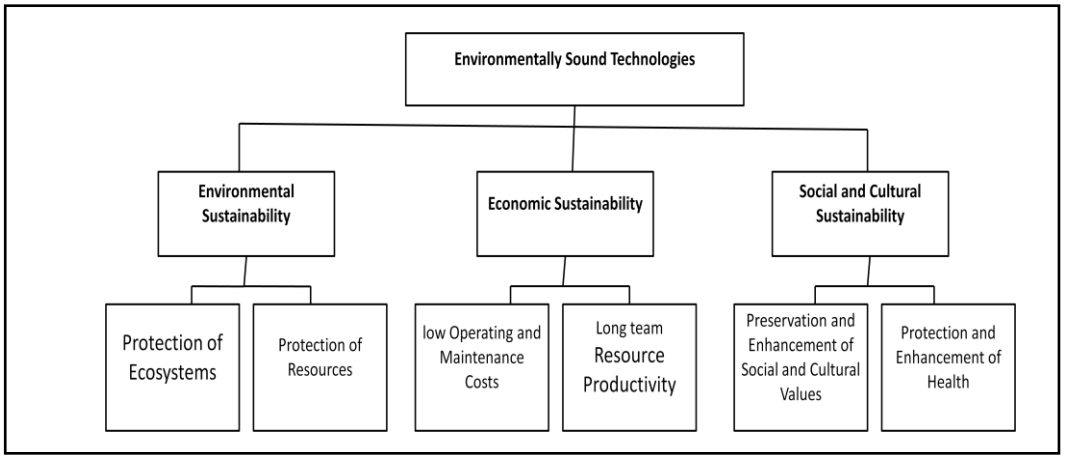
The concept of EST is based on that of environmentally technologies (ETs), but explicitly takes into account the context of technological application, as well as technological considerations ((Puustjarvi *et al.* 2003; Najam *et al.* 2007; Luken and Rompaey, 2008). As with environmental technologies, ESTs cover a range of approaches to environmental protection. In addition, involving of stakeholders including government and community is an essential factor in order for them to work together at the strategic level to build the necessary capacity and technological capabilities to facilitate the realisation of sustainable solutions. Clear policies are needed to encourage and support the adoption and use of ESTs (Luken and Rompaey, 2008).

The principal characteristics of ESTs are economic, social and environmental sustainability (Figure 2.3). Environmental sustainability considers protection of ecosystems and resources. Economic sustainability considers operating and maintenance costs as well as long term productivity. Social and cultural sustainability considers health protection and the preservation of social and cultural values.

EST is a technology adopted with a specific culture at a certain time, taking into consideration environmental values and aspects that have the potential for significantly improved environmental performance relative to other technologies (Van de Klundert and Anschutz, 1999) . Defining a technology as an EST depends on its impacts on the ecosystem, the availability of infrastructure and human resources (Puustjarvi *et al.* 2003). Puustjarvi *et al* (2003) stated that various African

countries, such as Benin, Senegal, Cameroon, Egypt, Nigeria, South Africa, and Zambia, were building composting plants on various scales, but all failed because either the final product was heavily polluted with impurities or there was no demand for the final product. He attributed the cause of the failure to use of equipment whose success depends heavily on the availability of specific factors such as local capacity to separate organic fraction from other materials. Therefore, what is environmentally sound in a certain country or region may not be in another, unless the practice is redesigned or adapted to make it appropriate for addressing local needs.

Figure 2-3: Characteristics of ESTs in relation to sustainability



Source: UNEP (2003:39)

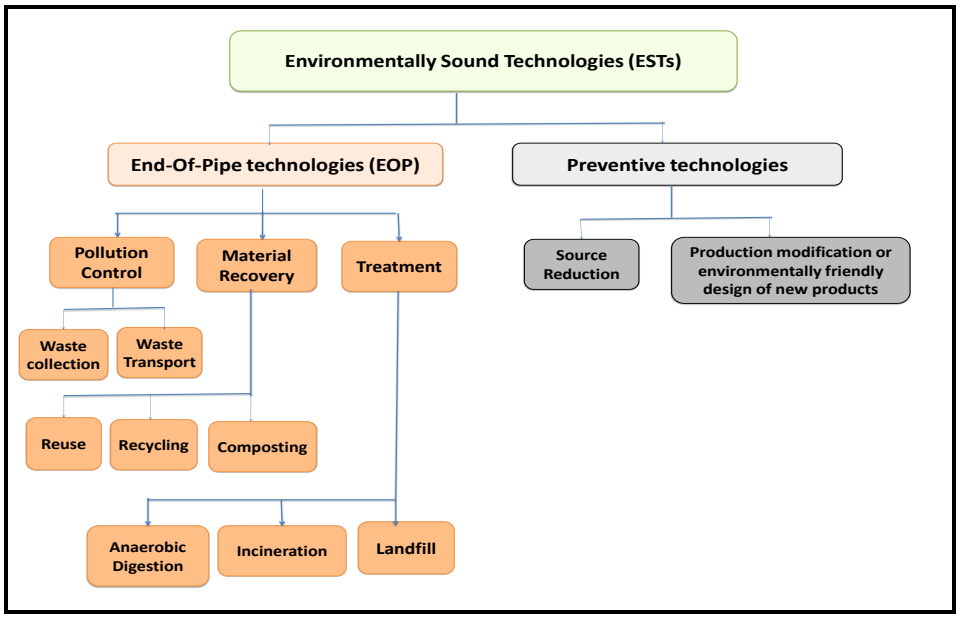
2.4.2 ESTs categories; appropriate ESTs for MSWM

A number of classifications have emerged for ESTs (Luken *et al* 2008; Bezama *et al.* 2007; UNCTAD, 2000, Hammar and L¨ofgren, 2010; UNIDO 2004). However, all the classifications are based on the current state of environmental aspects that determine the basis of appropriate technology selection. The most common one that meets the research objectives divides ESTs into two categories as shown in figure 2.4.

In fact, the application of End-of-Pipe (EOP) technologies throughout the world is closely linked to the attainment of two main objectives, environmental improvement and/or economic benefits (Hellweg *et al*. 2005, Begum *et al*. 2006). To determine the environmental benefits that can be achieved from different municipal solid waste treatment options, which certainly have different installing, operation and

maintenance costs, Hellweg *et al* (2005) acknowledged the use of environmental cost efficiency indicators, they are applied in order to integrate the economic and environmental proportions in adoption of EOP technology, to evaluate the tradeoffs between the environmental and financial advantages and disadvantages and so choose the best treatment technologies (EOP) for municipal solid waste. Hellweg *et al* (2005) ruled out the use of the eco-efficiency concept to determine the economic and environmental dimensions in the EOP technology and argued that it is not an appropriate model for MSWM because firstly usually no financial benefits are expected when applying EOP technology and secondly, the main aim of EOP technology is to reduce environmental impact. Therefore, to determine the efficiency of EOP technology it is necessary to concentrate on environmental costs and benefits. This requires separate financial and environmental assessments.

Figure 2-4: ESTs grouping and diffusion



Source: Derived from UNIDO (2004) and Hellweg et al (2005)

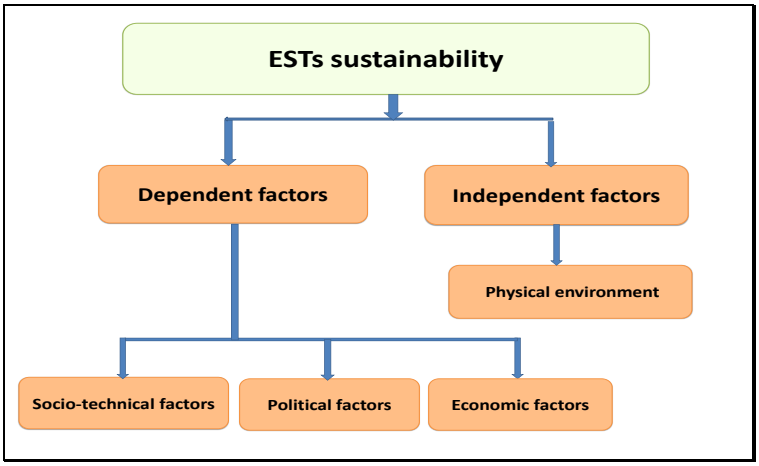
For this research, the researcher is concerned with pollution control, material recovery and treatment technologies, traditionally called EOP technologies. Mainly, this technology is used after the waste generation phase to collect, separate and treatment from the final waste stream and before being released to the environment, through employing physical, chemical or biological means. Although several technologies have emerged in recent decades that have been adopted and deployed in developed countries to minimise and reduce solid waste generation, such as design of

new products, product modification...etc., the end-of-pipe approach, to date, is still an essential technology and it is indispensable for MSWM treatment, especially for developing countries such as Libya, where there is potential for carrying out the first step of the system transition, but the available capacities do not allow adoption of further policies than in the EOP area. Even recently, EU member states faced difficulty in investment in preventive technologies and they are still heavily dependent on waste processing and disposal (Wolsink, 2001).

2.5 How to select an appropriate option of ESTs

There are a range of factors that determine whether or not MSWM activities are sustainable. For example Guerrero *et al* (2013) presented a number of factors that affect the performance of SWM system. When choosing technology procedures there are important elements to consider which are measured based on the capability of a certain technology to fit in a given society in terms of type, scale and adaptability. In this research, the concern is with the factors that affect the adoption of ESTs which are demonstrated to be sustainable in a certain society (Figure 2.5). These factors reflect the particular socio-cultural, economic and political conditions, i.e. dependent variables, of the society. In addition, there are natural factors (regarded as independent variables) that represent a particular location of ESTs adoption. The researcher intends to highlight these factors is an important issue for decision-makers. The objective is to clarify the ESTs prevailing principles in relation to these factors, as they play a supplementary role in the judging process.

Figure 2-5: EST adoption factors



Source: Derived from Al-Thawwad (2008); Dunmade (2002) and Madu (1989)

2.5.1 Socio-cultural, economic and political factors

Each country has different cultural principles, environmental conditions, work ethics, and motivation and rate of capability to contain the elements determining degree of success or failure of technology adoption. Moreover, there are differences amongst countries with regard to public perception and cultural perspectives in selecting and adopting technologies, so that a particular technology may be perceived within one society as environmentally sound, but not in another (UNEP/DTIE/IETC, 1996).

Often, developing countries follow a solely technical approach in selection and adoption of technologies to build their waste management systems (Van de Klundert and Anschutz, 1999). However, this is not a sufficient indicator to address the options of appropriate technology. These many practices of SWM whether in collection, storage, transport or treatment activities in developing countries are known nowadays as unsustainable, because decision-makers concentrate on the technical part and neglect other relevant significant factors such as social, economic, political and environmental issues. Van de Klundert and Anschutz (1999) presented a number of examples of systems that have failed in developing countries for this reason. They recommend that the concerned authorities in waste management must consider additional aspects such as social, political, financial during selection and adoption of technologies, to reach what is called a sustainable system. Many scholars support this recommendations; for example Dunmade (2002) and Madu (1989) stated that each technology transfer, whether it is hardware or know-how or both, from one location to another, often from developed to developing countries, has its own economic and social consequences. Therefore, Wilson *et al* (2004) assert that it is important for developing countries to design certain criteria based on their local conditions (social, and economic factors, as well as environmental requirements) that help SWM decision-makers to identify what are called ESTs.

In terms of sustainability, Van de Klundert and Anschutz (1999) and Shekdar (2009) defined ESTs as technology that can acclimatise with the local conditions where they are operating. They mean by local conditions the socio-cultural, economic and political circumstances of the countries hosting this technology. In fact, social, economic and political factors are numerous and intertwined with each

other. Therefore, for decision-makers, it is complicated to register and take them all into consideration. However, policy makers have to direct available resources where they would yield the maximum return to society. Degree of success, of course depends on to what extent the local and national capacities are available to accommodate these factors as much as possible, to facilitate the adoption process for decision-makers (Luken *et al*. 2008).

2.5.2 Physical environment

The physical environment factor is an important aspect for consideration in selecting and adopting technology to achieve the concept of ESTs (Al-Thawwad, 2008), as successful transfer of technology requires certain physical environmental factors to be taken into account (e.g., topography, weather, climate of the country...etc.). For example, the North African region, where Libya is located, has a semi-arid climate, high temperature with limited annual precipitation and deep water table among other features. Therefore, the physical environment plays an important role in this aspect, and each region or geographic area has its technical requirements and there cannot be a unified solid waste management strategy for all regions or countries. For example, the management of hazardous waste landfills faces different challenges in hyper-dry areas compared to more moist climate zones. The absence of appropriate guidelines has been a challenge for the disposal of hazardous waste in Arab states. In response to this, the Basel Convention Regional Centre for Training and Technology Transfer for Arab States in Egypt produced minimum requirements of environmental impact assessment (BCRC-EGYPT, 2005). This is recognised as a short term solution, made necessary by the lack of available alternatives to landfill for the management of hazardous waste.

2.6 Transfer of ESTs

There has long been a disparity in scientific and technological resources between developed and developing countries. However, sustainable transferring of a proven technology from one location to another can have very disappointing results. The degree of success in technologies transferred from a high developed to a less developed country will depend on its appropriateness; sustainability is proven through its successful application (Rath and Herbert-Copley, 1993).

The review in the following sub-section mainly focuses on external EST transfer as a base to analyse the adoption of SWM technologies in a developing country. Developing countries, such as Libya, are entirely depends entirely on imported technologies in developing projects.

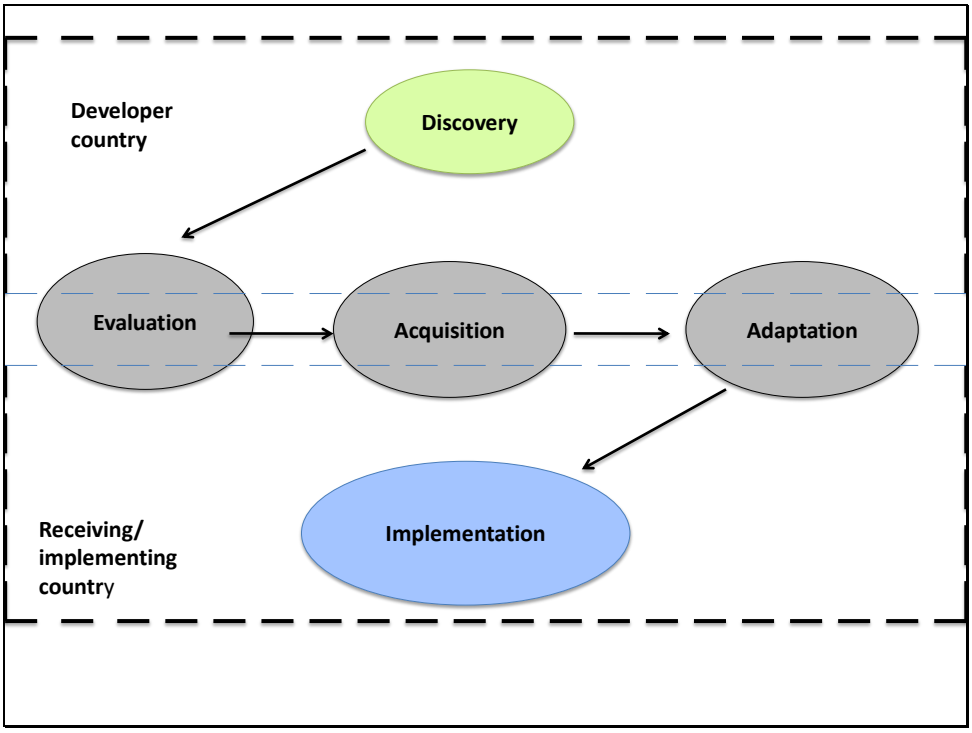
2.6.1 EST transfer mechanism process

Technology transfer can be carried out either between different sectors among one country, or transfer from one country to another. The last one is known as a 'geographical transfer'.

EST geographical transfer as described by Al-Thawwad (2008) is a more difficult transfer process than technology transfer within one country. He attributed the difference to the factors that need to be considered when carrying out EST geographical transfer, such as access to tool usage, local resources, spare parts, raw materials, and markets. Ascertaining the nature of these factors in the receiving country requires identifying a specific technology transfer procedure within local governance of SWM (Bezama *et al*. 2007). Bezama *et al* (2007) explained EST geographical transfer mechanisms as a series of processes to be carried out by both the originating and receiving counties, as shown in figure 2.6. The originating company can being international marketing, once the technology has proven to be reliable. At this time the role of the agent in the receiving country should start. The first phase for the receiver is evaluation, which is an evaluation of technical and economic suitability, though without ignoring local condition of social/cultural, political and environmental parameters.

The second phase is technology acquisition, which is the process of acquiring the rights to use the technology. In this phase, technology acquisition is primarily designed to ensure access to permission to use the technology it also includes the outright purchase of a patent, or know-how, which includes the intellectual property associated with it (Tsai and Wang, 2008). Lastly it is essential to create the required conditions to adopt the selected technology, for example, completion of the infrastructure, carrying out training courses and raising awareness. The degree of availability of such factors influences the rate and effectiveness of technology transfer or if indeed technology transfer occurs at all.

Figure 2-6: EST geographical transfer mechanism



Source: Bezama *et al* (2007: 148)

In many cases, during the technology identification process, particularly in developing countries, the ESTs selection principles can be overlooked. Instead, consideration is limited to the extent to which the technology has proven successful in a third party location, e.g., in a neighbouring country or one with what are considered countries with similar economically and/or politically conditions (UNEP/DTIE/IETC, 1996; Van de Klundert and Anschutz, 1999).

Alternatively, it has been argued that the EST transfer process starts by testing (piloting) the selected technology on a small scale before dissemination at local level (Bezama *et al*. 2007, De Palma, 2002). Application of such mechanisms mainly aims to show the potential of selecting ESTs under the conditions of the degree to which the selected technology and country available resources are integrated. Transfer of ESTs through piloting mechanism could be effective. Conversely, learning lessons from other applications is superficially a simpler, and likely cheaper, process, but requires a difficult calculation of the impact of local circumstances.

2.7 Assessment criteria for ESTs selection for SWM

This section considers the importance of assessment criteria and tools to analyse factors for the selection and adoption of technology at local levels. It will review what is available to help decision-makers and other stakeholders in their judgment and explore the current situation in developing countries in this regard.

2.7.1 ESTs criteria

Suitable criteria are required as a guide to help whoever is responsible for identification and selection of ESTs. Criteria are principles or standards against which something is judged, set on the basis of past experience and expectations (UNEP, 2003). Therefore these must be considered as part of a dynamic process. Van de Klundert and Anschutz (1999) discussed the sustainable approach to waste management through analysing Integrated Solid Waste Management (ISWM) aspects that require development of suitable criteria/indicators for ISWM, either quantitative or qualitative. Some organisations formulate such criteria in order to help officials to select appropriate technologies. For example, UNEP/DTIE/IETC (1996) International Source Book on ESTs for MSWM requests decision makers to follow particular criteria stated in the book, to facilitate selection and evaluation of available alternative technologies. Also, checklists were developed by the UNEP Expert Group, as an initial working template in an effort to define the essential criteria and indicators for identifying and selecting ESTs in different sectors (see Appendix 2.1 and 2.2). It includes key environmental criteria and related indicators; the second checklist includes some important socio-economic criteria and related indicators (UNEP, 2002). The Mediterranean Environmental Technical Assistance Programme (METAP) in 2004 issued a document (see Appendix 2.3) as an aid to Technology Decision-Making for Arabic regions. It includes a technology selection checklist as a group of questions designed to assist waste managers in the region to determine whether a particular technology is appropriate for application to their specific national conditions (METAP, 2004). However, considering that the cultural, social, economic and environmental conditions vary from country to country, some of these questions under certain circumstances may not be relevant, or may require a specific modification.

2.7.2 EST assessment

To ensure successful transfer of EST, public policies should be formulated based on a proper assessment at the national level and MSWM sector specific conditions. National MWSM conditions are often neglected in developing countries' analysis of EST criteria (Van de Klundert and Anschutz, 1999). Van de Klundert and Anschutz, (1999) observed that there had been a tendency to rely on obtaining technological information from the supplier-sales. However, such information mostly relates to the environmental performance, because there is a lack of knowledge of local conditions. Vernon (1989) states that developing countries that have internal capacity to search out and carry out an assessment of foreign technologies are usually able to access suitable technologies on satisfactory terms, whereas countries without that capacity experience the most costly errors in the acquisition of technologies.

There are several tools used to evaluate technologies to be selected, such as Environmental Impact Assessment (EIA), Environmental Risk Assessment (ERA), socioeconomic assessment (SoEA), Life Cycle Assessment (LCA), cost-benefit analysis (CBA) and Environmental Technology Assessment (EnTA) (Hellweg *et al*. 2005; Hay and Noonan, 2002). However, an aim of each applied tool is to achieve specific potential benefits. Following Agenda 21, many countries have focused on the improvement of analytical techniques for the new concept of technology assessment, or what is called 'environmentally sound technology assessments (Juma, 1994). This concept of technology assessment has become part of the administrative procedures in developed countries and some developing countries. For example, Pires *et al* (2011) study of European reveals that there is a variation among countries in applying such these tools, especially between the north and south EU countries.

As a result of a lack of human and financial resources, African countries are often unable to carry out such assessments (Achankeng, 2003). For African countries relying on aid, technology is often tied to aid with a prior agreement between the grantor and the supplier (Vernon, 1989). In this regard, Dunmade (2002) presented many examples of different techniques used in Nigeria, all based on foreign technologies. Dunmade (2002) stated that the success rate in most of the projects is very low. He attributed the failure to the unwillingness of the decision-makers to

perform adequate evaluations of the sustainability of proposed technologies within the local society.

The analysis of available financial resources, economic and social structures and environmental priorities, influences how SWM systems are implemented and what types of technology are appropriate for priority waste streams. Local circumstances also dictate the waste management technology options (METAP, 2004).

The processes of technology identification and selection in the MSWM sector may just focus on solving the health and environmental issues. However, they need to be positioned at the centre of economic and political decision making at the strategic and operational levels to ensure system sustainability. Thus, the decision-makers need to follow up or develop suitable criteria/indicators to integrate such factors, either quantitative or qualitative, to help them to make a suitable choice from alternatives options and to certify its functioning efficiency.

2.8 Benefits and principles of ESTs

There are many expected benefits of ESTs, as they can be applied to MSWM activities ranging from source reduction to final disposal, wherever there could be the greatest yield to society. ESTs advocates claim that they can provide a basis for reaching strategic decisions at the best informed level (Diaz, 2010; Luken *et al*. 2008; Metz *et al*. 2000; UNEP/DTIE/IETC, 1996).

It is expected that the application of ESTs would promote a rational balance of the possible solutions between cost-effectiveness, sustainability and environmentally benefit and social sensitivity to the MSWM problems. This means the perspective on applying ESTs is to realize a set of MWSM goals, by taking into account the requirements of the particular situation where a planned solution is to be implemented. This leads in the end, to determining what constitutes sound practice a specific context. Of course, this depends on the capability to identify and analyse the factors that determine what is an EST and decision makers must ensure that any recommendation should meet the reality of the current situation for the specific geographical site.

In general, application of technology in the MSWM sector at municipality level is mainly for four basic functions. Firstly according to Al-Thawwad (2008) in general, use of technology is mainly to improve the environmental quality at national level to achieve sustainable development. Secondly to alleviate the effects of pollution on human health and ecosystems (Makoni *et al.* 2004). Thirdly to comply or to improve compliance with environmental laws and regulations (Godfrey and Nahman, 2007). Fourthly for compliance with Global Environment requirements (Godfrey and Nahman, 2007; Willems and Baumert, 2003), either to keep pace with market requirements or/and to improve the environment at the global level by kind of local contribution.

Based on the supposed benefits of ESTs, the following principles can be expressed as objectives for applying ESTs in MSWM system:

- Ensuring strategic considerations are compatible with nationally determined socio-economic, cultural and environmental priorities and development goals:
- Ensuring that account is taken of the Level of development, including:
  - Economic development, including financial cost and benefit, cost recovery, labour, and other resources;
  - Technological development (research and development of technology);
  - Human resource development in the municipal solid waste sector specifically and in the society as a whole.
- Ensuring that social and political considerations are engaged:
  - Integrating existing social and cultural practices;
  - To what extent private sector and community could participate in carrying out MSWM activities; and
  - To what extent the political system constrains decision-making, and the character of those constraints.

The fact that inadequate provision of environmental services still exists in a considerable proportion of the world's communities, especially in developing countries, has been widely documented. For example, according to Oosterveer (2009), in Africa, especially in East Africa, there is an increase in the number of people who do not have access to basic public urban services, particularly solid waste collection. He added that, in general, residents in this region do not receive benefits from the official authorities according to their expectations. He attributed

this to the lack of local capacity to develop appropriate technologies compatible with their local conditions.

Summary

The concept of sound practices remains elusive, whether at the level of government authorities responsible for devising, implementing and supervising environmental programme or even in research institutions. The difficulty is compounded by the complexity and interdependence of local factors that reflect the actual social/culture, economic and political status in the receiving country. Moreover, technicians have difficulties in perception of the factors and features that could represent ESTs. This visibly creates difficulties in adopting appropriate technologies that can consider as sound practice. However, clarifying what are ESTs in the field of MSWM is very important in order to create a clear vision for professionals as a base reference for development of future plans and programmes. The ability to identify and recognise what are ESTs is depends on many aspects which should be taken into consideration and which represent selection criteria. Therefore, a basis for the choice of ESTs out of the large number of technologies available basically depends on the extent to which design-makers are capable of answering related specific questions, or following certain assessment criteria. However, without setting a clear definition and understanding of the specific context for local conditions, where the technology is applied, ESTs remain hard to define. It is necessary to focus on institutional aspects to enhance and develop local capacities in order to be able to reform current the system in a sustainable manner. The theoretical discussion in the next section responds to these requirements.

Section Three

This section discusses two issues; aspects of ESTs uptake at local level and the theoretical framework employed in this research.

2.9 Uptake of ESTs at local level

2.9.1 ESTs' characteristics; How ESTs differ from other options

In this sub-section, differences between ESTs and other technologies will be highlighted through displaying the key drivers and particular factors that contribute

to the potential for receiving and diffusion of ESTs within domestic sectors, including the public services sector, based on government regulation, policies and related practices, financing, research and development, host foundation and ESTs application. The information is derived from an UNCTAD (2000) study conducted pursuant to recommendations of the Commission on Sustainable Development for the United Nations in 1998. It draws on a number of previous studies in the United States, France (including the EU framework) and the MERCOSUR countries, and case studies in ten countries representing developed and developing economies, as well as one country with an economy in transition. The study aimed to take stock of the role, scope and relative importance of publicly funded research in the transfer and diffusion of ESTs and development, and explored the feasibility of implementing relevant provisions under Agenda 21. The results of this study have already been used in producing a working paper published by the Organisation for Economic Co-operation and Development (OECD) (Tébar Less and McMillan, 2005).

There seem to be a few areas in which EST transfers differ from technology transfer in general (Table 2.6).. A key observation from the report is that successful adoption of sound practices relies on the existance of suitable environmental regulation and their enforcement. In many developing countries, it is clear that enforcement of environmental laws has been hampered by inadequate staffing and funding (Ogawa, 2002). Nevertheless, as is well known, historically, regulatory pollution controls for MSWM have been the predominant approach in both developed and developing countries over time. In recent decades, EU member states have seen a shift in MSWM governance through adopting a number of policy instruments based on co-operation tools. The most important of these are the Landfill Directive and Packaging Directive, which marked a decisive shift from landfill towards the EU's new waste hierarchy, instead of ‘policing’. This has been due primarily to failure to obtain results that can meet the demands of those concerned. In contrast, according to Henry *et al* (2006) developing countries, especially in Africa, still concentrated heavily on the traditional approach for MSWM of landfill and open dumping. Libya is a case in point. This, of course, is a result of failure in compliance with and enforcement of waste legislations, which causes harmful deterioration in the management of waste.

Table 2-6: Summary of features distinguishing ESTs from other technologies

Aspect	ESTs	Other technologies
Main drivers	Regulation, public policy, multilateral environmental agreements	Market forces: demand, competition, production bottlenecks, etc.
Finance	Public funding is important	Largely private funding, including reinvested earnings, venture capital and sale of stocks.
Location of R&D	Mainly in universities, public R&D institutes and laboratories	Mainly enterprise-based
Mechanisms for transfer	Transfer to private sector; emerging role of public-private sector partnerships (e.g. university-enterprise co-	New structures through inter-firm R&D collaboration as well as partnerships of firms with public R&D
Commercialisation	Increasingly private; many SMEs involved; need for support structures and	Generally, private
Application	Often site-or location-specific applications in certain time	Increasingly global in unspecified time

Source: UNCTAD (2000)

Designing a proper policy and dedication of efforts and commitment backed by political support for their implementation in the receiving country is an important factor in adopting ESTs and bringing about substantial desired changes (Wilson *et al.* 2004). Another is to what extent developing countries are integrated with the global community, and their compliance with international environmental agreements, because some environmental problems cannot be solved through the implementation of domestic regulations, but are governed by international conventions. An example is Greenhouse Gases Emissions (GHE), produced in large quantity by anaerobic decomposition of municipal solid waste in landfill and composting plants. These are estimated to contribute 20% of the total global anthropogenic methane emission (Ahn *et al*. 2002). This, of course, requires a review of the technology used for solid waste treatment and disposal to reduce this ratio through developing and adopting sound practice.

Compared with technology transfer in general, ESTs transfer is more reliant on public funds than on private investment. According to the UNCTAD (2000) a broad range of ESTs are generated from publicly funded research and development activities that could meet the needs of developing countries in terms of global environmental protection. On the other hand they have been increasingly commercialized on the basis of market mechanisms and cost recovery criteria. In terms of MSWM technologies, a further condition is primarily demand, considering it is not subject to profit and loss criteria, but seen on the basis of activities that to a great extent are funded with public subsidy (Evans *et al.* 2009) and mainly aims to protect public health and the environment. However, here the concept is largely restricted by the extent to which such public funding is available for implementing authorities, because many of them face difficulties in providing the necessary facilities to implement their tasks. In this context, many developing countries are largely dependent on government revenues to fund the SWM sector, which is usually not enough to deliver a satisfactory service (Wilson *et al.* 2012). In addition, pressures are exerted from stakeholders to improve the quality of the solid waste management services provided and to reduce the impact on environment. Accordingly, most countries are faced with having to establish what the standards and composition of the improved services should be and how the investment and the ongoing operating costs of these services are to be financed. In this respect, the question of affordability is important at all stages of the policy development and implementation stages and is directly linked with proposed strategy in terms of being legally and financially affordable to the municipality responsible for implementing it (METAP, 2004). Macrae (2012) in this regard highlights the experience of the city of Bali in Malaysia, where the relevant organisations built a new successful SWM system of intermediate scale based on community to replace the large scale system. They overcame their obstacles only when they understood that sound practices could only be adopted if they concentrated on social and cultural factors, rather than on purely technical and economic issues.

Further, ESTs are most often highly localised in these application. That is because countries' physical environments differ widely, as do modes of human interaction with the physical environment (Tonglet *et al.* 2004; Al-Thawwad, 2008). These

modes, in turn, are enmeshed in social customs and culture. This specificity means that to be successful, ESTs must be adapted to suit local environments and cultures.

The time factor is another significant variable, given the evolutionary nature of the concept of sustainable development (Puustjarvi *et al.* 2003). Over the years, there has been a dynamic evolution in the composition and quantity of municipal solid waste. Changes and increase in consumption patterns and technological advances in the packaging of goods and to fulfil other human requirements are constantly changing the parameters for the design of solid waste facilities. For example increasing use of plastics and the use of packaged meals reduce the quantities of food waste in the home but increase packaging materials. These continuing changes present problems in collection, storage and treatment processes that need appropriate technologies to manage. Therefore, the time factor cannot be neglected because a form of technology that was environmentally sound yesterday may not be so today, as the social and cultural values of a given society evolve (UNEP/DTIE/IETC, 1996).

As mentioned above, the information for the ESTs aspects in this section is gathered from the industrial sector. Therefore, in the MSWM sector, the mentioned aspects may not enough to recognise a certain technology as a EST from other technology options. In terms of the mechanisms for the ESTs transfer and funding aspect, analysis of the service users satisfaction factor would help to choose appropriate technology, which in turn they could offer a kind of support and contribution.

2.9.2 Institutional measures to uptake ESTs

To ensure applicability of ESTs in the place to which transfer is contemplated requires the presence of similar factors to those in the practice area. In this context, Bezama *et al* (2007) conducted a study of a technology transfer project to South America countries in the field of SWM and contaminated sites. They clarified that in addition to following the EST transfer mechanism procedure discussed in section 2.6.1 (EST transfer mechanism process), also technical standards analysis should be carried out to ensure successful geographical technology transfer and that the technology is reasonable to adopt at a local level which are:

- **Cost and benefit analysis**

Cost and benefit analysis is a technique designed to evaluate potential outcomes of selected technology, in terms of both environmental protection and overall social welfare. It aims to assist decision makers to choose between alternative solutions in such a way that the chosen alternative is the most cost-effective within the context of budgetary and political considerations. These outcomes might include technology installation and operational costs, maintenance, profitability, value added, etc. (Heinzerling and Ackerman 2002).

(Hellweg *et al* (2005) and Goddard (1995) discuss that without carrying out appropriate economic analyses of the SWM problem, implementing and consulting authorities related to waste management continue to produce incorrect projects and plans for solving the solid waste management problem. Developing countries usually receive technologies without carrying out such economic analysis in advance to ensure successful technology transfer. For example most large composting plants in the Arab region, including those existing in Libya have failed, because of high operating and maintenance cost that the responsible authorities are unable to bear. Therefore, developing countries are required to draw up plans and projects with low costs and high efficiency technologies (Diaz, 2010; Alhumoud, 2005; Goddard, 1995).

- **Analysis of SWM regulations framework**

Weak environmental regulation and enforcement is considered to be one of the main obstacles to successful technology transfer and diffusion. Low environmental standards may perpetuate existing control technologies rather than support innovation. This type of standard-setting can result in regulations focusing on “end-of-pipe” type pollution control technologies, and can create strong disincentives for going beyond the proven standards dictated by existing technologies (TERI, 1997).

Lack of specific laws in developing countries is primarily due to the absence of national strategy and future plans for SWM that set future treatment targets. For example, all EU member states are governed by EU solid waste policy. Therefore, national legal frameworks were built on this basis. It serves as an opportunity to develop and improve the technologies used. The second aspect that characterises developing countries is weak law enforcement (Luken *et al*. 2008). As an example,

although there exists in Libya a body of law to deal with the environment, environmental health, and pollution issues, it is apparent that for many reasons, some related to administrative and legal impasses, these existing environmental laws are not being applied rigorously (Otman and Karlberg, 2007).

According to Tébar Less and McMillan, ineffective regulatory structures to support the phase-out of inappropriate technologies are a common problem for developing countries (Tébar Less and McMillan, 2005). UNCTAD (2000) suggested that for developing countries to overcome the problem and to facilitate EST transfer to their countries, relevant governments might consider exploring the possibility of exempting EST from some of the relevant legal provisions, subject to reaching a common understanding as to what types of technologies could be considered EST for such exemptions.

- **Analysis of SWM institutional arrangement**

In general, technology transfer is a complex process that cannot only be defined in terms of access to technology (the supply side), but needs to be examined in terms of the demand side as well. Although, in many countries great progress was made to facilitate transfer some developing countries continue to face difficulties in accessing foreign ESTs. According to Pap (2000), in developing countries, there is a lack of communication and consensus between SWM institutions. This requires them to work together in order to reaching a common understanding as to what types of technologies could be considered as EST, to be linked with the benefits of economic and political support.

Identification and classification of institutions and other parties related to the SWM and technology transfer activities is a very important step to accomplish integration among them. This allows firstly, setting of a policy that identify EST and distinction from other technologies. Secondly, it increases the level of involvement and promotion of SWM activity. Thirdly, it can improve the financial support system (Bezama *et al*. 2007; Fobil *et al*. 2008).

Infrastructure is another issue that needs to be analysed as one of the institutional arrangements. In this regard, it is observed that not only developing countries suffer from the inability to deliver required infrastructure for environmental sanitation in their societies. For example in the UK, according to Derfa, there will be weakness in

the availability of potential capability to deal with treatment of MSW during the years 2012 / 2013. Therefore, they recommended that relevant authorities take measures to modify their plans in order to support waste management infrastructure delivery (Defra, 2007).

Fobil *et al* (2008) refer to the deterioration in public sanitation services in urban areas of Ghana, particularly in solid waste management, which came as a result of failure of related institutions to build effective policies that can meet the requirements of modern cities. Fobil *et al* (2008) and Makoni *et al* (2004) assert that there are many reasons for the failures of institutions in Africa to play significant rules in developing their countries; they confined them primarily to the effect of two major factors; human and technical. In the next section, these issues and how they affect technology transfer are discussed.

- **Analysis of available human resources**

In the economic literature, the significance of human capital and technology catch-up has long been accepted in the process of technology transfer and diffusion (Benhabib and Spiegel, 1994). However, different countries have different educational conditions, work ethics and inspiration and the capabilities of these change factors have to be considered to successfully transfer technology.

Al-Thawwad (2008) and Dunmade (2002) considered the training of the workforce, research and development, employee attitude and language as critical to the success of technology transfers. They stressed the importance of the availability of local staff to provide services and maintenance in a timely manner, because the accessibility of technical know-how in the community not only has economic benefits but also environmental and social consequences. In addition to the extra costs resulting from hiring foreign experts, there may be health and environmental problems caused by the facility breakdown. This applies to waste management projects, which require repair on an urgent basis so as not to accumulate solid waste and cause health and environment problems.

Several studies in Africa and in third world countries confirm the absence of qualified persons. Therefore, this lack of course eventually leads to failure in building a sustainable SWM system in cities. An example of such lack of qualified staff was observed in a research carried out by METAP (2004), at western and

eastern Mediterranean countries. They found that one of the main reasons that led to inappropriate management of solid waste in municipalities of these countries was that waste management capacities were weak at all levels, Policy, legal and institutional instruments available for achieving waste management objectives were not well understood at the national and sub-national levels. Therefore, they recommend that the public sector, which is a leading sector for SWM, increase training programmes and facilitate access to SWM knowledge, to strengthen the capacity of municipalities.

2.10 Theoretical framework

The institutional capacity concept has been employed in this thesis, to explore the efficiency of ESTs in Tripoli city. In this context, the capacity of organisations that regulates the SWM system and how they interact with each other and with the service users is considered as a basic principle of system transition. There are, however, other theoretical frameworks that could also be used, such as ecological modernisation and good governance. Ecological modernisation for instance, could be used to address both environmental problems and successful practices (Korhonen, 2008) and /or to build a regulatory framework (Deutz, 2009) for environmental improvements, while the concept of good governance could be a useful framework for examining aspects of the waste management system in Libya such as the management from crisis to sustainable growth, as the World Bank did in some developing countries (Bhuiyan, 2010; World Bank, 1989). However, one single study cannot easily accommodate all these theoretical frameworks. So a preference had to be made on institutional capacity to reform the current MSWM system toward sustainability as many advanced countries did. The institutional capacity framework is therefore selected mainly because there is potential to respond to certain demands, such as a need for technology transfer, system partnership, to build upon current system configurations and to govern behaviour. Furthermore, existing studies on solid waste management in developing country cities show that the theory of institutional capacity to build sustainable SWM system has received less attention than the other concepts in the investigation of environmental issues.

2.10.1 Institutional capacity for sustainable transition management

In this section, issues of institutional structures, power to implement their roles and responsibilities, as well as network capacity to build cooperative and coordination relationships, are employed to view institutional capacity in the MSWM sector. Institutions and institutional capacity are commonly referred to in the agency literature. For example, within UNEP, the need to build sound practices within concept of integrated solid waste management is pointed out at different institutional levels (UNEP, 2005), and also when technology is transferred (UNEP/DTIE/IETC. 2003).

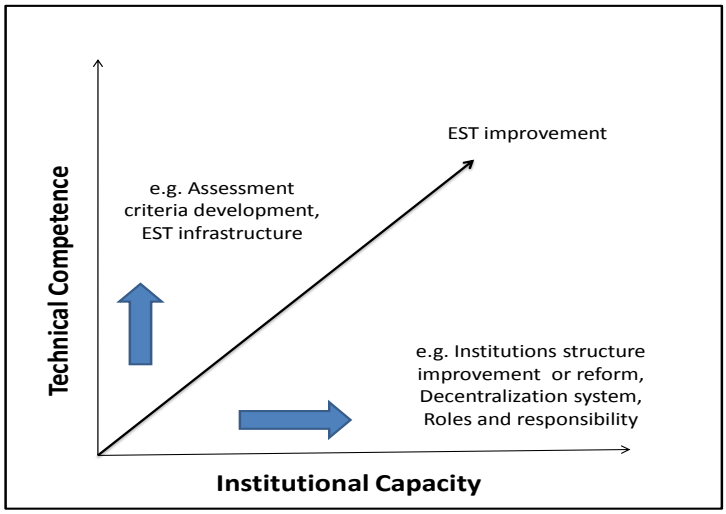
The significance of institutional capacity for provision of public services is identified by several scholars (e.g. Wolsink and De Jong, 2001; Silva-Ochoa, 2009). Building and development of local institutional capacity in terms of exploitation and use of the EST is largely recommended both at individual and national institutional level. For example, according to Zerbock (2003) UN organizations concerned with environmental affairs have introduced several tools in order to help and provide technical support to build institutional frameworks consistent with local conditions.

Institution is a complex concept. Many scholars, for example North (1991; 40) define institutions as "formal rules, informal constraints, norms of behaviour, conventions, and self imposed codes of conduct and their enforcement characteristics". However, DFID (1998) argues that North's definition covers only one side of the total concept. They argue that there is another side of institution besides North's definition, which is more specific and covers the concept of an individual organisation as an individual body within a set of relevant organisations, which has a clear structure, tasks and responsibilities. Such an interpretation of institution concept from two sides is adopted by many scholars. For example, Schubeler *et al* (1996; 30) argue that the institutional aspects of SWM concern "the institutional structures and arrangements as well as the organizational procedures and capacities of responsible institutions". Schubeler *et al* (1996) adopted both sides of the concept of institution, as rules governing the SWM sector, and the organisations that apply these rules. On the other hand, the view of Williamson (1998) is that the two sides of the institution conception represent the `institutional environment', which consists of formal and informal regulations and `governance structures' of an

institutional arrangement, whose function is to deal with a specific situation based on their responsibility. In his governance structures framework, in addition to organisations that play the game and their interaction, he includes the resource allocation and employment as a separate level of institutional structure. Such a level is mainly designed to solve the technical and financial constraints (Ogawa, 2002). In this regard, integrating the technical and financial aspect as a main component of the institutional framework is essential for such a study, because it is necessary to allocate the financial resources to cover the full cost of the technology transfer process and its operation, while, human recourses are crucial as a key for technology selection and adoption.

SWM systems in Libya need the technical competence to be able to tackle current MSWM problems. In order to achieve such an objective, they also need to be careful to make institutional changes that allow the technical improvements to work. Figure 2.7 illustrates ESTs improvement based on institutional capacity and technical competence. Although there are real limits to the extent to which sustainable reform can be advanced on one of the axes in Figure 2.7 without advances on the other, it is an indication that institutional capacity plays a crucial role for improving SWM systems wherever they are established.

Figure 2-7: Institutional Capacity and Technical Competence improvement



Source: Derived from DFID (2003) and Schuetze and Tjallingii (2008)

Institutional capacities in the field of MSWM system in order to promote ESTs are related to the extent to which the system has the ability to employ the following governance strategies;

a) Organisational structure of the institutions responsible for SWM, including the co-ordination and cooperation between MSWM and other relevant sectors (i.e. environmental sector, health sector, urban planning sector).

A variety of actors are involved as stakeholder group (i.e. ministries, environmental authorities, research institutions, public and private sector, NGOs, CBOs ...etc.) for carrying out MSWM system. However, each technology has its specific institutional structure, establishing and adoption of an appropriate structure is therefore recommended to achieve the waste strategies target. In many developing countries, for example, at present it is unclear what the ultimate objectives of MSWM in these countries are: just to get rid of waste or to maximise reduction, reuse and recycling. Capacities of institutions to draft MSWM policies according to their national and local conditions through participation of and co-ordination and co-operation with stakeholders are, however, an important issue to ensure successful implementation of a country's MSWM system (Van de Klundert and Anschutz, 1999). In regard to interactions at both national and local community levels, Zhu *et al* (2008) recommended that it assumed to be two-way and involve both the dissemination and receipt of information in order to raise public awareness and community participation. Inclusions of such interactions within institutions' functional roles are an essential issue to ensure viability and development participatory network

b) Distribution of functions, responsibilities and authority between stakeholders (public and private service providers and service users).

The MSWM often falls under the responsibility of the municipality, system participation and ownership and partnership is widely recommended (e.g., Ahmed and Ali, 2006, Tudor *et al.* 2008; Tukahirwa *et al.* 2013). In this context, if the roles and division of responsibilities of the different institutions and municipalities are not clearly defined and delineated, the sustainability of institutions could be affected. Hence, roles and responsibilities within the system should be clarified by law and widely published throughout the field (Schubeler *et al.* 1996). In this regard, Bushra

(2000); Fahmi and Sutton (2006) and El-Messery *et al* (2009) observe that In Egypt, the national MSWM policy in principle encouraged privatisation and public-private partnerships. They added that the national MSWM strategy has been drafted several times since 1992, because no agreement could be reached on its implementation, resulting in a duplication of effort, time, and money. On the other hand, monopoly of a system by a specific entity can have a future negative impact on the functioning of the system (Smith *et al.* 2005). For example looking at regional MSWM projects implemented in North African and Middle eastern countries in 2004, the emergence of MSWM problems was evidently a result of a lack of cooperation and coordination. Therefore, expectationed improvement will not be realised. Technological regimes require arrangement, cooperation and coordination of network entities, each in its field of specialization and according to its responsibilities.

c) Capacities of institutions for establishing and implementing MSWM policies and regulations.

In terms of establishing strategy for SWM based on a clear policy, many developing countries are facing serious difficulties. For example, based on studies carried out by UNEP (2002) for Mediterranean countries, national plans for SWM have been elaborated in most of the south Mediterranean countries (e.g. Egypt, Tunisia) but, at local level (level of implementation) strategic or prospective approaches are rare or nonexistent. For instance, in most cases in Tunisia, the local authorities rely on the Ministry of Environment for the elaboration of their own strategy.

Antipolis (2000), in his report summarising the legal framework four Arab, and one other Mediterranean, countries, argues that MSWM legislations in these countries remain sketchy, incomplete and vague. Further explanations are not clearly formulated, as in Egypt, or are non-existent as in Syria. On the other hand, even when clear regulations exist, such as in Tunisia, they are rarely enforced (Al-Yousfi, 2004). Such a failure in legal framework has implications on building long and short term strategies. Diaz (2010) and Ali (2010) in this regard claimed that the developing countries often received technologies that did not meet their needs. They attributed failure of developing countries to build modernised systems not directly to technical

or economic factors, but rather to their policy-makers' tendency to adopt technologies from developed countries without deep observation of local conditions. In this context, for example, it is observed that the vehicles used to transfer waste to the next destination are usually inappropriate in design because they are not matched with either the waste to be transferred or human resources to be maintained (Shekdar, 2009).

d) Capacities of institutions to develop a sustainable financial system on the basis of a variety of sources, which is cost-effective and affordable.

