Obstacles and Opportunities in Planning and Implementing Integrated Sustainable Municipal Solid Waste Management (ISMSWM) in Kuwait – a Gulf Cooperation Council (GCC) Country

by

Alyaa AlManssoor

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Examining Committee Membership

The following served on the Examining Committee for this thesis. The decision of the Examining Committee is by majority vote.

External Examiner	Name:	Virginia Maclaren
	Title:	Associate Professor, Department of Geography and Planning, University of Toronto
Supervisor (s)	Name:	Murray Haight
	Title:	Emeritus Professor, School of Planning
Internal member	Name:	Brent Doberstein
	Title:	Associate Professor, Department of Geography and Environmental Management.
Internal- external member	Name	Steven B. Young
	Title:	Associate Professor, School of Environment, Enterprise and Development
Other Member(s)	Name:	Mike Stone
	Title:	Professor, Department of Geography and Environmental Management

Authors' Declaration

I hereby declare that I am the sole author of this thesis. This is a true cope of the thesis including any required final revisions, as accepted by my examiners. I understand that my thesis may be made for public.

Abstract

The conventional municipal solid waste (MSW) management approach focuses on collection, transportation and final disposal, while at the same time neglecting the prevention of waste and recycling. The conventional approach focuses mainly on technical solutions and economic efficiency of disposal of MSW. Yet, because this approach deals with waste streams individually it is ineffective. The evolving concept of sustainable development (SD) indicates a transition from conventional systems to more integrated systems for resource management. Planning and implementing a sustainable MSW system imply the adoption of "integrated approaches" but there are gaps in the operationalization and often the social dimensions are overlooked. High-income nations continue to develop systems approaches that meet their current and future needs and ensure that both governments and residents understand the need for proper MSW management. A parallel situation does not readily apply to oil exporting high-income Gulf Cooperation Council (GCC) countries. The State of Kuwait was chosen as a case study to explore the obstacles and opportunities of planning and implementing an integrated and sustainable MSW management (ISMSWM) system. Accordingly, the current study established a goal to reach beyond the recommendation of "integration approaches" to better understand and recognize how to operationalize the "integration" of an MSW management system. As a first step, a conceptual framework of planning for an ISMSWM system was developed, refined and tested. In this research, an ISMSWM framework was designed to account for integrated environmental management (IEM) approaches along with sustainable development dimensions, stakeholders' involvement, SWM elements and approaches and Environmental system analysis (ESA) tools to address the obstacles and opportunities during planning, decision-making and operationalization of an ISMSWM system.

Based primarily on post-positivist epistemology, a research framework was built upon the case study of Kuwait, employing mixed qualitative/quantitative methods that included the review of documents, key informant interviews, waste actors' questionnaires, householder' questionnaires and a focus group discussion which centered on the results of a life cycle assessment (LCA). Over 80% of the 65 waste actors surveyed identified a lack of coordination between responsible authorities, and 91% identified a lack of collaboration between authorities at governmental, sectoral (among MSW management responsible

authorities) and public levels. Most of the waste actors also supported collaboration, a balance between top-down and bottom-up approaches, and the establishment of collaborative committees. Over 85% were also in favour of public participation in waste separation, promotion of public training programs and the inclusion of waste management topics in the educational curriculum. Widespread support was reported by the waste actors for the participation of the private sector and a decentralized approach for planning. Of the 400 householders surveyed 80% agreed to purchase fewer disposable products: to participate in activities which promote recycling; and, to separate organic waste if green bins were offered.

The researcher concludes that current MSW planning relies on a top-down approach in Kuwait. Although some critical changes at the regulatory and policy-making levels have been made with the aid of international institution, the outcomes have failed to deliver tangible changes at the operational level. There is a need for an intensive willingness to change the current situation in Kuwait and build a structure by local stakeholders that adopts integrated environmental management (IEM) approaches. The adoption of a conceptual framework for ISMSWM in Kuwait would be of assistance with the implementation of IEM management approaches to promote better practices in planning, decision-making and operationalization. Based on the research findings, the developed framework could offer an opportunity for the waste actors, researchers and decision-makers for comprehensive thinking and integrative planning, decision-making, and implementation of ISMSWM for oil-exporting high-income Gulf Cooperation Council (GCC) countries such as Kuwait.

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Dedication

To the awaited saviour of humankind…

To my beloved country, Kuwait, in the hopes that this thesis will help to contribute to the efforts to achieve sustainable development goals...

To the soul in peace of my beloved Dad …

To my beloved and best Mother ever…

To my amazing other half and husband Maitham …

To my wonderful children Husain, Mohammad, Ali and Mahdi…

To my siblings Dr. Alaa, Mohammad, Adel, Dr. Ammar, Abdul-Aziz and Aziza and their lovely children…

You are all my inspiration and the source of my power!!!!!