Many writers have cited the importance of funding and lack of it for SWM authorities in developing countries (Ogawa, 2002; Lohse, 2003; Parrot *et al.* 2009; Bhuiyan, 2010). According to Lohse (2003) there is a mismatch between what is available to SWM authorities from different funding resources and their expenditure needs. He added, failure to finance SWM authorities is increasing with time passing and as a consequence of increase in urban population and rise of infrastructure demand. Kang and Schoenung (2005) corroborate this observation observing that during the past three decades, there have been changes in waste production, such as electrical and electronic equipment, which need new waste technologies to address them..

In addition, Guerrero *et al* (2013) and Alhumoud (2005) describe the operation of SWM systems in developing countries as ineffective. A lack of financial resourceshave caused technologies to lose their efficiency. Scheinberg *et al* (2010) described the SWM systems in developing countries, Africa in particular, as prone to breakdown due to weakness in institutional capacity to provide basic requirements, such as stable administrative and financial systems. A study carried out under METAP and the World Bank in the Arab region (North Africa and Middle East) revealed that there is a gap between available financial resources and needs. They estimated the necessary investments for these countries to convert the raw dumping sites of their largest cities into sanitary landfills and to collect waste from75% of their population by 2010 and found these countries spend only approximately ten percent of what is being proposed annually.

The capacity of institutions is determined by the extent to which they can realize the objective for which they were created (Healey, 1998; Healey *et al.* 2003; Wolsink

and De Jong, 2001). For MSWM, institutions are created to provide MSWM services and through which waste management performance standards and environmental regulations can be effectively implemented. While these are necessary to ensure high quality waste management services at reasonable cost, they depend for their effectiveness on appropriate institutional structures through which to apply them. For example; the success or failure of applying an incineration plant mainly depends on a presence of a certain institutional framework, such as institutions to enforce environmental legislation and the support of multiple stakeholders (Rand *et al.* 2000; UNEP/DTIE/IETC, 1996).

The decision-making process with respect to MSWM generally takes place in a complex institutional environment, with a large number of public and private actors, each of which has its own interest and responsibilities (Zhu *et al*. 2008). Some of these actors, like the national, state or provincial governmental bodies, are in a relatively distant position from the actual projects or measures taken. Yet, they are influential via general or waste-specific legislation and overall planning procedures and policies. These parties play more or less specific roles within the formal policy-making and development process in respect of waste management. This in the end, will have some effect upon the type of technology used.

Healey (1998) pointed out the importance of networking capacity amongst stakeholders to make a system of organisations efficient in fulfilling its tasks. Building such a relationship from inside and outside the regional actors is an important issue to introduce ESTs in SWM system (Schuetze and Tjallingii, 2008). Each EST has a specific institutional framework based on the nature and scale of the project. It is therefore necessary to identify relevant stakeholders to distinguish the rules and roles of each party (Williamson, 1998). The capability to establish a network or co-operate between related organisations requires, however, specific skills from those organisations, and consistent procedures. In this case, as well as requiring cooperation between different central government organisations, regional waste management and municipalities, there is also a need to encourage the waste partners (stakeholders): private sector, NGOs and CBOs. Obeng *et al* (2009) observed that the participation of private sector firms in waste management systems introduces new responsibilities and relationships into traditional institutional

structures. Introducing NGOs and CBOs in MSWM activities has two advantages. On the one hand, it reduces the burden on government institutions and on the other, it gives them the opportunity to establish an effective policy and regulation framework and follow-up its implementation.

Employment of the institutional capacity concepts in this study will allow the researcher first to draw on experiences in transition of EU member states and elsewhere, especially those that have not adopted the Waste Framework Directive due to local circumstances. Second there are weaknesses in institutional capacity to improve waste management experienced by developing countries, particularly Arab States. This deserves study to ensure system transition in a sustainable manner.

Summary

Although difficulties with the implementation of the EST principles have been identified, there is currently a lack of an alternative framework within which to consider how to make SWM more sustainable in a developing country context. One problem with EST is that whilst it takes social, economic and political context into account, it does not critique that context. Sustainability is an evolving concept and technology is rapidly moving, whereas EST is a static concept. What is needed is a degree of organisational and technological capacity that can adapt to change. In this study institutional capacity is introduced as a concept that may offer advantages.

This study is building a bridge between the practitioner-international approach to sustainable SWM and theoretical perspectives developed in the academic literature. The theoretical framework is therefore employed to provide a detailed examination of the institutional structure and capacity for change within Tripoli, and significantly considers the views of service users as well as service providers.

CHAPTER THREE: BACKGROUND INFORMATION AND KEY ENVIRONMENTAL ISSUES IN LIBYA

3 Introduction

This chapter profiles Libya and its municipal solid waste management system. The aim of including this profile is to provide basic information on the country, review the key features of the context of the study and to identify the key factors that influence the sustainability of the solid waste management system in Libya. The chapter is in two main parts; the first part includes five sections describing the broader geographic, social (including population and urbanisation), economic, and political and administrative context. Then the next two sections provide an overview of the key environmental issues in Libya and a benchmarking of Libya's environmental performance.

3.1 The Geographical Characteristics

Libya is centrally located on the North African coast, between latitude (18-33) North and longitude (9-25) East. It overlooks the Mediterranean Sea on the north with a coast line 1900 km long. Some European countries are close to its coasts in some places, at a distance of 350 km (Figure 3.1). With a total land area of approximately 1,775,500 sq km (685,524 sq miles), Libya occupies third place in Africa and Arab countries after Sudan and Algeria. Over 90 percent of the land is desert or semi-desert, consisting of sandy areas and two areas of hills and mountains rising to a maximum of 650 metre above sea level.

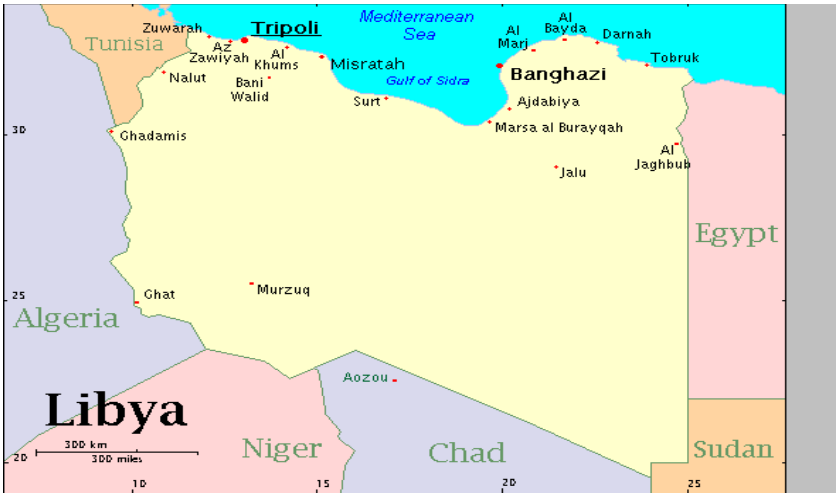
Libya is mainly characterised according to the Secretariat of the United Nations Convention to Combat Desertification (UNCCD, 2001; 15-20) by hot dry lands, high and extreme temperature, low and variable rainfall, desertification, drought and scarcity of water, and sand or dust-storms.

Rains fall on northern places in winter due to adverse winds and twisters. Deficiency in rainfall is reflected in an absence of permanent rivers or streams, and the approximately twenty perennial lakes are brackish or salty.

In Libya, groundwater represents the main source of water supply for drinking, industrial activities or even in the agricultural sector. It contributes more than 97% of the total water supply used for the different activities. Users of groundwater extract their

supply through wells ranging from a few metres to more than 1000 m in depth (Salem, 2002). Some groundwater aquifers located in the northern zones are renewable as they are in area with high precipitation rates, whereas others are non-renewable.

Figure 3-1: Political Boundaries of the Libya as well as the location of a number of major Libyan cities



The geographical character of Libya, for example, its low precipitation rate, hot weather particularly in summer, deep groundwater, and sandy desert, these factors may have effect on the selection and adoption of SWM technologies. Furthermore, consideration should be given to the variation between the regions, especially between north and south. Decision-makers in establishing SWM technologies have to take account of such elements in selection and adoption of criteria for ESTs.

3.2 The Social Characterises

The cultural and social structure in Libya has been influenced by the system of government, economically and politically. Libya's Human Development Index was categorised as one of high human development of 0.775 in 2010, which gives the country a ranking of 53rd out of 169 countries. In the 2008 classification, its Human Poverty Index was 13.6 %, giving Libya a ranking of 60th among 135 developing countries. The Human National Reports for the last ten years, published for the UNDP, reveal that in Libya there has been steady progress in indicators such as life expectancy, health and reproductive care, water supply, sanitation, and educational attainment (UNDP, 2010; 2011).

For the public health sector, according to the annual statistical report for the Ministry of Public Health and Environment, in 2010, total health expenditure amounted to about 3.5% of GDP, and government expenditure accounted for 81 % of this total. All citizens have free access to a seemingly generous package of health care. However, there are concerns about the quality of services provided, which is prompting many citizens to go to neighbouring countries for specialised treatment, or to use the emerging private sector. The management of the public sector is hampered by the lack of a clear sector strategy, the absence of a proper information system, and a distribution of financial resources which is not based on health needs. The same applies to other sectors.

In terms of education system, it is reported that the enrolment rates in the education system are very high by international standards, in particular in the primary and secondary sectors. Enrolment has also increased rapidly in higher education. However, despite these achievements, the quality of education has been questioned. Investment in the education system does not follow clear policy choices. For example, almost one in four students is enrolled in health studies (Authority for Information and Documentation, 2005). The education system does not seem to deliver the skills necessary for the rapidly growing new sectors of the economy. Therefore, private companies report a lack of specialised skills among Libyan-trained students, prompting them to hire foreign labour (Otman and Karlberg, 2007).

Libya is paying the cost, in terms of society, of not restricting illegal immigration from Arab states and sub-Saharan Africa to live in Libya. Thus, many nationalities have taken the opportunity to settle in Libya, as it is a wealthy country, or given its geographically strategic location, to use it as a stepping point on the way to North Mediterranean countries. Such issues will explored in the next two sub-section when we concentrate on population structure and growth, and level of urbanisation.

3.2.1 The population

In Libya, spatial disparities in population distribution have existed since ancient times and been affected by historical, environmental and political factors. Along the northern coast, the moderate climate, close water table and opportunity for trading with South Mediterranean countries, as Libya connected Africa and Europe, besides eastern and western neighbouring countries, contributed to early settlement in this region. In

contrast, in the middle and south region characterised by the arid and stochastic climate of the Sahara, the population settlements were limited, embodied in small communities.

After oil discovery in 1960s, the population distribution structure in Libya was reformed as a result of socio-economic improvement. Urban developments were promoted, with creation of administrative centres and expansion of modern infrastructure greatly contributing to the process in recent decades. Table 3.1 illustrates the marked increase in population since 1973; the figure is expected to be doubled within the next 25 years (Otman and Karlberg, 2007).

Table 3-1: Increase of Libyan population correspondence the rate of growth

Year	Population (Million)	% of growth
1973	1.3*	4.48*
1984	3,6*	2,52*
1995	4.8*	2.3*
2006	5.6*	1.9*
2010	6,4**	1.2**

Source: * Authority for Information and Documentation (2005)
** (PRB, 2010)

In addition to the population growth factors, population distribution was strongly affected by increases in the number of non-Libyan nationals in the population. According to Otman and Karlberg (2007) precise and detailed data on the number of migrants and refugees in Libya are not available as there is no official registration. Official records of the Authority for Information and Documentation (2005) suggest there are approximately 600 000 to 700 000 legal foreign workers and residents, while the number of legal and illegal migrants is estimated at 1.2 to 1.5 million. Compared to a local population of about 5.5 million, the number of migrants is very significant indeed. Overall, the vast increase of population certainly leads to generation of more solid waste in quantities and qualities that require to be treated in a sound way.

3.2.2 Urbanisation in Libya

Libya is one of the Arab countries marked by the widespread and very swift expansion of cities, with this high level of urbanization bringing about a range of social, economic, and demographic changes. El-Batran (2008) observed that between 1950 and 2000, Libya had the highest rates of urbanisation in the North African countries (from

20% to 88%). The level of urbanisation in Libya is expected to remain the highest in the region (See Table 3.2 and 3.3).

The high level of urbanisation in Libya is attributable to economic, social and country development, which entices foreign multinationals and immigrants, leading to the improvement of lifestyles and income levels. Urbanization in Libya has been fuelled by high fertility rates, substantial rural-urban migration, international labour migration and the concentration of economic activity in urban areas.

Table 3-2: Size and growth of urban population in Arab countries compared with Libya

country	Level of Urbanization (%)	
	2000	2015
Mauritania	57.7	68.6
Morocco	56.1	65.6
Algeria	60.3	68.5
Tunisia	65.5	73.5
Sudan	36.1	48.7
Egypt	45.2	51.2
Libya	87.6	90.3

Source: El-Batran (2008)

Table 3-3: Size and growth of urban population in Libya

Level of Urbanization (%)			Urban Population Estimates & Projections (thousands)		
2000	2015	2030	2000	2015	2030
87.6	90.3	92.0	4,911	6,841	8,465

Source: El-Batran (2008)

In Libya, the number of urban areas is different from one census to another as the socio-economic development changed. Based on Libyan Statistical Service, the number of urban settlements in the country increased from 98 in 1984 to 364 by 2006 (GIA, 2006). In spite of rapid growth of urban settlements in Libya as shown in Table 3.4, most of the settlements are concentrated on the coastline, representing approximately 80% of the total population.

Urbanization introduces society to a new, modern way of life, an improved level of awareness, new skills, and a learning process. However, negative impacts could occur, especially if the urbanisation is uncontrolled and unplanned, which is a dominant

feature in developing countries (Achankeng, 2003), where it has always brought environmental degradation. In Libya, for example, the rate of urbanization is out of control compared with neighbouring countries (Elbendak, 2008). Thus, the government faces challenges to meet residents' requirements. Therefore, in Libyan cities, it is normal to see narrow streets, haphazard urbanisation and uncompleted infrastructure. Such a manner of urbanisation will affect the quantity and quality of services provided, including solid waste management. The quantities of waste generated increase with the growth of urbanisation, and urban centres have become outposts that defy most efforts made by relevant government at local and national level (Achankeng, 2003). Thus, optimizing forces become weakened, institutional capabilities become inadequate and ineffective, and with these, the problems of urbanization are compounded. However, the ability of governments to engage in formulating policy or as an implementation body is the key indicator of system sustainability.

Table 3-4: Libya: Population growth in the ten largest cities, 1984 to 2006

City	Total Population			% of total population in 2006
	1984	1995	2006	
Tripoli	591,062	987,713	1,063,571	21
Benghazi	446,250	500,120	674,951	11
Musrata	121,669	251,377	550,938	10
Al-Zawiya	91,603	152,232	290,637	5
Derna	60,980	68,936	162,857	3
Surt	64,041	123,591	141,495	2
Al-Marj	54,010	93,171	184,531	3
Al-Khums	138,174	229,593	432,202	8
Tubruq	*162,500*	220,926	157,747	3
Al-Bayda	67,120	108,139	206,180	4
Total	1,797,409	2,735,789	3,865,109	70%

Source: Based on GIA (2007)

3.3 The Economic Characteristics

Libya has experienced rapid economic and social developments during the last decades as a result of oil discovery, According to Otman and Karlberg (2007); the Libyan economy depends primarily upon revenues from the oil sector, which constitute practically 95% of export earnings and about 30 per cent of GDP and 90% of total budgetary revenues. Based on the World Bank economic classification, Libya is categorized as a country of upper-middle income; per capita gross national income is $US 7,878; GDP grew by 4.8 % in 2007 (World Bank, 2008). Socio-economically, this

makes Libya one of the better-off countries in the Africa region. The relatively high socio-economic standing of Libya within the region is usually attributed to the oil revenues and the small population, which give Libya one of the highest GDPs per person in Africa and have allowed the Libyan state to provide an extensive level of social security.

According to the General Council for Planning (2000; 34), Libya's economy is classified into six main sectors:

1. Commodity and production sector (agriculture, manufacturing, mining and quarrying, and oil and natural gas).
2. Infrastructure or service sector (construction, electricity, water and gas, transportation, storage, and communications).
3. Production services sector (trade, restaurants and hotels).
4. Social services sector.
5. Public services (public administration, educational services, and health services). The SWM system is viewed as part of the infrastructure service sector.
6. Other services.

In terms of municipal solid waste, as presented in Table 3.5, generation of household solid waste per person in Libya compared with its neighbouring countries is relatively high. A major reason could be related to the affluent society as well as low population compared with Libya's area, and the very few informal recycling initiatives that are supposed to reduce the waste per capita, as a result of limited investment in the sector.

Table 3-5: Waste generation by country

Country	Level of economy	Solid Waste kg/per capita/day
Mauritania	Lower-middle[1]	0.38[2]
Algeria	Upper-middle[1]	0.90(Urban area)[3] 0.60 (rural areas)[3]
Morocco	Lower-middle[1]	0.33[4]
Tunisia	Upper-middle[1]	0.60[4]
Sudan	Lower-middle[1]	0.60[4]
Egypt	Lower-middle[1]	0.63[4]
Libya	Upper-middle[1]	0.78[5]

Source: 1. World Bank (2008) 2. Sidi Mohamed (2010) 3. Guermoud *et al* (2009) 4. Abou-Elseoud (2008) 5. Faras (2000)

3.4 Key Economic Issues

3.4.1 Privatisation in Libya's Economy

According to the Central Bank of Libya (2002; 3), the public sector in Libya has played a dominant economic role since 1973. Social and economic development plans and productive and service activities have been organized and managed by, and have relied heavily on, the public sector. According to the Ministry of Planning (2001; 40), eighty six percent of the total investment in the development plans in Libya between 1975 and 1999 was performed by the public sector. Only ten per cent was implemented by the private sector. However, by 1985, the state reviewed its public policies, mainly towards the industrial sector, as a response to the drop in the oil market in the mid-1980s, the failure of the public sector to meet national goals and the inability of the state to manage and fund. As a consequence, the public sector has undergone a slow process of privatisation since the second half of the 1980s. Many public factories, establishments, state-owned organizations and companies have since been privatized.

In 2003, based on earlier findings, the Libyan government announced a large-scale privatisation programme. In this phase the privatisation was described as a programme of broadening the ownership base through encouraging residents to own the public firms to avoid concentrated ownership (Alfourjani, 2005). The programme aimed to restructure the Libyan economy towards building popular capitalism through spreading share ownership more widely (Alsouia, 2005). In terms of the MSWM sector, participation of the private sector in this field in some Libyan cities began more than two decades ago, following Prime Minister's decree No 1225 in 1990. This experience remained confined to simple and limited activities. In general, private companies' activities are clearly visible in municipalities with a large population and big area and gradually disappear in areas of fewer population and small urban areas.

In general, these attempts to reduce the burden on the public sector and reform towards a decentralized system have failed. According to the Ministry of Planning (2010); most of the privatised industrial companies did not achieve their goals and suffered from low productivity, because creation of private ownership took place before strengthening and liberalisation of market institutions and state intervention in various form remained widespread, such as in structure and price-setting. Nowadays as a

consequence, most of the important public services are still in government hands and managed by public regulations, such as the energy sector, communication, waste and water services.

3.4.2 Labour force and foreign employment

Libya has relatively few human resources and a small labour market, as 32.5 per cent of the whole population are less than 15 years old (GIA, 2006). However, over the past five decades, the Libyan labour market has undergone significant changes. At the time of independence, according to the first Population Census, the total size of the workforce was around 335,000 (Grifa, 2006; 90). In the 1950s and 1960s, more than 70 per cent of the Libyan labour force were employed in agriculture (Glavanis, 1982; 287). The employment and income of the vast majority of the population thus relied heavily on agriculture. However, since the mid-1960s, labour drifted away from the traditional agricultural economy to the oil, administrative, public and private sectors. As a consequence, the public sector has been dominant in the Libyan labour market since the beginning of the 1970s.

The Libyan National Authority for Information and Documentation in 2003 reported that the workforce employed in Libya's economy is around 1.1 million employees; occupation in industry accounts for 31%, services 27%, government 24% and agriculture 18%. Approximately seventy one per cent of the workforce was males, and twenty nine per cent females. In addition, the survey showed that about eighty seven per cent of the total employed workforces were Libyan nationals. However, the survey did not consider the informal workforce. Furthermore, it is also found that around eleven per cent of the total employed workforce in Libya in 2003 was illiterate; about eight per cent had not achieved the basic educational certificate, nearly twenty eight per cent had the basic educational certificate, around fifteen per cent had intermediate certificates from vocational institutions, about thirty per cent had secondary educational certificates, and thirteen per cent had university degrees. Other statistical data obtained from the General Committee of Workforce, Training and Operation (GCWTO) shows that the active workforce in Libya was about 1.3 million in 2004. Faras (2004) estimated that around ten thousand employees were engaged in the SWM sector. The GCWTO report showed that the vast majority of the workforce was concentrated in the public sector.

However, owing to the small size of the national workforce and a lack of skilled workers, the Libyan labour market has depended on foreign workers.

The above points lead to the suggestion that foreign workers are important factors in Libya's economy in general and in the public service sector in specific. Nowadays, foreigners comprise a substantial proportion of the total workforce in Libya's market. The size and characteristics of the foreign workforce vary over time owing to political and economic conditions. For example, according to Ministry of Planning (2010) there were around two million foreign workers in Libya working in different economic sectors.

Libyan economy has recovered, practically, after the United Nations sanctions were lifted in 1999 and with increases in oil prices. In addition, an open door policy has been adopted to reform and reorganize the economy. However, the salary of the national workforce is still controversial (Otman and Karlberg, 2007). The workforce of the public sector whether engaged in production or service activities, are governed by law 15, 1981 whereby employees' monthly salaries are based on their education level and years of experience. In general, the workforce in Libya is ranked into thirteen classes earning from 190 Libyan Dinar for the first class to 477 Libyan Dinar for the lowest rank (Law 15, 1981).

3.5 The political and administrative system

Libya's political system from four decades ago until recently was in theory based on the political philosophy of Gaddafi's Green Book, which adopted state control of the economy and rejected parliamentary democracy and political parties. In reality, Gaddafi personally exercised near-total control over major government decisions. Gaddafi and 12 fellow army officers began a complete overhaul of Libya's political system, society, and economy, under the pretext of transition to better system performance. In 1973, Gaddafi announced the start of a "cultural revolution" in schools, businesses, industries, and public institutions to oversee administration of those organizations in the public interest. On March 2, 1977, Gaddafi convened a General People's Congress (GPC) where he proclaimed the establishment of "people's power," changed the country's name to the Socialist People's Libyan Arab Jamahiriya and theoretically vested primary authority in the GPC.

The GPC is the legislative forum that interacts with the General People's Committee, whose members are secretaries of Libyan ministries. It serves as the intermediary between the masses and the leadership and is composed of the secretariats of some 600 local "basic popular congresses." The GPC secretariat and the cabinet secretaries are appointed by the GPC secretary general and confirmed by the annual GPC congress. These cabinet secretaries are responsible for the routine operation of their ministries, but Gaddafi exercised real authority directly or through manipulation of the peoples and revolutionary committees.

Gaddafi remained the de facto head of state and secretary general of the GPC until 1980, when he gave up his office. Although he held no formal office, Gaddafi continued to exercise power until February 2011, with the assistance of a small group of trusted advisers, including relatives from his home base in the Sirte region, which lies between the traditional commercial and political power centres in Benghazi and Tripoli.

In terms of administrative system, Libyan has seen a number structural reforms since independence in 1951, as the initial federal system was replaced by a unified state in 1963, at which time the country was divided into ten provinces. Following the military coup in 1969 this division was reviewed, with some provinces being abolished and new ones introduced. However, this division was scrapped in 1975 and replaced by a new system in which the country was divided into counties and subcounties to be run by the Local People‘s Committees. In 1993 another new system was introduced in which the country was sub-divided into 13 regions (minatiq) consisting of 340 Basic People Conferences. In 1998 the county system was replaced by a new system of 26 administrative regions overseen by the people; a further six regions were later added (Shernanna and El-Fergani, 2007). Currently public administration is organised by the Basic People‘s Congress as well as People‘s Committees. The People‘s Committees constitute the main channel through which the government provides public services such as licensing different economic activities. The People‘s Committees are monitored by the Basic People‘s Congress which has selected them to execute their decisions (Grifa, 2006; 70).

In spite the relative peace and stability in in Libya over the last two decades, particularly during the period of international sanctions against Libya, which lasted for a decade since 1986, little has been achieved with regard to urban planning and

environmental management. Growth in different areas (economic and social) has been chaotic, while basic infrastructure and services are lacking. Much of this situation may be blamed on the political instability and centralised governance that characterised the country for four decades. Successive governments were often unable to complete their development projects before they were removed from office and this slowed the socio-economic progress of the country.

3.6 Key environmental issues in Libya

In this section, the local environmental problems are generally highlighted, in particular to explore to what extent solid waste represents a problem compared to other environmental issues.

3.6.1 Prioritisation of the environmental issues

As mentioned in section 3.2.2, Libya's coastal zone hosts 80 % of the country's population and most of its industrial and agricultural activity. There are no natural rivers in the area, only valleys (temporary dry rivers), which transport sediment, litter and pollutants from inland to the sea during storms. The 2008 report of the Arab Forum for Environment and Development written by Tolba and Saab under the title 'Arab Environment: Future Challenges', reveals that the major environmental concerns in Libya are water availability and the depletion of underground water as a result of overuse in agricultural and industrial developments, causing salinity and sea-water penetration into the coastal aquifers. The second major issue is desertification as a result of land degradation in arid and semi-arid areas resulting from various factors, including climatic variation and human activities (Tolba, 2008) . Those environmental issues are a feature of the region (North Africa and Arab region) not only in Libya. Moreover, the first national report on the state of the environment in 2002, which presents the main environmental problems in Libya, observed that the main pollutants resulting from human activities in Libya are mainly found in the vicinity of large coastal cities, and concentrated in a limited number of urban/industrial centres along the coast. The main sources of pollution are urban and industrial sewage, in addition to improper solid waste management. Furthermore, the EGA (2002) identified that the key environmental problems are:

1. Limited water availability; insufficient wastewater treatment due to breakdowns in pumping stations and treatment plants; lack of sewage networks in some areas; sea pollution from oil spills as well as land-based sources;
2. Insufficient municipal solid waste management and lack of sanitary landfills; waste is often disposed of in empty plots within town limits, creating health problems;
3. Lack of appropriate control and legal environmental specifications for the industrial sector, especially for the large number of small industries located within urban areas;
4. Heavy dependence on the very low cost of non-renewable energy, thus encouraging its wasteful use.

The National Programme for Environmental Sanitation (NPES, 2005) prioritised of projects for the transformation plan for the years 2006 - 21011 as follows;

1. Integrated solid Waste Management project
2. Control and monitoring of environmental pollution
3. Natural resources protection and control of desertification
4. Environmental awareness and education
5. Improving environmental regulation and strengthening international cooperation
6. National contingency plan
7. Environmental management
8. Integrated Management of coastal areas
9. Energy and renewable energy

From the above, it can be said that the solid waste issue is one of the top priority problems addressed in local and national reports, which means it is an issue that needs to be addressed.

3.6.2 Key solid waste facts

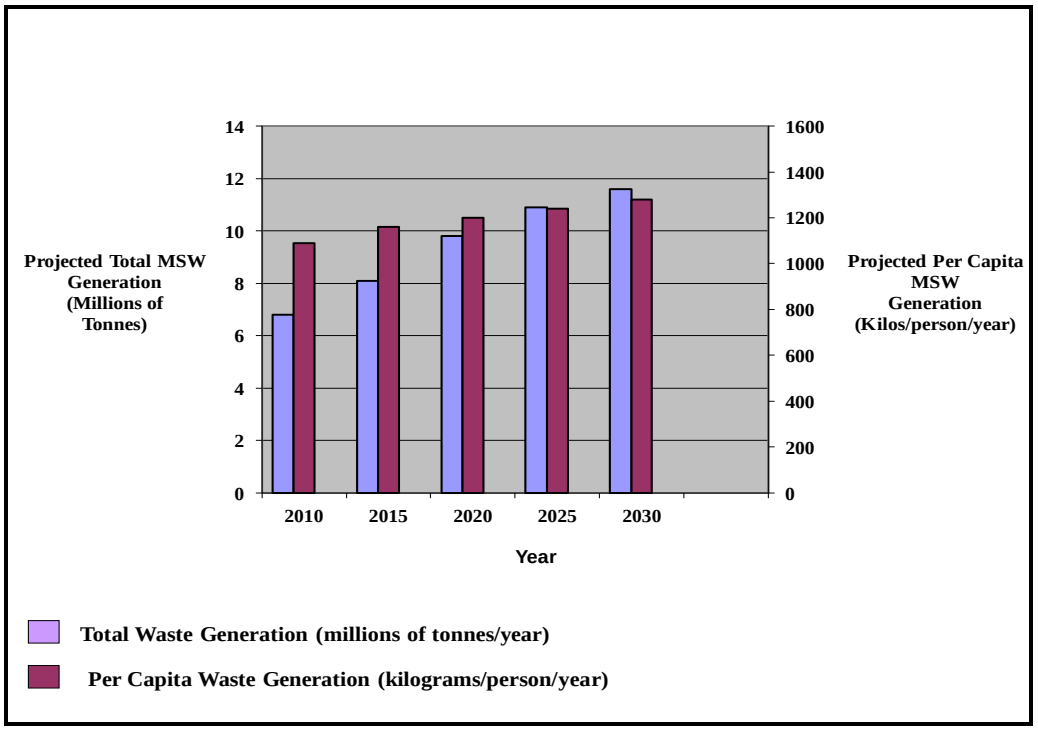
Libya in recent years has faced a significant increase in the magnitude of solid waste management problems for several reasons, such as the rapid growth of population, increase of urbanized areas and changing consumption patterns.

Almabrouk and Fonass (2003) estimated the amount of waste generated per capita as 0.85 kg/person/day. Faras and Al Kario (2004) reported that the weight of solid waste produced by each citizen in Libya ranges between 0.35 kg per day to 2.00 kg per day, with an average of 0.78 kg/person/day. Additional to the household solid wastes, the increase of building activity in the cities has resulted in great volumes of demolition and construction waste (Almabrouk and Fonass, 2003). Absence of plans and control operations contributed to widespread dumpsites, covering extensive areas on the seashore, the sides of roads and open areas. This estimation may not reflect the actual situation on account of inaccurate data recording systems in many final disposal sites. This value might also be inaccurate on account of some waste being collected and burned locally outside the official landfills due to equipment shortage. Although likely to be confined to poorer towns and villages, this is expected to be significant as Libyan has an insufficient solid waste collection coverage ratio.

According to a study carried out by the Ministry of Housing and Public Utility (2009) actions are not taken to influence the amount of waste generated, as shown Figure 3.3; the total amount of municipal solid waste generated is projected to grow by an average of 2.5 percent from 6.64 million tonnes in 2010 to 11.68 million tonnes by 2020. Growth in total waste generation is a function of population growth, economic growth and the extent to which people adopt "consumer" and "disposable" lifestyles. The data presented in Figure 3.2 identify that in the absence of actions to the contrary, the amount of waste generated on a per capita basis will grow over the 2010 - 2030 period from 1.090 kg/person/day to 1.290 kg/person/day.

As in other developing countries, solid waste management (SWM) systems in Libya are characterised by a lack of services and treatment, misuse of resources, and other instances insufficient and inefficient facilities (Abdelnaser *et al*. 2011). The lack of proper MSWM technologies was identified by the NPES (2005) National Programme for Environmental Sanitation, as one of the main environmental issues in Libya. However, Libya was one of the few African countries that attempted to recover value from the organic portion of municipal solid waste. Considerable attention was focused on the composting of municipal solid waste from the 1980s, by installing a number of composting plants in the main cities with sufficient capacity (Table 3.6), in order to reduce the volumes to be disposed in landfill and to provide organic fertiliser.

Figure 3-2: Projected waste generated 2010-2030



Source: Compiled by author based on data from Ministry of Housing and Public Utility (2009)

Table 3-6: Composting plants in Libya

city	Type of technology	Installation year	Capacity Ton/day
Tripoli	Anaerobic digestion	1982	500
	windrow	2003	160
Benghazi	Anaerobic digestion	1980	500
Musrata	windrow	-	170
Al-komous	windrow	-	150
Albida	Anaerobic digestion	-	120
Darrna	Anaerobic digestion	-	120
Total			1720

Source: Derived from Faras (2004) and Ministry of Housing and Public Utility (2009)

Nevertheless, the system of solid waste disposal was recognized by both NPES and most of the national reports of environmental conditions as being a source of water, air and soil pollution (EGA, 2002; NPES, 2005). Table 3.7 records the number of landfills registered around the country, which cover more than two thousand hectares, and accommodate three million tons per year (Ministry of Housing and Public Utility. 2009). None of the existing landfill sites are isolated from the surrounding environment,

usually adopting a simple method of operation, either by drilling trenches and discharging waste with daily sand covering or just covering waste with sand from nearby areas. Otherwise, waste in the most landfill sites is burned, as no operation method is adopted.

Table 3-7: Open and closed transfer stations and landfills in Libya

Transfer station		Landfill	
Still in use	Closed	Still in use	Closed
64	12	116	13

Source: Ministry of Housing and Public Utility (2009)

3.7 Benchmarking Libya's environmental performance

There is very little information on what has been done in Libya to tackle the environmental problems and to promote the concept of sustainability. The previous political regime in Libya isolated the country from the international community for many years. The result is that Libya is not involved in many of the international organisations' and groupings' projects addressed to the Mediterranean and/or North Africa region, which would provide the opportunity to benefit from the expertise and experience of developed countries. For example; in terms of MSWM, Libya did not participate in the World Bank regional project for Mediterranean environmental technical assistance. However, some organisations have attempted to highlight what might happen in the field of environmental protection. The following sub-headings present the available sources that assessed to what extent Libya could achieve environment sustainability. Two indicators were used:

3.7.1 The Millennium Development Goals (MDGs)

Libya has made slight progress towards achieving its Millennium Development Goals targets, as a limited investment is being made in resource recovery and renewable energy sources, while NGO's and CBO's are pursuing eco-tourism ventures and nature conservation activities. However, there is still much to be done in terms of establishing recycling plans, promoting responsible energy management and increasing education on these issues. Nevertheless, the United Nations Development Programme (UNDP) has suggested in 2008 that Libya is likely to achieve most of the MDGs by 2015. Table 3.8 reflects the country's progress on the environmental sustainability goal, in reference to

its three targets and six indicators. Clearly, there was slight improvement in environmental aspects; relevant government institutions are requested to devote efforts to achieve their millennium goal.

Table 3-8: Libyan's progress towards environmental sustainability

Indicator	1990	2004	State of goal achievement	State of supportive environment
Target 9: Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources				
Proportion of land area covered by forests	0.1	0.1	potentially	There is no improvement
Land area protected to maintain biodiversity	0.11	0.12	Potentially	Weak improvement
Carbon dioxide emission per capita	8.72	8.93	-	-
Target 10: Halve by 2015 the proportion of people without sustainable access to safe drinking water				
Proportion of population with sustainable access to an improved water source	71	-	-	-
Target 11: Have achieved by 2020 a significant improvement in the lives of at least 100 million slum dwellers				
Proportion of people with access to safe sanitation	97	97	potentially	There is no improvement

Source: UNDP (2008; 2010)

3.7.2 Environmental Performance index (EPI)

The Environmental Performance Index (EPI) was developed to benchmark the environmental performance of a country relative to other countries. The index has two major environmental objectives: (a) reducing environmental stresses on human health; and (b) promoting ecosystem vitality and sound natural resource management. This index is composed of a combination of 25 performance indicators divided among six well-established policy categories. The higher the score, the higher is the environment performance of the country in achieving environmental sustainability. A review of the trend of the EPI in Libya from 2005-2012, shows that Libya's score decreased from 42.30 in 2005 to 37.68 in 2012, which means performance decreased. Table 3.9 presents the EPI scores and ranks for The Middle East and North Africa (MENA). Libya ranked 123 out of 146 countries in terms of EPI; it occupies the lowest position among MENA countries. The lower EPI score compared to other MENA countries indicates a lower performance in terms of environmental sustainability, and may suggest the country's relatively greater need to address the environmental stresses it faces.

Table 3-9: EPI score and rank for MENA countries

Country	Score	Rank
Egypt	55.18	60
Saudi Arabia	49.97	82
Algeria	48.56	86
Lebanon	47.35	94
Tunisia	46.66	99
Qatar	46.59	100
Sudan	46.0	104
Morocco	45.8	105
Oman	44.0	110
Syria	42.75	113
Jordan	42.11	117
Libya	37.68	123
Kuwait	35.54	126
Yemen	35.46	127

Source: Esty and Levy (2012)

Summary

In this chapter, the main features of Libya were reviewed and the most important factors were highlighted, which could have an effect in one way or another on the selection and adoption of sound practices. In terms of geographical characteristics, Libya covers a large area, ninety percent of which is a desert or semi-desert, and is characterized by high temperature, low precipitation rate and deep water table. In the social characteristics, Libya has a high population and urbanisation rate and the vast majority of the residents live in the coastal area. Service sectors such as education and public health sector are marred by many defects in order to deliver services in a better way. Economically, Libya is classified as having upper-middle income compared with neighbouring countries. The level of privatisation in the Libyan economy is still limited; the public sector has a dominant role in the labour market. In this sense, the labour market in the Libyan context is characterised by low wages and foreign workers.

Finaly, the political syuatem in Libya is in the form of a central government in the form of a central government managed by a few people. Consequently, the social and economic growths have been negatively affected and many deficiencies were recorded.

In the second part, how much SWM is a problem among other environmental problems was determined. From the classification at local level, it is clear that SWM is

ranked one of the top environmental problems that face the country. This means that the authorities agree the SWM is a problem and they are aware of how much is a problem, but it may not have a proper solution based on their social, economic and political circumstances. The waste generation is high compared with neighbouring countries and it is estimated that there will be a continuous increase in the future. In this regard, the government has sought to contain the SWM dilemma, but the official reports suggest that the SWM system is a source of many health and environmental problems.

To know more about the Libyan environmental performance, two indicators were discussed; the MDGs and EPI. In this regard, the UNDP clarified that Libya could achieve some of the MDGs goals if the relevant institutions were dedicated to increasing their efforts. On the other hand, it is observed that the performance of Libyan toward addressing issues of environmental sustainability between 2005-2012 decreased, and it got a low score in the EPI ranks, not only among the MENA countries but also at the global level. This means that overall there is a weakness in addressing the environmental pressures that face the country.

In general, in Libya it is clarified that there are environmental problems led by SWM, and there is a challenge to solve such problems. In this regard, the local geographical, social, economic and political factors outlined have to be taken into consideration to facilitate setting of an appropriate solution.

CHAPTER FOUR: METHODOLOGICAL APPROACH

4 Introduction

This chapter presents in detail the research methods used to address the research questions. The chapter first discusses the justification for adopting of of extensive and intensive research approaches in this study; as well the rationale for combining them. Then, the selected study area and population are explained; after that the data required in the study are identified, and the techniques used to collect the data are presented in terms of their selection, design, reliability, validity, the researcher's positionality and reflexivity; methods of analysing gathered data are also presented. Finally the chapter concludes with the limitations of the research methods used.

4.1 Research Approach

When a researcher decides to conduct a study, one of the first things to think about is the method to be used to answer the research questions and achieve the objectives of the research project. Therefore, the researcher must ensure that his/her choice of research question is an appropriate fit with his/her choice of methodology. In this regard, Sayer (1992) related the type of method to be selected to the type of question to be asked rather than to a predetermined philosophy. He offers a concept of extensive and intensive research as alternative research designs. The researcher was steered by the features of the extensive and intensive research design to carry out the field work in this thesis. The following sections (4.1.1.and 4.1.2) highlight the concept of intensive and extensive research design.

4.1.1 Intensive and extensive research methods

Despite the difference between positivism and interpretivism in terms of their ontology and epistemology, Sayer's (1992) use of an intensive versus extensive classification provides a clear distinction between the two methodological approaches. He believes that each method has its own type of question, techniques, objects and boundaries.

In regards to extensive research, it has often been linked to quantitative methods and analysis (Sayer, 1992; Clifford *et al.* 2010). In this approach, the researcher always looks to answer questions that are addressing what is happening, because

he/she cannot currently describe the circumstances. In this context, Sayer suggests that the researcher should employ research techniques that are capable of collecting data to find common properties and patterns of a population as a whole. In this regard Jeppesen (2005) stated that the extensive research design is appropriate when the researcher would like to establish an overview of, for example, environmental practice located in a certain geographical area. Therefore, he/she has to carry out a questionnaire or interview survey with a large number of people, which helps to provide a description of the social phenomena in order, for example, to make comparisons and generalisations. Carrying out extensive research design therefore requires enough information to be collected on the phenomenon to be studied in order to set in advance the criteria of the sample that represents the study population (Swanborn, 2010).

In this regard, Miller and Brewer (2003) argue that first the researcher should select some variables that explain the phenomenon in broad terms, and secondly establish robust relationships between and/or across these variables. At the end, the aim is to demonstrate that these relationships represente the features of social phenomena. In sociology, it is observed that in many sciences, surveying a large number of people is a strategy to collect empirical data (Bryman, 2004).

By contrast in intensive research, the researcher usually employ flexible and sensitive methods of data collection to explore social phenimena (Grix, 2004). In this type of research design, the researcher is always looking to answer questions that address How and Why this happens (Jeppesen, 2005; 4), as there is a limitation of knowledge for example on the cause and effects of the event, so in general the researcher asks these question in order to obtain in-depth knowledge to understand social phenomena by using one or more data collection technique by qualitative methods (Hay, 2005). By this method the researcher can explore the social phenomena he/she would like to discover within a small or specific group of people who are related to each other structurally or causally (Geertz, 2000). For example when the researcher would like to investigate what is typical of a certain environmental practice, he/she needs therefore, to concentrate on those people who have knowledge of how the practice works or what might have caused a certain

change. The researcher in turn explains the phenomena on through disclosing the links between events, mechanisms and structures.

4.1.2 Intensive and Extensive methods as a mixed method

In addition to the argument for using intensive and extensive research methods in general in social research, as explained above, there is a debate on the feasibility of employing both methods for a single research study. Some writers argued that, as each method has its own specific epistemological and ontology, it is difficult to combine both in one study (Grix, 2004; Tashakkori and Teddlie, 1998; Brannen, 2005). However, in contrast there is another view that supports conducting mixed method research. It can be argued that there is a benefit from the use of mixed methods as the methods are complementary. The combination of intensive and extensive approaches was considered important to this study for two reasons.

I. The researcher's view was built on the vision of Bryman (2004) on employing both qualitative and quantitative methods. He pointed out that the researcher should focus on the methods as tools for data collection rather than on their epistemology and ontology, and also adopt a strategic perspective, considering each research method as capable of being applied in the service of another. In this regard, I use Sayer's features of intensive and extensive methods to explain how the research employed these features in one single study (see Table 4.1).

   From the table, each research design has its own strengths and weaknesses, and is therefore more or less appropriate to different research questions. In this way they should be seen as complementary. In this context therefore, the role of the intensive method is mainly to focus intensively on one or a few cases to study cause and effect in certain situations. For example, to investigate the defects of adopting sound practices in terms of institutional issues, the researcher is therefore looking for a causal group with which to undertake qualitative interview to answer the questions that explain the phenomena. Inevitably, answering the descriptive questions require large samples and extensive studies to describe cause-and-effect relationships that can then be tested in real-world settings, investigate the same way that taxonomic groups-sample behavioural study in SWM are used to looking for the people attitudes.

Table 4-1: Features of intensive and extensive research

Notes	Intensive	Extensive
Research question	How? What? Why? In a Certain practices	How representative is a feature, pattern, or attribute of a population
Relations	Substantial relations of connection (area of work, Co-workers, ...	Formal relations of similarity focus on variables like same living area, common service provider,
Types of groups studied	Causal (observations have causal powers in virtue of their relations with others)	Taxonomic (observations are independent of one another and only connected through having similar attributes)
Type of explanation	Causal explanation through in-depth examination and interpretation of certain objects or events	Representative generalizations are produced from repeated studies or large samples
Typical methods of research	In-depth interview of individual agents, Qualitative analysis	Questionnaires, large scale surveys. Statistical analysis
Philosophy	Method and explanation rely on discovering the connection between events, mechanisms and causal properties	Explanation based upon formal relations of similarity and identification of taxonomic groups
Type of account produced	Explanatory	Descriptive

Source: Adapted from Sayer (1992)

II. The purpose of combining intensive and extensive methods in this research is mainly to achieve the aims of triangulation. In an environmental study, the use of a combination (triangulation) of research methods is common. In support of this idea, Abrahamson (1983) points out that the triangulation approach prevents the research from becoming method-bound. Almost every research method has its advantages and disadvantages, so employing the strengths from one research method to counter limitations in another can improve research designs and strategies.

From the above explanation, it is clear that intensive and extensive research methods in a single study can complement each other to achieve what could not be achieved by using one method alone. Grix (2004) supports this point of view and he advised that there is no objection to researchers who carry out a quantitative research in an in-depth case study applying any other relevant method. He added the condition that, "As long as you are aware of how you are employing a specific method, and what this method is pointing you towards, and how this relates to the ways you employ other methods, there should be no problem" (Grix, 2004; 84).

Despite the criticisms directed to a combination of intensive and extensive methods to investigate a single study, the mixed methods approach is proving to be increasingly popular in social science research.

4.1.3 Methodological research approach

Given the purpose of the study as clarified in Chapter One, the nature of the data required to address the research questions was diverse. Consequently, interviews, a questionnaire survey, fieldwork observation and documentary analysis were all employed as instruments of data collection. Some of these are qualitative techniques while others are quantitative. The methodological approach of data collection in this study is therefore a mixed approach. Another reason for combining two research methods is that both are concerned with the relationship between individual observations, and there is an ability to generalize on the basis of these observations. In this context, the combination of intensive and extensive research designs in this study allows the researcher to assess the generality of the qualitative interview information about social relations in the context of municipal solid waste practices on characteristics found in quantitative data. This in turn allows the researcher to build better links between evidence on social process and causes (on how and why things happen) with evidence about social patterns (on what has happened).

As explained in the above section (section 4.2.3), the mixing of intensive and extensive methods seeks to achieve the logic of triangulation. Denzin (1989; 13) in this regard argues that; "...no single method can ever completely capture all the relevant features of the reality; consequently, sociologists must learn to employ multi methods in the analysis of the same empirical events". In this study, there are a number of advantages of applying a mixture of intensive and extensive research methods: it could reduce bias in sources and methods of data collection, enhance the scope and extent of the study and increase the validity and credibility of the study through enabling crosschecking of the data collected.

The important point that affected the decision to adopt a combination of intensive and extensive research methods in this study is that the researcher in this manner was able to explore the research questions from different perspectives in order to understand the solid waste management practices in Tripoli. In this context, Bryman

(2004) pointed out that both qualitative and quantitative research methods have their own aims in terms of who is the influencing factor in the interpretation of the results. He added that, in the qualitative research method, the researcher's perspective is dominant, while in the quantitative research method, the respondent's perspective leads the path of the study. The combination of intensive and extensive research methods in this study therefore facilitated understanding the principles of environmentally sound technologies related to solid waste management in Tripoli, as different points of view were collected from the stakeholders of the SWM sector, either from service providers or service users.

4.2 Research area

The research was carried out in Tripoli, Libya. The decision to conduct the research in this location was determined by both methodological and practical aspects. The main considerations in choosing the survey site were:

- Tripoli is the capital city of Libya. About 25 percent of the Libyan population is resident in the city. Therefore, it has the greatest of solid waste problems in Libya as a result of population growth and increased urbanisation in recent decades, which combine different socio-economic structures of residents in districts of different infrastructure. These are the three main elements that affect the delivery of MSWM.
- Tripoli city is divided into areas, some of which are privately served and others are served by a public company. Tripoli is the city with the highest number and oldest private SWM companies. Thus, it is an opportunity to analyse their experience in the city.
- Tripoli is a centre for economic and services activities, which are another source of waste generation in addition to households. Therefore, potentially, a wider variety of SWM technologies may be found here than elsewhere in Libya. The availability of an assortment of technologies will help to clarify the actual picture of the current SWM situation in Libya.
- Tripoli is a key location for Ministerial and Environmental bodies, some of whom are part of the study population (sample), such as the Ministry of Housing and Public Utility and Environmental General Authority, thereby giving access to decision makers.

Moreover, as a member of the Environmental General Authority, the researcher knows many decision-makers well and had knowledge of the archives and other sources of data within the public institutions.

An additional advantage was the fact that the researcher was familiar with the physical and socio-economic aspects of the city. This proved very important in dealing with the difficulties which arose in the field work.

4.3 Research population and sample

Since all SWM actors, whether implementing or supervisory (operational, regulatory and advisory bodies) and residents in Tripoli are involved in some aspect of solid waste management (they serviced or required collection and transport facilities and/or were affected by waste collection and transportation), the whole population of Tripoli city were regarded as the study population for this research. All MSWM actors are located in Tripoli.

For the purpose of conducting the fieldwork, however, key stakeholders in the MSWM sector were identified to include public and private municipal waste service providers and their clients and public institutions whose functions affect MSWM (Table 4.2).

Table 4-2: Key stakeholders in the study

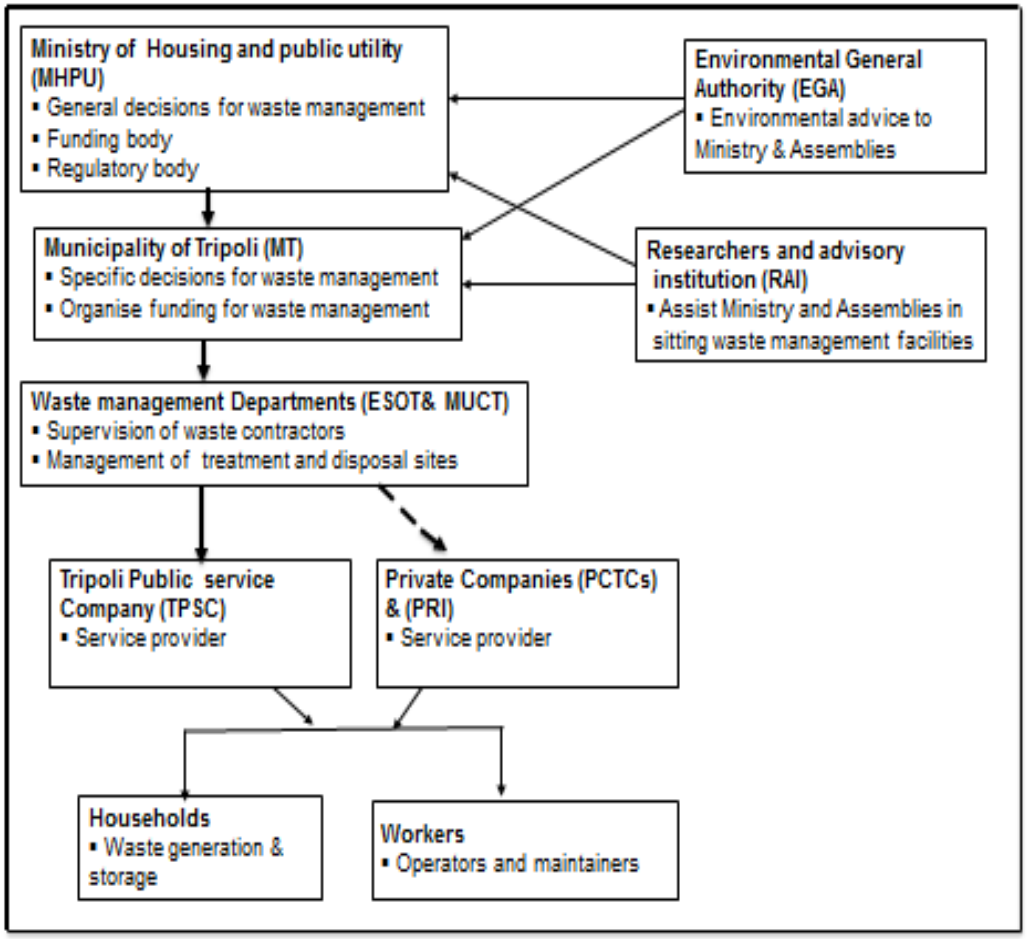
Category of stakeholders	Actual participants selected for study
Municipal Solid Waste management service providers	• Tripoli Public Service Company • Private sector (waste collection service providers companies) • Private sector (waste industry companies)
Public institutions with functions affecting municipal solid waste management	• Ministry of public utility • Municipal Waste Management Departments • Environmental General Authority • Research institutions
Municipal Solid Waste service clients	• Households

4.4 Selection of respondents

From the stakeholder groups identified in the previous section, those who would participate in interviews, fieldwork observation or the questionnaire survey were selected. Figure 4.1 shows the key stakeholders who participated in the study.

A number of sites were selected to visit and conduct fieldwork observation with the assistance of MSWM local authorities. The sites visited include waste storage sites, transfer stations, recycling and composting plants, and final disposal sites.

Figure 4-1: Municipal solid waste management sector stakeholders and their responsibilities



Source: Designed from fieldwork data

4.4.1 National Government

- **Ministry of Housing and Public Utility (MHPU)**

At the national level, the highest authority for solid waste management is the Ministry of Housing and Public Utility **(**MHPU). The MHPU is responsible for all aspects of managing the public services provided by the municipalities, including solid waste management. In order to realize its objectives, a number of administrative offices and operational companies are established in different municipalities. For example, there is a public company for solid waste management

in each municipality; in Tripoli it is the TPSC. MHPU plays a central role by virtue of its administration of local level affairs; its fundamental role is establishing the general policy framework for waste management. These include identifying the key stakeholders for the sector and engage them in SWM, setting out the modalities and mechanisms for awarding contracts and finally setting the standards for the organisation of waste management (The Prime Minister Office, 2007). The department of Pollution Control was the target of an interview. The head of department and other elite working in the offices of this department were interviewed.

- **Environmental General Authority (EGA)**

The Environmental General Authority (EGA) of Libya is a national scientific, regulatory and advisory body concerned with environmental affairs. It was established under the General People's Committee for Health and Environment in 2000. The EGA is an independent autonomous institution which exercises its duties to protect and improve the environment. In general EGA is responsible for the development of environmental policy and management of natural resources in all aspects, as provided in Law No 15 for 2003 (see Table 5.1 in Chapter Five). The Solid Waste Management Office and Environmental Impact Assessment Office were the targets of interviews. A senior official at each department was interviewed.

- **Researchers and advisory bodies**

Information about waste management in developing countries is scarce, especially in Libya due to a lack of studies (Sawalem *et al.* 2009). However, it is important to recognize the potential role of research and advisory bodies in improving SWM in Libya.

In Tripoli, there are a number of research centres and two universities. The researcher identified some of the important research centres and university departments, such as Industrial Research Centre, Biotechnology Research Centre and Al Fatah Engineering College. The managers/researchers in selected research and advisory institutions were interviewed. Two interviews were carried out; the first was with the head of the department of Urban Engineering at Al Fatah Engineering College and the second one with a senior official at the Biotechnology Research Centre.

4.4.2 Local government

- **Municipal waste management departments**

In 2007 a new system of local government was introduced. The country administratively was divided into 22 municipalities; under the previous (Gaddafi regime) these were commonly referred to as Shabiyahat. Depending on their population size, the Shabiyahat are divided into districts (under the Gaddafi regime) commonly referred to as Motamarat Al-Shabia. Tripoli Municipality, like any other, has full authority for providing public services and protecting the environment, including MSWM operations (i.e. Water and waste services). According to the terms of the outgoing laws, the municipality is responsible for "the collection, sorting, processing, removal and burial of waste in specially designated and monitored dumps".

Within the structure of the Tripoli municipality, there are two departments responsible for SWM, the Environmental Sanitation Office/Tripoli (ESOT) which is responsible for evaluating and monitoring the service provided, and the Municipality Utility Control Tripoli (MUCT) which acts as mediator in concluding contracts between MHPU and service provider. Those two departments were involved in interview discussions. Three interviews were carried out with senior officials[1], two in ESOT and the third interview with MUCT.

- **Tripoli Public Service Company (TPSC)**

Based on the applicable national regulation, law No 13 for year 1984, it was necessary to set up a company responsible for MSWM at local level. In this respect, the national government established Tripoli Public Service Company (TPSC) in 2004 and there followed a series of reconfigurations whereby the local government tried to develop a suitable body able to carry out MSWM activities in a sound manner. Based on its establishment decree, TPSC in addition to delivering MSWM services is also assigned the further tasks of management of public gardens and parks, development and beautification of the city, insect and rodent control and management of

[1] The senior officials are; the head office of ESOT, superintending engineer level at ESOT and the head office of MUCT.

cemeteries. The duties of TPSC are to run MSWM activities including operation and supervision of the treatment and final disposal units. The TPSC currently operates, in addition to the collection and transport activities, four transfer stations, two composting plants, one incinerator and two final disposal sites.

TPSC is a big company, with around four thousand staff. Therefore, the researcher decided to interview the elite representatives of policy and decision-makers in different company departments. The interviews conducted included policy and decision-makers from the following departments;

- Department of General Hygiene (cleansing);
- Department of Planning and Development;
- Division of Financial Affairs;
- The company's branch managers;
- Managers of composting plants;
- Moderators of transfer stations;
- Moderators of final disposal.

- **Private Collection and Transportation Companies (PCTCs)**

Predominantly, participation of the private sector in waste management outside of Tripoli is informal. However, the private sector in Tripoli plays a significant role in the MSWM system. Private companies have been engaged in the MSWM sector for more than two decades, since Prime Minister's Decree No 1225 of 1990. In Libya, private companies' activities are clearly visible in municipalities (Shabiyahat) with a large population and big area, like Tripoli city and gradually disappear wherever there are smaller populations and small urban areas. In Tripoli, there were 53 companies working in the field of collection and transportation of municipal waste in Tripoli at the time of the fieldwork (see Appendix 4.9). Due to the large number of private companies in Tripoli, therefore, it was not possible to include all of them, as a result of resource constraints. However, in this study, four of them were involved in interviews. Selection of companies for interview was based on the advice of departments of MT and willingness of potential participants to be interviewed. The interviews were carried out with the companies' owners.

- **Private Recycling Industry (PRI)**

These are companies that produce raw material for other industries by processing a certain fraction of the collected municipal waste. Mainly their role is to purchase or to collect items such as plastic, paper and metal from their different generation sources and/or from landfill. Incidentally, in Libya there is no recycling industry managed by the public sector. Very few waste recovery companies are active in Tripoli city and mostly their activities are limited. It seems that very little PRI is exists in Tripoli, mostly on a small scale, usually concerned with a specific waste fraction. These industries may be classified on a number of features like raw materials, finished product, registered or non-registered etc. However, only four private recycling operators were found by the researcher in the study area. EGA/UNDP report of the year 2010 was helpful to determine these recycling industries. Two of these recycling operators were presented in the report (EGA/UNDP, 2010; 57).While, the other two were found by using Snowball Sample technique (Patton, 1990). There is no formal list of registered recycling operators in Tripoli. Not only are the majority not licensed, they are also distributed irregularly among the city districts, which makes it difficult to determine the actual number and type of recycling companies in Tripoli.

Detailed discussions and semi-structured interviews were conducted with the manager/owner of two companies as a part of data collection. The choice was made based on those that were accessible and willing to be interviewed.

- **MSWM workers**

The sample consists of the workers who were working in SWM in either public or private sector, whether as operators or engaging in maintenance of the system activities, which include waste collection, storage, transportation and treatment. They include, for example, drivers, operators of composting plants and landfill, and technicians.

In Tripoli, many of the workers are immigrants from a neighbouring country, especially those who are working in collection activity and most of them cannot speak Arabic. In addition most of them are reluctant to talk to strangers, particularly during their work. Thus, to interview them directly was difficult. Moreover, these

workers are often casual (seasonal) employees and would not have the precise information required for this research. Therefore, they did not form a significant part of the sample. However, a questionnaire was distributed among them in work places such as composting plants, transfer stations, final disposal sites and service centres.

4.4.3 Service users

- **Households**

One of the objectives of this study was to assess householders' attitudes towards facilities and services provided for residential waste collection and transfer in households of different socio-economic status. This included MSWM practices provided by either public or private companies. The questionnaire was administered in accordance with the division of the city established by the municipality to provide the MSWM service. This means residential areas served by TPSC or PCTCs or both were involved in survey, which covered all city districts. The number of respondents in each area was based on population density settled in designated residential living areas as recorded in the census for the year 2006 (GIA, 2006). Once the residential living areas to be surveyed had been chosen, and the number of questionnaires to be administered in each living area had been determined, the next stage was to select the participating households in each area (Table 4.3). In the absence of a sample frame for households in the residential areas and bearing in mind that some households might be unwilling to participate in the survey, a convenient way of selecting the sample was to combine location of the sample (spatial selection of households) and willingness of householders. A total of 187 completed questionnaires were returned and 19 were invalid, giving a response rate of 85%.

Table 4-3: Respondents distribution by residential districts

	Frequency	Percent
City centre & Hayy al Andalus	56	30.0
Alhadapa & Abu Salem	56	30.0
Sug Aljumah	58	31.0
Tajora	17	9.0
Total	187	100.0

Source: Questionnaire survey, Dec-Jan, 2012

4.5 Research data collection

4.5.1 Database summary

Three tools were employed in this research as sources of primary data: interview, questionnaire survey and field observation. A total of 21 interviews, 187 questionnaires from households, 168 questionnaires from merchants and 14 fieldwork observations were conducted in the study area. Sample data collection tools are given in the Appendix section. A summary of the qualitative and quantitative database is presented in Table 4.4.

Table 4-4: Summary of database

Actors	**Key stakeholders**	**Interview**	**Questionnaire survey public sector worker**	**Questionnaire survey households**	**Fieldwork observation**	**Objective**
TPSC	Decision-makers and workers	8	18	-	9	To assess their attitude, to understand the operation, size of establishment, technologies used, processing and linkages with official agencies.
PCTCs and PRI	Company owner and workers	4	6	-	5	To assess their attitude, to understand the operation, size of establishment, technologies used, processing and linkages with official agencies.
MHPU	Key staff	2	-	-	-	To assess their attitude toward MSWM practices, their roles, processing and linkages with official agencies.
MT	Key staff	3	-	-	-	To assess their attitude toward MSWM practices, their roles, processing and linkages with official agencies.
EGA	Key staff	2	-	-	-	To assess their attitude toward MSWM practices, their roles, processing and linkages with official agencies.
Researcher institutions	Researchers	2	-	-	-	To assess their attitude toward MSWM practices, their roles, processing and linkages with official agencies.
Household	Tripoli residents	-	-	187	-	To understand the attitudes toward private and public sectors MSWM practices. their responsibility and contributions toward current practices
Total		21	24	187	14	

Data collection was carried out in two phases. In the first phase, from June to August 2010, the interview of elite and fieldwork observation were accomplished; much secondary date was also gathered. The questionnaire survey and collection of missing secondary data took place in the second round, from December 2011 to January 2012.

4.6 Data collection methods and techniques

Both qualitative and quantitative techniques were employed to collect data in an attempt to take advantage of the strength of each to obtain valuable data in order to increase its quality and validity

4.6.1 Interviews

Interviewing is a common way to collect a useful data from people who have knowledge and experience, especially the practical kinds, through one-to-one verbal interchange between the researcher and interviewee (Hay, 2005). The purpose of interviews in this research was to obtain more detailed information from the specialists and top managerial level relating to existing SWM practices and to investigate barriers and difficulties faced in order to build sound MSWM practices. The interview method was chosen because some respondents may not have time to fill out forms, some of the information needed was very sensitive and complicated and interviews allow the opportunity of raising additional questions in response to answers (Kalton and Moser. 1992).

In this research, the target population were policy-makers and specialists of implementing bodies, regulatory and supervisory, researchers and advisory bodies in Tripoli city. Selection of the target population was based on those who are responsible for technology transfer and adoption of MSWM practices. in general, planning and building a SWM system requires integration of these three relevant stakeholders, whereby the implementation body is responsible for operating and maintenance, while the regulatory and supervisory body is charged with overseeing compliance with environmental regulations, and the research and advisory body represents the foundation upon which the implementation and supervisory bodies rely in the selection and adoption of appropriate technologies.

Interviewees were selected from the following bodies, with the aims indicated:

a) Operational bodies (TPSC, PCTCs and PRI)

Aims:

- To explore the plans and programmes which have been implemented for SWM sustainability.
- To explore the effectiveness and efficiency of the current practices.
- To investigate the role of the private sector, and business involvement in waste management.
- To explore system problems and constraints.

b) Regulatory and supervisory bodies (MHPU, EGA and MT)

Aims:

- To investigate the SWM policy and legal framework adopted in Libya.
- To investigate assessment method and procedures used to evaluate the effectiveness of the SWM system performance.
- To investigate SWM system funding resources.
- To investigate SWM system technical and physical infrastructures.
- To explore criteria for evaluating technology alternatives.
- To investigate cooperation on local, national and international level with other relevant authorities.
- To investigate lessons learned internationally from North Africa, Arab oil economic based countries and EU member states regarding SWM public awareness, policy and legal framework, and institutional structures.

c) Researchers and advisory bodies (Universities and Government Researches)

Aims:

- To find out whether studies have been conducted into sustainable SWM; if so, what the outcomes were.
- To discuss the health and environmental impacts of current SWM.
- To discuss the potential of learning from North Africa and/or Arab oil economic based countries and EU member states' experience.
- To discuss the applied technology facilities and equipment.
- To explore proposed technologies that potentially could be ESTs.

4.6.2 Developing the interview guides

In preparing to conduct the interviews, I was guided by Bryman (2004) suggestions on the use of the interview technique in data collection. These include:

- Establishing interview structure based on the research questions
- Avoiding questions that could have a dual or multi-concept
- Clearly identifying the possible interview themes or subjects
- Determining the possible number and character of participants from a given population
- Deciding the mode of recording the interview (note-taking, tape recording or both)
- Seeking authorisation from respondents to conduct the interview
- Arranging a suitable time and place for the interviews

Based on the objectives set for the study, interview schedules were established for each of category stakeholders (see Table 4.2) which were relevant to their respective roles in municipal solid waste management. For all stakeholders, the interview schedules were semi-structured so as to allow the respondents some latitude to pursue what they considered relevant while making sure that my own questions were adequately answered.

The interview schedule for the implementing body (Tripoli Public Services Co and Private waste companies) was the most detailed and was divided into appropriate sections to deal with the various issues in waste management. The aim was to cover issues relating to the companies contracts, finance and logistics, cooperation and support derived and constraints on their operations. In general the themes which were covered by the questions included current EST employment in the waste sector, learned experience and factors that impact EST adoption (Appendix 4.3). Separate interview schedules were also designed for regulatory and supervisory bodies (Environmental General Authority and National and Local Authority) in the waste sector (Appendix 4.4). A third set of separate interview schedules (Appendix 4.5) was also developed for researchers and advisory bodies (Universities, Municipalities-Advisers and Government Researchers) These schedules were simple but covered

relevant issues relating to their functions and how these influenced adoption of EST in Tripoli city.

4.6.3 Conducting the interviews

Burgress (1984) and Coteerill and Letherby (1994) stressed that there is a need to take proactive measures to identify the elite and interview them. To achieve this demand, adequate preparations were made to maximise the chances for successful interviews. The first step was to compile an inventory of key stakeholders from different bodies (implementing bodies, regulatory and supervisory bodies and researchers and advisory bodies) in order to recognize them and enumerate them. Letters were sent that explained the aim of carrying out this study and to request interviews with them (Appendix 4.1). A copy of the interview schedules was attached to the letter of introduction for each interviewee to let them know the issues to be covered in the interviews and to give them an opportunity to browse the questions and then prepare themselves to answer. Direct contact was made with respondents to select and arrange a date, time and venue for carrying out the interview; also to obtain the respondents' full name and contact number to confirm the proposed appointment. All the information obtained was recorded in two copy slips attached. Each participant kept a copy of the appointment slip and I kept the other copy to keep track of the appointments. In cases where it was not possible to conduct the interview as arranged it could be rescheduled (and there were several of these). The day before each appointment, telephone calls were made to remind the participants of our meeting and to confirm whether they would be able to keep to the appointment.

Throughout the interviews, efforts were made to maximise the data obtained from the respondents. I always began the interviews by introducing myself to the respondents and telling them about my study and how it was an attempt to understand the waste problem with the hope of influencing improvements of waste disposal in the cities. This was helpful in stirring the interest of most respondents and facilitated the successful conduct of the interviews.

My observation was that there was a favourable response by many of the participants. I felt that they had the desire and ambition to improve the current

situation. This was reflected in their agreeing to carry out an interview and to allow it to be recorded, as well as their willingness to cooperate to provide more information at a later date after the interview.

On the other hand, I was aware of my lack of control of the situation and this made it difficult to obtain some of the responses I needed because the respondents during their talk focused on their financial and administrative problems, instead of the answer to the question asked. Therefore, it required re-asking the questions not answered and thus consumed extra time to finish the interview. As far as possible, these interviews were carried out during the first field season, in summer 2010.

4.6.4 Validation of the interview data

It is important for researchers to check their interpretations of interview data with respondents to ensure that people in the field find them credible and feasible. The researcher should give credence to what the interviewees say. However, they must develop and maintain a critical attitude towards respondents' answers. Checking the answers to the interview questions is recommended as an important issue because the interviewees always have their own considerations (Hay, 2005). Even if they tell the truth, often their answers contain contradictions and inconsistencies that need to be recognised and explored.

Thus, in order to ensure the validity of the data obtained from those who were interviewed, certain measures were taken. Firstly, a few days before conducting the interview, specifically at the first meeting with interviewees, a list of interviewees (not including the name of the interviewee, just the name of companies and department) was sent for each interviewee. This was to let the interviewees know who were the participants in this research, especially to let them know if others were working in the same company or in the field. Hence they would to realize that they were not the only sources of information. All the processes of carrying out the interviews were in coordination with the managers of the target organisations. Secondly information gathered by relevant SWM organisations' staff were compared with each other especially those who had to answer a similar interview and/or questions. For example, the responses to the interviews conducted with each of PCTCs were compared with each other, then with information from EGA, MT and

MHPU. Thirdly, to ensure the validity of the information given, a further step was taken to compare the responses obtained from interviewees initially with what the companies' workers and service users said, then with what was gathered from the fieldwork observation data. Finally, according to Miller and Brewer (2003) checks on the validity of interviews can also be achieved by comparing with secondary data sources such as magazines, newspapers, journals and official reports. In this study, thus some of the answers obtained from respondents were compared with secondary data already collected.

4.6.5 Fieldwork Observation

Observation is a useful method for gathering data in order to verify an ongoing process or situation, physical setting and/or activities (Taylor-Powell and Steele, 1996). Field observation can be used as an evaluation tool to assess performance and/or identify specific situations, to help overcome the constraints imposed on relying on data collection from other methods. Hay (2005) stated that observation is a careful watching, monitoring and noting of the events and evidence as it occurs. This approach is mainly used for the purpose of complementing evidence gathered through more structured forms of data collection, and going contextual understanding to construct an in-depth interpretation through direct experience. Observation in this case involved the researcher moving in the components of MSWM, and observing the work mechanisms of these components.

The aim in using this method was firstly to identify the current situation of SWM in Libya and secondly to interpret how regulatory, economic, social, cultural and political contexts influence the adoption of ESTs. In order to do this, site visits were made to SWM activities, such as collection points, transfer stations, composting plants, recycling industry and dumping sites. A format and checklist were developed for standard observation (see Appendix 4.6). It is worth mentioning here that the researcher has experience in this area, and was familiar with these places, having been a member of staff of the Environmental General Authority for more than 15 years.

The data gathered from the field observations were used to compare and/or to support information obtained through interviews, questionnaire survey and documentary analysis.

The basic information sought concerned the following;

- The practices used for solid waste management;
- What technology was used and how it was used;
- The general state of facilities, maintenance, pollution prevention and other servicing infrastructure;
- Health and safety procedures;
- Compliance with environmental standards;
- Efficiency and technical know-how of workers;
- Effectiveness and efficiency of technology.

This research attempts to investigate EST existence and function in the field of SWM in Libya. Direct observation was an effective method for evaluating the SWM process and workers' attitude. In effect, fieldwork observation method in this research included all the four types identified by Miller and Brewer (2003), including participant and unobtrusive observation, both covert and overt. Ethical principles were taken into consideration and assurance given that the information obtained would be used only for the purpose of this research. However, in order to successfully carry out the fieldwork, the researcher presented himself when necessary as an employee of the Environmental General Authority in Libya, in addition to being a PhD student. An official letter was issued from the Environmental General Authority, in Arabic, to assist and support the researcher; it identified the aim of the research and asked To Whom It May Concern to help and co-operate with the researcher.

In the course of the fieldwork observation, the researcher participated in site tours, such as sites of transfer stations, composting plants, recycling and final dump sites. During site tours, many photographs were taken of waste practices and waste facilities, such as collection bins, transfer vehicles, composting facilities, recycling facilities and final disposal. These photographs were used as evidence of practices applied and to further enrich the quantitative and qualitative data gathered.

4.6.6 Questionnaire survey

A questionnaire is a set of written questions, the purpose of which is obtaining information from large numbers of the population**,** for example or to identify the views of respondents about a phenomenon or a particular position (Oppenheim, 1992). As this research attempts to investigate the deployment of ESTs in Libya, in order to build an interpretative framework to assessing the potential to adopt technologies, a questionnaire was used as a method to collect data from service users in the study area. The target population selected for the questionnaire survey was householders resident in Tripoli City.

To explore how the technologies work, questions designed in the questionnaire were focused on support and stimulus provided by SWM responsible bodies, in addition to the obstacles encountered in the development of sound practices. The aim was to facilitate the capture of in-depth knowledge of the respondents and their attitudes and roles, in relation to the current SWM practices.

In order to quantify the knowledge and attitude of participants towards the current SWM system in Tripoli and the potential of EST employment, open and closed questions were used in questionnaire construction. The questionnaire was initially designed in English then translated into Arabic for the benefit of the respondents. To improve the response rate, and to obtain accurate answers, as well to improve the response rate from householders. The target population were approached one-by-one, enabling the researcher to provide explanation to ensure the understanding of questions. Permission to contact workers was requested in advance from facility managers.

Given the timeframe of the research, the views of the service users were sought in the second field season (December 2011). The target population of Tripoli residents was selected based on the following categories:

- Geographical location;
- Public/private service companies.

4.6.7 Developing the questionnaire

The questionnaire for the service users' survey was designed in line with the advice of Oppenheim (1992) who states that there are two types of questionnaire, open and closed questionnaire, and noted that the following have to be determined:

a) Types of questions to be asked,
b) Number of questions to be included in the questionnaire and
c) Features of the question sequence and overall questionnaire layout.

The questionnaires for householders was intended to investigate the attitudes and role of Tripoli residents (Appendix 4.7) towards the performance of current waste practices of storage, collection and transportation; access to information; their perceptions about the overall solid waste situation and how this situation had changed compared with last five years; their responsibility for and contribution to current practices such as paying for waste service, and reusing and/or recycling of some waste components. To achieve these aims, open and closed questions were employed, and simple language was used. Furthermore, the questionnaire structure was divided into appropriate sections to allow for the systematic collection of data from respondents.

The design of the questionnaire survey was based on the results of interviews and fieldwork observations. The researcher deliberately postponed the questionnaire survey to the second phase of fieldwork, in order to identify the main issues from the analysis of interview and fieldwork observation data, then to investigate and explore these issues compared with the literature review. Once these issues were confirmed, they were included in the questionnaire structure.

4.6.8 Reliability and validity of the questionnaire

In order for a questionnaire to be useful, the data it produces must be trustworthy, i.e., we must know that the results are meaningful and informative without necessarily being statistically valid beyond the respondents. It is therefore important to ensure that the research instruments used for data collection are reliable and valid. Reliability is the tendency to obtain the same results if the research instrument is repeated using the same subjects under the same conditions, while validity is the tendency of the research instrument to obtain the data which the researcher needs to answer their questions (Cohen *et al.* 2000). Burns (2000; 450) highlighted the importance in quantitative studies to achieving these two principles of research, and said;

"Quantitative research has a great investment in reliability and validity. If the data is not reliable and valid, if the assessment techniques are not reliable and valid, if the

design features do not create satisfactory internal and external validity, then the research is worthless in scientific eyes."

In this research, to ensure the reliability and validity of the questionnaire, several measures were taken. Firstly great care was taken in designing and writing the questionnaire to connect the questions with the research objectives. Then, the first draft of the questionnaire was reviewed, firstly with some university students (including Libyan students to comment on the Arabic version) conducting similar research and then with the supervisors, who could provide 'expert validation'. All of them gave useful advice for improving the question content, sequence and wording of the instrument. Secondly, to examine whether the instrument as a whole functioned well, the final version of the questionnaire was tested in a pilot study with families of Libyan students in UK who lived in Tripoli in recent years and were familiar with the SWM system in Tripoli. The responses were critically checked with the set objectives in the research, as well as ascertaining whether participants understood the questions and identified weakness in the instrument, by comparing the answers with each other. The responses from the participants in the pilot study showed that the questionnaire was well-designed and easy to understand except for a few minor unclear areas, and it was observed that the issues raised were relevant and adequately addressed the concerns of the study.

Changes and corrections carried out in the design of the questionnaire during these steps improved the quality and made the questionnaire more appropriate to the study conditions.

4.6.9 Sociodemographic character of the sampling area

Throughout the Gaddafi regime, Tripoli experienced instability of the structure of its districts like any other city. For example in 2007 it was organised to twenty three districts compared to twenty six in 2004. However, the solid waste provider has its own concept of how Tripoli could be organised into districts that would help to deliver a unique solid waste service. Four decades ago, they organised Tripoli city into five solid waste service districts (see Figure 4.2) (TPSC, 2008). In each district, they established an office to regulate delivery of solid waste service to the households. The area and population factor was considered to build this district structure. Table 4.5 shows the distribution of the city population among the five city

districts. Tajora and City centre have less population than other districts, mainly because City centre is an area of economic activity rather than a residential area, while Tajora is mainly a rural area (Urban Planning Agency 2006) . Based on the geographic character of the city districts, the residents are engaged in different activities. For example in Tajora and Sug Aljumah agricultural activities are dominant, while in City centre and Hayy al Andalus, administrative activities are common (TPSC, 2008).

Figure 4-2: Districts of Tripoli city

Table 4-5: Distribution of Tripoli population for the year 2006

Districts	**Population/Thousand**
City centre	143,040
Hayy al Andalus	391,142
Alhadapa & Abu Salem	272,553
Sug Aljumah	310,020
Tajora	84,254

Source: GIA (2006)

During recent decades, the city districts experienced demographic and social changes. For example, the area and the population of the city districts were increased. According to the Salhin (2010), in Tripoli there is an increasing demand for land for urban use and there is a steady physical expansion in last two decades. Ali *et al* (2011) show that the area of vegetated and barren land decreased

significantly as a result of population increase and informal settlement. The public sector in the municipality of Tripoli was unable to deliver a sufficient solid waste service because the population in the city districts had grown and the area had expanded. The private sector emerged as a solid waste service provider at the beginning of 1990s in some of these districts, and they have steadily increased to cover waste collection in all city districts represented at different levels (Faras and Al Kario, 2004).

Distribution and analysis of the questionnaire was based on TPSC classification, Tripoli city was considered as five districts, and the distribution of the questionnaire was based on the area and the population of these districts. The analysis was carried out in terms of socio-demographic differences between these districts to understand how the municipal solid waste service is delivered and what are the defects in the SWM system in the city.

4.6.10 Administering the questionnaire

After the questionnaire was designed and the final version approved, the next stage was concerned with how and where the questionnaire was distributed. This stage consumed some time, because of problems related to sample selection. In determining the sample of householders, the researcher faced obstacles because the streets and houses are not coded, it is socially unacceptable for an unknown person to knock on the door of houses, and during working hours, only housewives were available, most of who were likely to be illiterate. These factors prevented carrying out the householders' survey in their houses. Thus, it was necessary to look for an alternative way to represent the study sample. In this regard, consultations were made with different bodies, such as Libyan students in UK and some researchers who had previously carried out questionnaire surveys. In addition, the researcher reviewed some PhD theses. For example, Elbendak (2008); Grifa (2006); Elabbar (2011), in which a questionnaire survey was employed, to learn about some of the problems faced regarding this issue and how they were solved.

Based on previous work, it was decided to use primary and secondary schools as spot points to carry out the survey. This decision was based on the following considerations;

- Easy to contact and carry out the survey;

- Schools are places where men and women are available and;
- School staff are literate people and so capable of answering the questions.

Consultation was made with the head teachers of the schools on how to fill the questionnaire, and their advice was taken into account; the face-to-face method was applied by the researcher himself with help from some school staff. This gave the researcher a chance to answer the questions and queries of the respondents, and also ensured a high return rate (Oppenheim, 1992).

Some socio-demographic aspects for respondents were laid out in section 4.3.1. The questionnaire was administered in ten schools geographically distributed over the city districts. Carrying out questionnaire surveys in schools is a typical research strategy (Cohe *et al*. 2000). Apart from the potential to access respondents through schools, the respondents are also of an age when they are capable of understanding how to fill the questionnaire, as well they have an idea of the MSWM concept. Secondly, because the literacy and education level among Libyan society is somewhat low, especially amongst those aged over fifty years (the illiteracy rate of the population who ages ten years and over is 11.5%) (GAI, 2006). In this regard, the schools deliver an educated people who certainly are more aware of MSWM problems in their area than the general population would be. Finally, sampling through a school provides access to both men and women, whose views may differ systematically. It would not be possible for a male researcher access female respondents other than through an institutional setting.

In this study, the researcher tried to interview the householders who showed particular interest in the study and were willing to engage in further details. This approach enabled some qualitative data to be gathered to enrich the questionnaire responses.

Although the questionnaire is a useful data collection instrument, nevertheless, it has some limitations. In this research, some of the questionnaires were filled in the absence of the researcher therefore some of these questionnaires were found incomplete. This problem was, however, greatly minimised by encouraging respondents to fill out the questionnaires immediately, after explaining any questions

that were not clear and giving the impression that filling the questionnaire was simple and convenient.

4.6.11 Secondary Data

Secondary data is that which has been collected by individuals or organisations that did not experience first-hand or participate in the events or conditions of this particular research study (Montello and Sutton, 2006). It can play a substantial role in the different phases of research, for example to inform on government policy related to the research area or to find out the past experience to relevant practices. Considering that, relevant bodies relating to MSWM, such as governmental and private sector organisations were important sources of secondary data, providing data issued from their performance reports, studies and other activities, for example, annual reports, assessment reports, development reports investment and expenditure profiles. Therefore, in-depth analysis was carried out of internal and external sources of secondary data, which include official reports, guides and SWM system efficiency documentations, SWM treatment and equipment suppliers, and trends in financing of SWM, general historical works and monographs, and journal articles.

Whilst conducting interviews and fieldwork observation, the researcher obtained several official reports and other sources of secondary data. In addition, copies were kept of some secondary sources such as national and local magazines and journals and national reports that investigated aspects of MSWM at national and local level.

The data collected from secondary sources was employed in most of the study chapters. For example, in Chapter One, it was used to clarify the justification for the study. In Chapter Three, secondary data were used to highlight the issues related to MSWM at national and local level. In Chapter Five, they are used to clarify the actual MSWM situation in the city in the past and currently, whether regarding the administrative, legal and financial issues that affect ESTs adoption. This means secondary sources of information were used as a supplement to data gathered from the other three methods described above. Thus, the four methods used to collect the research data (the interviews, fieldwork observation, the questionnaire survey, secondary data) were triangulated to elicit information on the current MSWM in Tripoli city.

4.7 Data analysis

The method of analysis of the gathered data depends on the instrument used for data collection. However, the analysis of the data is a step to produce the research results from the raw data collected as outlined above (Flowerdew and Martin, 2005). The researcher in this step should be conscious of how to select the analysis method. The raw data collected prior to this stage does not express the full meaning of respondents. Thus, all gathered data, whether qualitative or quantitative, had to be analysed in order to be useful. In this context, the nature and the amount of collected data to a certain extent determine the analysis techniques to be adopted (Flowerdew and Martin, 2005).

In this research, both qualitative and quantitative analyses were employed. All the data and information were reviewed, coded and processed by qualitative and quantitative techniques of analysis.

- Regarding the analysis of the qualitative data, which was mostly derived from interview, the interpretative technique utilised was to adopt manual analysis of results. Application of this technique was mainly based on Bryman's definition, of it as "A strategy that respects the differences between people and the objects of the national sciences and therefore requires the social scientist to grasp the subjective meaning of social action" (Bryman, 2004; 13). Accordingly, the inductive approach for qualitative data analysis was utilised (Bryman and Burgess, 1994; Creswell, 2003). The manual method was preferred rather than using computer software as it allowed greater interaction, for better understanding of the data (context) (Flowerdew and Martin, 2005; Robinson, 1998). Before starting to apply the technique, the responses of the interviewees were read several times until the researcher understood the possible meanings. Then the main ideas from the interview transcript were discovered, summarised and then coded. In the second step, the coded key words, phrases and paragraphs were organised under different headings as key categories, and the relevant paragraphs which represented the key categories were extracted and reassembled to under key themes relevant to the interview topic guide. Eventually the main issues raised became clear in terms of similarities and differences between individual responses. The final findings extracted from themes were used in writing the

chapter 5, 6 and 7 and represented by a variety of techniques, for example quotation, citation, tables, diagrams and charts.

- The quantitative data gathered from the questionnaire were analysed by statistical tests using SPSS computer software. First, descriptive statistics were compiled as the variables were nominal and ordinal in nature (Field, 2000; Tabachnick and Fidell, 2001). Descriptive statistics in this study include frequencies and percentages. This technique was employed, both to discover and describe the current MSWM situation in Tripoli city and to explore the opinions of the service users towards the service they received.

  The chi-square (χ^2) test was used to test hypotheses regarding the relationships between variables. In this technique, before testing a hypothesis it is necessary to tabulate a variable into categories. In this study, some of the categories were found not valid, the researcher combined them to obtain valid results; for example in an assessment of delivery of solid waste service, the researcher combined the categories of very good and good, as well very poor and poor assessments into one category instead of two. The aim of employing Chi-Square is to test the difference between an actual sample and another hypothetical one; if the calculated value (value of χ^2) is less than the critical value, the null hypothesis (Ho) is accepted that there is a statistically significant relationship between variables, while If the calculated value is equal to or greater than the critical value, the null hypothesis is rejected, which means there is no relationship between variables. The test of (Ho) was carried out at the 0.05 level.

4.8 Research issues

4.8.1 Positionality

Methodologically, this research relied heavily on qualitative data from interview and fieldwork observation. Consequently, interaction with interviewees was an important issue for the researcher. In this situation it is recommended for example by Burgress (1984) and Coteerill and Letherby (1994) firstly for the researcher to be independent, unbiased and objective, and secondly to collect data characterized by accuracy and reliability. However, the views of those two authors differ according to the researcher's identity, background and experience. Abu-Lughod (1988) believes that when the researcher is characterized as an "insider", then the perception of the

research participants of the researcher is positive in terms of his/her intentions and the research purpose. This means, whenever the researcher is familiar with his/her study environment, the research process could be promoted. However, those who hold an opposite view, for example Burgress (1984), think that the familiarity of the researcher with the field of study can impact the investigation negatively. Burgress (1984) argues that there is a tendency for researchers who are linked to the context of their research area to shift toward certain behaviours that as hinder communication, and potentially take issues for granted and therefore fail to carry out an in-depth investigation.

Both views on how the researcher's positionality could affect the conduct of the research process have vital implications. However, the researcher adopted Mullings (1999) view that the "insider – outsider" boundary is in reality not only highly unstable but also subject to the dynamism of positionalities in time and through space. At the same time, the participants' perception of the researcher cannot be ignored in terms of its impact on their interactions with the researcher, which in the end is reflected in the effectiveness of data collection. In this regard, during the data collection phase, I was conscious of issues of positionality and always aware of my position, as an important factor in the data collection process, and tried to ensure it strengthened the research process rather than hindered it. As a Libyan and member of staff in the EGA, Department of Solid Waste Management, carrying out research in my home country and in the same working area, I considered myself as an insider compared with other researchers not familiar with the solid waste sector in Libya. Nevertheless, despite having worked in SWM public organisation for several years, in the past (before carrying out this research) I had not encountered the vast majority of stakeholders, for example the owners of private sector companies, respondents at MHPU and research institutes. Thus, I would to a large extent be considered as an outsider by most of the interviewees. However, my knowledge of the research subject under investigation would influence stakeholders, because they were aware of it during carrying out the data collection process, and therefore, would consider my position as an insider with regard to the MSWM issue. This position would influence this group of stakeholders to alleviate any suspicion about my intentions when I approached them. Consequently, this group of stakeholders responded positively during the data collection, whether from interviews or fieldwork

observation. Incidentally, many of those interviewed (senior officials at TPSC, managers of composting plants and owners of private companies) seemed to regard me as “a person who has knowledge" and in a position to help to address their issues. One owner of a private company, for example, said, "For a long time we’ve faced problems of how to be a formal sector so that the government will recognize us as a partner in the SWM system". Such a perception could have positive and negative impact on the data collection process. As a researcher; I tried as much as possible to minimise the confounding effects of positionality. When collecting data, I always began by giving an idea about the purpose of conducting the study and tried to maintain the impression that we were all in a research phase in an attempt to find solutions for such problems.

4.8.2 Limitations of the research

During the empirical investigations in this research, the researcher faced a number of limitations that affected the quality and quantity of information obtained. Some of these issues are related to the research topic, while other issues are linked to the data collection methods used. The following paragraphs discuss each in detail.

Firstly, the researcher suffered from the lack of any prior theoretical and empirical studies in the research area, especially at the local and regional level, to draw upon. The researcher noticed that in the Arab world, including Libya, there were a very few studies conducted in the 1990s, but in the subsequent decades studies are almost non-existent. This could be attributed to the political and/or financial situation. Thus, the researcher faced the challenge of setting basic principles for other researchers to carry out further study in this field, so urgently needed for those developing countries experiencing difficulties in adopting ESTs in their MSWM systems.

Secondly, in regard to data collection, the limitations can be summarised as follows:

The impact of the 17 February revolution in Libya; it was initially planned to conduct two rounds of data collection, the second within six months of the first, in order to keep up-to-date with information, as institutional structures and responsibilities changed suddenly; to fill in data missing from the first round and to conduct the questionnaire survey with householders and owners/managers of commercial premises. However, the outbreak of the conflict in the country, which

lasted for eight months, made it impossible to carry out the second round. It was therefore necessary to wait until conditions calmed down, in December 2011, about a year and a half after the first round. During the war, part of the service infrastructure was destroyed, most foreign staff left the country and the funding of the sector was reduced; all these factors of course contributed to a decline in the service provided. Thus, it was somewhat difficult to obtain information reflecting the actual state of MSWM in Tripoli. In this regard, the necessary arrangements were made to overcome these circumstances and limit their influence on the empirical study and its findings by ensuring that all the data gathered in this round represented the MSWM situation before the war started on 17 February. For example, on the front page of the questionnaire survey, householders were requested to answer the questions based on the situation before the war.

There was a limitation related to the social/cultural context of the interview respondents. Although the researcher was familiar with the staff of most relevant SWM organisations, it was difficult to carry out interviews on the arranged dates. The participants in the research interviews did not adhere to the agreements made. In many cases, several appointments were booked prior to actually conducting the interview. The second issue was that respondents made intensive use of mobile telephones during the interviews, which interrupted the continuity of the interview and made it difficult to go back to discuss the issues. Both problems were attributable, in general, to personal and cultural circumstances.

Another limitation was related to a lack of secondary data in the private sector (PCTCs and PRI). The researcher did not get adequate documentation to show the contribution of the private sector in MSWM system, because firstly, the private companies do not possess documentation about their history, and secondly, data presented in public reports and studies are limited.

The researcher could not avoid these conditions, because to a large extent they were related to Libya's society and political situation. The researcher in this regard did all he could to minimize the impacts of these limitations, and to obtain the best information available. For example, the researcher tried to keep the interviewees on track to conduct the designed interview, to repeat the question when there was an interruption of the interview and to re-visit organizations to obtain more secondary

data. In general, the decision to utilize four data collection methods proved justified as in this way it ensured that enough data were collected to carry out the research as planned.

Summary

The rationale for using mixed methods of extensive and intensive research as a research approach was clarified. The nature of the data to be collected was the main reason behind of selection the research approach. Consequently, the sources of data were determined and therefore interview, fieldwork observation and questionnaire techniques were employed to collect primary and secondary data. Analytical methods were described based on the type of data gathered. During conducting the research, issues were taken into consideration in advance and efforts made to address such issues have been explained. The next three chapters analyse the data collected.

CHAPTER FIVE: REGULATORY CONTEXT OF MSWM SECTOR AND ITS CURRENT PRACTICES

5 Introduction

As clarified in Chapter One, the first objective of this study is to describe the current situation of the MSWM system in Tripoli city. This chapter presents the findings of the first research question regarding these practices and the extent to which the current system employs ESTs. The purpose of this chapter is to display a clear picture of how the MSWM sector is managed. In order to understand the present arrangements, it is necessary to include a review of how relevant regulations have changed since first being introduced in the 1970s. As will be shown, there have been numerous adjustments to the organisation and regulation of MSWM. The various regulations share a lack of effective means of implementation, whilst the periodic changes have resulted in a confused situation, with conflicts of interest. The legal framework, waste quantity and quality and practices adopted to manage solid waste generated from the city are outlined. This information is used to assess the capacity of the relevant institutions to adopt sound practices for the solid waste sector.

5.1 The legal framework

5.1.1 MSWM policies

Libyan policy in the field of solid waste management has been drafted twice since 2001. The initial draft in 2001 proposed principles and guidelines for MSWM, but these were not translated into an integrated implementation strategy at national level (EGA, 2002). The second draft was conducted as part of the National Programme for Environmental Sanitation (NPES). It was one of the transition plan projects introduced for the period between 2007-2011 to enhance and improve the performance of various economic sectors, including the environmental sector. There were nine environmental projects at the national level, including a SWM project. The latter is based on a disposal model, with environmental improvement coming from a move towards controlled landfill in the big cities (NPES, 2005).

Neither SMW plan gave the relevant local scale actors the power to achieve an agreement on implementation; they remain obsolete documents stored in drawers.

For example, the national government did not allocate the necessary funding to activate these initiatives. Both initiatives aimed firstly to introduce new technologies for waste management rather than current facilities, which they considered a source of health and environmental problems (e.g., replacing open dumps with sanitary landfill). Secondly, they aimed to gain private sector support to be an effective partner in waste treatment as well as collection. However, under the Gaddafi reign, the economic policies of the country tended towards a state controlled economic approach more than a market economic approach (OECD/AfDB/ECA, 2009). Policies that called for participation by, and support of, the private sector, and thereby confined the government role to planning and facilitating, were not acceptable to national level decision-makers. At the local level there is a perception that the private sector could play a significant role in both collection and treatment activities based on the sector experience for much of the past twenty years, but the necessary structures were not put in place to facilitate this (see section 6.1.2, which discusses ownership and system operation).

In Tripoli, the current policy is mostly focussed on preventing the accumulation of waste inside the city. Antipolis (2000) described such a policy as a pure “cleaning approach" where there is no room for other options of reduction and treatment practices. Options of municipal solid waste treatment in the city are limited. Interviewees at MT, TPSC and PCTCs said that there is no plan after waste has been collected and transferred to landfill. In this regard, the senior officials at TPSC clarified that it is not their responsibility to carry out treatment facilities, according to the resolution to establish the TPSC; their role is limited to cleaning up the city (i.e. collection and transportation practices).

Formulation of waste policy in the Libyan context displays the characteristic noted by Deutz and Frostick (2009): there are often variations between the declared goals and implementation capacity for waste management, particularly in developing countries that face lack of resources necessary to implement their policy in an effective way. Therefore, evaluating the human and financial resources is an important issue during policy formulation. The success of a project therefore depends on the level of implementation capacity (Kumssa and Mbeche, 2004). In Libya, there is an acute shortage of human and financial resources. As the national report on the state of the environment revealed, most technical staff involved in the SWM system

have a low level of qualification. In addition it estimated that available resources do not exceed 30% of sector requirements (EGA, 2002).

5.1.2 Ruling legislations

In Libya, since 1976, there has been a package of laws and decrees concerning MSWM. Generally, the laws have been formulated to define municipal responsibilities for waste management and the mechanisms through which the MHPU can facilitate the financing of waste management facilities and raising funds for waste management operations. The legal framework currently governing the municipal solid waste management sector is summarized in Table 5.1. However, Law No. 13 of 1984 "For Public Cleaning" is the only law that addresses the MSWM system, while the other legal instruments listed in Table 5.1 cover particular MSWM issues.

Act No 106 of 1973 and its implementing regulations was the first law to address health and environmental issues. It elaborates in detail all aspects of the environment and environmental protection, including solid waste related activities that can create health problems. In its chapter 5, the law elaborates the regulations of hygiene and waste collection and disposal, starting Article 321 with definition of terms, then proceeding to set out provisions on MSWM. The following examples explain some provisions that are enshrined in the law for MSWM;

- Only those licensed by the relevant authority shall engage in solid waste collection;
- The solid waste collectors and street cleaners must wear protective clothing while doing the work;
- The contractor is controlled by the municipality to provide facilities to collect and transfer waste collected to a disposal area that is determined by the municipality, and these facilities should meet the updated standards described in this regulation. If the contractor cannot fulfil this requirement, the municipality will carry out the task at the expense of the contractor;

Table 5-1: SWM Legal Framework in Libya

Type of instrument Name of instrument		Solid waste management elements					
		Waste type addressed	**Functional Responsibility addressed**	**Waste management system components addressed**	**Institutional roles addressed**	**Financial and cost recovery provision**	**Other**
Environment and other Acts	Law No. 15 for protecting and improvement of the Environmental, 2003	Domestic, municipal, Industrial hazardous waste	Enforcement/ regulatory /monitoring/ penalty Environmental Impact Assessment	Waste collection, treatment, disposal	EGA is responsible for enforcement and monitoring Municipalities and other institutions are responsible for operation	None	-
	Health Law No. 106 of 1973 and its Executive Regulations	Water, food, public health, domestic, municipal and Healthcare waste	Operation/ enforcement / monitoring	waste collection, transport, storage and final disposal (selecting disposal sites)	MPHE Municipalities	None	-
	Law No. 5 for 2005 for Transport of hazardous	Hazardous material	Operations and penalty	Hazardous material transport	Ministry of Justice	-	-
Solid waste management Acts	Law No. 13 of 1984, "For Public Cleaning", and its Executive Regulations	Municipal solid waste	Operation/ enforcement / monitoring	Solid waste collection, transport, storage and final disposal (selecting disposal sites)	MHPU Municipalities	Municipal budget and penalties.	Charges for municipal SWM
Regulations	Finance Act No. 30, 1998	Household and Commercial waste	Cost recovery	All	Municipalities	Charges for municipal SWM	-
Draft regulations	Draft Executive Regulations (Integrated medical waste management)	Medical waste	Regulatory/ operation /enforcement	Must be collected and disposed of separately from other wastes	MPHE	none	-
	Draft Executive Regulations (Hazardous waste management)	Hazardous waste	Regulatory/ operation /enforcement	All	EGA	none	-

Source: Derived from field work and Otman and Karlberg (2007)

- The transfer of solid waste in vehicles that are not allocated to carry waste is prohibited, and it is also prohibited to house these vehicles and other facilities used in a place that is not allocated for such a purpose;
- It is prohibited to sort solid waste except in designated areas.

The primary environmental legislation in Libya is Law No. 15 of 2003: Law for the Protection of the Environment. The law is structured to provide for management of environmental issues according to environmental aspects (air, soil, water etc.) but does not explicitly address municipal solid waste management. It provides for environmental reviews of projects, the creation of standards for aspects of waste management that may impact upon the environment and the monitoring and enforcement of those standards. There are also some articles on the public health. This law was drafted after a review of old law No 7 for 1982. Updating of environmental law was very important at national level, after more than 20 years, during which significant changes in social conditions occurred.. However, the new version, according to an interview conducted with a senior environmental impact assessment office of EGA, is almost the same as law No. 7. He commented that "The Law No. 15 of 2003 was not at the level of our aspirations; we thought that many environmental issues would be addressed in the new law, such as clarifying the ambiguous issues of solid and liquid waste management. The changes made focused on adding a new chapter to address the issue of "bio-safety". The respondent thought that the national government intended the new chapter on bio-safety to provide support for the regime's then idea to challenge the domination of the seed industry by certain countries.

The senior environmental impact assessment office of EGA in this respect argued, "This issue is important to us, but it is not our priority, I think we have other environmental problems at local level that require taking serious measures such as water and wastewater, solid waste and desertification".

One of the major obstacles that may have affected the activation of Law No. 15 of 2003 was the national government's failure to issue Executive Regulations, which could have decoded ambiguity in the law's articles and set up the necessary standards

and other related specifications. Therefore, EGA worked without a detailed regulating law governing its operation for more than six years. For example in Chapter Six article fifty one of Law 15, it is mentioned that solid waste should be disposed of in a sanitary landfill, but at the same time there is no definition of what sanitary landfill could be, either in Law 15 or in any other regulation. Therefore, further explanations should be included to understand such a concept.

Law No. 13 of 1984, with its Executive Regulations and Provisions, specifically addresses municipal solid waste. The law sets the basic principles of solid waste management and makes local administration agencies responsible for waste collection and disposal. Furthermore, the law outlines the necessary measures for waste collection, transfer and final disposal, for example, selection criteria for transfer stations and final disposal sites, see Table 5.2. However, detailed operational instructions such as landfill operation and land filling procedures are not considered. In addition, the law does not contain provision to classify and determine risk, treatment mechanism, and handling of waste. Furthermore, there is no specific law regulating hazardous waste management. Even Law No 15 of Environmental Protection did not address hazardous waste management. The absence of such an important law regulating the waste most dangerous to human health and the environment represents an obstacle to sound municipal waste management. There is a failure to set a clear definition of toxic and hazardous waste and to design a separate stream in order to exclude such waste from municipal solid waste approaches. For example neither Law No 13 of 1984 nor Law No 15 of 2003 contain a broad explanation or a list that classifies hazardous and non-hazardous waste. Hospital waste in Tripoli is still an issue for local government. They handle it with municipal waste, in one stream. In this regard, the TPSC senior official said,

> "The national government still think that hospital waste collection, transport and treatment are our responsibility as a public company for cleansing. While there is no law regulating such hazardous waste, we cannot leave such waste in the street or in the hospital yard, we have to collect it and transfer it to landfill".

The head of department of SWM in EGA explained that during the last few years the EGA has put together a team to create a specific regulation and instructions for

hazardous materials and another for medical waste management. The resulting work was completed in 2007 and released to the relevant national government office for approval, but since that time there had been no reply.

Table 5-2: Criteria for setting of transfer station and landfill practices

Transfer station	**landfill**
To be served of a residential area that their diameter 5 kilometre	The site should be away at least 5 kilometre from any residential area
Be supplied with bins and skips	The land of the site should be viable to drill
Other specifications should be determined by the local municipality	The site should be surrounded with a fence on a 1.8 metre high
	Be supplied with a water source and fire fighting facilities
	Be supplied with pest control instrument
	Be supplied with toilets and stores used to keep medicines and operation facilities

Source: Law 13 for 1984

With regard to supplementing existing laws, several decrees have been released to update and/or develop on the existing laws, whether by the Prime Minister's Office or through MHPU to arrange specific MSWM issues. However, it is observed that all the MSWM laws are old, most of them dating back more than a decade. Law No 13 "For Public Cleaning" was enacted more than a quarter of a century ago. Such old laws could not meet the requirements and needs of the current situation, where there are dynamic circumstances in the social, economic and political areas. In general, the ongoing problem at local level remains the absence of new guidelines that interpret how to enforce the existing laws. The EGA and MT reports showed that there are many basic elements for SWM missing in the national regulatory framework, and most recently in the EGA (2010) report that outlines the EGA's position as regards the current legal framework. The following examples summarise their view with regards to the laws that regulate MSWM;

- They did not contain a legal basis for a national waste plan and regional waste plans;
- They did not define further competences concerning disposal of waste on controlled landfills and the operation of such facilities;
- They did not provide for time limits in which the existing landfills have to comply with the laws and in what time and how they should be restored.

- They did not provide for financing instruments, for example; polluter-pay, user-pay principles;
- They did not define hazardous waste in order to exclude those dangerous wastes that cannot be accepted on municipal landfills, therefore, there is no national waste catalogue. Finally;
- It is not clear that the municipalities are not responsible for hazardous and industrial waste that could not be treated in municipal facilities due to its quality and/or quantity.

In general, it appears that the existing laws do not cover the necessary technical or organizational details of MSWM. Therefore, such general provisions are not sufficient to enforce a coherent national waste policy (Wilson *et al*. 2004). The relevant organisations and others concerned (i.e., administrative authorities, producers, holders, treatment and disposal companies ... etc. as well as citizens) do not know precisely what their roles and obligations are. In this regard, only detailed legally binding rules can provide an appropriate framework to reach this objective (Zhu *et al*. 2008). On the other hand, given the failure to address the SWM principles in the legal framework, the system of waste management has remained severely deficient and outdated. However, from the result, although there is division between different government agencies/departments, it seems that there is an apparent desire for improvement.

5.2 MSWM generation and composition

Estimates of amounts of municipal solid waste generated in Tripoli vary from one study to another. This is mainly because, as EGA/UNDP (2010) indicates, researchers did not set up a clear definition of municipal solid waste. Secondly, very few studies were carried out in this area. Thus it is difficult to assess the generation rate accurately, which makes planning for MSWM extraordinarily difficult. For example, in 2010, a joint project between Environmental General Authority (EGA) and United Nations Development Programme (UNDP) estimated that household waste generation in Tripoli city is 0.39 Kg/day. Conversely, in 2004; a study by the Ministry of Housing and Public Utility revealed that the per capita generation of solid waste in Tripoli city was 0.77kg/day. In the absence of accurate data on municipal waste generation, the relevant organisations of MHPU, MT and TPSC

agreed to use the value of 1.0 kg per person per day of municipal waste (household, commercial and services waste combined) as a standard to calculate the quantities of solid waste generated within their jurisdictions and for contract procedures.

It is questionable whether the nationally adopted value of 1.0 kg per person/day is accurate in Tripoli. Firstly, because the regions of Libya are different in terms of urbanisation level, which impacts on waste generation. According to Faras and Al-Kario (2004), the waste generation rate per person in urban areas is usually higher than in rural areas. Secondly, significant changes to population dynamics in terms of population growth and settlement, and the change in life style could have brought about changes in the quantity and quality of waste generation since this figure was selected in 2004. Thirdly, even if we assume the national per capita figure is applicable in Tripoli since the Tripoli population is not known accurately (owing to the migrant and floating population to Tripoli from neighbourhood cities) the total level of waste generation cannot be estimated precisely.

There is no unique figure for the physical composition of municipal solid waste in Tripoli city. The national and local government organisations employed the results of different studies carried out on Tripoli city in recent years. This variation in results obtained could be attributed to the lack of unity in the definition of municipal solid waste. For example, what is reported by the Environmental General Authority (EGA) in this regard does not match the data adopted by Tripoli Public Service Company (TPSC). In the EGA the figure only focused on waste generated from households, whereas the TPSC figures also included other sources such as commercial waste. However, the literature on municipal solid waste composition (Table 5.3) indicates that the organic fraction is the predominant component in waste generated, whether from households or business activities. This is followed by plastics materials and paper, as a result in changes of life style, where paper and cardboard packaging materials have been substituted by plastics. This explains the decline of the paper and cardboard fraction of waste and increase of the plastics fraction over time. Other important constituents of the waste stream are textiles, metals and glass.

Given the high organic component in the municipal solid waste stream in Tripoli city, an opportunity could have been taken to produce compost for the agriculture sector. The compost could have substituted for artificial fertilizers as well as

reducing the amount of waste sent directly to landfill. However, despite the establishment and operation of several composting plants, this has not been attained. Interviews with staff of the composting plants acknowledged that the organic fertiliser produced in Tripoli composting plants was not a competitor to what is available in the local markets, both in terms of price and impurity content (for more detail see 5.3.4).

Table 5-3: Development of Municipal solid waste composition rate

Components	**%**			
	1971*	2002*	2008**	2010***
Organic material	48.8	52.6	56.3	70.1
Plastics	19.5	16.9	10.0	7.5
Paper and cardboard	2.1	13.2	13.5	5.5
Metals	3.8	7.8	3.7	4.3
Textiles	3.1	4.2	10.8	1.3
Glass	3.3	2.5	2.6	3.1
Timber	1.9	1.3	0.8	-
Dust, stones, ashes, etc…	16.7	1.4	2.0	2.5

Source: *EGA (2002); **Minicipality of Tripoli (2008) ***EGA/UNDP (2010)

With regard to the other major constituents of the municipal solid waste stream, mainly these are recyclable materials, the most important being paper and cardboard, plastics, textiles, metals and glass. Generally, generation of such components is mainly due to the increased number of commercial and service activities in the city, and modernisation of production and consumption patterns witnessed by the city in recent decades. Table 5.4 shows the potential of waste that can be recycled for sixteen cities including Tripoli. However, there is very little recycling in the cities (for more detail see 5.3.5).

Table 5-4: Potential recovery rate of recycling materials

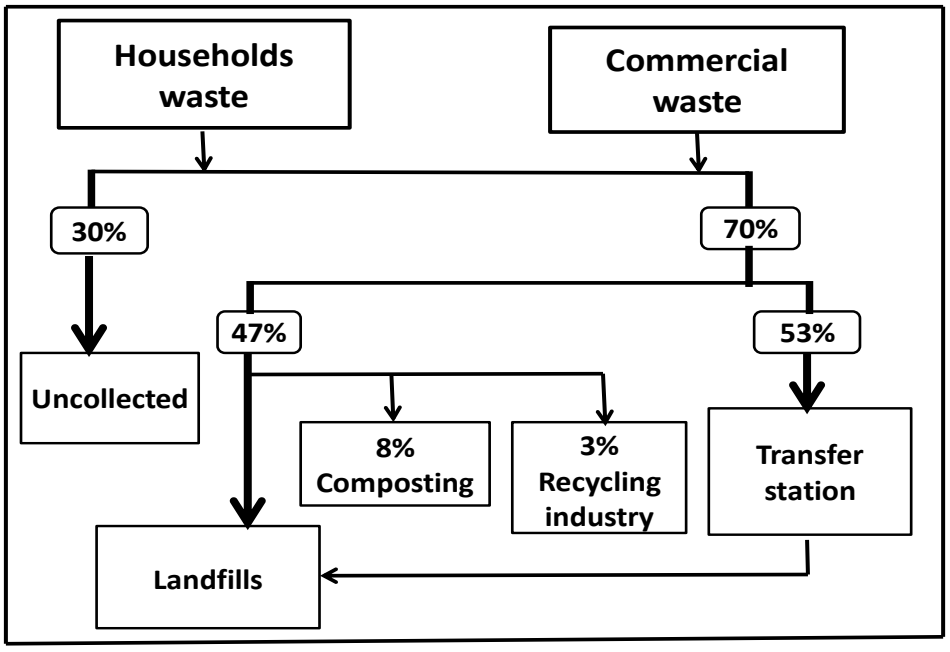
Description	Recovery rate
	%
Paper and cardboard	60
Plastic	60
Metal	85
Glass	50
Tissues	30

Source: EGA (2002)

5.3 Flow of Municipal solid waste and current practices

This section presents practices of MSWM whether carried out by the TPSC or PCTCs. In general, municipal solid waste in Tripoli city flows almost directly to dump in landfill. Figure 5.1 presents a diagram of the city's municipal solid waste system that shows the possible flow streams. The waste management data obtained from the municipal waste departments for the year 2010 reveal that only 70% of total waste generated in the city is collected by the service providers (TPSC and PCTCs), 8% of what is collected is composted, 3% is recycled while the rest is dumped in landfilled. In the following sub-sections each of the given streams will be discussed separately in detail.

Figure 5-1: Flow Diagram of municipal solid waste streams



Source: Fieldwork 2010 and EGA/UNDP (2010)

5.3.1 Waste storage and source separation practices

The municipality of Tripoli through TPSC has placed containers/skips in various locations of the city for primary and secondary collection of waste. People use footpaths, open places and abandoned land to dispose the waste where there are no containers (see Figure 5.2). The number of containers provided is very few and not enough to cover all the residents in the city. The Director of the Cleanlines department at TPSC in this regard said they have only 17% of the wheeled bins that are required delivered to the city residents. Failure of TPSC and PCTCs to provide storage containers is inconsistent with the requirement of the law No 13 of 1984, which required service providers to deliver a sufficient number of containers in the collection points. Hence, the plastic bag has been performing a useful function in garbage disposal for most of the householders in Tripoli city to cover the deficiency in the storage bins. Nevertheless, different type of bins (i.e. wheeled plastic and metal bins, 6 and 10 m^3 skips and plastic bags) were observed being used for temporary storage of waste in the household and commercial areas. Table 5.5 show the percentage of containers used in the city by the city residents. For medical waste a blue wheeled metal bin is used (see Figure 5.3). Usually people bring out the waste in plastic bags and bins and put it outside the house and at the kerbside. The householder takes away the bins when the collection crew have emptied the waste. In densely populated settlements in the city, a communal type of container such as skip bins is used for storage of waste. In apartment housing areas the people use plastic shopping bags to store waste and bring them out to dispose either at a designated collection point, if it is available, or in any accessible road side and open areas. This has become the common practice of disposing of waste in the city.

Figure 5-2: The residents bring out the waste in plastic bags

Source: Fieldwork, June to Aug, 2010

Table 5-5: Storage containers used by householders

	Frequency	Percent
Wheeled bin	24	12.8
Skip	60	32.1
Plastic pages	80	42.8
Other	23	12.3

N= 187

Source: Questionnaire survey, Dec-Jan, 2012

It is observed that the waste storage practice outside the household and commercial premises is co-mingled. In this respect, senior officials at TPSC stated that the containers delivered to service users are allocated for all waste components. They added "we do not request service users to separate their waste to different components because we are not operating treatment projects, except two composting plants, and we deliver municipal waste to those plants from specific residential areas we think have a high percentage of organic waste". From these practices, despite of environmental and economic benefits of source separation (Lardinios and Furedy, 1999), it is implied that this activity is limited or not practiced in the city.

Figure 5-3: Wheeled bins to collect municipal and hazardous waste

Source: Fieldwork, June to Aug, 2010

5.3.2 Waste collection practices

In Tripoli, both public and private sector collect municipal solid waste, and their involvement is varied from one residential area to another with an increase of private companies in recent years. However, a percentage of waste generated remains

uncollected. The service providers collect as much as they can, because the main priority of the national and local government is to drive the service users into removing the solid waste away from the city (a cleaning approach policy). In this regard, solid waste collection crews at TPSC work seven days a week and with three shifts a day to cope with the daily waste generated.

The waste collection service is provided by either house-to-house, kerbside or communal collection systems (see Table 5.6). From the table, street collection is the most common method used in the city, nearly half of the waste is collected from the streets, while waste collected by door to door and block collection represents around one fifth for each method. However, the selection of collection method depends on who provides the service (TPSC or PCTCs) and the demographic and geographical location of the served area.

Table 5-6: Waste collection scheme

	Frequency	Percent
Door to door	39	22.7
Block collection	37	21.5
Street collection	78	45.3
Other	18	10.5

N= 172

Source: Questionnaire survey, Dec-Jan, 2012

In the city, primary[2], secondary[3] and direct collection[4] systems are employed. Table 5.7 summarises different vehicles involved in the collection system that employed by TPSC and PCTCs. Collection crews in the TPSC and PCTCs range from two to five people in addition to the driver (see Figure 5.4). The Director of the Cleanlines department at TPSC stated that a high percentage of collection crew in all city districts consists of four or five workers plus driver, because most of the waste is scattered on both sides of streets and in open areas.

[2] Primary collection refers to house to house collection of waste in the community bins or transfer station.
[3] Secondary collection refers to the collection of solid waste from primary collection points and transferred to next destination (composting plants or landfill).
[4] Direct collection refere to a collect of waste from primary collection and transferred directly to final destination.

Table 5-7: vehicles used and organisations involved in collection practices

Activity	Equipment in use	Implementation body		
		Generator	TPSC	PCTCs
Primary collection	By hand	✓		
	Handcart		✓	
Secondary collection	Tractor		✓	
	Open truck		✓	✓
	Compactor vehicle		✓	✓
	Container carrier		✓	
	Trailer		✓	✓
Direct collection	Open truck		✓	✓
	Compactor vehicle		✓	

Source: Designed based on TPSC (2008); TPSC (2009) and questionnaire survey, Dec-Jan, 201

Figure 5-4: Waste collection crew of five people plus driver

Source: Fieldwork, June to Aug, 2010

The current waste collection practices in the study area are carried out by different organisations, using a variety of methods with various technologies. The collection practices constitute a mayor demand on municipal expenditure, as well as having great impact on the environment and public health (Coffey and Coad, 2010). Therefore, the relevant organisations are concerned to look at such issues in planning and implementation in order to avoid a wastage of expenditure and effort that could be happen.

5.3.3 Waste transfer and transfer station practices

At local government level, it is found that there is financial and administrative benefits for adopting transfer stations[5] technologies to collect municipal solid waste (Coffey and Coad, 2010). Yet, in developing countries their concern to set appropriate technology is not essential (Ogawa, 2002), because of its economic cost and lack of a coordinating body among the local governments to cover such a cost. However, such an infrastructure is available in Tripoli city. Transfer stations have existed in the city for decades, albeit not necessarily employed to their best advantage. In the eighties, there were around ten sites recorded as transfer stations employed to collect waste from the city centre and other densely populated areas. Population increase and the growth of urbanization experienced in the city in recent decades were the real reason why the municipality closed these sites. Some reports at the municipality offices (e.g.; TPSC, 1999) suggest that the residents living near them complained about the dire environmental conditions in their community, due to the sites' release of foul odours, and they were a source of nuisance and proliferation of flies and rodents. Thus, the MHPU issued resolutions to close the facilities and expropriate them for other purposes. Hence, what remains nowadays, owned by the municipality of Tripoli, are only three sites, the transfer stations in Abu Salem, Al-Sawani and Tajora.

The Abu Salem TS is located in the city centre and is used for storage of waste collected from there. The Al-Sawani site is co-located with the Al-Sawani composting plant in the south of the city and used as a co- transfer station with Jfara municipality. The Tajora site is in the eastern part of Tripoli and it is employed to carry waste from the Tajora area. The three transfer stations, although owned by the municipality, are operated by different partners. Tables 5.8 and 5.9 present a broad outline of the current state of the existing TSs in Tripoli.

[5]Transfer station (TS) is as an integral part of municipal solid waste management systems, It is a facility constructed to receive waste from primary collection and stored for a while until re-transferred for processing anf/or for final disposal (Tchobanoglous *et al*. 1993; Bovea *et al*. 2007).

Table 5-8: Basic information on the existing transfer stations

TS site	Date operated	Area/Ha	No of employees	Operator	System design
Abu Salem	1976	4	16	TPSC and PCTCs	Loading from ground[6]
Al-Sawani	2008	1	8	TPSC	Loading from ground
Tajora	2008	1	10	PCTCs	Loading from ground

Source: Designed based on observation and TPSC (2008) and TPSC (2009)

Table 5-9: Transfer stations practices in Tripoli city

TS site	Waste receiving Ton/day	Waste sources	Distance between the collection area and the TS	Distance from the TS to the next destination	Average storage period (day)	Collection vehicle used for the delivery of waste	Load of a transport vehicle
Abu Salem	490	Residential and Commercial	Within area	60 Km	Unknown	Light vehicle, compactor, tractor, handcart	Open top trailers, open truck
Al-Sawani	210	Residential and Commercial	1- 8 Km	45 Km	1 - 7	Light vehicle , compactor, tractor	Open top trailers, open truck
Tajora	140	Residential and Commercial	1- 3 Km	65 Km	1 – 7	Compactor, tractor	Open top trailers, open truck

Source: Designed based on TPSC (2008) and TPSC (2009)

[6] Loading from ground, is a flat piece of ground onto which the wastes are dumped by the primary collection vehicle and then loaded into the transport vehicle (Coffey and Coad, 2010)

In the three sites there is a limited system of record keeping, whereby the amount of waste received at the sites is not known accurately. The records are not computerized. The number of vehicles entering the sites is counted and the data are recorded manually on hard copy. There is no weigh bridge. Thus, the total quantity of waste received at the site is estimated based on the number of vehicles arriving at the site and the type of vehicles. Data on the total quantity of waste received at the sites daily obtained from the EGA departments shows that 50% of all waste is disposed via the three transfer stations. The greater part of this waste is handled in Abu Salem transfer station, which represents about half of the waste transferred (50%), compared to 40% in Al-Sawani and 10% in Tajora.

The Tripoli Public Service Company (TPSC) has realized that the transfer of waste directly from housholds to final landfills is very costly in terms of vehicles used, and is therefore inefficient. Therefore, to make up for the transfer sites lost in the past, and mainly for cost effectiveness, they decided to rely on what Coffey and Coad (2010) called "bulk transport vehicles". A fleet of large compactor trucks and trailers is maintained in fixed places around the districts. However, some technical issues hinder the workflow. According to a statement made by the driver of a compactor truck:

> “According to the operating instruction of this large compactor truck, loading of waste should be through a hole in the roof. Currently, feeding the truck in an effective way is not easy, because suitable equipment that is compatible with such an operation procedure is not available and feeding is done only by wheeled tractor, and this sometimes causes collision and causes damage to the truck, in addition to the wasting of time as they need a step to reach the roof hole”.

When the Transfer Stations were established in the 1980s, the local government expected them to reduce the cost of waste transfer, especially as the operational landfills (Sidi Al-siah and Alazizia) are both far away from the city about 60 Km away. The vehicles used to collect waste from the city may not be able to continue to work effectively if also used to carry waste such a long distance, especially as the private collection companies working in Tripoli, in general, own a limited number of

trucks. Transfer of the waste they collect directly to landfill is a major concern for them (figure 5.5).

Figure 5-5: Open truck transporting waste to the Sidi Al-siah landfill; a journey of tens of kilometres

Source: Fieldwork, June to Aug, 2010

Drivers from both TPSC and private companies used to carrying waste to the landfill in light vehicles and trucks, expressed their concern that they could not carry a large quantity of waste such long distances, especially given the road hazards and costs associated with the operation. They therefore desire to have a transfer station in their servicing area in order to reduce operational cost, to improve the service they offer, and for reasons of health and safety on the road.

In terms of operation, at the three sites a traditional technology is applied (figure 5.6). In general, the three TSs are a flat piece of ground. Waste is dumped by the primary collection vehicle and then re-loaded into the transport vehicle, often using wheeled loaders. As shown in Tables 5.8 and 5.9, the private sector plays a significant role in waste transfer to final landfill. They operate Tajora TS and take part in Abu Salem. In their operation, they mainly use open trucks and large semi-trailers and the wheeled loader to transfer waste from the ground into vehicles.

Figure 5-6: Practice at Tajora transfer station; loading from the ground

Source: Fieldwork, June to Aug, 2010

My field observations at the sites focused on health and environmental problems. Some effects resulting from adopting of traditional technology of loading and transfer were noticed, such as release of foul odour, flies, dust and the waste being scattered around the site. In interview with a TPSC truck driver, he explained that the drivers who come to the Abu Salem site usually wait for hours to find a free space for tipping the waste out. He added that waste sent to this site may remain for several days and often for weeks before being removed because large amounts of waste are sent to this site daily and waste is not removed in order of delivery.

Figure 5-7: Open top trailer is ready to transport waste to landfill

Source: Fieldwork, June to Aug, 2010

5.3.4 Composting facilities

Composting plants were first established in Tripoli city on the recommendation of the national government in the beginning of the 1970s when they planned to provide capital subsidy to install seven composting plants in the major cities of the country including Tripoli (Faras and Al-Kario, 2004). In the 1980s, a composting plant processing 500 tons per day started working. The aim of the national government at that time was to reduce the amount of waste transferred to landfill, to generate suitable organic fertiliser for agriculture activities and to improve soil condition to reduce the rate of desertification.

In 2001, the municipality of Tripoli decided to install more plants in the city. The decision to establish new composting plants was based on law No 13, which permits districts that have a population of over 50,000 inhabitants to set up a composting plant, subject to approval from the legal authority in terms of project planning to obtain permission for a certain location. Secondly, this decision was taken based on a study carried out by EGA and MT to consider opportunities for the production of compost. Indeed, the decision-makers in the municipality decided to import five composting plants made in Egypt. One of them was installed in 2002, while the rest of them remain obsolete in their packing. In a question to the composting manager in regarding the lack of use, the answer was

> "Failure of the municipality to install the remaining plants is due to the unwillingness of the Ministry of Housing and Public Utility to divert the financial dues required for installation''.

This gives the impression there is absolute control over the municipality practised by national level organisations. Thus what is planned at national level is not supported by provision of the requisite funds at local level.

The following comments on the compost plants in the Tripoli area are based on personal visits and managers' responses in interview.

- **Al-Sawani composting plant**

Al-Sawani composting plant was built on the site of an old composting plant that was operated during the 1960s. The plant was supplied by a French company. It was installed in 1982 while the actual operation started fourteen years later in 1996. The

delay was due to lack of readiness of municipality staff to operate such technology in an effective way. Technically, the design of the plant was based on the anaerobic digestion technology. Therefore, most of the processes are mechanically based, and certain skills are required to keep operating conditions at the appropriate level of temperature and moisture and so on. The plant manager agreed that availability of skilled workers who have the desire to work in the composting plant is limited, mainly due to the low salaries paid by the municipality compared to what they could earn in the private sector. In addition, more than half the waste materials transferred to the plant, as shown in Table 5.10, are rejected. Also, due to the type of collection method adopted by TPSC, usually the type of waste arriving at the plant is mixed municipal solid waste from different sources, which requires more energy to process, causes mechanical breakdowns, and reduces the quality of the final compost. Thus, in 2001, the TPSC carried out some modification of operational techniques (adopting manual sorting instead of a mechanical and an aerobic system instead of anaerobic decomposition) to overcome operational problems and to improve the plant performance (see Figure 5.8).

Table 5-10: Tripoli composting 2008-2009

Input output materials	**Al-Sawani composting plant**				**Sidi Al-Siah compost plant**			
	2008		**2009**		**2008**		**2009**	
	Ton/ Day	**%**	**Ton/ Day**	**%**	**Ton/ Day**	**%**	**Ton/ Day**	**%**
Total waste input	367.0	100	319	100	25.09	100	45.9	100
Composting output	176.4	48.1	155.9	48.7	11.76	46.9	19.5	42.4
Recyclable materials	0.6	0.1	0.4	0.1	0.74	2.9	1.1	2.4
Amount of rejected materials	190.0	51.8	163.1	51.2	12.59	50.2	25.3	55.2

Source: Calculated based on TPSC (2008) and TPSC (2009)

Figure 5-8: Manual sorting of wastes at Al-Sawani composting plant

Source: Fieldwork, June to Aug, 2010

A large quantity of rejected materials accumulated around the plant (Figure 5.9). In an interview a representative of the General Environmental Authority said that such accumulations affect working conditions, are a source of odour and attract flies, insects and rodents. The plant management had difficulty in finding customers for some recyclable materials, because they are not clean. Additionally, there is no market for such a product, as very few recycling industries exist in Tripoli. The manager of the plant reported that, for example, in 2009 a large quantity of glass was dumped in landfill as there was no demand for it in the local market.

Figure 5-9: Al-Sawani composting plant surrounded by quantities of impurities

Source: Fieldwork, June to Aug , 2010

- **Sidi Al- Siah compost plant**

The Sidi Al- Siah is a municipal composting project that began in 2002. The four hectare plant is located in a public owned area close to a final dump site which serves the municipality of Tripoli. The plant is operated by TPSC. The facility consists of a cement pad constructed for windrows, curing, screening and storage. In the windrows technique, after separation of organic matter from other waste contents whether manually or mechanically, appropriate pile dimensions of prepared organic matter are set up.

In this technique, controlling the curing period is essential for safe production. If the composting process does not achieve almost 100% kill of organisms, they will be present in the finished product. If such material were applied to land, the potential for contaminating crops arises, with health risks to the public associated with eating raw vegetables (Domingo and Nadal 2009). Failure to operate Sidi Al-Siah composting plant more effectively, as stated by interviewees from the municipality, is due to the poor understanding of the (biological) composting process. It was observed that the product is still mixed with high quantities of plastics, metal and glass (figure 5. 10). The view of the composting plants' managers in Tripoli on the reason for the inefficiency of the plants is that the concept of source separation has not been adopted yet at the municipality level. A mixture of waste components send to composting plants, so large quantities of rejected material need to be removed in order to produce clean compost.

Figure 5-10: Compost pile in Sidi Al-Siah plant contaminated with inorganic waste

Source: Fieldwork, June to Aug, 2010

In terms of quantity, the amount of compost produced by Sidi Al-siah is low compared with its capacity of 120 tons per day. Table 5.11 illustrates the total amount of waste received by the plant and the confirmed amount of compost produced per day. It is clear that in both years 2008 and 2009 the average production, even though it has increased, remains small estimated at 11.76 and 19.50 tons /day respectively. During the site visit, it was observed that there were some problems causing environmental impacts, such as odour and soil pollution released from leachate as a result of deficiency in practices (see figure 5.11).

Figure 5-11: Release of leachate in Sidi Al-saih composting plant

Source: Fieldwork, June to Aug, 2010

Although experience of the composting industry in Tripoli city started more than forty years ago, the authorities do not seem to have progressed in terms of the effectiveness of operation of the technology. The authorities at local level have not taken seriously the formal responsibilities of associated advanced experience to improve the performance of the existing plants. It appears that there is no improvement of the composting industry, as the production of fertilizer is low compared with the operational capacities and it is still contaminated with impurities as there is a deficiency in the operation (see figure 5. 12).

Figure 5-12: Compost with impurity

Source: Fieldwork, June to Aug, 2010

5.3.5 Recycling activities

The recycling industry in Tripoli is almost negligible. The recycling activity existing in Tripoli is operated by the informal private sector; as the researcher observed, neither the national government nor the local government have official records regulating the private recycling sector, whether in terms of the number, size, and activity of companies or even to ensure they comply with health and environmental regulations. The recycling rate is very low compared with generation of recyclable material, as shown in Table 5.4. Data from the EGA waste department indicate that it does not exceed 2.7% of total waste generated. Recycling initiatives in the city are formulated on a simple concept; their operation is mainly focused on removal of impurities starting with shredding, compacting and then packing or selecting some of them based on type of production (figure 5.13). What is produced is then shipped to reprocessing companies both in Libya and beyond.

The activities of the recycling sector are mainly concentrated on processing of materials that can be used as raw materials for other industries, which are often cheaper than non-recyclable raw materials. My field observations at some recycling plants showed that they mainly deal with different plastic materials such as plastic bags, plastic bottles and plastic sheets and their second priority is the processing of cartons and paper and/or metal cans.

Figure 5-13: Some recyclable material ready for sale

Source: Fieldwork, June to Aug, 2010

As observed from field work, because there is no waste source separation activity in the city, the recycling companies in Tripoli collect material for processing from wherever it can be found. Most of it is collected by individual pickers, who remove recyclable materials from collection points at households and commercial premises and landfills for sale on to recycling plants. In addition, some recycling companies buy their raw material from industrial plants, which could be waste, by-products, objectionable material and/or non-conforming to industrial standard. There is no door to door collection of segregated waste, and no sites to which householders can take materials for recycling. What is important for companies collecting recyclable materials is how to access materials that could make a profit with less effort. In interview with a technician for a company, he stated that,

> "Processing of waste materials that comes directly from different commercial centres, whether from trading or services activities is more effective than those wastes that come from landfill. We always raise our voice to collect clean materials that do not disturb our operation system. Our objective is basically to get clean products. Because we are mainly working in a market that accepts just clean raw materials that they need for certain products".

Accordingly, the company owners call for collecting materials based on firstly their economic value, secondly, by their ease of extraction, handling, and transport and finally, it is necessary to be consistent with the operating conditions. This could

restrict the motivation to undertake collection initiatives. Consequently the sector growth has been limited, and it is limited to simple technology.

In general, the recycling rate is very low compared with the proportion of waste consisting of recyclable material. Therefore, much valuable material is dumped in landfill, instead of yielding environmental and economic benefits.

5.3.6 Final disposal practices

Even in countries with high rates of diversion of waste from landfill, a final disposal option is a requirement as long as there are residuals from other treatment options such as recycling and incineration technologies. In developing countries with low diversion rates, landfill is likely to be indispensable for some time to come. However, it is important that landfills are operated to high standards of environmental protection. There are some styles of landfill management that are particular to each country based on their national and local capacity. In this sense, landfill operated in Tripoli city could be described as open dump (Johannessen and Boyer, 1999; Jeppesen, 2005).

Until the 1980s, the disposal sites were inside the city. There were empty spaces within the city; the residents were mainly concentrated in the suburbs near the coast. Since then residential areas have expanded and new districts have been created around dumpsites. With the passage of time, the accumulation of waste in the dumpsites has increased and health and environmental problems have arisen. Observations at one of the old sites inside the city (closed site) showed that a huge mountain of waste covering a large area of land still exists (Figure 5.14). Neighbourhoods' complaints and calls for closure of used dumps have continued and even increased since 1990s. Relevant government bodies responded to the appeals from residents and decided to look for alternative sites outside the city. In the early 1990s they selected two new sites and in 1992 started operating in Sidi Al-siah site; while the Alazizia site began operating in 1993.

The two operational landfills remaining in Tripoli city are owned by the municipality, after expropriation for the public interest. Transfer of land ownership always happens when the State intends to set up a public project. As Libya has a very large area, much land is untapped, especially away from the cities. Usually such

lands are unsuitable for cultivation, and therefore do not have economic value. Accordingly, the local government has no have difficulty acquiring lands. However, the challenge for local government is now the distance of the available lands from centres of population, which are the main sources of waste generation. In the current case, the two sites are at a distance approximately of 60 km from Tripoli. Given the limited recycling and reuse activities in Tripoli, the vast majority of municipal solid waste generated is disposed in the two landfills.

Figure 5-14: The Mountain of waste at disused Landfill in Alhadapa area in southern Tripoli

Source: Fieldwork, June to Aug, 2010

In the city, the TPSC and PCTCs responsible for transferring municipal solid waste from the collection centre to final disposal at Sidi al-saha and Alazizia, both complain about the distance (from 50 to 60 Km), which takes up their time and decreases vehicles' life span. The Public Service Company in Tripoli (TPSC) as the main waste collection company in the city has to transfer a large amount of waste a long distance. In order to resolve the predicament, the TPSC has released a statement seeking the intervention of private companies to take part in waste transport activity, to reduce the burden on them. The TPSC has set a scale of payment allowances for private companies according to the distance that the waste will be conveyed (Table 5.11). The TPSC mangers argue that this figure is very high compared what is allocated by the MHPU to carry out waste collection and transfer to landfill by public sector staff. Thus the company will pay vast sums, even by comparison with the

global perspective on solid waste transport to landfill as calculated by (Cointreau *et al*. 2000). The TPSC figure is about six times that paid in other countries with the same economic level. In interviews with TPSC senior officials, they criticized the decision to adopt those options as final disposal sites. Consequently, the TPSC proposed some ideas to reduce waste transfer cost. One idea revolves around the establishment of a railway network connection between transfer stations and final disposal sites, which may require substantial investment.

From the above observations, it is indicated that waste transfer to landfill is a significant problem. The high disbursement of TPSC funds could reflect the sites distance of the from the city and it raises the question of the validity of the decisions on selection of those sites. Continuing in this manner could drain TPSC's resources, and thus could adversely affect other SWM activities.

Table 5-11: Funds owed for waste transfer stations to landfill

Activity	**Distance Km**	**Libyan Dinar**[7]
Transfer waste directly to landfill	55	39.125/ tonne
Transfer waste from Tajora transfer station to landfill	65	90/car
Transfer waste from Abo-Salim and Alsowani transfer station to landfill	60	70/car

Source: Designed based on TPSC (2009).

The local government is determined to continue to work as it has done for a long period of time, continuing the operation of old sites inside the city. Certainly, the management of the new dumpsites of Sidi Al-Siah and Alazizia is not significantly different from that of the earlier landfills. The managers of those dumping sites confirmed that there was no improvement in the operation procedure since work started in those sites. They attributed this to failure to offer the required facilities that could improve working conditions inside the sites. The interviewees from the Environmental General Authority (EGA) asserted that during site selection, whether

[7] Changing rate in 2010 was 1US$ = 1.25 Libyan Dinar

in Tripoli or in any other municipality, the EGA is either not involved or its suggestions are ignored. For example during the selection process of the Sidi Al Shiah site, the EGA was a member of the committee for site evaluation and selection. Nonetheless, according to EGA representatives, TPSC ignored what EGA recommended for site preparation and operation requirements. The interviewees from EGA believe that relying on the transfer of waste to dump sites is the cheapest option for TPSC as they acquire the sites free from state property holdings and the standards required for pollution control are not very strict. In this regard they added that the EGA is worried about operational conditions in those sites, which will certainly lead to some health and environmental damage.

Both landfills have been receiving waste from all parts of the city as well as neighbouring cities. Alazizia landfill, for example, is exploited by municipality of Aljfara. Waste companies use their own facilities to bring waste to these landfills.

Fees and record keeping

As the operator of the two landfills, the TPSC charge tipping fees for incoming waste upon entry, whether sent by private companies or from individuals, whether using their own car or renting someone else's. The fee is a fixed amount of ten Libyan Dinar per car, regardless of size. A range of vehicle types are used to transfer municipal waste to landfill (Figure 5.15). Fee collection requires a payment for each load of waste received at the landfill, as at both sites, there is no means to accurately calculate amounts of waste given the lack of a weighbridge and manual recording. Lack of facilities to recording data on receiving waste may constitute a major problem for managing waste inside landfills and at the same time it would be an obstacle for future planning of MSWM.

Hazardous waste

The landfills in the city are used to co-dispose hazardous waste with MSW. The hazardous waste arrives at the landfill from different sources such as hospitals and clinics, business and industrial companies. Hazardous waste sometimes arrives to landfill mixed with the municipal waste; other times it is transferred in separate vehicles. Those who are sending hazardous waste pay the same disposal fee as municipal waste generators. The operators at landfill dispose hazardous waste in the

same manner as they do with the municipal waste; they use the same area to dump all in-coming waste and mix hazardous waste with the municipal waste.

Figure 5-15: Different types of vehicles engaged in Sidi Al-siah landfill

Source: Fieldwork, June to Aug, 2010

Operating practice

The waste received at the landfills is simply dumped and spread around using compaction equipment such as the bulldozer shown in figure 5.16 which was used at Alazizia landfill. The two dumping grounds are not engineered, so there are no provisions to extract the landfill gas and drain off leachate from the decomposing waste. Top soil cover is applied occasionally in Alazizia landfill, whereas at Sidi Al-Siah site the waste remains uncovered on the site surface. Landfill fires are banned by law No 13 of year 1984. Nevertheless, burning of waste in landfill was observed when visiting the sites. Figure 5.17 shows the smoke released from the Sidi Al-Siah landfill and spread around the site, covering a considerable neighbouring area. One operator stated that firing at the landfill has been continuous for a long period of time; he estimated that the site has been burning for about three years. He attributed this situation to the site receiving most of the waste collected from Tripoli and some neighbouring areas, the quantity of waste received every day is around a thousand ton (TPSC, 2009). He added that what makes things worse is that the waste received at the landfill is mixed with hazardous materials, some of which release smoke

containing toxic gases. There are other additional important issues observed at the two sites that affect the surrounding area due to its mismanagement, such as odours and serious disease vectors such as flies, rodents, cats and dogs.

Figure 5-16: Equipment used to settle and compact waste at Alazizia landfill

Source: Fieldwork, June- Aug, 2010

Figure 5-17: Landfill fire at managed dump, Sidi Al-Siah landfill

Source: Fieldwork, June- Aug, 2010

In general, in the study area, it appears that the concept of sanitary landfill for both the municipal and hazardous waste is not understood yet. The waste disposal conditions had not improved since it started in the 1980s. Perpetiuation of such practices in the city will certainly cause environmental and health problems. Learning from neighbouring countres and/or countres that have succeeded in this field perhaps is one of the appropriate solutions for such a problem.

Summary

The institutions related to the MSWM have undertaken a great effort in recent decades to tackle the municipal solid waste problems. For example, Libya was one of

the first countries in the region to establish a specific law addressing MSWM and also installed composting plants to reduce the amount of waste sent to landfill. The attempts being made were, however, not sufficient to implement the principles of ESTs. The institutions at national and local level need to be professionally managed to achieve the sustainability of their current and future practices. Therefore, there are challenges that need to be addressed if the relevant institutions are to be in a position to develop sound practices (ESTs) in the municipal solid waste sector.

Firstly, in the context of the legal framework, it is observed that in the past, there was no commitment to implement the designed plans and projects, the capacity of operational bodies might not realised, and this therefore created an imbalance between what is planned for and the potential to implement it. On the other hand, the waste policy included some elements which could be seen as politically undesirable. For example, the plans were based on involving the private sector formally, while the government institutions still insist that it is an informal partner. Accordingly, it seems that in Libya, it is not a problem of setting a legal framework but rather the ability to take further steps. The basic principles of laws have already existed for some decades and waste policy has been formulated more than once. The challenge in this regard is therefore initially to comply with what is planned, and then carry out an improvement based on local economic, political and social conditions.

Secondly, there is a difficulty in obtaining actual figures on waste generation rates and its composition. It is clear that the service providers adopted a rough estimation to calculate what is generated per capita and total waste generation in the city. Lack of MSWM data according to Antipolis (2000) could complicate carrying out many of the service providers activities, such as technology selection, adoption and the development of a strategy. Therefore, obtaining accurate data that reflect the actual reality is urgently needed to build a system on a sound empirical base. The research institutions and other relevant organisations can be involved to provide such facts.

Regarding the current practices, it is evident that the service providers are failing to carry out sound practices, despite the policy–makers' support. In the city, attention was given mainly to collection and transfer of waste outside to the landfill, yet there is a part of waste generated not collected. From the findings in this chapter it is clear that there are defects in the current waste storage, collection and transportation

practices and even in treatment. The observed faults vary from one practice to another; some are related to technologies and others relate to how the technology is operated. Both reflect the weakness of the service providers' capacities. In this regard, there are a number of issues that need to be considered to carry out system reform. This should begin by taking advantage of, and building upon, past experience. Some of the requisite municipal solid waste practices already exist in the city and they have been known about in the sector for decades, such as transfer stations and composting plants. Therefore, policy could build on the reinvigoration of such practices to improve weaknesses in the current system. A further step is to involve the private sector in waste treatment. This is a challenge for local government to assign responsibility to a specific body, because the TPSC is not legally responsible for operating landfill and recycling industry. Another important step challenging the relevant MSWM organisations is to encourage and support to creation of both recycling industries and recovery activities. The city generates daily a large amount of waste, the vast majority of which is dumped in landfill and only few recycling industries are recorded in the city. Applying recycling and recovery will reduce the amount sent to landfill and thus make it easier to operate and adopt sound practice.

In general, this chapter clarified that there are deficiencies in each MSWM element; the ESTs concept is not achieved. To explain causes that hinder adoption of sound practices in the study area, the opinions of the SWM institutions and the service users will be analysed in the next two chapters.

CHAPTER SIX: THE INSTITUTIONAL FRAMEWORK AND ITS INTERACTIONS TO REGULATE MSWM PRACTICES

6 Introduction

The modernisation of Tripoli in recent years has resulted in an increasing demand for environmental services. The provision of solid waste services has become one of the residents' priorities (Elbendak, 2008). However, relevant national and local government actors responsible for SWM have been unable to keep pace with development in the city

As Chapter Five has shown, the waste technologies applied, whether in collection, storage, transportation or in treatment and disposal, have not kept pace with the social transformation that has happened in the city. Analysis of the data reveals that relevant national and local government bodies are unable to set up practices that meet local social, economic and political conditions.

In order to identify the potential for system reform, this research has assessed the institutional procedures regulating technologies at MSWM practices. The concept of EST views technology holistically, i.e., in its social, economic, institutional context (Al-Thawwad, 2008). This chapter discusses what has emerged from analysis of these principles about issues that contribute to the emergence of unsound practices. These principles were investigated based on the findings of the research; and can be highlighted under three key areas;

- Organizational framework; implications of institutional arrangements for adoption of ESTs;
- Environmental policy and ESTs;
- The financial system for funding the MSWM.

6.1 Organisational framework; implications of institutional arrangements for adoption of ESTs

6.1.1 Instability of organisational structure and arrangement

The political situation during Gaddafi's regime was such that the form of institutions and their arrangement was strongly controlled by Gaddafi and his

immediate circle. The regime reformed the structure of the institutions several times during the last four decades. Interviewees from municipal offices, EGA and TPSC thought that the attempts made by the government to change the form of institutions and their arrangements had only led to the instability of these institutions, thus hindering progress in building sound practices. The interviewees argued that the political regime had gone too far in the reform of institutional arrangements, which affected both national and local institutions. Consequently, most of the public service sectors have been affected by continuous changes, including the solid waste sector. Table 6.1 summarises the dates when the bodies responsible for MSWM in Tripoli were formed.

From the beginning of the Gaddafi regime until 1980, the municipality of Tripoli was responsible for providing solid waste services. Later this function was shifted from the municipality to the Ministry of Housing and Public Utility. After this point the role of the municipality became secondary; it had no significant impact on SWM policy making. At the beginning of the 1980s, the public body responsible for providing solid waste service experienced successive changes in its structure. Sometimes the sector was considered as a public service within a combined structure; at other times it was considered as a stand along sector in a separate organisation structure.

The Director of the Cleanliness department at TPSC argued that; ‘’for thirty years I’ve been working in this sector. During this period I’ve noticed that more than twenty of the sector directors have been changed’’.

During his review of this issue, he mentioned; “When they carry out an institutional reform, they start with institutions at national level, then these who take over the new positions start reforming the institutions at local level that belong to them and so on”.

He added;

> “If I tell you the truth about the reality of the company, what has happened to the company in terms of changing its name and dependency, you will laugh; initially we were a cleaning company, then we changed the name to a prevention Company. After that we moved to form as a company under the

Environmental Protection Agency. Subsequently, they added some other tasks and named us the Agency for Operation, Maintenance and Protection of the Environment. In another attempt to recover the Company, they separated some tasks and called it the Public Company of Cleanliness. That attempt failed and it returned to what it was as the Environmental Protection Agency. Then another proposal was raised. They structured all public service bodies at municipal level into one organisation and they gave it the name of the Company of Occupancies and Public Services. Later, this body was divided and they launched us under the name of Company of Public Service. You know, during the last two years we've experienced two changes in terms of task separation".

Table 6-1: Temporal changes and delivery of MSWM in Tripoli

Period	Management agency	No of decree (resolution)
Before 1970	Private Sector companies	-
Until 1980	Municipality of Tripoli	-
1981-1986	Environmental Protection Agency	45/ 1981
1986-1987	Environmental Protection Agency + Operating and Maintenance System	192/1986
1987-1999	General Cleanliness Company	394/1987
1999-2003	Company of Public Authority	11/1999
2003 -2006	Company of Occupancies and Public Services	78/2003
2006	Tripoli Public Service Company	138/2006

Source: Fieldwork, June to Aug, 2010

The senior officials at TPSC invariably expressed their concern about the actions taken by government on how to carry out an organisational reform. They said the changes in institutions' structure and arrangements have become unbearable. When institutions were changed, they had to re-arrange the organisation again to meet the new structure. Consequently, at the level of the company, much time and money was wasted that could have been put into building an effective organisation and accessing appropriate technologies.

An example of how these changes have influenced the development of the TPSC was given by the Director of the Finance Department at TPSC. He stated:

"I was pessimistic about what is called institutions reform. Due to this restructuring, we faced difficulties to cover the cost of the service we provided,

> whenever the national government changed things, they forced on us a new funding system. For example once we were funded directly in a lump sum from central government, then they asked us to cover the cost by levying fees, then again, they asked us to stop collecting fees and forced us to sign contracts, and so on. Currently the system has almost collapsed and they are trying to find another way to fund the sector".

A second example was from the manager of the composting plant at Sidi Al-Siah, who said, "We are sunk in the complexity of administrative routine. For example when we send a letter to take a particular decision, due to the slowdown unwillingness to bear the responsibility, they lose the correspondence and the action is not taken".

6.1.2 Ownership and system operation

Not only was institutional stability in the solid waste management sector undermined by structural arrangements, but these also affected the responsibilities of some of these organisations. From the data gathered in this study through interviews with the representatives from both the TPSC and PCTCs, it was noted that the rules governing responsibility for the provision of solid waste services in the city remain vague and responsibility fluctuates between the public and private sectors. Participation of the private sector in the solid waste service was an attempt to overcome the deficiency in the provision of service by the public sector. However, the boundaries of this partnership between the two sectors in terms of responsibilities were not clear. When the private sector first became a partner, its responsibility was collecting solid waste from specific zones in districts where it had been contracted. At that time, many districts were served solely by the private sector, despite the legal responsibility of the public sector to provide cleaning services for all Libyan cities. In an attempt to reform the partnership, arrangements were agreed upon between the parties to divide service responsibility. The responsibility of the private sector was to provide a collection service to the householders and activities existing in zones where they had contracts. The duty of the public sector was to clean the main roads and streets. However, as in other areas, the procedures for implementing the agreement were not adequate. There were no monitoring and controlling of arrangements. Consequenly, in this stage the provision of service was not as

expected; there was duplication in efforts undertaken to provide the service with simple and limited technologies available, when both public and private sectors intervened to serve within the range of the other sector. Thus, in this phase, the parties blamed each other for the inability to provide appropriate practices.

In 2009, the government intervened to set a radical solution which they believed would solve the problem. The idea was that the provision of the service would be assigned to the private sector. To implement the proposal, the national government released a decree exempting the TPSC from providing waste service and opening the door to contracting with private companies. The residents were exempt from the payment of fees and the national government undertook to cover the full cost of the contract (For more details, see 6.3.1). The responsibility of TPSC in this new form of partnership with the private sector was for supervision of the transfer stations, landfills and composting plants. In this new partnership, they also did not develop the necessary arrangements to safeguard the right of each party to organize the service more effectively by using Environmentally Sound Technologies. In any case, the ministry (MHPU) was unable to activate this proposal to divide practices between the public and private sectors as described. After less than a year of problematic operation, the system was returned to the way it was before, i.e., a combination between public and private companies.

The municipal solid waste sector in the city has undergone many policy revisions. For example: participation of private companies in service provision, levy of service fees from residents and commercial and other service activities; and financial support from the government. However, no arrangement has received the funding necessary to make it work effectively. Interviewees indicated that changes have always been made without any analysis of the system to identify weaknesses, which would have enabled reform based on the shortcomings observed. Interviewees at municipal departments and EGA were asked about the role of the private companies in adopting sound practices. They mentioned that the existence of a large number of private companies had afforded a potential opportunity to improve the operation of the MSW sector. However, the potential for the private sector to contribute to redefining waste operations was neglected. None of the positive features in the practices carried out by this sector were taken into account during decision-making on who would run the solid waste management activities.

The respondents from EGA explained the role played by companies in delivery of MSW services as very important. The Head of the department of solid waste management at EGA, during his discussion of private companies' practices, gave me a copy of a study carried out by the EGA on the MSWM in Tripoli city to show me some records on the status of private companies. One of these figures represents the percentage of their service coverage in districts in the city (Table 6.2).

Table 6-2: Privatization of cleansing job in Tripoli, 2009

No.	Number of private companies	Service zones	Service coverage	
			Private company	Government
1.	1	City centre	1%	99%
2.	20	Hayy al Andalus	95%	5%
3.	9	Abu Salem	50%	50%
4.	14	Alhadapa	70 %	30%
5.	5	Sug Aljumah	70 %	30%
6.	4	Tajora	35%	65%
Total	53			

Source: EGA (2010)

As shown in the table, the proportion of private sector involvement in service delivery was up to 95% in a given district of the city. Also the table shows that the total number of private companies working in the city is estimated at 53. These figures reflect the status of the private sector in 2009, while in an interview with the Director of ESOT in 2010 he stated that the number of private companies working in the city had since decreased to just 35. He explained the decline in the number of private companies working in the city as a result of the national government's change of contract policy. This meant if the government insisted on implementing its policy, the number of companies would continue in decrease in future. This statement was confirmed by the owners of the private companies interviewed. They reported that if the national government continued working with the same contracting criteria, probably most of them would leave the work. The interviewees at ESOT believed that the idea of involving the private sector to work in MSWM was helpful and had met with some success. However, the arrangements were not well thought through. Thus, the attempt to reform the system that was carried out by the national government recently to engage the private sector was unsuccessful.

Private sector waste management companies have shown an interest in expanding their involvement in SWM. The operation of composting and landfill in the city is monopolized by the public sector. The owners of private companies have attempted to work in these options, but the national government always rejected their demands. Three of the four private sector companies who were interviewed said they had attempted to get a licence to practise in the fertilizer industry and/or in recycling activities, but they did not get approval. They said no one at national or local level could say if there is a policy regarding recycling industry or who will be involved. The owner of Mediterranean Company (one of the private companies) said, "During my attempt to get a licence to operate composting plant technology, I met senior officials at MHPU and they told me, you shouldn't think of the composting industry, just even think, as it was a prohibited industry[8]". The opinion of the owners of private companies' on this matter, was that the prevention of private sector involvement in waste treatment was due to the authorities' lack of confidence in the local companies to operate treatment practices. As a consequence, there are just a few companies working in the recycling industry in the city. Meanwhile, the national government has not clarified yet who is eligible to own the operation of the solid waste system. The interviewees at MHPU reported that the private companies who have applied for solid waste management do not have the technical and financial capacity to run such activities in an environmentally sound way.

Attempts to involve international companies are also being considered by the national government. Many companies working at international level in the MSWM sector (e.g.; Veolia) have submitted offers to clean up the city based on their technologies that have been applied around the world, but they were not approved. The national government appears to have a bias in favour of the public sector, in spite of the failures that have been experienced under this policy over the past decades. Participation of private companies is just to cover the defects of the public sector. The owners of the private companies believe that the national government at any time does not consider them as a part of the MWSM sector which is capable to deliver solid waste service or a source of experience, funding, or strategic insight

[8]I.e., not permitted for private sector companies to work in this field.

relevant to the development of Environmentally Sound Technologies in the waste sector. The concern of government in this regard could be just to improve the existing technologies to be more effective by used than at present.

6.1.3 Organisations' relationship and support

In terms of inter and intra-organisational cooperation, a question was raised about cooperative relationships at different levels. Based on responses from interviewees, cooperation among the SWM parties is limited and even in some cases non-existent. For example, the senior officials at TPSC stated that cooperative links with other parties are very weak except with the municipality and MHPU, with whom they were linked by responsibilities for daily work. The managers of the composting plants at Al Swami and Sidhi Al-Saih said sometimes they had a cooperative relation with the composting plant at the municipality of Benghazi. The interviewees at the municipality (MUCT and ESOT) pointed out that they had agreements with some Arab and European cities to exchange experience in the field environmental protection and information, but they are inactive. The private sector organisations were the ones that complained the most regarding a lack of cooperation at all levels. All the respondents at PCTCs and PRI pointed out that there was no kind of cooperation with any other party.

The operational institutions in Tripoli city criticized the role of official bodies at national level that are responsible for setting policies and strategies, especially the role of the EGA. The TPSC and private sector (PCTCs and PRI) respondents mentioned that the role of the EGA in formulating environmentally sound solid waste practices is very limited. The Director of the development and planning department at TPSC stated: "The absence of the EGA and other environmental organisations means that the arena is left empty for the ministry (he meant the MHPU) to do what they want to us and it is not helpful for us to adopt sound practices." He added:

> "For example when we concluded a contract with Ministry, they forced us to sign for only 45 Million. They refused to see our bid or even to discuss the situation. In fact, we are facing the higher authorities with two different faces.

> During the official meetings, and written transactions they promise us to give the necessary support and assistance, while what actually happens on the ground is the opposite. They control us in everything; in the purchase of technologies, in time of payment, how the private sector can be a partner and so on."

Lack of support and cooperation with and between authorities, especially those related to environmental protection, could have many disadvantages in terms of operational effectiveness. This would be especially true with respect to efforts to addressing MSWM issues through adopting sound practices.

6.1.4 Human resources engaged in Municipal Solid Waste Management

Human resources at the Municipal solid waste management sector in Tripoli have largely been neglected. The government at both national and local level see the waste sector as of very low status in terms of the skills needed to work in it. Lack of financial resources and poor planning prevent it from improving its professionalism, which is a hindrance in any effort to improve the sustainability of MSWM. A similar story happened in Bangladesh (Bhuiyan, 2010); the relevant SWM organisations spend about 70–80% of allocated budget just to pay the salaries and fringe benefits to sector employees. According to Bhuiyan (2010) the rest of the money is not enough for institutional development, and this is evidence of how the government organisations manage the SWM sector in a deficient way. From the data gathered in this study, the following sub-headings reveal the real situation of human resources in both TPSC and PCTCs.

I. Staff recruiting

- **TPSC**

In TPSC local administrative and technical staff work on permanent contracts while sanitation workers, who are usually foreigners, are on temporary contracts because of budgetary constraints and restrictions on recruiting permanent staff.

The performance of municipal staff is constrained by employment and salaries criteria which can serve to de-motivate staff, who may otherwise be well trained and effective. Thus, even when TPSC has attempted to recruit permanent staff (especially

sanitary workers in street sweeping and collection activities), they have not been successful.

The lack of stability and continuity of the TPSC workforce is demonstrated by Tables 6.3 and 6.4. The national composition of the staff has changed between 2008 and 2009. From the Table 6.3, local staff have been decreased by about 10 % over that time, whereas, there has been a great change in the recruitment of foreign labour. Labour from Arab nations has sharply declined, from about half of total staff to only 7%. At the same time, employees from Sub-Saharan African countries significantly increased to represent 76% of total staff in 2009 compared to 24% in 2008. The number of people employed changes not only from year to year but also from month to month. This means that employment in the TPSC is often short-term (Table 6.3). Moreover, Table 6.4 reveals the variation in the numbers of employees from month to month. For example; the number of workers from January to February decreased by about two hundred and seventy six persons. The interviewees at EGA and ESOT expressed their view that the reason for staff instability was decision-makers' lack of awareness of the consequences of reliance on casual labour. They added that such workers are usually unprofessional and of low educational level. Senior officials at TPSC commenting on a question on recruiting staff procedure explained that the TPSC does not have to offer foreign labour long term contracts; there is a difference in employment rights between local and foreign people. The current state of the labour market in Libya is dominated by short-term contracts or verbal agreements. No one will offer a long-term contract, because the majority of those seeking work do not have identity cards. Thus, they cannot enter into a formal contract. Moreover as a company under the public sector, TPSC is not allowed to contract with workers from abroad unless they obtain permission; this issue is within the jurisdiction of the MHPU.

Salaries of MSWM staff working in TPSC, like any other public staff wages, are governed by Law No 15 for 1982 which categorises salaries for different employment classes. This means those who work in SWM earn the same as those employed in other sectors, despite different working conditions. For example MSWM workers do not receive any risk allowance or health insurance.

The manager of the composting plant at Al Swani was asked about the reason for employees leaving a job. He replied; "Always the technicians and workers leave their job when they find an alternative, and this basically is due to working conditions themselves, Workers are afraid they might get some diseases due to lack of facilities and weakness of health care''.

Table 6-3: Local and foreign staff in TPSC during 2008 and 2009

Statement	**Year 2008**		**Year 2009**	
	No	**%**	**No**	**%**
Local permanent and temporary labour	1258	27	819	17
Arabic region temporary labour	2287	49	352	7
Sub-Saharan Africa temporary labour	1144	24	3712	76
Total	4702		4890	

Source: Derived from TPSC (2008) and TPSC (2009)

Table 6-4: Monthly fluctuations in TPSC manpower in 2008

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
No of staff at 2008	4655	4379	4485	4638	4699	4744	4769	4823	4591	4801	4924	4920

Source: Derived from TPSC (2008)

The manager of the composting plant at Sidi Al-Siah believed that the situation of staff who run the MSWM sector under the municipality needs to be reviewed, as they earn low wages despite their difficult working conditions. He said,

> "As manager, I felt I could not order any of the workers to do the best they can, because he knows clearly their situation, and if he did perhaps the first time they would respect him, but he was certain that if he repeated the order they would ignore him. Thus the work in the plant went slowly and the production of fertilizer was much lower than expected".

He added,

> "If we compare the condition of the staff working at TPSC with those working in the private sector, especially those working in our sector (MSWM)

with private companies, in terms of salaries, incentives and health care, you will notice the difference and to what extent our staff are suffering from a lack of such things. I will try to give you some example to prove it. The Bulldozer driver at our landfill, he's an uneducated person (he has a secondary school certificate) and also his working years record is less than five years, so in this situation according to employment law he will earn a monthly salary of around 400 Libyan Dinar. while when we decided to resort to the private sector, another bulldozer driver was employed, and the driver who worked for the private sector earned most of the time three times what our driver earns, because his working is arranged per hour which is very high and they do not have to comply with an employment Law, which orders the monthly salary as a sum lump. The second example I can express to you; our staff who work either in the composting plant or in landfill do not have a meal or even regular health care, for which they are legally eligible based on the law No 13 for 1984. Frankly our company is suffering from a lack of financial resources to cover such requirements".

The employment conditions at TPSC can be described as unstable - staff, especially those who working in waste collection crews and in composting plants, are paid poor salaries and they do not receive their rights. Of course, the presence of a combination of factors will affect the effectiveness of the company's ability to adopt new practices. This was revealed by TPSC interviewees, who reported that improving employment conditions was beyond their control. Therefore, the interviewees argued that under such arrangements the TPSC are not able to operate effectively, let alone change their current practices to incorporate advanced technology.

- **PCTCs**

As I mentioned in the method chapter, the private sector is engaged in MSWM in Tripoli in the form of small companies (excepting one working in Sug Aljumah). Private companies employ their staff (usually drivers and waste collectors) through informal contracts. This means that the parties do not require any notice or reason to terminate the arrangement on either side. The private sector is not governed by law No 15 for 1982, as explained in Chapter Three (heading 3.4.2), so the owners of

private companies are free to set the wages they consider appropriate to meet the function to be done. However, the salary paid to workers in private companies is higher than that of their peers working at TPSC. Thus, conditions are conducive to stability. This was confirmed by the interviewees at PCTCs and PRI, who said that most workers remain in their jobs for long periods. The owner of the Al-safoa company said that "the waste collection staff working in my company for several years, most of them they are Egyptian, they travel for vacation and come back." Hiring of staff for long periods was said by the company owners as having many benefits. They gave several examples, such as the staff will learn from experience how to collect the waste; they could built a good relationship with service users, which will facilitate their job and finally their work is facilitated by their knowledge of the area they are working in. Therefore, the owners of the companies said they pay a high enough salary for their staff to ensure they are happy with them and do not think to leave them at any time. Whilst positive for the operation of the PCTCs and their staff, the difference in conditions between public and private sector employees in the same sector creates tensions and contributes to the difficulties of the public sector.

II. Staff skills and training

- **Skills**

As explained above, employment in the MSWM relies heavily on temporary workers, most of whom are foreign, except those working in the administrative departments. This means it is difficult to recruit skilled workers, especially at TPSC, and even if they are employed it is difficult to retain them because of a lack of incentives that encourage them to prefer to remain rather than leave when there is an opportunity. The Director of the development and planning department at TPSC reported that most of the staff have more than twenty years' experience as workers in the company (i.e., Libyan staff involved in Administrative Affairs, operators of maintenance workshops and the supervision team). These employees are the permanent staff at the company and form the elite that currently runs the company. Recruiting conditions for each of those employees was according to a decree issued by MHPU. Thus, anyone who decides to stay to work in the company can remain forever unless they breach the laws regulating progress of the work. Continuity in the

same work has many benefits as well as disadvantages. For example it could build experience in a specific technique as they repeat what they do and solve obstacles and difficulties during running the practice. Thus, the administrative staff and many technicians may have experience in their field and can develop solutions to improve the company's practices, which is an advantage of having local skilled staff. However, those who occupy permenant position may not have been hired for their sustainability awareness or abilities and therefore there may be limits to what they can do.

However, the TPSC still has difficulty meeting its requirements in some skilled jobs, especially from local labour. For example; managers at two composting plants, stated that there is reluctance among local labour to work in the solid waste management sector, except those who are uneducated or cannot find a job. To explain this phenomenon the Director of the Cleanliness department at TPSC commented that "Libyan citizens' reluctance to work in this sector is due to a large extent to society's view; citizens are afraid of street criticism. They say "I'm afraid people (i.e.; relatives) could see me sweeping or collecting waste in the street or working in a waste factory". The Director of Cleanliness department at TPSC said the story is like this:

> "When a job seeker comes to the company requesting work, he declares he will work at any job offered, but after getting a job in the composting plant or waste collection crews, he will start to attempt to transfer to another job in the administrative or supervision area, and he will never stop until he gets his wish".

The interviewees at TPSC argued that because of these staff recruitment issues, the companies will not be able to establish an effective technician cadre in different waste practices.

- **Training**

In Tripoli, although the TPSC has made some attempts to raise the skill levels of its staff over the past years, most efforts were focused on how to improve the training of the administrative staff. By contrast, for the technical personnel, the potential for getting an opportunity for training is very limited. All the participants interviewed from TPSC claimed that the training sessions available are always either in

computers or in documentation, or in general on how to improve the administrative situation at the company. Only two of 12 staff operators at composting plants interviewed mentioned that they had received training and/or orientation since they started working at TPCS. One of the training courses received was related to operations, while the other was related to administrative guidance. Overall, from the interviews conducted with eight senior officials at TPSC, it appeared that there is no clear plan to train the staff. For example the senior official who is responsible for training programmes at TPSC when interviewed concerning this matter said,

> "The Company is unable to carry out training programmes for the staff, because firstly our financial resources are limited and it is confined only to covering the cost of day to day operations. As a company we have a big staff with different disciplines. We cannot provide the necessary training, especially for those working in service provision, most of whom leave their job after months or maybe after just a few weeks, such as the sweepers, collectors and those who are working in composting plants and landfill in temporary jobs".

He added,

> "As a company we only offer the training which we believe is very important for us. We cannot develop an integrated training plan, for example a yearly plan. We believe it is the municipality's task in cooperation with MHPU and EGA".

At the municipal level, interviewees at MUCT stated that during the past years they had not noticed any training session carried out by the municipality. It appears that the staff members at MUCT who supervise the implementation bodies are frustrated with inaction by the municipality and its failure to play its role in providing training for staff. In explaining their position in the absence of a training programme, as they represent a part of the municipality, they admitted that their role is to follow up and monitor the SWM sector, but they claimed they lack the power to set up a training programme, because the higher authorities in the municipality always reject their proposals on the grounds of lack of facilities, especially financial resources. Therefore, usually they did not try.

Training sessions, whatever their objective, are organised on an occasional basis for a specific event or when there is a particular request. Thus, very few sessions are organised, sometimes no more than one a year. The head of the department of Solid Waste management at EGA said,

> "The cooperation between the EGA and the municipalities in the field of training is limited. We know trainers at local level and national are not available in many training areas, but as we are a focal point between the international institutions such as UN environmental organisations and the organisations at national and local level, we have the opportunity to collaborate with experts at international level whenever necessary. However, I, personally, I have worked with the EGA for many years and did not notice the officials in the municipality requesting assistance to raise their staff capacity. We carry out some courses for many sectors, according to what we see is important for us, but overall the number is limited, for example in solid waste sector last year we carried out only one".

Companies of the private sector are facing the same problems as public companies. The owners of the companies who were interviewed criticised the role of the government authorities in providing training programmes that should be available to them. To develop their staff, the companies' owners decided to rely on themselves to organise some training courses and they had carried out a number in cooperation with NGOs in Tripoli.

6.1.5 Access to information relating to ESTs

The improvement of service operation and even more so the adoption of new technologies and procedures is requires the availability of information on technologies and their operation. Luken and Rompaey (2008) in their literature review, indicate that a lack of information was one of the obstacles of technology diffusion in developing countries, and they discussed it as one of the barriers to ESTs adoption.

To gather data in this respect, two kinds of questions were posed to the operational and supervision and regulatory bodies. The first question was whether

staff have access to hard and soft tools of information (i.e.; magazines, scientific journals, internet access).

All the interviewees either in operational bodies or in the supervision and regulatory bodies expressed their concern over a shortage of information and accused the authorities to which they belonged of failing to provide this. For example; the respondents at TPSC complained of lack of access to scientific journals and the internet. The Director of the development and planning department at TPSC explained the matter, saying,

> "The weakness in the financial supply affected the ability to improve our company. As you see, our offices are empty of computers. As you know, all the institutions at the country level haven't access and they are facing difficulties to obtain publications and scientific periodicals, and the role of MHPU in this concern is weak, though it is important that they should play it".

The respondents at EGA had the best access to information. They mentioned having access to some publications and scientific periodicals related to SWM. They said the information usually came from international organisations, with which they had links. They added that EGA staff have access to the Internet, so they can access information that is freely available.

The second question was whether staff have information on the practices in neighbouring and EU regions.

At the operation bodies, all those interviewed at the TPSC had visited some Arab countries, especially Egypt and Tunisia, and they said they had a reasonably clear picture of MSWM in these countries. One of the eight interviewed at the TPSC said, "I have some knowledge on EU practices", whereas all those interviewed in the private sector (PCTCs and PRI) stated that they had no information on practices either in the Arab region or in the EU.

At the supervision and regulatory bodies (EGA and ESOT); the respondents at EGA said that, to some extent they had an idea about the practices in Arab countries and EU, formed by working with some international organizations such as UNEP and MAP. However, those interviewed at ESOT said they had some idea on the Arab region but did not know clearly what is in the EU. They attributed their position to a

lack of information exchange, such as organising conferences and seminars at local level.

The potential for the existence of practices similar to the EU's in Libya is difficult to achieve. All respondents agreed on this, though some did n'ot know what the EU policies are. They argued that the current local conditions (they meant the financial, political and the institutional structure) made it difficult to approach what the EU did or even neighbouring countries like Tunisia. First Libya needs to concentrate on how to improve the current situation, perhaps mainly by increasing the reliability and stability of the system; then it might be possible to look towards future development.

These findings demonstrate the lack of potential for Libyan SWM institutions to reform themselves without some deep rooted changes in operation, and/or the input of appropriate advice from external sources. Simply giving staff access to information would likely have a limited effect without accompanying training.

6.2 Environmental policy and ESTs

The aim of analysing the content of the policy and legal frameworks firstly is to explore the potential for adopting ESTs under the current circumstances. The second purpose is to identify to what extent the national and local government could carry out system reform. To gather the data in this context, questions regarding policy and legal framework were asked to elicit responses on perceptions on three related issues:

- Policy framework and the role of relevant government
- Environmental regulations; are they sufficient to accommodate ESTs
- Enforcement of environmental regulation and the role of supervision bodies.

6.2.1 Policy framework and the role of relevant government agencies

- **Making a decision to adopt technology**

The respondents at MHPU, MT and TPSC reported that criteria that facilitate technology selection do not exist, in the sense of written criteria to facilitate a selection procedure that meets local factors (strategic, operational, financial and social level). Decisions for technology acceptance or rejection depend predominantly on what is written on tender documents and aids provided by suppliers. The interviewees from MHPU and MT commented on the failure to develop local criteria that would help in selection and system design, due to lack or inaccessibility of

information. The Head Department of SWM at EGA stated that the EGA was not always involved in making decisions to select SWM technologies purchased by the TPSC and MHPU. They have a role in evaluating technologies that foreign companies would like to introduce at national or local level. In terms of participation and cooperation of governmental actors at different levels and other stakeholders in making decisions, it was observed that the government tends to form committees charged with technology selection tasks. Such committees are often restricted to members of the departments of MHPU as the funding body and TPSC as the implementation body.

As the interviewees at MHPU, MT and TPSC said, in general the selection of technology in Tripoli city was based on the low cost option with little consideration of other aspects. They gave examples such as buying open collection vehicles and tractors from a local manufacturing company which are not compliant with standards. Moreover, it was observed that the country's political orientation can lead the choice. The interviewees at MHPU, MT and TPSC said with respect to some of the technologies that have been purchased, that political factors were usually behind decisions.

- **Top-level of policy-makers behaviour**

The respondents in all organisations raised arguments on the role of the decision-makers at top level and criticised the way they treat the SWM sector. The researcher considers it is important to present some of the interviewee opinions on this matter as individual perceptions (see Table 6.5).

The comments outlined below are critical of the decisions and policies of the organisations led by those who are described as an unconscious to environmental issues. The interviewees argued that those policy-makers never leave the MSWM policy stable whilst searching for improvement. Rather they always launch decisions without careful study and advance warning. This is not conducive to the implementation of sound practices. For example, they gave the private sector authority to collect municipal solid waste from the city, and after only six months retracted their decision. This tarnished the image of the private sector's abiliy to manage solid waste in a proper way, because it left a bad impression.

Table 6-5: Respondents' views of policy-makers

Private companies (PCTCs and PRI)	The owner of African Union company for recycling	Those policy-makers do not understand the issue of MSWM, they lead us to disaster.
	The owner of Al bahar Almotawsat company for waste collection	Because of the unwillingness of policy-makers, we cannot leap to wrestle with the treatment problems, we are still struggling in collection and waste transfer programmes.
	The owner of Al-hadaf company for waste collection	.....those policy-maker are corrupt people, they have an interest in foiling the local private sector, to open the way for foreign companies to take their place.
Public company (TPSC)	The director of Financial department	They are not interested to allocate adequate financial resources. …..and they are not interested in environmental issues especially SWM, and the environmental and health risks that may occur.
	The director of Development and Planning department	They haven't knowledge on how to steer the SWM system toward sustainability
Municipality office (MT)	Senior official at ESOT	…. If I was responsible or in the perspective of responsibility, selection of educated people to lead the system is my priority instead of those politicians.
	Senior official at MUCT	It is possible to develop appropriate policies, but those responsible do not want. This is not in the interest of the people or the country.

6.2.2 Environmental regulations and accommodation of ESTs

In Libya, at the national level, most of the environmental regulations especially those regulating MSWM were established several decades ago (see Chapter Five, Table 5.1). They therefore may not meet the current needs of either the municipality or its partners as service providers and the residents as service users. To investigate if the legal framework that is currently employed provides coverage for the principles of ESTs, the interviewees were asked about two issues: first, does the existing regulatory framework meet their present needs; second, does it contain sufficient incentives and support to facilitate transfer of ESTs. Otherwise, improvement in waste legislation is an imperative step to accommodate ESTs.

- **Adequacy of existing regulatory framework**

With regard to this issue, there were three points of view. First the owners and managers of the private companies considered that the current regulatory framework did not meet their requirements. This was simply because in the existing laws there are no provisions regulating the private sector as an essential partner in MSWM. Therefore, they claim to be vulnerable to policy instability. The second point of view reflects the opinions of the vast majority of the interviewees in operational bodies in the public sector and supervisory bodies at different levels. They assert that the existing laws that regulate MSWM are satisfactory, particularly when it comes to collection system practices, but are still deficient in the setting of instruments interpreting these laws to make them clear and understandable for all parties involved in waste management. This second group argued that most of these laws, especially law No 13 for 1984, are very old, so it is necessary to develop terms and additional rules to cover deficiencies that arise due to the country's social, political and economic development during these years. One such development is the increase of plastic materials and electric and electronic components in the waste stream. These are generally not biodegradable and furthermore can emit hazardous materials to land and water. Specialised technology is therefore required, but there is no procedure to adopt sound practices to reflect changes to the waste stream. In this regard, senior officials at ESOT reported that lack of such instruments that clarify the role of relevant organisations was one the main reasons which negatively affected past attempts to reform the system.

These instruments provide the criteria that distinguishes the rights and obligations of each party, whether an operational body or supervision body or even the user body (Schubeler *et al.* 1996). Respondents at ESOT and MUCT said they had attempted to set some standards but they had not been adopted yet by the MHPU. Thus, they now faced many problems in carrying their tasks. For example, the contractor does not know the implications of what he has signed up to; and the inspector does not know what to notice. One of the ESOT respondents gave an example of how difficult it is implement and follow up the terms of the contract, saying

> "In the contract conditions there is a clause that says the contract is signed to carry out the collection and sweeping activities for the district (written the name of the district) with due respect for the current laws and regulations, this is a

vague phrase, but if there were terms of reference for each activity derived from laws explanations, then, everyone's task would be clear".

Those interviewees who agreed with this point of view acknowledged that the consequence of vagueness in the current laws has contributed to service delivery in the city that often did not apply appropriate technologies in the collection and treatment practices carried out via public company or private companies, leading to poor practice in terms of public health and environmental aspects.

The third point of view, explained by two interviewees from MHPU and EGA, was that due to non-enforcement of the laws though-out their life, it is difficult to assess whether this regulatory framework is sufficient to carry out and adopt sound practices or not. They said that, in general, they could not say they were not sufficient, simply because the operation of current waste practices, whether in waste collection or treatments, did not rise to the level of existing laws. They considered it necessary for national and local government to devote their efforts to activating these regulations as a first step, and then it might be easy to decide and identify deficiencies in order to carry out the necessary amendment.

- **Incentives and legal support facilitating transfer of ESTs.**

Public and private companies in the solid waste management sector are treated like other business sectors in administrative and financial terms. The owners of private companies criticized the existing laws, arguing that these laws do not treat them fairly. The bodies dealing with them often do not treat them as a sector that provides services of public cleanliness, but as a sector running a business. In other words, there is no government intervention to ensure an adequate level of service. They said the main reason they did not have the appropriate technology was because the government did not support them with adequate incentives, like long-term loans and sales tax exemption when they purchased equipment. So it is essentially a financial problem.

The respondents agreed that the current regulatory framework does not provide suitable context either to improve existing practices to become sound practices or to encourage use of other treatment technologies appropriate to local conditions. They blamed the top level of policy-makers for steering the MSWM sector towards only collecting waste from the city and transporting it to be dumped in an open area at the

landfill, which is not sound practice, and accused policy-makers of having no idea of how to plan projects with a view to sustainability. Also they were unconscious of the risks that could occur when implementing unsound practices or even worse, when there are no practices for handling of such waste. The head of the department of solid waste management at EGA said:

> "The EGA recognises that there are too many gaps in the legal framework and has attempted to rectify the matter and carry out system reform. The EGA submitted in 2005 the National Programme for Environmental Sanitation for five years of 2006-2011. One of the main project objectives was to reform the laws and formulate new policies to extend the participation of the private sector and promote recycling and reuse activities".

He added:

> "Always the policy-making at the top level remains the main obstacle (he means failure to provide financial and technical support) to implementing such a project. This behaviour which the policy-makers adopt indicates that they are not interested to carry out system improvement and unconscious of the system sustainability".

In general, the perception of the respondents interviewed in relation to the policy instrument that is adopted in Libya described it as entirely depending on command-control, while other co-operation policies such as economic incentives are still unknown. They presented examples for clarification, such as absence of the polluter-pays principle, recycling credits and tax revenue.

6.2.3 Enforcement of environmental regulations: role of supervision bodies

The respondents asserted that there is a lack of enforcement of environmental regulation, which they argue is more important than the enactment of laws. In Libya, enforcement has not been realised.

As mentioned in the organisational arrangement section (6.1), Libya has its national environmental protection agency (EGA), which is responsible for

developing and promulgating (in concert with the National People's Congress, the State Council for planning, and the Ministries) environmental regulations and programs, but environmental protection enforcement is vested in local governments at the municipality, called Environmental Sanitation Offices (ESOs). This is part of the explanation for the failure to enforce the environmental regulations. Mainly; the local ESOs are structurally positioned outside the top-level of policy-makers interests and concerns. As explained in Chapter Four (4.3.1.2), ESOs is a restricted body, administratively and financially under supervision of the municipality, while technically overseen by the Ministry of Housing and Public Utility. The head office of Environmental Sanitation Offices at Tripoli (ESOT) reported, "We haven't the physical and financial resources to carrying out the inspection practice and our other tasks in effective way".

Given the weak structural position of the municipality offices, they revealed that the response to written reports on cases and results of field work carried out by inspectors was very weak and often there was no response at all. Here other problems arise that limit their enforcement abilities. The operational bodies (TPSC and (PCTCs) subscribed to this issue. They claimed that the current institutional structure is weak and there is a need for a body that meets the requirements.

Two interviewees from TPSC explained to me the organisational arrangement in the neighbouring countries like Tunisia and Egypt. They said those countries' institutional framework consists of a national waste management agency at the national level, while in Libya such a body does not exists. Such a gap in organisational structure has affected the establishing and implementing of waste policies and strategies, as well as in the regulatory context. They believed that the solution lies in the setting of similar structure as in neighbouring countries. In addition to what is mentioned above, there is another reason why the environmental regulations are not enforced, related to the role of EGA, which is weak or in many cases EGA does not have an official role in making decisions on operational practice that are relevant to its responsibilities and/or would benefit from its expertise. The respondents reported that the EGA did not play its role as they would wish in promoting MSWM practices, such as increasing awareness amongst stakeholders and

facilitating access to ESTs. Table 6.6 summarises what has been raised through these arguments.

Table 6-6: Respondents, criticisms of EGA role

Private companies (PCTCs and PRI)	The owner of Al-safoa Company	.... and I did not see any action from EGA in what is happening nowadays to the private sector
	The owner of Al-hadaf company	.... I'm working in this field for more than 19 years, I didn't see them execpt just once when they sent me a letter asking me to not collect hazardous waste with municipal waste
	The owner of Shaty Al-andalusia Company	..... Unfortunately the input of EGA is absent, it is a lazy authority
	The owner of African Union Company for recycling	...I would like to say something to you, the MHPU, EGA and TPSC all are working against protection of the environment, they refused to support me to improve my recycling plant
Public company (TPSC)	Senior official	The role of the EGA now is played by the MHPU and the MHPU is increasingly controlling everything
	Senior official	... I think the input of EGA would very important to adopt new technologies. Unfortunately, their role is still limited
	Senior official	...the EGA haven't the capacity to create initiatives and thus it does not have anything to offer.
Ministry of Housing and Public Utility	Senior official	The EGA and other relevant authorities are to blame because they are absent and failed to provide support to improve the service
Municipality offices	Senior official at ESOT	...I assure you that the EGA now does not know what is happening on the ground, it seems they are not interested

The interviewees expected that the EGA would do a lot, as designated by the Law 15 for 2003. However, the interviewees' opinion, it has failed in what it is supposed to do. The private sector complained about the EGA and they argued that the role of EGA did not occur through support and encouragement and that its activities depend

on the vagaries of institutional arrangements and funding sources. The opinion of the TPSC, meanwhile, was that the EGA did not play their role and thus environmental issues were not their concern. In this regard the EGA believed that its role was undermined, firstly by their position within the institutional arrangement as they belong to MPHE and MHPU, and secondly due to their limited human resources.

Another reason raised that was a cause of failure to enforce the environmental regulations, was linked to top level decision-makers' behaviours, in that they do not take action decisively against violators. They have tried to play on the concept of consensus building, which is favoured by Libyan culture, rather than conflict. They have not worked on activating the role of prosecutors. Incidentally, in Libya there is a special court to settle the issues of public utilities (i.e. water pollution and SWM issues). The environmental regulations (i.e. Law No. 13 of 1984 and Law No. 15 of 2003) do allow for law suits. The offices at the municipality instigate action in the courts, while the EGA do not have a role in this regard. However, the head office of ESOT reported that court rulings are rare, both because of the desire to avoid conflict and because the Libyan legal system has structural defects.

6.3 Funding of the MSWM sector

Libya as a developing country faces similar financial constraints to those experienced in other Arab countries, as explained in Chapter Two. In this section the funding system elements will be discussed to understand the obstacles to applying ESTs principles in current practices.

6.3.1 Source of sector funding

- **TPSC**

Traditionally, SWM infrastructure and equipment owned by Tripoli municipality have been financed through central government allocation. The national government fund is used to finance municipalities' (Shabiyahat) expenditures; part of these allocated funds is used to subsidise MSWM activities. In an interview the Director of the Finance Department at TPSC said that "For the last three years, since 2007, the central government had allocated 330 million Libyan Dinar yearly to fund MSWM sector at the country level". The Ministry of Housing and Public Utility (MHPU) is responsible for distribution of funds earmarked from central government among Shabiyahat and according to the service price schedule which was adopted in decree

No 241 for 2006. Based on the estimation of the Director of the Finance Department at TPSC the annual money from the national government (MHPU) represents approximately of 70 percent of the total revenues planned for TPSC, while the remaining 30 percent must be collected by the TPSC's own resources. This 30 % comprises fees levied for the services provided to industry, commercial entities, schools, universities, hospitals and clinics. There are no fees collected from residents. The Director of the Finance Department at TPSC explained:

> "When the funding system of the municipal solid waste sector changed in recent years, the national government requested us not to ask the residents to pay fees for service provision. Paying the full cost of the contract is undertaken by the government except 30 percent of the contract which the company has to collect from commercial and service establishments". He added, "Even if they asked us to collect the fees imposed on the population, there is no feasibility of doing so, it's not worth it, it's only a symbolic value of one Libyan Dinar imposed for residents, set many decades ago. It's not equivalent to the cost of the service provided".

When I asked about this, respondents at national level assumed that residents could not, or would not, pay a realistic amount. For example, the senior official at MHPU said, "The government decided to exempt the residents to ensure service improvement and this could be achieved when we conclude an annual contract with the service provider and it is fully paid by the government".

With respect to the second source of the TPSC budget, which as mentioned above represents 30 percent of the total funds, the value of the fees paid is based on a central government decree issued in 1990. The decree requires every commercial and service entity to pay a certain fee to the service provider. The company has problems with the mechanism developed to collect these fees. In an interview conducted with the head of the revenue collection office at TPSC he said that,

> "This part of the company's revenue constitutes only a small fraction of the subsidy, more than 10 percent of total funds". He added that "It does not cover the cost of services provided to these bodies, simply because the vast majority

of these fees are not collected and services are provided to most of these entities free of charge".

Generally, it appears that the TPSC relies almost entirely on government funding. The relevant organisations including TPSC have failed to address related issues that could improve the financial situation of the company. It seems those who are responsible for SWM, whether at the decision making or making policy level, are not familiar with the ESTs principles concept of total accurate financial cost (Goddard, 1995) in terms of its finance routes. The participation of residents and other waste service users could be the key solution for raising company revenue if they set appropriate and affordable fees and institute reliable mechanisms for their collection. These tasks would not of course be without their own challenges. Central funding might be critical to institute improvements to service that might increase the willingness of residents (and businesses) to contribute to the costs.

- **PCTCs and PRI**

The financial arrangement between the Libyan government and the private sector is different from that with the public sector. Private companies, whether they participate in collection or in transport of waste, do not receive any kind of governmental subsidy. Owners of the private companies (PCTCs and PIC) are totally dependent on their own financial resources to buy waste collection vehicles and other necessary equipment and to pay workers' wages. The private sector in Tripoli city collects a solid waste service charge from residents in the areas served, estimated at from 5 to 10 Libyan Dinar per household per month. It was observed that the estimation of fees is normally based on the socio-economic standing of the household, which can be recognised by the suburbs inhabited by residents.

In fact there is no legal basis supporting collection of such fees from residents. Company owners determine the price, and do not have the right to force residents to pay for the service. In other words, residents' contribution in private waste collection services is not compulsory; it is based on accepting the offered service. As the nature of the system is fragile, the private companies are not obliged to keep up service delivery if payments are not made. In general, the problem of insufficient Shabiyahat funds is complicated further by Shabiyahat tax collection inefficiencies.

6.3.2 Cost recovery

Cost recovery is undertaken by service provider companies, whether by the TPSC or PSTCs, each from their own allocated financial resources.

TPSC is supposed rely on a service fee as main source of funding as set out in the legal system to cover the expenditure of service provision. However, they depend heavily on funding allocated by the national government. Recurrent cost recovery is a preliminary responsibility of the TPSC, in the form of a "cleansing tax" paid by solid waste generators (commercial and services establishments). Table 6.7 shows the revenue sources that could be employed to recover the service cost and their availability. Although the central government has agreed to cover the cost of provision of solid waste services, the MHPU does not comply with the contractual condition to pay dues on time.

Table 6-7: Sources of revenue intended for TPSC

Source	Amount	Accessibility
MHPU	70% of total TPSC budget	Available
Household fees	0.5 Libyan Dinar /Month/ household	Not available
Commercial and industrial Activities' fees	15-2,000 Libyan Dinar /year depends on type and size of activity	30% of the total is available
Open market of agricultural products	5 Libyan Dinar per event per person	Not available
Transport of C&D waste	10 Libyan Dinar /ton	partially available
Dumping waste at landfill	10 Libyan Dinar / Car	Available
Penalties	In accordance with the provisions of Article 15 of Law 13/1984	Not available

Source: Fieldwork, June to Aug, 2010

All the TPSC participants interviewed reported that there has always been a delay in payment of amounts owed for preceding months. At the time of the interviews there was a delay of four months. Therefore, it cannot be said that this source is reliable. Households are exempted from charges, while commercial and services activities are forced to pay, yet, the company cannot collect more than 30 percent of the estimated cost of the service. In theory, the public company (TPSC) has a legal right to try collect fees for service provided to the users. As shown in Table 6.7, the regulation set a value of 5 dinars for each user in order for cleaning their area occupied in the market. The following row of the table displays the costs to be paid

for transporting Construction and Demolition waste (C&D) to landfill. However, the TPSC does not take advantage of these regulations. For example, the head of the revenue collection office at TPSC said:

> "It is true that the municipality collects the tariffs from agricultural open markets on a semi-regular basis, but what is collected is not delivered to the company; the municipality is the beneficiary from this revenue to cover some emergency services, such as carrying out a cleaning campaign".

Regarding the transfer of C&D waste, he commented.

> "This option of revenue is almost not accessible for the company. Construction and Demolition waste generators are not interested to transport their waste and there is no legal deterrent forcing them to comply with the payment, such as other penalties prescribed by law which have not been activated".

The head of the department of development and planning in Tajora zone at TPSC described the problem of accumulating construction and demolition waste in streets and open areas in Tajora: "The TPSC had carried out a field survey to record the amount of waste dumped in these places, and the results were frightening, showing that 78,144 tons should be transferred to the final dump".

Revenues from taxes for the services provided by the TPSC are far below theoretical amounts. Although power to impose taxes by issuing a decree is given to the TPSC from higher authorities, they have tried but they failed to levy sufficient taxes. The tax base is generally very weak. For example, many commercial and industrial premises do not pay the fees charged by TPSC, on the pretext of deficiency of the service. On the other hand, the laws are not enforced. In general, the situation for tax recovery is very poor. Many taxable properties are not registered and not licensed to engage in commercial activity. Certain property holders somehow manage to escape the tax net.

The resource recovery operations run by TPSC do not generate revenue on a scale that can make a significant contribution to the costs of running the operations. In general, the resource recovery activities run by the TPSC are weak. In addition to what is mentioned above, the company did not run any recycling practices except

two composting plants. In the two composting plants, the production rate is low due to continuing breakdowns in their operating system, high level of material rejection and so on, as explained in Chapter Five (see Table 5.10). In interview, the managers of the plants reported that the revenues from those composting plants did not cover the cost of operation and maintenance. They sold what was produced based on the price schedule (27 Libyan Dinar / ton). The manager of Sidi Al-Siah composting plant acknowledged that the income of the plant covered less than half of its operation and maintenance cost, mainly because its production rate was law compared with the salaries of the staff operating the plant and daily running costs.

- **PCTCs**

From establishment of the private companies (PCTCs) to the second half of 2009, their operational and maintenance costs of MSWM were covered through user charges. Residents paid what was agreed upon. After this date, the private sector became dependent on contracts from the government and paid by MHPU occasional sums to cover some of its costs. The owners of private companies who were interviewed emphasized that their previous situation was good and stable; in the past, they meant before second half of 2009, the residents were willing to pay for the service provided, and they had play an effective role in improving the service delivered. The compny built a good relation with our users; they became familiar with the system. On the contrary, they revealed that nowadays the financial situation of the private companies has become worse, similar to the public company, due to low contract values and irregular payments. However, they maintaned better conditions for employees compared to the public companies.

6.3.3 Users' fees collection mechanism

- **TPSC**

In order to provide a means of funding for TPSC, which would treat the various waste users, the national government in recent decades designed a number of charges. Table 6.8 illustrates the tariffs for commercial and industrial establishments according to the general financial Law No (11) for the 1994. This law specified the maximum and minimum limits for the fees. In addition, the government at national level has given the TPSC and PCTCs the authority to conclude individual contracts

with some other entities not included in the table, such as hospitals and clinics, schools and ministry offices and branches.

Table 6-8: Waste collection fees groups for each commercial and service activity

Type of activity	**Fees category Libyan Dinar /annually**
Industrial companies	240-1200
Hotels	400-2000
Restaurants and snack shops	300-1000
Cafes shops	250-500
Theatres, cinema	650-1000
Other shops subject to the provisions of licenses list	15-1200
Marketing of agricultural production of public markets	5 Libyan Dinar /daily

Source: Ministry of Housing and Public Utility (1994)

The task of collection of these fees is assigned to TPSC. However, senior officials at TPSC who were interviewed argued that undertaking this task was not their duty and that other competent authorities should be commissioned to facilitate collection. The MHPU and MUCO at the municipality forced them to undertake this task, and since access to money was a matter of concern, they tried their best to collect whatever they could. However, in the end, they failed, because they did not have the legal authority to control these activities. In this regard, in an interview with the head of the revenue collection office at TPSC, he said;

> "We were not able to collect fees from the various activities settled in the city, because how to activate the mechanism of fees collection is not in our hand, it is organised by a certain decree issued by national government. We are a company providing services, but how can we force the owner to come and pay? .... He added, "In my opinion, this issue is within the Ministry of Economy's jurisdiction. When the owner of any activity decides to establish any activity, whatever is it, they should obtain a licence from the Ministry of Economy, and one of the criteria to get the licence should be to submit evidence that he had to pay fees for solid waste service".

The decision taken about fees collection, as they saw it within top level decision-makers including MHPU, is within the service provider's jurisdiction. This action caused much damage to the TPSC and constituted a further burden. The company

had formed an internal committee to count the activities and collect fees for them. This committee was supplied with all the facilities to ensure that its work was carried out. This of course required a certain budget to cover expenditures such as salaries, purchase of cars for mobility and to carry out field tours to count the existing activities and to force service users to make a payment. The source of funding for this committee is basically an intermediate part of the company funds that has been earmarked for solid waste management. The Director of the Finance Department at TPSC, in commenting on this matter said, "The Company is in desperate need of such a budget to run their daily operation rather than use it out of our terms of reference".

- **PCTCs**

As for the private sector, the mechanism for collection of fees is almost the same as with TPSC. The private companies collect their fees by themselves. This situation, as explained, is because the relevant authorities, whether at national or local level, have not shown an interest in setting fixed rules for collection of such fees. The method applied is vague and it is not based on any principle of administrative procedures. Neither the supervisor's authorities nor private companies have a policy regulating the methods of collection. There is no legal provision from the national government to permit the private companies to collect a cleanliness fee. The municipality has left the role to the local departments at district level and within their jurisdiction to make arrangement with the private sector, whereby they are given the authority to levy direct taxes as well as collect fees. As a result, each company is allowed to collect fees within the area it serves. Each company is free to fix waste collection charges. The fees range between five and fifteen Libyan Dinars. When the owners of PCTCs were asked to explain the criteria for setting waste collection fees for households, the respondents interviewed said that waste collection charges were mutually agreed between the company owner and the residents of the district; the arrangement was that fees should be collected at the end of each month. Most of the interviewees asserted that in cases where the residents did not respond to the financial demands of the company, the action of the private companies in this regard is different from public company; they would stop providing services. The same mechanism was applied to collect fees from commercial and other services activities.

At the end of each month, from door to door the company levied a certain amount according to what was agreed upon.

6.3.4 Contracting and flow of funds

In the study area, the flow of money to the service provider (TPSC) is traditionally secured by means of an annual contract; which is supposed to be concluded between the parties at the beginning of each financial year. Deliberation on the terms of the contract occurs on a direct basis between MHPU and TPSC, while MUCO acts as an intermediary body.

The value of the contract uses typical prices for each service as a key reference. Therefore, the total contract price is estimated based on assumptions of total service prices. Table 6.9 displays the prices allocated to cover each activity that could be carried out. The service price schedule was adopted in the decree No 241 for 2006. The prices were set based on the quantity of waste supposed to be generated, the percentage of waste to be treated and landfilled at the municipality level and length of streets to be cleaned. The prices were calculated on the assumption that all waste generated will be managed. Operating and maintenance costs associated with the implementation of the SWM activities are assumed based on the resident population in the city, waste generation rate per person and number of commercial, industrial and economic activities existing in the city.

Table 6-9: Solid waste activities and corresponding pricing

Activity	Cost / Libyan Dinar
Street Sweeping	0.13 per metre length
Collection and transfer to transfer station	27.125
Collection and transfer to landfill	39.125 per ton
Deportation from transfer station to landfill	12 per ton
Composting	13.0 per ton
Landfilling	13.375 per ton

Source: Ministry of Housing and Public Utility (2006)

A number of senior officials at TPSC clarified that they had problems with the contractual procedure. The first concerned the criteria adopted to estimate the size of the city population. The officials at MHPU claimed that "they used the accurate figures for the actual city population by employing the most recent population census statistics published by the General Authority of Information and Documentation

(GAI)". Whereas those responsible at TPSC are took a different approach. They argued that such a figure does not reflect the population actually accommodated in Tripoli. The city of Tripoli is seen as a stronghold of economic activities such as commercial and services and thus is a haven those seeking work. They were convinced that tens of thousands of these workers and employers live in Tripoli, at least temporarily, without formal registration. One informant said:

> "We all know that foreign workers exist not only in Tripoli but in the whole country coming from sub-Sahara African and from other Arabian countries, which cross Libya's borders without visas. They constitute a significant number. We have had contact with the GAI on this matter; they reveal that there are around three million people around the country. Tripoli as a capital city therefore will have its share. In addition, there are commuters who visit Tripoli on a regular basis, staying the whole day to run their activities".

In summary, they said the value of the contract calculated is based on documented population size, whilst the real population is more than the MHPY believe.

The second issue that makes the TPSC dissatisfied with the criteria that determine the value of contracts is pricing of activities. They thought most of the prices did not cover the cost of the corresponding service. The Director of the Finance Department at TPSC, in interview, gave an example of pricing of collection and direct transport to landfill, which is 39.125 Libyan Dinar. He commented;

> "The collection method is almost manual; we collect waste from the street. Thus we employ more workers to clean the city. We estimate that to collect one ton of waste we need to employ four workers. So if you make an assumption to calculate the cost of collecting one ton when the wage is around 350 Libyan Dinar/month, we find they will cost us at least 45 Libyan Dinar, a part what is it costs to transfer the collected waste to the landfill".

In an interview with The Director of the development and planning department at TPSC, he was asked what the company does to increase the value of the contract. In response he asserted:

> "The price of service provision did not meet our aspirations to improve our performance. Such a price keeps us looking for how to afford the simple and traditional collection cost and then what is collected is transferred to the landfill. We as a company have studied these prices and we made an amendment thereto and raised our price to 80-100 instead of 64.5 Libyan Dinar /ton as was planned by the MHPU. However, unfortunately, our offer for this year is refused; we have been scheduled based on the new price".

After clarifying the prices that control the value of the contract, another question raised here of was, "Why do you accept the contract in this manner when you know in advance that the prices are actually inadequate?" The Manager of Financial Department at TPSC answered with these words:

> "As you know, because we are working in a public company owned and belonging to the public sector, we are forced to accept the offer submitted, we have no right of refusal, because by law we are obliged to provide the service for Tripoli city and at any price they propose".

Notwithstanding that during the contract arrangement, they calculate the total cost of services, the actual value delivered to the TPSC is the total value of the contract minus funds raised by charges levied in the Tripoli city, including charges to commercial and service activities. A senior official at MHPU, in response to a question related to the financial aspect said, "This year we estimated the fees supposed to be collected from different sources constitute about 30% of total contract value. Thus, we will grant the TPSC just 70% of the total contract value". Flow of contract value to the TPSC is controlled by the MHPU. The Ministry (MHPU) sets a method for how the TPSC receive their money; the contract value is divided equally among four seasonal payments.

Summary

This chapter explored and discussed the institutional measures that are taken in operating the MSWM sector in the Tripoli city. The ESTs principles relating to the institutional elements of MSWM were discussed. Therefore, three basic elements

were considered; the organizational framework, environmental policy and the financial system for funding the MSWM. This chapter has discussed the MSWM institutions in terms of their structure and responsibilities before investigating the ESTs principles to understand their arrangements and role individually.

As discussed in Chapter Five, the current practices of MSWM were not successfully implemented and therefore the relevant institutions are facing a number of challenges to reform the system. The findings of this chapter recorded that there are a number of implications in each ESTs principle. In the organizational framework context it was found that: firstly there was instability of institutional structures, arrangements, and responsibilities. The public body responsible for service provision has shifted from one structure to another; in addition to the fluctuation of the system ownership in terms of collection and transfer practices, it has sometimes been assigned to the public sector and other times to the private sector, while the private sector has been banned from investing in treatment practices. The second implication relates to support and assistance which are practised in a narrow range, for example it was observed that there is a relationship between composting plants and municipality offices, while such a relationship and support was almost non-existent between different levels of institutions, especially with private sector, because the institutions at national government did not consolidate the basic principles of building relationship and provide support. On the other hand, there is a lack of activating the agreements with relevant parties abroad. The finalist impact of the organizational framework was on recruiting, training and provision of information on SWM to the staff. Although the staff of PCTCs is stable due to incentives and a non-bureaucratic system, the TPSC complains of a difficulty in recruiting skilled staff, especially those who working in waste collection. Service providers (TPSC and PCTCs) complained of a lack of training programmes and availability of information about practices in different world regions relating to environmentally sound practices, in order that they could learn from the experience of people and organisations working in the solid waste management sector.

The implications of the legal framework for MSWM were recorded as follows; firstly, policies provide no written criteria to make a decision for technology selection. Decisions were always based on financial criteria and mainly on information that was delivered by the supplier in the absence of EGA. Secondly,

lessons from those who have experience of adopting ESTs, such as EU operators were limited, especially in the private sector an in all institutions except the EGA , few employees were aware of EU policy. Thirdly, the implications are a product of the unconscious behaviour of the top-level policy-makers toward system stability in terms of its arrangement and responsibilities.

In terms of existing laws, the respondents' views on its adequacy were inconsistent. The private sector thought that participation of the stakeholders is not covered. For the rest of the institutions, their representatives' views were divided between those who saw its operation as satisfactory (the largest number) and a few who believed it is difficult to assess this situation as there is not adequate enforcement. With regard to incentives and legal support, the implication recorded was that the service provider companies did not receive such support, which distinguish them from other companies.

Lastly, in terms of enforcement of environmental regulations, it was observed that the current institutional arrangement compared with some neighbouring countries and top level decision-makers' behaviours toward violators have an impact on the role of supervision bodies. In the study area, it is found that an organisation whose role is waste management at national level is missing from the institutional structure. Also the position of the EGA is problematic, it should not belong to MHPH. In addition, the role of prosecutors is not activated.

In the third part of ESTs principles, the implications of the financial system revolve around how the service providers are funded. In this context it was found that the budget of TPSC mainly comes from government (about 70%), and that this is both insufficient and subject to irregular payment. The remaining 30% is supposed to be collected from commercial premises, but there is also difficulty in levying this amount. The funding source for PCTCs is completely dependent on the service users' fees, and there is no legal basis to determine the amount of payment or even to force the users to pay. Secondly, in terms of cost recovery in the sector, in theory the user pays the cost of disposal for what is generated, but in fact many of these fees are not collected. The government took the role of funding the sector in order to meet the failure of the system finances. Contracts with public and private companies were the final thought. However, the TPSC and PCTCs were not satisfied with the current

financial system due to many defects in its arrangements, such as the method used to estimate the price, contracting and payment method.

The deficiencies raised in this chapter require substantial review in order to carry out system reform and to build instead in line with the requirements of the ESTs principles.

CHAPTER SEVEN: SERVICE USERS' PERCEPTIONS AND INTERACTION BETWEEN SERVICE PROVIDERS AND SERVICE USERS

7 Introduction

As explained in the literature review, the service users (individuals and organisations) should be seen as partners in solid waste management. In respect of this issue, this chapter presents the findings of the research with respect to the service users' attitude to system reform. Data were collected by a questionnaire survey carried out on households in Tripoli city and interviews with operational and supervisory bodies. This chapter is organised into two sections covering: (i) opinions of service users towards current practices; (ii) the efforts that have been made by the service providers (TPSC and PSTCs) to keep the service users positive towards what they offered to them.

Section A: Questionnaire results; opinions of the households

7.1 Introduction

This section discusses the opinion of households as service users. The following sub-headings highlight the service users' views, the current practices that are offered and the role they play in MSWM.

7.2 Outline of MSW service providers in Tripoli

The public company (TPSC) is the main service provider in the study area (Table 7.1). The TPSC serves approximately 49.2% of total respondents compared with only 34.2% by the private companies (PCTCs). Those who were not covered by solid waste service and used their own facilities to collect and remove their waste constituted 16.6% of respondents.

Table 7-1: Waste service provider

	Frequency	Percent
TPSC	92	49.2
PCTCs	64	34.2
None	31	16.6

N= 187

According to respondents, the provision of waste services varies between different residential areas (Table 7.2). 69.1% of households in City centre & Hayy al Andalus said that they are served by TPSC. In these areas, all the householders have access to

waste service. City centre & Hayy al Andalus is the oldest residential area in the city, and it is a centre of services and sites of a political nature, such as foreign embassies (Ali *et al*. 2011). This might be a source of pressure to keep this area clean. Alhadapa & Abu Salem had the highest proportion of households serviced by private companies at 42.5%. According to Ali *et al* (2011), Alhadapa & Abu Salem houses have the largest population compared other areas. Sug Aljumah and Tajora had the lowest proportion of solid waste service deliverers, with 23.4% and 29.1% respectively of their householders not covered by solid waste service and removing the solid waste by their own facilities. In Sug Aljumah and Tajora, the urban infrastructure is not as developed compared with other areas in the city (GAI, 2006). Therefore, providing solid waste service to all the residents in these areas could be difficult.

Table 7-2: Residential areas cross tabulated with waste service provider

Count	Service provider (%)		
	TPSC	PCTCs	Yourself
City centre & Hayy al Andalus	69.1	30.9	0.0
Alhadapa & Abu Salem	37.5	42.5	20.0
Sug Aljumah	40.0	36.6	23.4
Tajora	57.1	13.8	29.1

N = 187

7.3 Respondents' opinions on the performance of current practices

7.3.1 Storage practice

Householders in Alhadapa & Abu Salem and Tajora said that they store their waste in wheeled bins, at 20.9% and 17.6% respectively (Table 7.3). In the City centre & Hayy al Andalus and Sug Aljumah the respondents reported the lowest proportion of wheeled bins compared their neighbourhood areas at 10.7% and 9.9%, respectively. According to respondents, the City centre & Hayy al Andalus had the highest number of skips, followed by Alhadapa & Abu Salem, at 39.3% and 30.2% respectively. The Sug Aljumah and Tajora recorded a smaller number at 28.2% and 23.5% respectively. In relation to plastic bags, the percentages of households who used this type of storage facility in the various neighbourhoods were very similar. However, Sug Aljumah and Tajora recorded the highest number of residents using

plastic bags to store their waste. However, the Chi - square test indicates that there is a non-statistically significant relationship between storage container and district. Thus it seems that the nature and size of districts are not taken into consideration during arrangement to select and set up of waste storage containers.

Table 7-3: Living area cross tabulated with type of container used

Count	Type of storage container (%)			
	Wheeled bin	Skip	Plastic bag	Other
City centre & Hayy al Andalus	10.7	39.3	42.9	7.1
Alhadapa & Abu Salem	20.9	30.2	37.2	11.6
Sug Aljumah	9.9	28.2	45.1	16.9
Tajora	17.6	23.5	47.1	11.8
Value	df	Significant		
X^2 7.635	9	.571		

N= 183

Table 7.4 shows the distribution of storage containers by who is delivering the waste service. From the figures the respondents reported that the TPSC provides most of the wheeled bins and skips in Tripoli city. The TPSC has provided 26.0% and 30.0% respectively, compared with only 17.1% and 11.9% positioned by private PCTCs. However, according to respondents, the PCTCs choose to collect waste usually from plastic bags. In contrast, of those who provide their own waste service, the majority (72.4%) use plastic bags to store solid waste. The high usage of plastic bags by those who manage their own waste can be explained by the ready availability of plastic bags and the lack of alternative storage facilities (see Chapter Five, Table 5.5 and 5.6).

Table 7-4: Deliverers of waste service cross tabulation with type of container

Count	Type of storage container (%)			
	Wheeled bin	Skip	Plastic bag	Other
TPSC	26.0	30.0	32.8	11.3
PCTCs	17.1	11.9	36.7	34.3
Your self	4.2	10.7	72.4	12.8
Value	df	Significant		
X^2 134.316	6	.000		

N= 183

The chi-square test shows that there is a strong statistically significant relationship. Service providers are a significant factor in determining the type of

containers. Thus, the financial capacity of the TPSC and PCTCs could be critical in this regard.

- **Householders assessment**

Most householders interviewed (59.3%) were not satisfied with the waste storage facilities available to them (Table 7.5). Table 7.6 shows the householders' views towards the status of storage bins in the area where they lived. While 55.6% of the households thought that their storage bin did not release leachate at any time during their usage, the presence of all the other problems raised was reported, especially in terms of type and size of storage bin. Respondents described their bin as not compatible with the type and quantity of waste generated (64.2% and 63.1% respectively).

Table 7-5: Householders' satisfaction with waste storage bin

	Frequency	Percent
Yes	70	40.7
No	102	59.3

N= 172

Table 7-6: Householders' estimation of status of storage bin

Count	**Percent**	
	Yes	No
Typically it is appropriate	35.8	64.2
It is an adequate size	36.9	63.1
It releases odour	63.1	36.9
It releases leachate	44.4	55.6
It is burnt	50.8	49.2
Good accessibility	47.6	52.4

N= 169

7.3.2 Collection practices

I. Regular collection

65.3% of 187 households reported that they receive irregular waste collection services. In general, no living areas reported a regular solid waste collection service (Table 7.7). Householders living in Sug Aljumah and Tajora areas (73.4% and 71.4% respectively) said that they are suffering more from irregular waste collection than those in other residential areas. However, the difference is not statistically significant (Table 7.7).

Table 7-7: Regular waste collection service by area

Count		Do you have a regular waste collection service (%)	
		Yes	No
City centre & Hayy al Andalus		48.1	51.9
Alhadapa & Abu Salem		38.9	61.1
Sug Aljumah		26.6	73.4
Tajora		28.6	71.4
	value	df	Significant
X^2	1.038	3	.792

N= 187

According to respondents, the regularity of service does not vary significantly by service provider. However, a greater proportion of householders served by TPSC complained of irregular waste collection service than those who served by PCTCs, 70.2% and 51.1% respectively.

- **Householders' assessment**

66.7% of 123 households said that there is a problem in waste collection practice and they were not satisfied with current waste collection practices. Most of those who were not satisfied with the collection practices were resident in Tajora and Sug Aljumah, 75.0% and 70.3% respectively said they were not satisfied with the current waste collection practice (Table 7.8). More people satisfied with the current waste collection practice were living in Alhadapa & Abu Salem and City centre & Hayy al Andalus areas than those living in Tajora and Sug Aljumah. However, the chi-square test shows that dissatisfaction with waste collection practices is prevalent regardless of place of residence.

Table 7-8: Waste collection satisfaction by area

Count		waste collection service satisfaction (%)	
		Yes	No
City centre & Hayy al Andalus		41.7	58.3
Alhadapa & Abu Salem		34.3	65.7
Sug Aljumah		29.7	70.3
Tajora		25.0	75.0
	value	df	Significant
X^2	1.027	3	.795

N= 123

Table 7.9 shows the householders' views towards aspects of currents solid waste collection practices. Time of waste collection was the only aspect not confirmed as

unsuitable, 68.3% of householders said that the time of waste collection was not a problem for them. Respondents described their waste collection practice as unsatisfactory in terms of method used and workers, at 83.7% and 82.9% respectively.

Table 7-9: Households' views on current solid waste collection practices

Count	**Households %**	
	Yes	No
No collection practice	61.8	38.2
Method introduced is inappropriate	83.7	16.3
Time of collection is unsuitable	31.7	68.3
Unskilled staff	82.9	17.1

N=123

II. Collection Staff

- **Householders' assessment**

Almost two-third of households reported that staff wear a uniform. 61.0% of householders reported that staff of service providers did not handle equipment carefully. 69.0% of householdes reported that staff of service providers did not have safety equipment such as hard hat, high visibility jacket and gloves.

III. Collection vehicles

Open truck is the type of vehicle regularly used in all living areas to collect waste and transfer it to the next destination (Table 7.10). In Alhadapa & Abu Salem and Tajora areas for example, 69.2% and 64.3% of respondents respectively said that the the service providers use open trucks to collect waste. According to respondents, use of tractors, handcarts and other types of vehicles is limited in all living areas, except in Tajora, where tractors account for 21.4% of collection. However, the use of compactor trucks is important in all living areas except in Tajora. The service providers rely on compactor trucks as a second priority after open trucks. This result can be explained by that use of open trucks is recorded in secondary and direct collection, while the compactor trucks were not used by the private sector in direct collection (see Chapter Five, Table 5.7).

However, the chi-square test represents a statistically significant relationship, where the type of vehicle used is dependent on the district to be served. Thus it

seems that the nature and size of districts are taken in consideration during arrangement to select the type of vehicles to be used.

Table 7-10: Type of vehicle used by area

Count	Type of vehicle used to collect solid waste (%)				
	Compactor truck	Open track	Tractor	Handcart	Other
City centre & Hayy al Andalus	38.2	49.1	3.6	3.6	5.5
Alhadapa & Abu Salem	12.8	69.2	5.1	7.7	5.1
Sug Aljumah	37.3	40.8	4.7	3.1	14.1
Tajora	7.1	64.3	21.4	0.0	7.1
value	df	Significant			
X^2 22.456	12	.013			

N= 187

According to respondents, the open truck is the main vehicle used by private companies (PCTCs) to collect solid waste from households and transfer it to the next destination. 72.9% of respondents reported that they served by open trucks, compared with compactor trucks and tractors at only 5.9% for each. The housholders also said the TPSC mainly uses open trucks; they constitute half of the fleet used (see Table 7.11). However, in the public company (TPSC) a compactor truck is the main vehicle used to collect solid waste and transfer it to the next destination; they represent a quarter of the fleet used. Chi-square test presents a strong statistically significant relationship. From the result it indicates that the public sector own more appropriate equipment than the private sector.

Table 7-11: Service providers cross tabulation with vehicle used

Count	Type of used vehicle (%)				
	Compactor truck	Open track	Tractor	Handcart	Other
TPSC	25.0	54.8	5.8	5.8	8.7
PCTCs	15.9	72.9	5.9	1.5	3.8
value	df	Significant			
X^2 13.925	4	.003			

N= 156

- **Householders; assessment**

The assessment by householders of all reported aspects of vehicles used was negative. For example, most of the householders believed that the vehicles used are

not appropriate to transfer waste and observed that the waste falls off vehicles during the transportation journey (59.3% and 54.7% respectively). Nearly half (47.1%) considered collection vehicles inappropriate for their neighbourhood. (Table 7.12). Based on personal observation, collection vehicles can be too large for the narrow streets in some areas.

Table 7-12: Households' estimation of vehicle used

Count	**Households %**	
	Yes	No
Appropriate vehicles are used to collect solid waste	40.7	59.3
The waste falls off vehicles	54.7	45.3
The vehicles used are not consistent with the nature of the area	52.9	47.1

N= 187

7.4 Access to information

- **Householders' assessment**

21.1% of 187 householders said that they knew the destination of their waste, but most of them (78.9%) had no idea of what happened to their waste after it was transferred from the collection point. On the other hand, a few interviewed householders reported that they received information on how to improve solid waste management, but most of them (63.6%) had no such information.

According to respondents, the EGA was the main source of the information they received, compared with other relevant organisations (Table 7.13). 48.4% of householders said that what they knew about the improvement of solid waste management at the city was from the EGA. In contrast, the role of MPHE is very limited in the dissemination of information among householders; only 11.6% of householders reported that they heard information about MSWM improvement programmes and projects from MPHE. The role of MT and MHPU is intermediate and at a similar reported level, mentioned by 24.2% and 21.0% of respondents respectively.

Table 7-13: Sources of information

Source of information	**Households**	
	Percent	
	Yes	No
Municipality of Tripoli (MT)	24.2	75.8
MHPU	21.0	79.0
MPHE	11.6	88.4
EGA	48.4	51.6
NGOs	21.0	79.0
Other	17.8	82.2

N= 187

7.5 Overall practices

The proportion of respondents who rated the practices as fair was approximately a quarter (Table 7.14). Only a small proportion of householders estimated the overall MSWM situation in the city as very good or good; 3.8% and 14.0 % respectively. On the other hand, over half of the respondents (approximately 55%), rated the service as very poor or poor.

Table 7-14: Householders' estimation of overall MSWM

	Frequency	Percent
V.good	7	3.8
Good	26	14.0
Fair	50	26.9
poor	55	29.6
V.poor	48	25.8

N= 186

Householders at the City centre & Hayy al Andalus more than in other areas believe that the situation of overall SWM in their neighbourhood is poor and very poor (Table 7.15). 70.7% of households at City centre & Hayy al Andalus said the situation is poor and very poor compared to 51.2% and 53.5% at Alhadapa & Abu Salem and Sug Aljumah respectively. On the other hand, most of the households at the Tajora (41.2%) saw the situation of MSWM in their living area as acceptable, while 23.5% of them thought it is good and very good and 35.3% rated it poor and very poor.

The chi-square test shows that there is no significant difference in satisfaction between service providers, which means a poor quality of service is delivered to all districts.

Table 7-15: Living area cross tabulated with state of MSWM

Count			
	Good & v.good	Fair	Poor & v.poor
City centre & Hayy al Andalus	14.3	25.0	70.7
Alhadapa & Abu Salem	16.3	32.6	51.2
Sug Aljumah	21.1	25.4	53.5
Tajora	23.5	41.2	35.3
Value	df	Significant	
X^2 4.504	6	.609	

N= 186

Although the majority of householders saw the overall SWM situation as poor or very poor, householders served by PCTCs perceived the overall situation of SWM as less bad than with those served by TPSC (Table 7.16). 51.3% of those served by PCTCs thought the situation of MSWM was poor or very poor, compared with 54.8% served by TPSC. However, the chi-square test shows that there is no significant difference in satisfaction between service providers. This means the poor quality of the service delivered by TPSC is like that offered by the PCTCS.

Table 7-16: Service providers cross tabulated with state of MSWM

Count	MSWM description (%)		
	V.good & good	Fair	V.poor & poor
TPSC	12.5	32.7	54.8
PCTCs	20.6	28.1	51.3
value	df	Significant	
X^2 4.703	2	.095	

N=155

7.6 Changes in practices over time

The householders said that the current overall practices of MSWM in the city had changed based on a comparison between their perception of the last five years and the current state of MSWM. More than a half of the householders (54.5%) saw no improvement in the current situation of solid waste practices and thought it was still the same as five years before (Table 7.17). However, there were slightly more of those who thought the service had deteriorated in the last five years than those who thought it had improved. 22.5% of householders thought the current situation of MSWM is better than it was in last five years compared to 23.0% of households who thought the current situation of MSWM is worse than it was in last five years.

Table 7-17: Householders' estimation of MSWM system change

	Frequency	Percent
Has Improved	42	22.5
The same	102	54.5
Deteriorated	43	23.0

N= 187

Table 7.18 shows how households thought the overall practices of solid waste management had improved. This question was directed only to those respondents who had said there was an improvement in MSWM compared with the last five years; householders' perceptions were based on their agreement on those factors that had contributed to an improvement in current MSWM practices. The result shows that the main contributory factors that led to improvement of the system were the increased number of vehicles and staff and greater areas of the city having access to regular waste collection (Table 7.24). The householders believed that the MSWM system had improved basically because the service providers have increased the number of vehicles and staff and included more areas of the city in regular waste collection, 60.9% and 52.2% respectively. There was no significant perceived improvement in terms of use of better technology and increase in waste treatment activities such as composting and recycling. Only approximately 30% of households agreed that the reason for improved practices was due to using better technologies and creating more initiatives for composting and recycling activities.

Table 7-18: Contributory factors in SWM change for the better

Count	**Percent**		
	Agree	Disagree	Neutral
More of the city has regular waste collection	52.2	43.5	4.3
More frequent collection	47.8	47.8	4.4
Use better technologies	30.4	60.9	8.7
Increase number of vehicles and staff	60.9	34.8	4.3
Increase of recycling activities	36.1	40.1	23.7
Increase of composting plant	30.5	47.8	21.7
Reduction in pollution	26.1	56.5	17.4

N= 42

Table 7.19 shows why householders thought solid waste management had deteriorated or remained the same. This question was directed only to those respondents whose answers indicated no improvement in the MSWM situation, based on their agreement on factors that contributed to deterioration or stagnation.

The householders agreed on all the contributory factors suggested, except lack of adequate finance; 51.4% of the respondents did not believe that lack of funds was the main reason for system deterioration or stagnation. Contributory factors acknowledged were lack of public awareness, lack of technology and poor organisation, at 72.3%, 68.0% and 62.5% respectively.

Table 7-19: Factors contributing to SWM change

Count	**Percent**		
	Agree	Disagree	Neutral
Poor organisation	62.5	25.0	12.5
Lack of adequate finance	36.1	51.4	12.5
Lack of technical/Know how	41.7	38.9	19.4
Enforcement agencies	54.1	19.5	26.4
Lack of technology	68.0	23.6	8.4
Non-collaboration of parties	47.2	29.2	23.6
Lack of public awareness	72.3	20.8	6.9

N= 145

Summary

Most of the households in the city were served by the public company (TPSC)). However, servicing by the private sector was observed in all city districts. Public-Private partnership and increase the role of the private sector is widely recommended for cost-effectiveness and service quality and coverage (i.e., (Scheinberg *et al*. 2010; Zhu *et al*. 2008; Obeng *et al*. 2009; Kassim and Ali, 2006). In this section, this result suggests that the public sector is still dominant, and the role of the private sector in delivering waste services is still limited, and it therefore confirms that shared system ownership is not well defined yet. The result of defining who delivers waste service confirms the EGA/UNDP report and it shows that one sixth of households have no access to a service provider.

Evidence suggests that there are some fundamental issues to be overcome in improving the service to households. Most of the residents use a plastic bag due to a lack of wheeled bins and skips, especially those who are served by private companies. The respondents in this regard stated that their companies are unable to provide a sufficient number of collection bins. Shortage of waste bins (Alam *et al*, 2008) or their dilapidated state (Zia and Devadas, 2008) have been found elsewhere

to be indicative of serious barriers to establishing appropriate collection practices. In addition, more than a half of households in all residential areas, whether served by TPSC or PCTCs, claimed they received an irregular waste collection service. Furthermore, in terms of waste collection vehicles, the open truck is the most common vehicle used, especially by PCTCs, to collect waste and transfer it to its next destination. From the result it appears that the private sector owns less than the private sector of the facilities necessary to store and collect solid waste. The private sector according to their owners operates on a small scale and with limited human and financial resources, which in turn could have effects on the ability to acquire and use appropriate equipment (Cointreau *et al.* 2000), especially when there is no enforcement of regulations (Antipolis, 2000).

The majority of householders had no information on what happens to their waste after collection or on improving solid waste management in the city; it was found that the majority of the respondents had no information on these issues. Few programmes have been launched in the media. The role of MHPU and MPHE in dissemination of information is limited, while that of EGA and MT is moderate. However, householders expressed strong opinions of their experience of the current waste service. Householders had a negative evaluation of both the storage and collection practices. They were not satisfied with the containers used, especially in terms of quality and quantity. Dissatisfaction with collection was mainly due to the method being inappropriate, e.g., the type of vehicles used and the skill level and equipment available to staff. Negative evaluation was also expressed of overall practices of solid waste in the Tripoli city. More than half of city residents described the situation of MSWM in the city as poor or very poor. Thus, the service providers have failed to establish sound practices that can be accepted by their service users. However, the opinion of householders toward current practices was not a surprise to service providers. TPSC staff, for example, acknowledged that residents are not satisfied with the practices offered.

Thus, given the dissatisfaction of the householders, current practices appear not to comply with the principles of ESTs. However, their dissatisfaction could also indicate a lack of awareness of a role for service users as a partner in the provision of SWM. Householder behaviour may need to converge with ESTs principles. In this

respect, service providers could perform initiatives that lead to improve their partnership

Approximately half the households believed that the service provision has not changed significantly in the last five years. More householders thought the situation had declined than thought it had improved. Those who thought that the situation of MSWM has improved mainly attributed this to the increased number of vehicles and staff, including more areas of the city in regular waste collection and more frequent collection as contributory factors. Those who thought that the situation of MSWM had deteriorated or remained the same, mainly attributed this to all the suggested contributory factors except lack of adequate finance and lack of technical/know how, which are assumed as not an issue. The fact that the situation is widely considered worse or to have barely improved over the last five years gives an impression that the service providers are not capable of overcoming their own shortcomings.

7.7 Householders' responsibility and contribution

Studies in developed countries indicate that significant change to service users' behaviour is required to successfully implement waste recovery programmes (e.g., Schubeler *et al.*1996; Henry *et al.* 2006; Troschinetz and Mihelcic, 2009). Therefore, service users were asked about their attitude and behaviour towards relevant practices.

7.7.1 Source separation initiative

Few householders sort the waste they generate into different items. 19.7% of 172 respondents said they kept their waste separate at home. Householders at the Sug Aljumah and Tajora are the most likely to do waste separation at home (Table 7.20). 22.8% of Sug Aljumah residents and 31.1% of Tajora residents are reported that they carried out source separation of their waste, while Alhadapa & Abu Salem was the living area with least source separation of waste, at 14.5%. These differences are statistically significant.

Table 7-20: Living area cross tabulated with source separation initiative

Count		Do you store waste separately? (%)	
		Yes	No
City centre & Hayy al Andalus		18.4	81.6
Alhadapa & Abu Salem		14.5	85.5
Sug Aljumah		22.8	77.3
Tajora		31.1	68.9
	value	df	Significant
X^2	8.223	3	.042

N= 172

Households served by the public company (TPSC) are slightly, but not significantly, more likely to do waste separation at home than others (Table 7.21). 21.5% of city residents served by TPSC compared to 18.3% of residents served by PCTCs reported that they carried out source separation of their waste at home.

Table 7-21: Service provider cross tabulated with source separation initiative

Count		Do you store waste separately? (%)	
		Yes	No
TPSC		21.5	78.5
PCTCs		18.3	81.7
	value	df	Significant
X^2	.177	1	.674

N= 141

7.7.2 Paying for solid waste service

Approximately two thirds of households did not make a payment for delivered solid waste service. 64.3% of 171 respondents said they did not pay for the solid waste service received. Most of the residents paying the solid waste service (62.3%) said they usually paid solid waste service fees.

Most of the householders (56.9) who paid the fees said they received value for such payment. According to respondents, Sug Aljumah has more households paying for solid waste service than other living areas (Table 7.22). 41.2%, compared with 38.5% of Alhadapa & Abu Salem residents and 35.7% of Tajora residents. On the other hand, it was obsereved that City centre & Hayy al Andalus is the area where

fewer residents pay for solid waste service, at only 29.1%. However, the relationship is not statistically significant.

Table 7-22: Living area cross tabulated with paying for solid waste service

Count		Do you pay for solid waste service? (%)	
		Yes	No
City centre & Hayy al Andalus		29.1	70.9
Alhadapa & Abu Salem		38.5	61.5
Sug Aljumah		41.2	58.8
Tajora		35.7	64.3
	value	df	Significant
X^2	1.869	3	.600

N= 61

Most households served by the private company (PSTCs) paid for solid waste service (Table 7.23). A greater proportion of households reported that they paid PCTCs for their solid waste service than those who paid for PCTC's services. Because there is an exemption for householders to pay the public sector, a limited number of householders have initiates to pay TPSC. This is a significant difference, as would be expected, given the funding mechanisms of the two organisations.

Table 7-23: Service providers cross tabulated with paying for solid waste service

Count		Doyou pay for solid waste service? (%)	
		Yes	No
TPSC		11.5	88.5
PCTCs		63.5	36.5
	value	df	Significant
X^2	94.283	1	.000

N= 61

It is clear that most of the residents who have a regular waste collection service pay for the service (Table 7.24). More than a half of households who have a regular waste collection service reported that they pay for the service received, compared to only one third who do not have a regular waste collection service. The Chi-square test indicates that there is a strong statistically significant relationship, as would be expected given the rules of PCTCs for payment versus the service.

Table 7-24: Regular waste collection service cross tabulated with paying for solid waste service

Count			Do you pay for solid waste service? (%)	
			Yes	No
Do you have a regular waste collection service	Yes		56.9	43.1
	No		33.1	66.9
	value	df		Significant
X^2	5.965	2		.011

N= 61

7.7.3 Reuse and/or recycling initiatives

29.7% of 180 respondents said that they sold or gave to charity those materials that would otherwise be discarded, such as bread[9], clothes and plastics.

Households in the Sug Aljumah and Tajora were more inclined to reuse and/or recycle waste materials than other city districts (Table 7.25). The geographical location and social factor of these areas might have had an impact on carrying out such activities (Elbendak, 2008; GAI, 2006). However, the chi-square test shows that there is no statistically significant relationship between living areas and carrying out reuse and/or recycling initiatives.

Table 7-25: Living area cross tabulated with carrying out reuse and/or recycling

Count			Do you reuse and/or recycling some waste materials? (%)	
			Yes	No
City centre & Hayy al Andalus			23.3	76.8
Alhadapa & Abu Salem			22.8	77.2
Sug Aljumah			39.1	60.9
Tajora			33.8	66.2
	value	df		Significant
X^2	1.422	3		.700

N= 180

[9] Economically recycling bread is common in Libyan society, because bread flour is a commodity (Ministry of Economic, 2013), so it is consumed widely among Libyan society and thus leftover bread is one of the solid waste components. Many households are eager to collect bread to feed their animals or they sell it to livestock farmers.

According to respondents, households served by the public company (TPSC) were the more likely to carry out reuse and/or recycling of some waste materials (Table 7.26). 32.4% of city residents served by TPSC compared to 21.4% of residents served by PCTCs reported reusing and/or recycling some waste components. The difference is not statistically significant.

Table 7-26: Service providers cross tabulated with carrying out reuse and/or recycling initiative

Count		Do you reuse and/or recycle some waste materials? (%)	
		Yes	No
TPSC		32.4	67.6
PCTCs		21.4	78.6
	Value	df	Significant
X^2	2.147	1	.143

N= 149

Summary

This section investigated the responsibility and contribution of households towards waste recovery practices. It was found that very few householders, approximately one- fifth of them, separate their waste and store different items seperately; these were mainly householders living in Sug Aljumah and Tajora, which are semi-rural areas (UPA, 2007), where there is opportunity to take advantage of some waste components, for example, to feed livestock. However, it was found that the service provider was not a paramount factor in whether source separation is practised. This result is not compatible what is recommended by many scholars; for example, Zhuang *et al* (2008) suggested that, it is always requires subsidization from government organisations to increase service users participation, such as providing storage equipment and encouraging service users through an incentive programme.

Only one third of householders paid for solid waste services. The role of service users is limited in this respect, though most of those paying live in Sug Aljumah and Alhadapa & Abu Salem, where service by private companies is more common. Thus, the householders have to pay in these areas, or their service would be discontinued. Of those service users who pay service fees, it was found that one-third of households did not pay the fees regularly. However, more than a half of householders thought they received value for payment.

There are limited numbers of householders who recover, sell or even give to charity some of the solid waste they generate. However, these householders comprise no more than one-third of respondents. Most of those residents were in Sug Aljumah and Tajora. In the test of the relationship between service providers and carrying out reuse and/or recycling of some waste components, it was found that the service provider was not a paramount factor in carrying out such activity. This finding indicates that the service providers may not intervene to involve service users in reuse and/or recycling activity, which is necessary to change the service users' behaviour to increase the potential of their reusable and recyclable components.

Section B: Interview result; approach of operational and supervision bodies towards service users' behaviour

7.8 Introduction

This section highlights the perception of the operational and supervision bodies regarding the implications of the service users' behaviour for the current practices they offer to their users. This section aims to understand how the service providers and users interact with each other and what mechanisms and effort are adopted to bring the views closed.

7.8.1 Service users' pressures towards service providers

This sub-section discusses whether service users are impressed with the service providers, and if so, how the service providers responded to this issue.

In Tripoli, as discussed in Chapter Five sub-heading 2.1 and in Chapter Six (enforcement of regulations), exerting pressure on waste producers and through relying on laws and MSWM regulations is not effective. The problem is essentially embodied in a failure to enforce the laws. Leaving of solid waste in the streets and open areas for extended periods causes foul odours and the proliferation of flies and rodents. Consequently, service users exert pressure in different ways to express their rejection of the services provided. The residents and traders deliberately throw their waste in the streets and other areas not designated as collection points. The service users in Tripoli know such behaviour affects the service providers and forces them to collect what has been thrown. In this regard, a senior official in the TPSC stated that;

> "Such behaviour is evidence that the service users know according to the laws that we are responsible for collecting waste from wherever it is. Consequently, they undertake such practices just to show us that they are not satisfied with the collection practices that we offer to them".

The owners of the private companies (PSTCs) also expressed their view on their service they provided. They acknowledged that the service they carried out is usually unprofessional and tainted by a lot of defects. They mentioned several examples that may explain why service users resort to such behaviours. For example, one company owner said:

> "We do not commit ourselves to specific times of collection, because the traffic in the city is crowded; as well, the vehicles we use are old and the landfill is far away. For those reasons we cannot guarantee to collect at a certain and regular time. Accordingly, we often collect waste in the evening, while we'd told them we would collect in the morning; or sometimes, we may not come at all. The service users consequently apply pressure as a reaction, such as not making payments of the fees on time and throwing waste in the streets".

The service provider companies, especially the TPSC, blamed the behaviour of service users for throwing their waste in non-designated places, and lack of support to facilitate the companies' work, and they said such actions show that the residents are not aware of what the company do and at the same time, it made companies' work and the development of future plans more difficult.

In response to the demands of service users, often the service provider companies increase their service provided in terms of frequency of waste collection. In this regard, to tackle the immediate situation, the TPSC usually increase their collection crews, and when necessary, they organise a campaign to collect accumulated waste from bins and where it may have been abandoned. PCTCs resort to repeating the collection of waste (i.e. increasing the frequency of collections). Neither procedures

are long term solutions to demands for a better service. Furthermore, the TPSC's response suggests that they do have the resources (financial land technically) to improve their service, contrary to their claims. Thus, the problem may be lack of institutional capacity to plan and execute an improvement to the regular service, rather than simply a shortage of resources.

7.8.2 Requests and complaints; and acceptance of designed projects

This section discusses firstly the mechanism used to receive service users' inquires about the possibility of carrying out a specific work, and complaints of unsatisfactory practices; secondly; operational bodies' view towards service users' acceptance of projects proposed that aim to achieve the ESTs concept.

The formal sector of MSWM in Tripoli (the municipality offices, EGA and MUPU) has mechanisms to receive and follow up requests and complaints of those who have been affected. For example the EGA and ESOT have within their institutional structure a unit designed to look at complaints that cannot be resolved at the service providers' level. In the EGA, the Unit of Environmental Inspections reports on the case and then refers it to the MPHE if they cannot resolve it at their own level. In the ESOT, the Unit of Inspection and Health control is responsible for reporting on a case then transfers it to the MHPU if it cannot be resolved at the municipality level.

The operational body also receives requests and complaints from users. At the TPSC, there are three mechanisms that are used to file complaints. First, the TPSC has a unit within its structure that works twenty-four hours a day to receive and report on cases. Users can contact the unit personally or by telephone. After the case is recorded it is forwarded for consideration by the relevant department. Most complaints and comments are related to waste not being collected within a certain time, especially in critical areas such as density areas and areas where embassies and other important buildings are located. Secondly in the local daily magazine 'Al-Jamahiriya', there is a page designed in cooperation with the Authority of Press and Media. The TPSC responds to demands of service users that are published in the magazine. Thirdly, also in cooperation with the Authority of Press and Media, a programme is broadcast once a week on local radio in Tripoli, which hosts TPSC's representatives to answer service users questions or to respond to requests and

complaints. The private companies (PCTCs) deal with their service users differently. Complainants contact the private company that serves them and they process the requests and complaints.

In response to the second part of the question; do the service users accept the projects that have been proposed that aim to achieve ESTs concept?, the operational bodies' views differ. The private companies said they had not introduce any development in their practices, and since starting working in this field; they employed the same technologies. However, they thought that their clients were satisfied with the service they provided. For example, the owner of the Boaba Africa Company said, "Despite our company having limited resources, it has succeeded in having status and good image among the citizen". However, the TPSC indicated that most of the service and development projects they offered were not accepted by the service users. Respondents said the company was always trying to improve its service, especially regarding separation of waste at source. In this context, they said that within the last ten years, they had introduced several projects to consolidate source separation principles, but had failed. They attributed the failure of such projects to a lack of service users' awareness. In this regard, the service users criticized firstly the technologies that are used to collect and transfer solid waste, which do not constitute sound practices. Secondly, the awareness activities and information available, are limited and do not meet the communication concept and setting of a cooperation and coordination network.

7.8.3 Raising service users' awareness

This section discusses the efforts that have been made to raise the awareness of the service users to MSWM practices and to increase the service users' response to service providers' demands for service users' behaviour change. The data gathered from respondents shows that there is a disparity in the efforts made by organisations. While the EGA and TPSC have attempted to carry out a number of activities to increase the awareness of citizens, the other operational and supervision bodies of MHPU, MPHE and MT carry out few of such activities.

In the EGA, from the early 1990s until 2005, several activities were run to raise awareness of solid waste issues, but what is left nowadays is limited activity confined to publishing articles in their journal and carrying out activities just at local

and international events, such as World Environmental Day and Arabic Environmental Day.

Activities for raising public awareness are mostly carried out by TPSC. The managers at TPSC thought that those authorities whose task is to promote environmentally friendly behaviour among citizens towards urban solid waste issues have largely abandoned such activities. Thus, the TPSC had taken the lead in awareness activities. Currently, the TPSC carry out a number of activities to raise awareness of waste problems. For example, the TPSC has its own newspaper, published monthly and distributed free of charge to local organisations (see figure 7.1). The aims of the newspaper are to highlight the efforts that undertaken by the TPSC and at the same time urge the residents to cooperate and communicate in order to achieve the company's goals. They have a semi-regular programme on local radio, especially during Ramadan, when they observed an increased amount of solid waste disposed.

Figure 7-1 : Sample of TPSC newspaper

Source: Fieldwork, June to Aug 2010

The interviewee described the awareness activities as run as discontinuous programmes. They noted that the lack of financial resources and cooperation and coordination between government institutions was the main reason for awareness programmes being limited. Therefore, the objective of these programmes and the potential for service users to respond by cooperation with service providers and awareness of SWM problems is difficult to realise.

7.8.4 Service user's responsibility and contribution to current practices

Regarding this context, the interviewees at TPSC and PSTCs were asked whether the operational bodies in Tripoli city believe that the service users have a role in MSWM practices, and if so, what role is played to promote current practices.

Interviews indicate that the operational bodies believe that the role of service users is fundamental and complementary to the company role. This was revealed by all those interviewed either at TPSC or PSTCs. For example, the Director of Cleanliness Department at TPSC commented, "The role of the residents according to law No 13 is significant and I can mentioned to you some. For example, the residents should put out the waste at a specific time, separate their waste and clean the area in front of their door up to the middle of the road".

The Director of Finance Department at TPSC said, "If I want to give the contribution of the residents as a proportion, I would say it constitutes 50%, and I recommend raising their awareness to be active members".

The owner of Al-mohtamon Company said, "The residents and the traders have a major role in SWM in the city. Without resident contribution, my company and other private companies could not continue doing work".

In response to the second part of the question, there were two answers; the first one reflects the opinion of TPSC while the second reveals the PCTCs' view. In general, the point of view of TPSC was that the city residents and traders do not have a positive response and enthusiasm toward the current practices and to projects that are designed for management of their waste. They argued that they face improper behaviour from residents and other waste generators. The residents throw their waste in the streets at any time. The company crews roam the streets to collect litter

discarded throughout the street and open areas. This reflected negatively on the performance of the company, which was forced to change its way of service delivery. The waste crews of the company had started to perform sweeping and waste collecting activities day and night. Also they had adopted new practices to overcome the accumulation of waste in spot areas, such as the use of open trucks and tractors with a greater number of workers than usual.

In addition, they say, the city of Tripoli is experiencing urban development. Nowadays, it has become common to see new building construction and/or maintenance work on old buildings. Therefore, there is a large quantity of waste generated from such activities. The residents who generate such waste usually leave it in front of the place where the activity is carried out, or transfer it to the nearest open area, which forces the TPSC to collect what is thrown out. The head of department of Tajora Area at TPSC said, "In the last three months, we have an inventory of the amount of C&D waste that should be removed immediately in Tajora area, estimated at around 87144 tons, which is about 3350 trips to final landfill".

The PSTCs expressed a different opinion. They saw the service users' contribution and support to solid waste practices as generous. They said the residents in Tripoli regularly collect the waste they generate in their houses and do not throw it in the streets, they clean their streets and even in areas where the waste is accumulated they are usually keen to clean these areas and they try to rehabilitate them for other purposes than as waste dump sites, such as turning them into gardens. They argued that there are a few people who do not want to be involved in MSWM projects, but the vast majority would like to develop their area if they can find someone to guide them.

Summary

This section examined the opinions of operational and supervision bodies. Initially, it was highlighted how the service users interact with the service providers. It was shown that the service users exert pressure in an attempt to change the current unsound practices of SWM. This is an indication of service users' dissatisfaction with the delivered service and attempt to improve solid waste diversion and disposal systems and is in agreement with other studies. For example, Buenrostro and Bocco

(2003) mentioned that service providers should analyse social and economic conditions in order to cope with sound practices. At the same time, the result confirms the service users' view. Service providers admitted that their waste collection and transportation practices are not appropriate. Their method of coping with service users behaviour was always temporary; increased frequency of waste collection and/or increase of number of workers could not be sustainable aspects. Such a solution is a subject to the availability of financial resources and labour. A radical solution in this case is necessary to establish appropriate practices based on the type and quantity of waste generated.

Then I have shown the measures taken by the operational and supervision bodies to deal with service users' concerns were reported. It was found that several tools are employed to respond to the service users' requests and complaints at different levels of operational and supervision bodies. This suggests that the organisations at different levels desire to appease their service users. However, the practices are originally not appropriate for residents, as it is argued above, and the legal framework that regulates these practices is not enforced as required, as discussed in Chapter Five. Consequently, such a mechanism may not succeed achieving the purpose for which it was established. From the result, it is observed that the residents also did not accept many of projects founded by service providers. The service providers in this regard accused the service users of not being aware of what the service providers are undertaking to improve the practices. While the questionnaire survey result shows that lack of public awareness and technology were among the contributory factors that led to lack of implemention of waste practices compared to the last five years.

Raising awareness of people is widely recommended to make the local society more conscious about the implications and impacts of SWM (Buenrostro and Bocco 2003). In the present study, it was found that a few programmes have been launched to raise service users' awareness to improve the co-operation between service users and service providers. Most of these programmes were carried out by TPSC and a few by EGA, while the role of MHPU, MPHE and MT in this issue was inactive. The result shows that the awareness raising activities are carried out in discontinuous programmes and can be described as not inclusive. Many residents, thus, may not

benefit from such awareness programmes, for example, reliance on semi-regular programmes on local radio and on a newspaper that is distributed just to local government organisations.

In the last part of this section, the role of service users in solid waste practices was examined. Both the TPSC and PCTCs saw the role of service users as important in the practices of SWM and they believed it is a complementary to their role. However, the TPSC saw the role currently played by service users as negative, while the PCTCs saw it is positive and claimed service users take part in the solid waste management process. The view of the public sector supports the questionnaire results; it found that the role and the contribution of the service users to carry out source separation, recycling and reuse or even to pay for waste service were limited. Thus, from the result it does not appear to be a priority of policy-makers to incorporate the service users within their consideration of sustainable waste management.

CHAPTER EIGHT: DISCUSSION OF THE FINDINGS

8 Introduction

As highlighted in Chapter One, the research for this PhD was conducted to investigate how the current municipal solid waste practices are carried out in Tripoli city in order to analyse how its socio-technical system could be made more sustainable. The discussion therefore in this chapter is therefore carried out based on the main objectives which were:

- to describe the current MSWM practices in Tripoli city and their regulatory context;
- to assess the institutional procedures regulating MSWM practices;
- to explore the interaction between the service providers and service users;
- to explore how MSWM system reform could be carried out to employ the EST concept in the study area.

The empirical chapters (from Chapter Five to Seven) contained an analysis of the data gathered from different resources in order to meet the first three objectives outlined above. In each of these chapters a summary was written to highlight the key findings and in order to facilitate carrying out further discussion of these key findings. To achieve the fourth research objective, some recommendations were proposed as a baseline for system reform, based on the discussion of the first three objectives. This chapter aims to present conclusions that underpin deeper understanding of the potential of adopting ESTs in order to carry out a reform on the current MSWM system toward sustainability. The following sub-headings discuss the findings of the empirical chapters based on the research objectives stated above.

8.1 The current MSWM system in Tripoli city

Chapter Five addressed the current MSWM system in the city and a critical review was carried out of the legal framework and MSWM practices. The findings from the chapter revealed that much work needs to be done in each system element to meet the concept of ESTs.

In terms of waste policies and regulations, it was found that the policies created in the past have not been translated into current practices. In this context, Godfrey and

Nahman (2007) analyed the waste policy instrument in South Africa to try to find if the South Africa is ready to implement the first world policy, they argued that the main reason for a policy's success is that the relevant government organisations have the willingness to improve the system and the SWM is defined as the first objective in their priority. In contrast, analysis of secondary data in Chapter Five reveals that there was no commitment to comply with what was designed in policies and therefore the service providers failed to improve system performance. For example, analysis of the academic literature in Chapter Two reveals that the EU set their member states a challenge to move from the disposal model to a variety of technologies based on a hierarchy of policy options within a specific time frame (Davoudi, 2000). Although Godfrey and Nahman (2007) suggest that developing countries could adapt EU policies to local conditions, there are many barriers to doing this successfully. To some extent such policies do exist in Libya and are not implemented. Policy implementation in Libya therefore requires firstly commitment from the national and local government and then mobilisation of the available resources. In the study area, although the legal framework is available, the analysis of the findings indicates that firstly, the laws regulating MSWM are old, especially municipal solid waste law No. 13 of 1984, and secondly, there is a lack of standards and specifications that explain the technological requirements of each element of solid waste management. This result confirms what is Otman and Karlberg (2007) argued in chapter ten of their book, and it can be concluded that there is no improvement in the legal framework since it was established. Otman and Karlberg (2007) argue that there are several weaknesses in the current legal framework that need to be overcome, and they suggested establishing new legislation in order to address the environmental and sustainability issues.

In addition to the problems that face the organisations of the MSWM sector related to the legal framework, another dilemma was detected linked to a lack of an institution to carry out studies to define the amount and components of solid waste generated in the city. The research results in this regard supported Antipolis (2000); Al-Yousfi (2004) and Al Sabbagh *et al* (2012) arguments about some of the Arab countries' lack of sound data. It is found that there is scarcity and conflict of information and records on waste generation and composition. However, the national and local government assume that the city generates 1.0 kg waste per person/day. In

addition, they found that the organic fraction is a greater part of the waste, which is a major characteristic of developing countries (Al Sabbagh *et al*. 2012), which could build upon different composting technology options, in addition to the opportunity to set up other recycling technologies based on recovery rate as shown in Table 5.4.

Management of solid waste has improved particularly in developed countries (Pires *et al.* 2011), and in some of the developing countries (Shekdar, 2009) to achieve sustainability goals. In contrast, in the study area, it is found that the laws governing MSWM are still weak. Hazardous and non-hazardous solid wastes are handled in a similar way, which would make it difficult to build sound practices. In addition, the municipal solid waste is seen as comprising useless materials, and required to be collected and dumped indiscriminately in landfill. Such an approach will not help decision-makers to design a new system for treatment options based on a sound practices. In contrast, developed countries realise that the amount of solid waste continued to increase, as does as the economic and environmental cost of landfill (Mazzanti and Zoboli, 2008). Thus, there is a need for alternative technology options and sources for its funding. The EU in this regard has kept abreast of such developments, in the UK, for example, there is a continuous development in electric and electronic waste policy to engage the producers in order to undertake their responsibility (Calliafas *et al* 2012).

It seems that the non-implementation of waste policies and defects in the laws have implications for SWM practices in Tripoli. The research findings show that in the city there are no sound practices at any waste management element - even comparing the situation over the last five years, the residents' assessment was that it is almost the same or even slightly worse. Source separation, according to Troschinetz and Mihelcic (2009), is the basic principle in the transformation of the system to become socially, economically and environmentally visible, but in the study area it is not practised, and thus it would seem that there is no room for service users to play their role. Many scholars argue that MSWM technologies should be integrated. For example, Coffey and Coad (2010) stated that storage, collection and transportation practices should constitute an integrated system in order to be economically viable. In Tripoli, however, the practices employed in waste storage and collection are marred by some defects. An insufficient number of storage

containers compel service users especially those served by private sector to use plastic bags and put them outside along the streets. Consequently, the service providers were forced to recruit more workers in collection crews, up to six people per vehicle even for compactor trucks, which in turn affects the companies' budget and their capacity to provide full service coverage.

In an attempt to reduce the cost of waste management, the study shows that the government at the local level has tried to provide transfer stations' technology. Fixed and mobile stations exist in Tripoli city, and a number of transfer vehicles and loading tractors are accessible in the city. Furthermore, private sector companies have been engaged to meet the shortfall in vehicles and in other equipment. However, sufficient improvement in the transfer station practices has still not been made since they were established. It has been found that waste is accumulated in the transfer station sites for longer than necessary. Operating transfer stations in Tripoli in such a manner may not achieve the objective of improving the collection system at the lowest cost, and thus it could have negative impact on human health and the environment.

Troschinetz and Mihelcic (2009) found that there are a number of factors that need to be addressed by the relevant organisations in developing countries such as to collaborate and make necessary arrangements to create recycling industries. However, in the study area, there is no separation of the waste at source, a limited number of recycling industries and only two composting plants in the city, with a low productivity rate. Even though waste received at the composting plants from designated areas is supposed to have a high percentage of organic components, analysis of the data shows that more than a half of input materials are rejected. This has a further implication for the technology used, such as poor quality of production and breakdown of plant. Therefore, very little municipal solid waste is recovered and recycled in the city; the vast majority is disposed in open dumps in landfill sites. In this context, the EGA expressed their concern about the use of landfill with inappropriate technologies, such as not installing leachate and gas collection systems, due to the risks to human health and to the environment in general. Analysis of the academic literature in Chapter Two reveals that many countries, especially in the EU, have recognised that this approach is no longer the best practice and they concentrate

on alternative technology options. Nevertheless, disposal of solid wastes by the open dump practice is still common in the study area. The service providers collect all types of solid waste from different sources and transfer it to final dump sites as the only available option.

To summarise, in Tripoli, the national government policy and efforts of local authorities are geared merely towards prevention of the accumulation of waste in the streets. This is what Antipolis (2000) refers to as "a cleaning approach". The delay in preparing a proper policy framework is preventing a clear division of responsibilities and clear plans for local governments to make the change from this "cleaning approach" to a more sustainable approach to SWM, applying more EST options for material recovery and treatment.

8.2 The institutional reasons for non-adoption of ESTs in the MSWM sector

From the assessment of the institutional procedures regulating technologies at MSWM practices, the study identified three areas where the potential to adopt EST principles is undermined. These are (1) Institutional arrangements including instability in structure, system ownership, relationship and human resources and access to information on sound practices; (2) Policy and legal framework to select and adopt ESTs; (3) Arrangements to fund the sector, including the source of funding, cost recovery, fees collection, contracts and flow of funds. This section discusses the factors that have been identified as hindering the application of the ESTs concept in the current practices in each area.

8.2.1 Lack of organisational arrangements

The organisations of the municipal solid waste management sector in Tripoli city have been subject to several changes in the last four decades. From the analysis of secondary data and the interviews in Chapter Six, it was found that from time to time, the national government carried out restructuring of its organisations, either by reducing or enlarging the TPSC and PCTCs' structure and changing their responsibilities. Such frequent changes have had implications for system performance and have hindered improvement, as they are always accompanied by a new administrative and financial process. In this regard, Ali (2010) argues that the

decision-makers in developing countries tend to make changes in the priorities for, and approach of, the SWM in the short term, because they would like to reach rapidly the level of sound practices applied elsewhere, mainly in order to gain a political advantage. However, most such changes bring consequences contrary to what is expected and thus the situation remains the same or will get worse rather than being solved. In the study area, although several changes had taken place, setting of a suitable institutional arrangement was a dilemma for national and local government. An analysis of findings on the regulatory context of MSWM in Chapter Five, the interviews in Chapter Six and the opinions of service users in Chapter Seven shows that the current practices did not meet the concept of ESTs and in general there has been no improvement over the last five years. System ownership fluctuates between public and private sector, especially in waste collection and finally poor organisation was a main contributory factor that led to the system remaining in the same situation or deteriorating.

In Libya, the attempts to shape the MSWM institutions had no structure as many scholars commented (e.g., Alfandi, 2004; Davoudi, 2000; Schubeler *et al.* 1996; Obeng *et al.* 2009). They argue that the aim of structuring and/or restructuring of institutions is to build a new network characterised by defining clear roles and responsibilities, strong relationships and cooperation. According to the results obtained, the past experience of restructuring of institutions in Libya was built just on how to form the service provider's body, mainly in the public sector (TPSC). Though the system ownership was carried out and divided between the public and private sector, system performance remained ineffective because the system reform was not integrated with further steps such as formulating clear funding sources, which would confirm the success of such a partnership. By comparison, when Ghana reshaped its service providers' structure, Obeng *et al* (2009) found that the government's policy of involving the private sector succeeded due to removal of gaps and overlaps between them. From the analysis of secondary data in Chapter Five and the interviews in Chapter Six, it was found that the reshaping of MSWM institutions was not accompanied by new technologies and practices being introduced, as Bulkeley *et al* (2007) suggested is necessary. There is no improvement in the technologies used; it is observed that what is used currently is the same as past

practice, for example, use of single bins and plastic bags, and open trucks to transfer waste from collection points to the next destination.

It is also found that the most important factor that hindered the successful restructuring of MSWM institutions in the study area was failure to implement the waste policy formulated in the past years. The existence of waste policies is the driving force to build a new structure and/or to restructure the old system. In this context, Davoudi (2000) noted that in the UK, the EU policies were the reason behind rapid changes in the institutional landscape, which in turn led to the introduction of new streams of technology based on local conditions.

Reshaping of institutions at different levels in the study area without commitment to implementing the designed policies has affected not only the setting of a sustainable structure, but also the conditions to recruit staff capable of running sound practices, and of building good relations with each other and with other internal and external relevant authorities. It is also observed that the current organisations are affected by lack of access to the necessary information that defines EST and makes it accessible. From the analysis of interviews in Chapter Six, firstly it is found that the financial aspect and the bureaucratic system were the main issues that impact the process of staff recruitment and retention at TPSC. The method that was adopted to finance the sector was unsatisfactory, as the amount and time of the national government payout of the financial dues to the TPSC were not fixed properly. Thus, workers' salaries were not paid on time. In addition, remuneration of those working in this sector is not satisfactory, because salaries and wages in the public sector have been governed by law No 15 since 1981 (as explained in Chapter Three). Such factors have affected the ability of local government to employ skilled staff, especially those who work as practitioners or who have experience of the day-to-day work. In contrast, staff at PCTCs are easily recruited and retained, because the private sector finance is derived from service users' fees and the salaries of their workers are not governed by law No 15 of 1981. On the other hand, lack of finance and coordination between relevant organisations have also affected provision of training programmes to TPSC and PCTCs staff. The results of this research in this regard supported the claims of Al-Yousfi (2004) and Antipolis (2000) in relation to other Arab countries, as it was found that there is no plan to train the TPSC and

PCTCs staff, because there are no funds earmarked for this task and it is not clear for who is responsible to carry out such a task.

Regarding the MSWM organisations cooperation and support, it is found that there is a weak relationship among MSWM organisations at national and local level, while at international level it is observed that there is no relationship with the relevant organisations. It is clear that the MSWM organisations in the study area did not take into account the issues raised by Schubeler *et al* (1996) Many authors (Bezama *et al*. 2007; Troschinetz and Mihelcic, 2009; Zhu *et al*. 2008, Zotos *et al*. 2009) assert the importance of a network of cooperation and coordination link between MSWM organisations at different levels to facilitate administrative and financial processes, and to share experience and lessons learned.

In terms of access to information, the results show that difficulties are faced by relevant MSWM organisations in gaining access to information and obtaining knowledge related to MSWM practices. This is the case in many developing countries (Schubeler *et al*. 1996; Bezama *et al*. 2007; Guerrero *et al*. 2013). The staff of supervision and regulatory bodies could access some information and they have some knowledge of the practices of the neighbouring and EU countries. However, the staff in the service providers, either in TPSC or PCTCs do not have the necessary tools that would enable them to obtain soft and hard information. The TPSC staff have limited knowledge of the practices of the neighbouring countries, while PCTCs do not have knowledge of the practices of either neighbouring countries or the EU countries. In this regard, existence of supporting structures like those established in the EU to provide the necessary and adequate information to their members is critical as they are an important aspect of institutional arrangements servicing environmental improvements and technological development.

8.2.2 Policy and legal framework reasons

Section 8.2.1 highlighted a lack of commitment to the designated policy and deficiencies in environmental and MSWM legislation, which in turn have affected operation of the current practices. In this section, how the relevant authorities select MSWM technologies, their top level policy-makers' behaviour, and the satisfactoriness, incentive and enforcement of the laws will be discussed.

In regard to how technology is transferred, the findings show that the method pursued is no different to that followed by most other developing countries (Van de Klundert and Anschutz, 1999; Bezama *et al.* 2007) or some developed countries (Zotos *et al*. 2009). In the study area, there are no criteria that regulate and can be used as a guide to select ESTs. In general, assessment processes and decisions on choice of technology in Tripoli city were based on the lowest cost and on the supplier's instructions. At the same time, it was observed that political orientations intervened to influence the MSWM system, while some important and relevant organisations were not involved in the selection process. Focusing on the financial aspect only gives a clear perspective of operational process such as actual costs and potential jobs/income (Zhu *et al*. 2008). However, neglect of other categories and failure to integrate economic, social and environmental considerations in order to ensure resource efficiency and social acceptability will prevent the achievement of ESTs objectives.

Applying policy via such an assessment approach usually limits the options to open windrow composting plants or to retention of open dumps. Near-total dependence on those options for final treatment and disposal in Tripoli city restricted collection and storage facilities. A single container of a large volume was used to store all types of municipal waste components and open vehicles were used in collection. Both these choices were made in order to facilitate transfer of municipal solid waste from residential areas to disposal sites, as options of lower cost (Coffey and Coad, 2010) than alternative sound technologies. A barrier to use of ESTs is lack of information/knowledge needed to make informed choices on technologies for various aspects of municipal waste management, including sorting, aggregation and storage technologies. This study revealed that the relevant authorities of the MSWM sector do not benefit from the EU's lessons, because most of the organisations, particularly the operational body, lack knowledge of what the EU has done and is doing. Thus they are not familiar, for example, with how EU states formulate their policy, or how they set a time frame for compliance, or with the technology options selected for implementation.

Results from this study show that top-level policy-makers' lack of awareness to environmental issues was one of the main factors that contributed to the failure to

reach an agreement on policy implementation. This in turn has had many negative impacts on adoption of sound practices in order to shift from the open dump-based approach to other more sustainable treatment technologies. Luken *et al.* 2008) explained that in the industry sector, the regulatory pressure in developing countries is generally weak, due to limited monitoring and enforcement capacities, and thus it is assumed there would be limited adoption of EST. The result of this research supports Luken *et al* (2008) study, founding that the law enforcement is not sufficient to instil many basic principles of ESTs, because the laws are old and they do not include incentives to facilitate accommodation of ESTs. Secondly a number of organisations whose responsibility is to update and enforce these laws are falling short in their performance in this regard.

Existence of these factors, collectively, was the reason for the system continuing to rely on traditional technologies, without reforms toward a more appropriate system.

8.2.3 Lack of arrangement to fund the sector

In the study area and from the analysis of interviews in Chapter Six, it was found that government revenue is almost the only source of funding for the sector. The study revealed that 70% of the sector budget comes from government revenues. The national and local government in the study area asked commercial premises to pay for service provision, while householders were exempted from paying such a fee as a political choice. Reliance on government revenue as a main source of funding is accompanied by many defects, such as uncertainty as to the amount and time of payment. According to Scheinberg *et al* (2010) and Bulkeley *et al* (2007) funding sources should be varied and the decision-makers in turn should determine the appropriate funding sources among those available based on their local needs. In the study area, decision-makers do not look at other ways of raising revenue that could work in the city, such as users' fees to finance the existing technologies or to improve practices. The analysis of academic literature in Chapter Two reveals that such a variety of funding is available in most of the countries that have succeeded in establishing ESTs. It is true that national and local governments have a role in the funding of the sector as they are partially responsible for protection of human health and the environment. However, the service users even in low-income countries are

prepared to pay certain fees for waste service provision (Scheinberg *et al.* 2010). This should be even more feasible in Libya, which has upper-middle income earners and where the residents in the study area are willing to pay, as shown by the experience of the private sector. Policy-making in Libya is therefore blocking the important role that service users could play as a source of finance.

The budget of the public and private sector is allocated mainly for waste collection and transferred to final disposal. From the study it is found that little attention was given to financing treatment and disposal technologies such as composting technologies, and recycling industries. Nor was attention given to sanitary landfill, due to a lack of policy-driven activity. However, the service providers complained of miscalculation of service costs.

At national and local organisational level, two criteria are employed: population size and the price of each activity to be done. However, since the organisational structure that regulates the financial system originated as a public system, contract value is controlled by the public budget for the current financial year. For that reason, the MHPU did not seriously consider design criteria, but rather their concern was with the allocated share of the public treasury. Service providers (TPSC and PCTCs) in this regard consider that in estimating the value of contracts there is no solid foundation for arriving at realistic cost estimates and making appropriate investment. They considered that there is misjudgement in the distribution of financial resources. On the other hand, some sources of revenue are not available, which are supposed to be paid to meet actual service cost, such as the cost of removal of solid waste from open markets of agricultural products and transport of C&D waste to landfill.

The findings suggest that there are discrepancies between what is allocated to the sector and the actual cost of the service. The national government does coordinate with the local level to find out the real cost of services. The following example reflects the fact that the national government is controlling and acts unilaterally in disposing of the sector's financial resources. They reserve a portion of the sector allocations in order to buy technology. However, the senior officials at TPSC complain that the money is not paid on time, and assert that there has always been a delay in payments. On the other hand, failure of service providers to recover the cost

of the service is mainly due to inefficiency of the fee collection system. The TPSC collect just around 30% of fees due from commercial and services premises. In this context, many developing countries have succeeded in levying solid waste taxes by setting suitable criteria for collection of such fees from service users, such as designing a system to collect solid waste fees with the water supply bill, gas bill, television licence, electricity bill or other services delivered to the users or combining all together in one bill. For example in Egypt (Abdrabo, 2008) and Bahrain (Al Sabbagh *et al*. 2012) service users' fees are collected alongside those for electricity consumption. In the study area, in contrast, from analysis of interviews in Chapter Six, it was found that the TPSC and PCTCs are responsible for collecting service users' fees but they have no clear mechanism for collecting such fees from their clients. This put a strain on service providers, especially TPSC, because they do not have enough legal authority to enforce payment, and there is no cooperation with the authorities responsible for licensing those activities. With regard to the private sector, providers have discretion to decide the amount of fees to be collected and how they are collected. This could affect both the service providers and service users because of potential disagreements between the two parties. In this regard, the result of the study shows that about one third of the householders did not pay the private sector. The reason for non-payment could be not accepting the service pricing. Therefore, delivery of a regular waste service was affected, because in the private sector view, delivery of a regular waste service is linked with payment of waste fees.

8.3 Interaction between the service providers and service users

This section discusses the third objective for conducting this study, which was to explore the interaction between the service users *(*households and service providers (TPSC and PCTCs) to raise the level of current practices and to meet the EST concept. The interaction of the service users was explored firstly in terms of their opinion toward current practices and then their responsibility and contribution to these practices. The interaction of the service providers was explored based on the measures that they have taken to address service users' concerns. In respect of this objective, the discussion is presented under four headings, as follows:

8.3.1 Unsound private sector practices

The data of this study shows that the private sector provides solid waste collection in almost all districts of the Tripoli city. However, it is observed that there is a difference in the number of people who receive service by PSTCs from one district to another. The appearance of the private sector is attributed to the inadequate capacity in the TPSC.

In general, many scholars, for example Fobil *et al* (2008); Kassim and Ali (2006) and Fahmi and Sutton (2006) believe that the private sector's key success factors are competition, transparency and accountability. Consequently, if they have the opportunity to participate in the SWM system they can improve efficiency and lower costs by introducing commercial principles such as limited and well-focused performance objectives, financial and managerial autonomy, a hard budget constraint, and clear accountability to both customers and providers of capital. The private sector plays other important roles by mobilizing needed investment funds, and by providing new ideas, technologies and skills. In this study, it seems some of these features may be achieved. Results from this research show that the satisfaction of residents whose collection service is provided by the private sector is fair (almost fifty percent received regular collection). However, the assessment of the city residents towards the facilities used by the private sector to collect and transfer waste was that they employ less appropriate technologies than those used by the public company. It was found that their client mainly uses plastic bags and they rely on open trucks to collect waste from residents. It seems that lack of the financial resources was the main factor for not owning appropriate facilities. On the other hand, the owners of these companies pointed out that they did not provide training for their staff, and they did not have enough contact with relevant organisations such as EGA. Also the legal framework did not address private sector related issues fairly. Lack of government subsidy, support and cooperation could be the reasons for the private sector continuing to use poor facilities. In this context, the government especially at national level has not paid much attention to improving the private sector and has not benefited from success stories that show the importance of involving the private sector in delivering waste collection (Fobil *et al*. 2008; Obeng , *et al.* 2009), especially in Tripoli city, where the private sector has been providing service across the city for decades.

The private sector respondents also viewed the role and the contribution of the service users as important, and confirmed that they are played in many respects. However, lack of their own instrument or other relevant organisation that could facilitate communication activity is still a challenge to maintaining the necessary interaction with the service users.

8.3.2 Unsatisfactory practices and negative evaluation

As is typical in developing countries, the capacity to collect solid waste in Tripoli does not match the volume of the waste generated, and use of inappropriate technology is one of the issues (Coffey and Coad, 2010; Wilson *et al*. 2012). It was revealed that around one sixth of residents did not receive a waste collection service. Analysis of the data shows that service users viewed storage and collection practices mainly as unsound. With regard to storage practices, use of plastic bags to store solid waste was the dominant practice in the city, compared with wheeled bins and skips. The majority of households in all districts, whether they received a service or not, bought plastic bags to store their waste, because the TPSC did not deliver enough containers and according to interview results only 17% of the bins required in the city are available. This was reflected in the service users' assessment. Dissatisfaction of householders with the storage bins therefore could cause them to abandon their responsibilities to carry out sound practices. Providing proper containers for storage in terms of type, size and placed in a proper location is important to motivate residents to be real partners (Martin, 2011), in Tripoli, containers are limited and the residents depend almost entirely on plastic bags, which is not a sound practice (Al-Maaded *et al*. 2012). As explained in Chapter Five, people in this case throw their waste alongside the road and in open areas, which makes it difficult to collect and thus creates unsound practices.

Regarding collection practices, the residents were dissatisfied because the service providers (TPSC and PCTCs) could not deliver regular waste collection in any district. The practices employed and the staff engaged were described as the main issues of concern.

It was observed that service providers mainly rely on open trucks and unskilled staff to collect waste from the city residents. The research results in this regard supported what many scholars have observed. For example Diaz (2010); Coffey and

Coad (2010) and Martin (2011) discussed how developing countries select inappropriate vehicles and employ unskilled workers, and they argued that it is important to use approved vehicles that meet their needs and requirements, even when using low technologies, provided that the employees are trained in accordance with the vehicles used.

As the city residents were dissatisfied with the storage and collection practices, the evaluation of overall practices delivered by TPSC and PCTCs was also negative and they were described as being below very good or even good practice. In this regard, the householders evaluated the overall practices delivered by TPSC as worse than those of PCTCs. Besides their negative evaluation of the overall current practices, they considered the situation had not changed from five years ago; indeed some of them went further and claimed it was worse due to deficiencies in three areas: financial arrangements, technical/know how and non-collaboration of parties.

In general, from the analysis of the data, it appears that the service providers have failed to establish sound practices that can be accepted by their clients. However, the opinion of householders toward current practices was consistent with what service providers expressed in this matter, especially TPSC staff. To a certain extent, the service providers recognised that residents were not satisfied with the practices they offered but accused them of not being aware of what was delivered.

Thus, the dissatisfaction of the householders in this case may mean that the current practices are indeed not in line with what people think is appropriate. Therefore, it can be argued that the current practices did not meet the EST principles, because the service providers failed to determine satisfaction factors when deciding to apply the current practices. Another point could be related to the extent to which householders are aware and able to be positive partners in order to convergence their views to meet ESTs principles in their practices.

8.3.3 Limited responsibility and modest efforts to contribute current practices

The role of the service users in developing countries (such as delivering the waste they generated at a specific time and place and paying fees for waste service) is not played as it is in developed countries (Wilson *et al.* 2012, Al Sabbagh *et al.* 2012, Shekdar, 2009). From the opinions of the housholders it is found that there a

difference between the districts in carrying out source separation as self initiative. In contrast, from the analysis of the gathered data in Chapter Five, it was found that there is no source separation practice in the city, and the service users use one container to store their waste or in plastic bags deposited on both sides of the road or bins and skips, as is common in designated areas. In this case, the opportunity for the service users to carry out sound separation practice on their own is limited. Thus, the result in this regard was not surprising; most of the city residents do not take the initiative to separate their waste into different types. In this context, in a test of the relationship between service providers and carrying out source separation, it was found that the service provider was not a paramount factor in carrying out separation activity and reuse and/or recycling in the city. This finding indicates that the service providers perhaps did not contribute to promoting a sound source separation practice. This result is not compatible what is recommended by many scholars. For example, Zhuang *et al* (2008) suggested that subsidization from government organisations is required to increase service users' participation, for example by providing storage equipment and encouraging service users through an incentive programme. In addition, identification of the public behaviour in advance before embarking on real projects for learning lessons is also examined in many cases (Phillips *et al*. 2011). For example, in order to analyse public behaviour and configure it to be consistent with future policy, the relevant authority in the UK implemented several pilot projects in selected areas (Phillips *et al*. 2011). In Tripoli, such a pilot projects could be carried out to realise and understand the local public behaviour, which in turn can determine the EST adoption factors.

In cases where there is no source separation practice, such as in Tripoli, in addition to loss of the economic benefit, there are also impacts on ability to carry out recycling and reuse initiatives (Al-Maaded *et al*. 2012; Tonglet *et al*. 2004). The result that has been obtained supports this assumption, and it is found that the majority of householders are not willing to take the initiative to recycle or to reuse their waste. In this regard, it can be concluded that the decision makers at municipality level have failed to involve stakeholders in solid waste management activities; they neglected stakeholders' interests and ignored the important roles they could play. For sustainability of a solid waste management system, it is essential,

according to Zhuang *et al* (2008) to clarify the roles and interests of people and organizations who are directly or indirectly linked by a common significance.

In regard to the obligation to pay for the service, the result of this study indicates that most of the city residents do not have a role in paying for waste service provision. Exemption of the city householders from waste collection fees and the fact that some of the residents do not receive regular waste collection or even do not have access to waste service could be strong reasons for not making payment. However, those householders who are making payments are usually PCTCs' customers and they pay regularly, mainly because they receive a regular collection service.

Delivery of sufficient and adequate data and information, engaging the service users in the MSWM plans and selection of technologies are two of the important issues that measure the degree of users' inclusion in MSWM systems (Wilson *et al*. 2012). However, blocking or lack of such important information was found in this study, where the relevant authorities do not do what they should to provide the necessary information, for example on what to do or what is already being done to improve the current MSWM practices. This could prevent service users from cooperating with the service providers, which in turn impedes establishment of sound practices (Scheinberg *et al.* 2010).

Although the service providers believed that the role of the service users is important to build practices that meet the EST concept, and is equal to their own role, it seems that this belief was not followed by actions on the ground to attract the service users and join with them as an integrated body. The idea that the service users are actual partners is still no more than an idea. Lack of initiatives from local and national government to motivate service users to take positive steps is the main factor that contributes to this gap between them.

8.3.4 Measures to satisfy service users

This section analyses the efforts of the operational and supervisory bodies to make the service users satisfied with and positive towards the current practices. By analysis of the data of the householders' opinion on the performance in current practices, we have seen that the service users were not satisfied with most of the service providers' practices. Thus, the service users have attempted to attract the attention of the service providers and exerted pressure on them. For example, instead of presenting the waste

they generated at the specified day and/or time, they dump it in areas not designed as collection points. Such behaviour is an expression of their dissatisfaction with what is delivered to them and their demand for improved practices. Many countries, particularly developing countries, could face such a tragedy. Scheinberg *et al* (2010), analysing results obtained from different cities around the world, warned that countries need to be very aware of what happens to some countries when they do not address EST concepts on how to collect waste regularly and reliably, and dispose of it properly. In this regard, they found that the weakness in the provision of waste services is usually reflected in on the service users' behaviour, which becomes passive. However, in the study area, the research found that service providers were not aware of this lesson. The behaviour of the service users toward service providers' projects and proposals was unfavourable, because the service users thought such steps did not meet their expectations, and were attempts to solve the problems without deep understanding of what was needed from the grassroot level.

To respond to the service users' demands, the result of the study shows that several mechanisms were employed within the national and local government to receive and answer enquiries. Establishing such procedures is a good attempt to look at the service providers' commitment towards delivery service via sound practices and secondly it indicates that the national and local government are dedicated to making service users satisfied with what is offered to them. However, the setting up of similar units at different levels of government institutions could imply that there are too many inquiries and complaints that need to be considered and solved; also it could be difficult to solve these concerns, because there is no clear role for each institution, which is common in developing countries (Obeng *et al* 2009; Scheinberg *et al.* 2010). In turn this affects who will take the decision, as either each of them will leave the other body to address the concern or there will be duplication in their effort. Moreover, as long as the competent body is inactive, many of these inquiries and complaints could not be successfully resolved.

Raising awareness was another step taken by some of the national and local government bodies to keep the service users aware and to inform them of the service providers' plans and projects. Carrying out such activity is important for cooperation and coordination between service providers and their stakeholders, including service users (Van de Klundert and Anschutz, 1999; Schubeler *et al.* 1996). However, in this

study it was found that many of the relevant institutions at national level did not play their role in this regard and very few programmes were launched. The interviewees demanded better institutional financial arrangements, to enable them to run regular and permanent awareness sessions.

8.4 Implications of the study findings for reform of the MSWM system

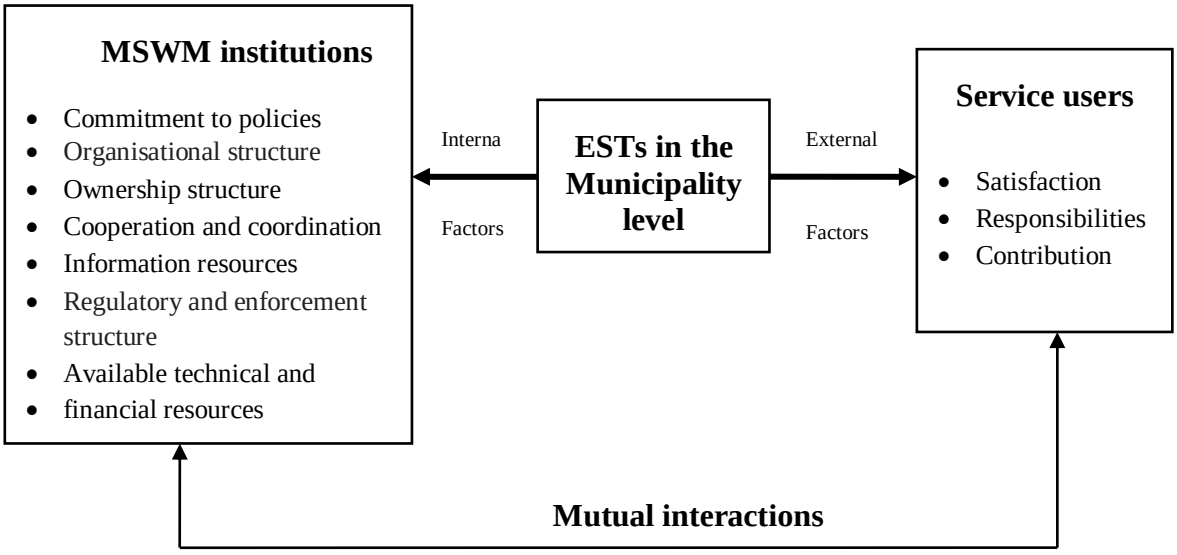
In this section, the fourth research objective is addressed with a view to facilitating finding solutions. Based on the discussion of the research findings, the study has raised new approaches on how the MSWM institution could be more active at municipality level.

8.4.1 Factors for uptake of ESTs in the MSWM sector at municipality level of Tripoli

As discussed earlier, in the city of Tripoli, several factors and obstacles were detected, which hindered adoption of ESTs in the MSWM sector. These factors and obstacles are originally derived either from the relevant local and national SWM institutions or from service users. The factors related to the local and national SWM institutions can be addressed firstly through reconsidering the current practices. The current method of waste handling had affected the service user satisfaction and at the same time the subsequent treatment processes. In this context, for example, waste recycling and composting activities in Tripoli city suffered from use of a single container practice to collect household waste. Waste arrives at the recycling industries and composting plants contaminated with undesirable materials, which complicates processing. Therefore, since there is a crisis in the system, thinking of appropriate practices is the starting point for transition to a sustainable system, either by building on the old configurations or expanding into new configurations, subject to compliance with national and local policies. More importantly, there is a need for commitment from top-level policy-makers to ensure provision of support to facilitate technology transfer and project success. Secondly, determination to carry out change in the current inappropriate practices must be accompanied with an understanding of the available capacities and resources. In other words, sector restructuring needs to be based on a new vision as to how the MSWM system could be reformed. Figure 8.1 shows the institutional aspects that need to be reformed. From Figure 8.1, available capacities and resources can be determined in respect of the SWM

institutions, which are described as internal factors of ESTs uptake. Relevant SWM institutions at different levels should identify their capacities and resources that can lead to the desired change. These capacities and resources, based on the result of this study, are focused upon three MSWM aspects: relevant organisational arrangements, regulatory measures and arrangements to finance the system practices. In regard to organisational arrangements, system structure and ownership is one of the main issues that should be addressed by clarifying the boundaries between the public and private sector, as well as opening new opportunities for involving the service users. Then an effective network should be established for cooperation and coordination locally, nationally and internationally, and finally raising awareness of what ESTs are, available practice and how knowledge can be transferred is another key issue in the system. In regard to the regulatory framework; it is found that the absence of a clear and transparent framework is critical. The extent to which the relevant organisations are capable of selecting an appropriate legal framework covering all aspects of MSWM and committed to its implementation is the key issue for uptake of ESTs. The final aspect is related to the capacity to provide a sustainable financial system, starting by determining the actual costs of each practice and then making available the resources that can cover these costs. In this context, participation of service users and other resources could be available to pay for the provision of solid waste service collection and treatment instead of their being paid for through revenues of the public sector, as an opportunity for system gradual to reform.

Figure 8-1: Determinats of ESTs uptake at municipal level



From the result of this study, there are also factors that affect uptake of ESTs (see Figure 8.1) which could be described as external factors, which are related to service users. Understanding of these factors is indispensable for the improvement of the system, because the service users are the second part of the equation for uptake of ESTs. The result of this study revealed that the role and contribution of the residents as service users are important and required to adopt and improve current MSWM practices. The service providers showed implicit recognition of this issue. They also admitted that the service users exert pressure, they stated that, the residents in Tripoli no longer accept non- collection of solid waste from their residential areas. The result was that the service user is dissatisfied with the services provided and their roles and responsibilities were limited or not practised in many cases. All of these factors should be considered in order to realise the role that service users can be play and the contribution they can provide to establish sound practices based on these circumstances. However, unless there is mutual interaction between service providers and service users, the reform process remains fraught with failure. A common understanding of what is a sound practice can achieved only through use and activate of appropriate interaction tools.

To address these factors, developing countries such as Libya need to learn from the experience of transition processes in developed countries. This would involve not just the relevant technology or even technological knowhow in isolation, but how to build institutions that are capable to transfer and use ESTs. It is necessary to be realistic; each country has its own experience. Nevertheless, such learning can assist in selection of appropriate alternatives according to the factor to be reformed.

CHAPTER NINE: CONCLUSION AND RECOMMENDATION

9 Introduction

This chapter evaluates what has been reached from the results of this study. It starts by outlining the institutional capacity as a means for EST analysis. After that, the research contribution is outlined. Finally, the chapter presents the research recommendations.

9.1 Institutional capacity as a means for EST analysis

Institutional capacity has proved a useful concept with which to analyse the development the factors for adopting EST for reform of the MSWM system in Tripoli city. There is continuous change in the nature of technology available for SWM as well as in political and economic circumstances. There is a need therefore for dynamic adjustment in the institutional interactions to both determine and implement sound practices. Thus, issues of institutional capacity were explored and discussed with respect to both the current SWM practices in Tripoli and the perspective of the various MSWM organisations and associated service users (including Ministry of Housing and Public Utility, Environmental General Authority, Municipality of Tripoli and householders in Tripoli).

Two aspects of institutional capacity were considered in the analysis of EST suitability for system reform: the interactions of institutions within each other and the interactions between service providers and service users (*i.e.*, relational capacity in the term of Healey *et al.* 2003). It was found that the relationship between organisations was not functional. There is overlap of responsibility in some areas, and under-defined responsibilities in others. There have been several changes to SWM institutions and their interrelationships in recent years. However, these changes appear to have generated confusion rather than clarifying responsibilities. They have not resolved the fundamental problems of underfunding and lack of specificity in regulatory requirements. For example, private sector involvement in SWM is notionally encouraged, but under conditions that favour the public sector body overseeing arrangements and which strongly discourages investment in improvements to service. Confusion over current practice is not a promising starting

point for the implementation of new technology. It is not easy to determine where the initiative should come from, quite apart from the funding.

Additionally, there are communication and perception problems between the service providers and service users. Both groups are aware of deficiencies in the service, but each is frustrated with the other. The poor waste service over many years with a lack of improvement, was a common comment from service users in all city districts. The interaction between the service providers and service users was not serving the waste service improvement; the service providers do not encourage users to be a partner in their waste practices, and the service users refuse to pay for waste service received.

However, as well as highlighting problems with the EST approach, the institutional analysis also points to potential solutions. A number of institutional factors were identified (see section 8.4.1) as an aid for decision-makers to take up the ESTs at the municipality level. For example, the lack of commitment to resource mobilisation was a significant barrier to implementing waste policy, which was noted in connection with both the 2003 and 2005 reforms. Lack of awareness among senior officials is a real problem in Libya that needs to be considered to ensure that this important group positively interacts with system reform.

Furthermore, the factors raised in this research can be used as assessment criteria for technology selection and/or during its implementation at local level. However, the use of these factors or some of them is dependent on the type of practice. Institutional interactions vary with different practices. For example, technical, operational and therefore institutional relationships differ between collection for recycling and collection for landfill. Landfill operations have greater need for pollution control; recycling requires an end user for the reprocessed materials. Understanding of such interactions is essential to build a sound practice. The research in this context explored a range of factors, not only those related to public and private MSWM organisations, but also those associated with the service users. This wide ranging set of factors provides a good starting point from which to determine potentially suitable ESTs. The suitability of EST at local level is dependent on the potential to build new institutional structures that meet environmentally, socially and technically necessary interactions.

9.2 Research contributions

9.2.1 Contributions to theory

By conducting this study, the following contributions are achieved;

- Better understanding of MSWM issues, related to the obstacles to the adoption of appropriate technologies that can meet the social, economic and political conditions in the Tripoli city, in order to build sound practices rather than the current unsatisfactory ones.
- Analysis of institutional reforms through review of related prior research in developed and developing countries; new ideas were employed and rich data were collected from different MSWM stakeholders in the city of Tripoli.
- Strengthening the understanding of the ESTs concept and the potential of the relevant MSWM organisations to reform their structure in order to be able to replace the current unsound practices through selecting and adopting ESTs.
- Inventory of the factors that hindered adoption of ESTs in the MSWM sector. The factors were derived from the key issues raised from criticall review of different prior research in the literature review chapter and also from empirical research. The identified factors were a combination; some of them are attributable to the relevant MSWM institutions, while the service users are the basis of the other factors.
- Interaction between service providers and service users. The opinions of the service providers and service users in this regard were was analysed, and the tools used to interact between them were identified.
- Engagement of the service users as an important factor for ESTs concept. In this study, the service users' attitude towards their satisfaction, assessment, responsibilities, contribution and interaction with service providers were investigated. Several factors were explored that need to be avoided in order to reform the current configurations.

9.2.2 Contributions to practices

In this study, introducing the ESTs concept was the significant contribution to MSWM practices in the context of selection of appropriate technologies and adoption of sound practices in the municipal solid waste sector. In this concept not

only technical issues, but also the organizational and managerial aspects were included in the system transition. Factors for institutions reform in Tripoli city were formulated as a result of exploring the opinions and attitudes of the operational, regulatory and supervisory MSWM bodies towards current practices, how they are adopted and how they run, the city householders also took part, as their role is critical in applying sound practices. The factors identified would help both the decision-makers and the policy makers in the Tripoli city and in Libya as a whole to reform MSWM institutions in order to be able to accommodate sound practices based on their capacities and resources. Addressing the ESTs concept that addressed in this research contributed to understanding the following main MSWM problems in the Tripoli city, in order to create necessary institutional reforms.

- The current MSWM system in the Tripoli city is facing challenges to the uptake of sound practices.
- Defects in the arrangement of the organisational framework were detected, including instability of organisational structure and arrangement, System ownership boundaries between public and private sector are not clear and public sector is likely prevailing, there is a weak or no relationship and support at different levels between relevant organisations and finally lack of access to information.
- Legal framework deficiencies were also highlighted, whether in the political context or in the laws in terms of insufficiency of the ESTs selection and uptake mechanisms, and enforcement issues.
- Failure of the system finances was identified in terms of lack of sources of funding, cost recovery and contracting and contracting mechanism issues.
- The role of the service users has been identified; the limited responsibilities and contributions currently of the city residents were addressed.
- The study provides empirical evidence of how service providers interact with the service users to cooperate in adopting ESTs, which is the starting point for measures to increase their contribution.

9.3 Research generalisation

As clarified in the literature review (Chapter Two), there are several interrelated factors that need to be understood and determined in order to establish ESTs practices. For example, Van de Klundert and Anschutz (1999), based on their personal experience, identified factors that affect selection of appropriate technology and design of sustainable systems. Also Guerrero *et al* (2013) highlighted developmental factors that can be used in the planning or reshaping of the MSWM system. However, the factors that determine the ESTs are dependent on the social/culture, economic and political situation of the area where ESTs will be accommodated. Accordingly, these factors will vary from one country to another and from one municipality to another.

From the empirical study of this research and previous experience of the researcher, the following circumstances are evidence for the potential to apply the research findings and recommendations to other Libyan municipalities, like Benghazi, Sabha, Musrata, Al-Jabil Al-akdar and Alzawia. There may also be possibilities to generalize the research methodology, findings and recommendations of this study to other developing countries that have similar social/culture, economic and political situations.

- In Libya, the MSWM sector always operates according to the policies and the regulations that are designed at the national level. The MSWM institutions at the municipal level are treated similarly in terms of the funding sources and the laws that regulate their system. The previous experience of the researcher and the findings of this study show that the service providers in municipalities throughout Libya rely heavily on national government funding and they are regulated by Law 13 for 1984.
- In each municipality, there is a public company similar to the TPSC in Tripoli which provides a waste service at the city level. These companies are supervised and regulated by a similar institutional structure. Consequently, their operational circumstances are to a great extent similar to each other.
- The empirical study and experience of the researcher showed that the private sector within the MSWM institutional structure is informal and limited. Nevertheless, in most Libyan cities, like Tripoli, Benghazi, Musrata and

Alzawia, the private sector has a role in waste collection and transfer from residential areas to the next destination.

- The workforce in the MSWIM sector is governed by unified laws at the country level in terms of recruitment, incentives and so on.
- From the literature review, most developing countries, especially those countries in the Arab region are facing almost the same managerial and organisational procedures to set up appropriate socio-technical system. To solve these problems it is therefore required to apply the same mechanisms, as long as their conditions are identical.

However, certainly there are differences among countries and even between municipalities in terms of capacity and available resources that can affect understanding of the ESTs concept and how it can be applied. For example, developing countries have different economic levels of income; some of them are low, while others are characterised as a middle-income. Thus, these variations should be considered and some caution should be exercised when generalising this study.

9.4 Recommendation for MSWM system improvement

As discussed in Chapter eight, MSWM system in Tripoli is surrounded by a number of deficiencies. Applying of EST concept is therefore remains complex. Given these limitations, this research suggests the following recommendations for system improvement toward sustainability.

Improve the current MSWM infrastructures

As discussed in the literature review, the infrastructure is important in establishing sound practices. In the study area, it was found that many elements of the MSWM infrastructure are available and could have potential to meet the EST concept if they were modernised, mobilised or innovated to be more appropriate for local conditions. In this concern, the following recommendations are offered.

- The current MSWM system collects hazardous waste from different sources with municipal solid waste in one stream. To create sound practices, it is recommended to construct new separate streams for hazardous waste, particularly for hospital waste, away from the municipal solid waste.

- Some of the technologies owned by the public sector are not used or face difficulties in use, such as a number of composting plants and mobile transfer stations. There is also a lack of other technologies such as collection bins and equipment for landfill. In this context, better distribution of the available resources is therefore important. They need to be integrated with each other in order to improve the current practices and establish new technology options.
- Many of the MSWM principles were developed years or decades ago, such as transfer stations, composting plants and landfill sites. However, the objective of establishing such technologies is not achieved as intended. Improving the operation condition of such current practices is the convenient way to modify practices to meet the ESTs concept.

Reshaping organisational arrangements

The institutional structure that exists in the city of Tripoli consists of national level supervision and regulatory bodies and at local level, in addition to the supervisory and operational bodies, there are also the public and private sectors. However, there is still weakness in the understanding and applying of the EST concept. The following recommendations are proposed to restructure the current organisations in the study area;

- To enhance the system relationship, support and ownership, the role and the responsibility of each organisation should be clearly defined, especially in terms of contracting arrangements, public and private sector ownership and waste treatment and final disposal responsibilities.
- The current structure needs to be reorganised on a scientific basis by adding new structures, firstly to stop the previous failed restructuring of the system and to settle on an appropriate structure, and secondly to meet the concept of MSWM sustainability, because there are new waste components and waste treatment technology options that need to be considered.
- There is a need for building institutional capacities, firstly by solving the problem of temporary job contracts, then by training of MSWM staff at different levels, providing incentives and increasing salaries to retain the current staff and attract new qualified staff.

- Studies are needed to build data on the MSWM sector which must then be disseminated and information exchanged, locally, nationally and internationally to facilitate technology transfer, and exchange of knowledge and expertise
- As revealed in the discussion (section 8.1.3.1), the private sector has not improved since it was established in 1990s. Open trucks are still exclusively used to collect waste from the service users and transfer it to the transfer stations and/ or dump sites. Also the companies do not own storage equipment. In general, the practices adopted by the private sector are controversial. In this regard, it is recommended to support these companies in the city and allow them the opportunity to prove their capacity to carry out sound practices. This can be done through establishing solid foundations for participation to ensure the rights of all parties.

Reforms of the policy and legal framework

The current policy and legal framework are not conducive to sound practices. Policies agreed in the past were not implemented; a clear technology selection mechanism was not included and so on. In terms of MSWM regulations, the relevant laws are old and not enforced. In this regard, the following recommendations are indispensable to reforms of the current policy and legal framework:

- Formulation of a new waste policy is the most important issue for carrying out system reform. However, all the relevant parties must show their actual commitment toward its implementation. In addition, the new policy should include goals for the short and long term that can be achieved based on local economic, social and political conditions. Also a grace period should be given for the implementation in order to build a new institutional structure that meets new policy orientations.
- Libya, like other developing countries, faces a lack of human resources in the field of solid waste. Taking advantage of other countries' experiences and sharing success stories is an important step to formulate appropriate waste policies.
- The results of the study show that the national and local organisations have a policy geared solely towards a traditional technologies approach, which focuses on prevention of the accumulation of waste in the city and disposal. Today, such a waste disposal culture no longer has a place in our world. Most countries at different economic levels have shifted or are seeking to rely on other technology

options, such as recycling, reuse, recovery or even sanitary landfill. Therefore, the relevant organisations are required to develop their current legal framework based on their local conditions. A variety of experiences around the world can be employed to address the strategic issues, for example ensuring financial sustainability and engaging stakeholders. In addition, care should be taken to develop appropriate mechanisms for enforcement. These measures will significantly contribute to reform of the MSWM system toward transfer and adoption of the ESTs concept.

Rearrangement of the financial system

Public companies for waste cleaning services in Libya are to a great extent funded by the national government. Service users' contribution to cover the expenses of the service provided is very limited and not sustained because it is not addressed clearly in the legal framework. The MHPU on its own controls the contracting mechanisms, including the cost of the service and method of payment, which in turn affects ability of the public sector to deliver service by sound practices. In general, from the analysis of the study data, it has been seen that the financial system for both the public and private sector has witnessed many crises. Thus, it urgently requires reconsideration; the following proposals should be included in the formulation of a new financial system:

- A new MSWM system should not rely only on government funding, but it is essential to extend it to include the local, national and international available sources that can fund MSWM practices and projects.
- Analysis and determination of the actual cost of each technology option is the main issue in selecting ESTs, which challenges the national and local government. Therefore, reliable cost information is the basis for adopting sound practices that are characterized as affordable and efficient.
- Short term contracts and their terms of reference have affected both public and private sector in different ways, especially on how to own sound technologies. Therefore, contracts in the future should be formulated for a long term and should include details that ensure the rights of all the parties. In this regard, several experiences around the world can be used to share knowledge on to how to build an agreement between public and private participation in the solid waste sector.

Engage the service users as a main partner in the MSWM system

The results of the study show that service users are not satisfied with most of the practices that exist in Tripoli city. The role and/or contribution of the service users to promote these current practices are therefore limited or in many cases they do not participate. The following suggestions are the key issues for partnership activation between the service providers and service users;

- Improvement of the current practices; such as increasing or introducing new collection bins and vehicles for collection and transfer. These technologies must be adopted based on local economic, social and political conditions to ensure that the service provided meet the aspirations of the service users, to make them positive in their responsibility and contribution.
- Extent of the service users' participation and responsibilities based on the type of practices offered. Some of these users' responsibilities and contributions can be achieved through the enactment of legislation, others through their motivation and encouragement, which can be raised in several ways, such as awareness and training sessions, information campaigns and dissemination of teaching and learning materials.

9.5 Recommendations for Further Research

As clarified in the introductory and literature review chapters, there have been few studies conducted in the Arab region, in particular Libya in the field of the MSWM. Therefore, a single study, such this one, will not solve the current MSWM problems totally. There are too many areas that need to be reconsidered, and thus conducting studies and research in these areas is recommended in order to understand the real situation and to develop sustainable solutions. In this regard, researcher encouragement and support should be given from competent authorities to facilitate carrying such research.

As this study was a complex and comprehensive study, a wide range of MSWM issues was explored, including the management and organization of the solid waste sector. The study revealed that there are many deficiencies in the administrative, regulatory and coordination and cooperation aspects. Consequently, this study opens the way for a number of further studies in these areas to extent the given results and

recommendations. In fact, in the Libyan context, there is a need to conduct sufficient studies to cover all these areas, so at this point, it is difficult to confine suggestion to a few studies. Nevertheless, in the researcher's view, studies in the following areas should be given priority; as they are a more meaningful and necessary for immediate consideration to start to build a sustainable SWM system.

- I believe that in order to adopt sound practice, initially there is a need to establish a typical institutional structure that ensures all parties are engaged, especially the private sector because it is an important body for the improvement of system efficiency. In this regard, the results of the study reveal that the role of the private sector is almost neglected and it is not considered as a main player the MSWM institutional structure. To improve system structure, some studies are recommended. Firstly studies that outline the obstacles and problems that face private sector to carry out sound practices are strongly recommended for sector progress. Secondly, the potential of the private sector not only to deliver waste collection and transport services but also to carry out different waste treatment options within the EST concept, also needs deep exploration.

- Public participation in local government schemes is the key to increasing the levels of system performance toward adopting sound practices. In this regard, the study result shows within the institutional structure the role and responsibility of the public is not played and it is almost neglected. Conducting studies in this context to understand why the concept of public participation, such as to express cooperation, support, sharing responsibility...etc is not common in Libyan culture is an important issue to address ESTs adaptation.

- Nowadays, there are different schemes developed to fund the SWM sector. In this study, funding resources for MSWM sector in the study area is limited and mainly rely on government revenue. Therefore, study is needed to determine the available sources that can be employed to fund different waste streams. Such studies should include not only the resources that fund and cover the cost of waste collection, transportation and disposal, but also other

issues as an integrated system that covers the sector, including how to fund the recycling programmes and technology research and innovation fund.

- Within the current MSWM system, the government at different levels bases build the structure on to how collect and dispose municipal waste, whilst structure of waste treatment is not considered. In order to shift the system from the traditional structure and to build new institutions that are able to transfer ESTs based on a waste recovery policy, carrying out related studies is recommended, such as the opportunity of waste reuse and recycling.

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APPENDICES

Appendix 2. 1: Proposed Checklists of Environmental Indicators for ESTs

Criteria	Proposed Indicators	Yes	No	Quantitative Indicator (i.e., mount saved/spent and/or reduced/ increased	Qualitative Indicators (i.e., based on potential local, regional and global impact
Technical Suitability	• Addresses fundamental scientific and engineering principles (i.e., laws of thermodynamics and reactivity) • Production or process yield • Contaminant removal rates or treatment efficiency • Potential for generation of secondary pollutants/by-products • Noise • Thermal losses and radiation emissions • Performance at different settings and different locations • Sensitivity to specific operating conditions • Reliability • Replicability • Potential for system failure • Profiling of risks and uncertainties				
Compliance with Regulations and Standards	• Quantity of waste generated (water, air and solids) • Quantity of waste controlled by environmental permits • Compliance with local and regional standards • Compliance with MEAs (i.e., POPs, Biosafety, etc.) and other internationally recognised standards (i.e., ISO, etc.) • Availability of reliable data • Part of a 3rd party assessment programme (i.e., Ecolabelling, ETV, etc.)				
Eco-Efficiency and Conservation of Biodiversity	• Useful life (in accordance with optimal performance specifications) • Efficiency of energy, water and materials use relative to the service provided • Lifecycle performance (i.e., overall GHG emissions throughout lifecycle) • Use of renewable resources • Incorporation of closed loop processes • Design for the environment • Cumulative air, water and waste emissions • Impact on ecosystems health & integrity (including biodiversity and ecological footprint)				

Protection of Water Resources	• Water use • Conservation of water • % use of recycled water • Wastewater treatment requirements • Level of treatment (primary, secondary, tertiary) • Overall water efficiency				
Optimisation of Materials and Energy Use	• Use of fuels and energy resources • Quantity of renewable resources • Quantity of non-renewable resources • % of recyclable and reused materials in the production process • Use of environmentally friendly materials • Use of locally sustainable resources • Duration of product use or useful life • Energy efficiency and savings • Overall efficiency of resource use				
Minimisation of Toxic Materials and Waste	• Quantity of waste (air, water and solids) • Quantity of toxic and hazardous waste used and generated • % of waste materials used as raw materials for other industries (i.e., based on industrial ecology and CASE principles) • Quantity of by-product recovered • Cost of pollution control abatement technology • Need for waste treatment and disposal • Ultimate disposal costs of unmarketable by-products and waste • Overall operations and maintenance cost				
Protection of Terrestrial Resources	• Space required for construction • Compatibility with immediate or adjoining facilities and systems • Transportation and materials flow requirements • Potential for soil contamination • Potential for geomorphology, landscape and ecohydrological impacts				
Protection of the Atmosphere	• Air emissions • Potential for long range transport of atmospheric pollutants • Potential for climate change impacts				

Source; *(Prepared by UNEP/IETC Expert Group on Environmentally Sound Technologies* UNEP/IETC, 2002, P. 64-65)

Appendix 2. 2: Proposed Checklists of Socio-Economic Indicators for ESTs

Criteria	Proposed Indicators	Yes	No	Quantitative Indicator (i.e., mount saved/spent and/or reduced/ increased	Qualitative Indicators (i.e., based on potential local, regional and
Financial Viability	• Capital investment • Return on investment • Payback period				
Operations & Maintenance Viability	• Management and labour costs • Expertise and skills requirements for operation and maintenance • Utilities cost (water and energy) • Cost of other consumables • Cost of pollution prevention and control • Cost of residuals management and SW disposal • Cost of environmental remediation and restoration • Cost of natural capital • Cost of environmental health and safety liabilities • Frequency of maintenance • Parts and service cost • Overall cost effectiveness				
Responsive to Local Needs and Benefits	• Public acceptance • Public health & safety risk • Social benefits • Cultural value • Employment • Use of local resources • Capacity building requirements				
Quality of Information	• Reliability of data • Existence of a QA/QC programme •Available comparisons to existing systems •Transparency of data collection and reporting •Third party substantiation				

Source; *(Prepared by UNEP/IETC Expert Group on Environmentally Sound Technologies* UNEP/IETC, 2002, P. 66)

Appendix 2. 3: Solid waste management checklists for technology selection

Section A: Strategic Considerations

What benefits will the technology bring beyond those relating strictly to waste management?
Job creation
Enhanced public health
Recovery/conservation of resources
Water conservation
Energy conservation
Combating desertification
Support for development of other economic sectors (e.g. tourism)
Other

Section B: The Technology and the Waste Management System

Is the technology consistent with previously determined or planned national/community needs?
What types of waste will the technology manage?
How much waste will the technology receive (tonnes per day and tonnes per year allowing for maintenance and other down-time)?
What proportion of the waste stream will the technology manage?
In what ways will the technology compete with existing or planned waste management activities, including those of the informal sector? Can these issues arising from competition be resolved? If not, what is the consequence of competing technologies on the waste management system?
If this technology is adopted, what are the risks and consequences to the waste management system of failure of the technology to operate as planned? What can be done in advance to mitigate these risks/ consequences?

Section C: The Technology

Where has this technology previously been applied relevant to the current proposed application, and with what results? What have been the critical factors in successful/unsuccessful implementation?
What is the design life of the technology?
What is the maintenance schedule of the technology for the location and environment for which it is proposed?
What is the power/fuel demand of the technology and what assumptions is this based on?
What is the staffing requirement of the technology and to what extent can this be met locally?
What is the staff training requirement?
What occupational health and safety requirements and procedures should be put in place?
What are the implications/consequences of the technology receiving more/less waste than planned or receiving a different quality of waste than planned?

Section D: Financial Cost and Benefits

<u>Capital Cost</u>

What is the capital cost of the technology, including equipment to provide required levels of public health and environmental protection and including any ancillary investment (e.g. access roads, upgrading power supply etc.)?

What special arrangements are anticipated/expected regarding the financing of the technology (e.g. concessionary financing terms, government guarantees, tax exemptions, other)?

Recurrent Cost

What is the recurrent cost (on an annual basis and on a per tonne of waste received basis) of the technology at full operation, including an appropriate allowance for maintenance and excluding revenues that might accrue from the technology? What are the assumptions that underlie this estimated cost?

Net Cost

What is the net cost of the technology on an annual and per tonne of waste received basis, including amortisation/repayment of capital and financing costs, and payment of recurrent costs and excluding sale of recovered materials, energy, compost etc.?

Financial Benefits

What revenues will accrue directly from application of the technology (e.g. sale of recovered materials, energy, compost etc)?

Net Cost

What is the net cost of the technology on an annual and per tonne of waste received basis when financial benefits are added to the "net cost"?

Section E: Cost Recovery

Who will pay the capital costs and how?
Who will pay financing costs and how?
Who will pay the recurrent costs and how?

Section F: Legal Frameworks

What legal requirements must be in place to make the technology operationally viable?
What legal requirements must be in place to make the technology commercially viable?
What European Union environmental standards are applied to this type of technology for each of the following, as appropriate?
Sitting
Design
Atmospheric emissions
Noise at property line
Wastewater discharge
Receiving surface water quality
Receiving groundwater quality
Land application
Leachate management
Solid waste
What European Union occupational health and safety standards are applied to this type of technology?
For the identified environmental and occupational health criteria, are there reasons to apply different criteria in this instance? If yes, provide details.

Section G: Institutional Considerations

Is there opportunity for other municipalities to participate in this technology?

What strengthening of local financial management capacity and control is required in support of implementing this technology? What local institutional reorganisation is required to ensure this technology is effectively operated? What strengthening of local management capacity is required to ensure this technology is operated effectively (e.g. functional management skills, training etc.)? What opportunities are there for private sector involvement in the application of this technology, and how can these be facilitated?
Section H: Community Issues Will implementation of this technology require displacement of any people/communities? If yes, how will displacement of people be managed, where will they go and what will be done to facilitate their movement? Will people or organisations have to change the way they manage their wastes? If yes, what is proposed to facilitate new behaviours? What groups are likely to not be supportive of the application of this technology? What can be done to facilitate their support? What are the consequences of their failure to support application of this technology? How will the application of this technology impact women and children? What needs to be done to mitigate negative impacts on them? Who should be the audiences of a public awareness initiative regarding the implementation of this technology, what should be the key messages and how should they be delivered?

Source; METAP, 2004. Policy, legal and institutional guidelines. Aid to Technology Decision-Making. 2004, P. 5, 6 and 7

Appendix 4. 1: Consent letter

Dear,

Re: Interview on analysis of sustainable municipal solid waste management system in Tripoli.

I am Jalal Etriki a PhD student at The University of Hull Department of Geography in UK.

My PhD research is on analysing Environmentally Sound Technologies (ESTs) for a sustainable municipal solid waste management system in Tripoli. My objectives are to learn about current SWM practices in Tripoli city to see what can be learned from experiences of neighbour and what factors effect EST assessment and choice.

I would be grateful if you could agree to participate in this study. I would like to meet with you at your convenience to discuss issues relating your role on SWM system in Tripoli.

Your participation in this study is entirely voluntary. You may withdraw at any time without discrimination or prejudice. All information is treated in confidence and your name will not be used in my thesis or any publication arising from the research. If you withdraw, all information you have provided will be destroyed.

Please make sure that you ask any questions you may have, and that all your questions have been answered to your satisfaction before you agree to participate. If you have any questions about this project please feel free to contact either myself, Jalal Etriki on j.Etriki@2008hull.ac.uk or Tel; +218 91 3774296 and/or my principal supervisor, Dr Pauline Deutz, on P.deutz@hull.ac.uk or Tel; +44 1482 465968. My supervisor and I are happy to discuss with you any question you may have on this study.

I will be in touch by telephone or a person in the next few days to see whether you have ability to participate. Please do not hesitate to get in touch with me or my supervisor if you have any questions.

Thank you for your assistance with this research project.

Sincerely

Jalal Etriki

Appendix 4. 2: Arabic consent letter

الديموقراطية
هي رقابة الشعب
على نفسة

الجماهيرية العربية الليبية الشعبية الاشتراكية العظمى
اللجنة الشعبية العامة للصحة والبيئة
الهيئة العامة للبيئة

الرقم الإشاري / 403
ملف رقم / 10/2

التاريخ : / / 13 و.ر
الموافق : 07/04/2010 ف

الى من يهمه الأمر

بعد التحية،،،

تفيدكم الهيئة العامة للبيئة بأن المهندس/ جلال إبراهيم التريكي هو أحد العاملين التابعين لها، وهو حالياً في طور إعداد بحثه لنيل درجة الدكتوراه في جامعة " هل" ببريطانيا حول التقنيات المناسبة بيئياً لإدارة النفايات الصلبة.

عليه،،، نأمل منكم مساعدة المعني في إجراء المقابلات مع المختصين لديكم وتزويده بما يتوفر لديكم من معلومات تساعده على إستكمال دراسته.

والسلام عليكم ورحمة الله وبركاته،،،

د. محمود الصديق الفلاح
أمين اللجنة الإدارية للهيئة العامة للبيئة

صورة الى/
ملف الموضوع
الملف الدوري العام
م.نوري**زعبية

العنوان / الفيران - طرابلس : ص.ب 83618 هاتف 4873761 (021) بريد مصور: 4872160 (021) مبرق: 20138
سرت - هاتف 63988 (054) بريد مصور 63989 (054) الجبل الاخضر - هاتف 637187 (084) بريد مصور 636867 (054)
بنغازي - هاتف 9080689 - 9080690 (061) بريد مصور 70247 مصراته - هاتف 615825(051) بريد مصور 615824 (051)

Appendix 4. 3: Interview with operational bodies (TPSC and PCTCS)

Date:

Name of company

Name of Interviewer:

Location:

Checklist

Introduction: salutation and personal introduction

Purpose of the discussion:

This is an academic exercise; the purpose is to learn about current SWM practices in Tripoli city to see what can be learned from experiences of neighbour and what factors effect MSWM technology assessment and choice. His/her advice is vital for this study. Candid opinions are appreciated. Confidentiality is assured. The findings will be shared with respondents.

Primer:

- Briefly outline the interviewees' role and responsibilities.
- Brief history of the company?
- Request brief description of functions and responsibilities of your (department) or company?

Current MSWM system

- Can you outline the current SWM system in Tripoli, and your company's involvement in it?
- What, if any, are the environmental problems with current practises? (Pollution of air/waterways, public health, greenhouse gas emissions, conserving resources).

- What SWM technologies are currently in use by your company, and why?
- Have you considered any technologies that would promote the diversion of waste from landfill? (e.g., composting, recycling, energy from waste, anaerobic digestion?
- Do you think there is a suitable local and national institutional institution to set SWM in a sustainable way? Describe?

- Do you expect the services that you provided will satisfy the Tripoli community? Why
  - Is the community having a role in current practices?

Adopting new technologies

- If you wanted to adopt a new technology, what would be the process?
  - Are you contracted by a local authority?
  - Would you need permission to change the SWM system?

- How would you raise the finance? E.g., loan/grant from the government, private loan from a bank, from shareholders in the company?

- What technologies are you aware of?
  - Have you considered adopting any new technologies? (i.e., composting or recycling).

- What in your view would be the barriers to adopting these technologies?

  - Cost of purchase/maintenance
  - Public attitudes...
  - Lack of local/national governmental support
  - Policy for SMW
  - Environmental protection regulations
  - Training required to operate/repair
  - Lack of familiarity with the technology (Information)
  - Lack of infrastructure
  - Difficult to locate

Making a decision for new technology

- How do you set about making decisions on SWM technologies?
- Is there a certain criteria guide such a selection?
- Can you give any examples of decisions taken with the environment in mind (e.g., a technology that was accepted or avoided)?

Lesson learned

- Are you familiar with SMW practices in other Arab countries of north Mediterranean countries?
  - If yes, do you think Libya could learn from their experiences, or vice versa?
  - Do Libyan laws permit you to purchase technology from these countries?

- In Europe at the moment there are policies aimed at keeping waste, especially biodegradable waste, from landfill.
  - Do you know about these policies?
  - Is there anything similar in Libya?

Appendix 4. 4: **Interview with supervisory bodies (MHPU, EGA and MT)**

Date:

Name of company

Name of Interviewer:

Location:

Checklist

Introduction: salutation and personal introduction

Purpose of the discussion:

This is an academic exercise; the purpose is to learn about current SWM practices in Tripoli city to see what can be learned from experiences of neighbour and what factors effect MSWM technology assessment and choice. His/her advice is vital for this study. Candid opinions are appreciated. Confidentiality is assured. The findings will be shared with respondents.

Primer:

- Briefly outline the interviewees' role and responsibilities.
- Brief history of the organisation?
- Request brief description of functions and responsibilities of your (department) or organisation?

Current MSWM system

- Can you outline the current SWM system in Tripoli, and your organisation's involvement in it?
- What, if any, are the environmental problems with current practises? (Pollution of air/waterways, public health, greenhouse gas emissions, conserving resources).
- How much leadership in SWM policy is provided by the national or local government?
- To what extent do the bodies responsible for implementing SWM design/contribute to the policy themselves?
- Do you think there is a suitable local and national institutional institution to set SWM in a sustainable way? Describe

- Do you expect the current practices will satisfy the Tripoli community? Why
  - Is the community having a role in current practices?

Making a decision for new technology

- Is your organisation having a role in making a decision for new technology? Explain?
- Is there a certain criteria guide such a selection?
- To what extent are environmental issues taken into consideration in decisions relating to waste management technologies?
- Are you aware of/familiar with any alternative SWM technologies that could be socially or environmentally beneficial?

  What is it/they?
  - Why do you think it/they would be beneficial, and in what ways?

  - What in your view would be the barriers to adopting these technologies in Libya?
  - Cost of purchase/maintenance
  - Public attitudes
  - Lack of local/national governmental support
  - Policy for SMW
  - Environmental protection regulations
  - Training required to operate/repair
  - Lack of familiarity with the technology (Information)
  - Lack of infrastructure
  - Difficult to locate

Lesson learned

- Are you familiar with SMW practices in other Arab countries of north Mediterranean countries?
  - If yes, do you think Libya could learn from their experiences, or vice versa?
  - Do Libyan laws permit you to purchase technology from these countries?

- In Europe at the moment there are policies aimed at keeping waste, especially biodegradable waste, from landfill.
  - Do you know about these policies?
  - Is there anything similar in Libya?

Appendix 4. 5: Interview with research institutions

Date:

Name of company

Name of Interviewer:

Location:

Checklist

Introduction: salutation and personal introduction

Purpose of the discussion:

This is an academic exercise; the purpose is to learn about current SWM practices in Tripoli city to see what can be learned from experiences of neighbour and what factors effect MSWM technology assessment and choice. His/her advice is vital for this study. Candid opinions are appreciated. Confidentiality is assured. The findings will be shared with respondents.

Primer:

- Briefly outline the interviewees' role and responsibilities.
- Brief history of the organisation?
- Request brief description of functions and responsibilities of your (department) or organisation?

Current MSWM system

- Can you outline the current SWM system in Tripoli, and your organisation's involvement in it?
- What, if any, are the environmental problems with current practises? (Pollution of air/waterways, public health, greenhouse gas emissions, conserving resources).
- Do you think there is a suitable local and national institutional institution to set SWM in a sustainable way? Describe
- Do you expect the current practices will satisfy the Tripoli community? Why
  - Is the community having a role in current practices?
- What do you think are the priorities for SWM in Tripoli in the coming years, and why?

Making a decision for new technology

- Is your organisation having a role in making a decision for new technology? Explain?
- Are you aware of/familiar with any alternative SWM technologies that could be socially or environmentally beneficial?

  What is it/they?
  - Why do you think it/they would be beneficial, and in what ways?

- What in your view would be the barriers to adopting these technologies in Libya?
  - Cost of purchase/maintenance
  - Public attitudes
  - Lack of local/national governmental support
  - Policy for SMW
  - Environmental protection regulations
  - Training required to operate/repair
  - Lack of familiarity with the technology (Information)
  - Lack of infrastructure
  - Difficult to locate

Lesson learned

- Are you familiar with SMW practices in other Arab countries of north Mediterranean countries?
  - If yes, do you think Libya could learn from their experiences, or vice versa?
  - Do Libyan laws permit you to purchase technology from these countries?

- In Europe at the moment there are policies aimed at keeping waste, especially biodegradable waste, from landfill.
  - Do you know about these policies?
  - Is there anything similar in Libya?

Conclusion

- Do you think the municipality of Tripoli is able to apply more appropriate technologies in the field of MSWM?
- What are your suggestions to address SWM sound practices?

Appendix 4. 6: Samples of form used in the field of observation

1. Transfer station sites

Transfer station descriptions		Observations
location		
Date		
Operating year		
Ground size		
Opening times		
Waste types		
No of workers		
Tonnes per day		
Operator		
Times of delivery		
Intermediate storage		
Distance between the collection area and transfer station		
Distance from transfer station to the next destination		
Environmental Setting		
Climatic zone		
Collection vehicle used for the delivery of waste to the transfer		
Equipment used for transfer storage waste		
Conditioning of waste at the transfer stations		
Operating techniques		
Safety Equipment		
Other...		

2. Landfill sites

Landfill descriptions		Observations
Location		
Date		
Operating year		
Landfill category		
Waste types		
No of workers		
Tonnes per day		
Operator		
Tipping fee		
Disposal area (ha)		
Waste pickers		
Environmental Setting		
Climatic zone		
Operating Techniques		
Equipment used		
Liner		
Leachate collection		
Leachate treatment		
Gas management		
Safety Equipment		
Other..		

3. Composting plants

Composting plant descriptions		Observations
Location		
Date		
Operating year		
No of workers		
Working times		
Type of waste received		
Waste resources		
Operator		
Production/Tonnes per day		
Quality of product		
Composting Process (technology used)		
Origin of technology		
Operating Techniques		
Faults, weekly/monthly/annually		
Working conditions		
Safety Equipment (Health and safety procedures)		
Other		

4. Recycling plants

Recycling plant descriptions		Observations
location		
Date		
Operating year		
No of workers		
Working times		
Type of waste received		
Waste resources		
Operator		
Production/Tonnes per day		
Quality of product		
Technology used		
Origin of technology		
Operating techniques		
Faults, weekly/monthly/annually		
Working conditions		
Safety Equipment (Health and safety procedures)		
Other..		

Appendix: 4. 7 Questionnaire for Tripoli residents

N.B. The information requested is purely for academic purposes and will be treated confidentially. Thank you for accepting the questionnaire.

Questionnaire Number:

Date:

A. Demographic information

1. Settlement or area name:

- ○ City centre
- ○ Hayy al Andalus
- ○ Alhadapa
- ○ Abu Salem
- ○ Sug Aljumah
- ○ Other, please specify.....

2. Gender ○ Male ○ Female

3. Degree of education

○ Undergraduate ○ Postgraduate

Other, please specify.....

B. General information

4. Is your waste removed from outside your property, or do you have to deliver it somewhere?

……..

4.1 If you deliver your waste by yourself, then go to **Q 6**

5. Is your waste collected by?

- ○ The Municipality
- ○ A Private company

C. Waste Storage

6. In What type of container do you store your household waste?

- ○ Bin (metal, plastic, rubber, wood)
- ○ Plastic bag
- ○ Skip
- ○ Other, Please specify.....

7. Is the container used in your house have been delivered by the company or have you bought by yourself?

.....

8. Are any items stored separately?

○ Yes ○ No

If yes, please specify.....

9. In your neighbourhood, does the municipality set a public bin?

○ Yes ○ No

9.1 If yes, would this be;

○ Individual use or
○ Neighbour use

9.2 Which of the following types of bin is used to store the solid waste outside your house?

○ Wheeled container, either plastic or metal (1.5 M3)
○ Container/ skips (6 M3)
○ Other, Please specify..... .....

10. Is it a problem for you to deliver your waste to the public bin?

○ Yes ○ No

11. How can you best describe the state of the public bin near you? Would you say is it...?

Typically it is appropriate	○ Yes	○ No
It is an adequate size	○ Yes	○ No
It releases odour	○ Yes	○ No
It releases leachate	○ Yes	○ No
It is burnt	○ Yes	○ No
Good accessibility	○ Yes	○ No

Other, please specify.....

D. Waste collection.

12. How the company does collect the waste?

○ Door to Door collection
○ Block collection
○ Street collection (curbside)
○ Other, please specify.....

13. Do you have a regular waste collection service?

○ Yes ○ No

13.1 If yes, how often the waste is collected?

○ Less than once per week

○ Once per week
○ Two per week
○ Three per week
○ Other please specify.....

14. How would you best describe the work of waste collection workers? Would you say is it...?

They are dealing with equipment careful	○ Yes	○ No
They are wearing uniform	○ Yes	○ No
They are wearing a hard hat, high visibility jacket and gloves	○ Yes	○ No

15. Do you have any problems with this collection system?

○ Yes ○ No

If yes, which problems?

○ No collection bins
○ Method introduced is inappropriate
○ Staff collection
○ Time of collection is unsuitable
○ Other, please specify.....

E. Waste transport

16. What type of vehicle is used to transfer your waste?

Compactor truck	○ Yes	○ No
Open top truck	○ Yes	○ No
Tractor	○ Yes	○ No
Handcart	○ Yes	○ No

Other, Please specify.....

17. Do you know what happen to the waste when it is removed from your neighbourhood?

○ Yes ○ No

17.1 If yes, could you tell me where?
.....

18. How do you describe the method used for waste transfer from primary and secondary collection, would you say?

○ Transportation vehicles used are appropriate
○ The waste fall of from vehicle during transportation

○ Vehicles used are not consistent with the nature of the region

○ Other, please specify.....

F. Social acceptance

19. Do you pay for solid waste services?

○ Yes ○ No

If yes, how much do you pay per month?

○ 1-5 LD per month
○ 5-10 LD per month
○ Over 10 LD per month

20. Do you get value for money?

○ Yes ○ No

21. Do you ever reuse, sell, give as a present or receive as gifts, any of the following old things;

○ Bottles
○ Plastics
○ Metal
○ Clothes
○ Tin/cans
○ Bags
○ Shoes
○ Bread

22. Recycling is easier if materials are kept separate. Would you be prepared to store different material separately? (e.g., have separate bins for plastic, paper etc)

○ Yes ○ No

23. How do you evaluate the state of solid waste management in Tripoli?

○ Very good ○ Good ○ Fair ○ Poor ○ Very poor

24. How do you think the situation has changed the last 5 years?

○ Has improved **go to Q 25**
○ Remains the same **go to Q 26**
○ Has deteriorated **go to Q 26**

25. By which of the following has the situation improved?

Indicator	**Degree**				
	Strongly disagree	disagree	Strongly agree	Agree	Neutral
More of the city has regular waste collection					
More frequent collection					

Use better technologies					
Increase number of labours					
Increase of recycling activities					
Increase of composting plant					
Reduction in pollution					
Other					

26. Which of these may be contributory factor of waste management deterioration or remain in the same situation? And to what do you degree?

Indicator	**Degree**				
	Strongly disagree	disagree	Strongly agree	Agree	Neutral
Poor organisation					
Lack of adequate finance					
Technical/human know-how					
Lack of moderator					
Non-collaboration of parties					
Lack of public awareness					
other					

27. Up to what extent are you satisfied with the overall cleanliness in your neighbourhood?

- ○ Fully Satisfied
- ○ Satisfied
- ○ Not Satisfied
- ○ Totally un-satisfied

G. Solid waste management information

28. Have you ever had any information on improving waste management?

○ Yes ○ No

If yes, through what way?

- ○ Over TV
- ○ Over Radio
- ○ On Poster
- ○ In school
- ○ Other please specify.....

Who organise it?

- ○ Municipality of Tripoli
- ○ Ministry of public utility
- ○ Ministry of health
- ○ EGA
- ○ NGO
- ○ Other please specify.....

29. Your suggestion; how can the waste management situation in Tripoli be improved up on?

.....
.....
.....
.....
.....
.....

Appendix 4. 8: Semi- structure questionnaire for technicians and Workers

N.B. The information requested is purely for academic purposes and will be treated confidentially. Thank you for accepting the questionnaire.

1. Your name; ----------

2. Your nationality;

○ Libyan ○ Foreign

3. Your company name; ----------

4. Your duty; ----------

--

5. What is your responsibility?

---

6. Your experience (Working period time);

○ Less than one year

○ 1-3 years

○ 3-5 years

○ Over 5 years

7. Are you satisfied with your work?

○ Yes ○ No

If no, Why?

……

……

…….

8. Do you like to be the technologies used in solid waste management in Tripoli

○ Public ○ Private ownership?

Why?

……

……

…….

9. Are the different types of equipments that you need is available in order to do your work effectively?

○ Yes ○ No

10. Does your company have the necessity technologies to operate their activities in an effective way?

……

……

……

……

11. How do you rate the work done with your equipment?

○ Very good ○ Good ○ Fair ○ Poor ○ Very poor

12. Is there a training plan for your company?

○ Yes ○ No

And does the company implemented?

○ Yes ○ No

13. Have you received any training or orientation?

○ Yes ○ No

If yes, what type?

……

……

……

14. Are you receiving up to date information related to technologies for SWM?

○ Yes ○ No

15. In your opinion how can the efficiency of Company in SWM be improved?

……

……

……

16. Your suggestion; how can the waste management situation in Tripoli be improved up on?

……

……

……

Appendix 4. 9: Private sector waste companies in Tripoli

Name of company	Date work began	Name of company	Date work began
Al Shoulla Waste Services	1994	Al-Mohtamon Company	1990
Nosour Africa Waste Services	2001	Al-hadaf company*	1997
Alnma Waste Services	1992	Alnahda for waste service	2001
Nawres Al bahar Ltd	1992	Nosour almotawasst for waste service	1994
Al bahar Almotawsat Ltd	1995	Almontassour waste service	1996
Boaba Africia Company	2009	Alamal for cleaning service	2002
Al bahar Almotawsat company*	1991	Al-nourr Cleasing Company	2001
Al-safoa Company*	1993	Alahrrar for wastye service	2000
Shaty Al-andalusia Company*	1992	Almorouj for waste service	2002
Al-noussour Company	1997	Al- alouroba for waste service	1998
Abtal Al-hejara Company	1999	Alafricia for cleaning service	1994
Alaiman waste service	2001	Al-saquor Company	1999
Alnajam waste service	2001	Almotahida for waste service	1995
Alhouria Cleansing Limited	2000	Amany Cleaning Limited	19997
Al-rabiah waste service	1999	Alkalije for waste service	2000
Alamal Company	1995	Almonhamel Company	2000
Alasal company	1993	Alsafa for waste service	1996
Almohtamoun waste service	1999	Aljaoutah Company	1997
Altahady Cleaning service	1998	Alssarah Cleaning Limited	1995
Alkalha for waste sevice	1999	Alloloa for waste service	1999
Al-horria Cleaning Limited	1993	Alwefak for waste service	1997

*Participated in interview.

Source; Ministry of Housing and Public Utility, Waste Management Department, Tripoli. 2010.