Table of Contents

List of Figures

List of Tables

List of Abbreviations

AD	Anaerobic digestion
ADB	Asian development bank
BOT	Belong-operate-transfer
CBA	Cost-benefit analysis
CBOs	Community based organizations
CCME	Canadian Council of Ministers of the Environment
CD	Capacity development
CDM	Clean development mechanisms
CSR	Corporations Supporting Recycling
CWG	Collaborative working group
DEFRA	Department for environment food and rural affairs
EEA	The European environment agency
EAD	Environmental Affairs Department
EFW	Energy-from-waste
EIA	Environmental impact assessment
ENGOs	Environmental non-governmental organizations
EPA	Environmental public authority – Kuwait
EPIC	Environment and Plastics Industry Council
EPR	Extended Producer Responsibility
ERS	Environmental Requirements and Standards
ESA	Environmental systems analysis
ETC/SCP	The European topic centre on sustainable consumption and production
EU ETS	European Union Emission Trading Scheme
GCC	Gulf Cooperation Council
GHG	Greenhouse gas
HCl	Hydrogen Chloride
IBK	Industrial Bank of Kuwait
IEA	International energy agency
IEM	Integrated environmental management
IEMA	Independent environmental management agency
IETC	International environmental technology centre
IPCC	Intergovernmental Panel on Climate Change
ISMSWM	Integrated sustainable municipal solid waste management
ISO	International organization standardization
ISWM	Integrated sustainable solid waste management concept
ISWA	International Solid Waste Association
IWRM	Integrated water resource management
IWM	Integrated waste management
IWM-Model	Integrated Waste Model
KEP	Kuwait Environmental Police
KEPIs	Product environmental performance indicators

KISR	Kuwait institute of scientific research
KMAF	Kuwait Municipality Administrative Framework
kWh	kilowatt-hour: The kilowatt-hour (symbolized kWh) is a unit of energy equivalent to one kilowatt (1 kW) of power expended for one hour (1 h) of time
LCA	Life cycle assessment
LFG	Landfill gas
MBT	Mechanical-biological treatment
MOF	Ministry of Finance
MRF	Material recovery facility
MSW	Municipal solid waste
NIMBY	Not in my back yard
NOx	Nitrogen oxides
PM	Particulate matter
OECD	Organization for Economic Co-operation and Development
PAAFR	Public authority of agriculture affairs and fish resources (in Kuwait)
PET	Polyethylene terephthalate
PTB	Partnership Technical Bureau
RDF	Refuse derived fuel
SD	Sustainable development
SDD	Sustainable development dimensions
SEA	Strategic environmental assessment
SETAC	The Society of Environmental Toxicology and Chemistry
SOx	Sulphur oxides
SPSS	Statistical Package for the Social Sciences
SWM	Solid waste management
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNHCR	United Nations High Commissioner for Refugees
UN-HABITAT	United Nations Human Settlements Programme
USAID	United States Agency for International Development
USEPA	United States Environmental Public Authority
VOCs	Volatile organic compounds
WCED	World Commission on Environment and Development

List of Symbols

e	Margin of error
g	Gram
kg	Kilogram
GJ	Gigajoule
N	Sample size
Q	Question
Z	Level of confidence needed

Chapter 1

Introduction

This research aims to understand the obstacles and opportunities associated with integrated and sustainable municipal solid waste management (ISMSWM) planning and implementation in The State of Kuwait1. Kuwait was selected as a case study because it is an example of an oil exporting high-income Gulf Cooperation Council (GCC) country, which continues to work through the challenges of achieving goals of sustainable development 2 (Kuwait Voluntary National Review 2019, UNDP 2010, 2016, World Bank Group, 2016, p.131).

Since environmental management issues are so complex and have multiple social and ecological dimensions, many global researchers have increasingly suggested that a holistic approach to dealing with environmental problems is much more effective than a solely individual approach (Hanna, 2007, p.22; Mitchell, 2002, p.104). In particular, integrated environmental management (IEM) has evolved as a holistic and interdisciplinary conceptual and methodological approach for analyzing the full range of actors, variables and interrelationships that affect a system. It has also been found to be an effective model for implementing and managing critical components related to environmental system problems (Mitchell, 2005).

Waste management, including municipal solid waste (MSW) management, requires a holistic approach to deal with the factors that describe their relevant interrelated systems. Over the course of the 1990s, it became apparent to those involved directly and indirectly with managing waste that a one-dimensional approach to regulatory, planning and decision-making processes was insufficient. Conventional approaches toward MSW management including waste generation, collection, transportation and disposal operations have historically been treated as being independent while, in fact, they are linked. These system components require balanced planning and interconnected cooperation that have social,

[1] The State of Kuwait will from hereon be referred to as Kuwait.
[2] The SDGs were substituted for the Millennium Development Goals (MDGS) in 2015.

economic and environmental impacts (Seadon, 2010). There are a number of issues, challenges and opportunities of MSW management inherent to working across multiple dimensions of environmental and social issues that must be addressed

by community decision–makers in addition to waste actors, planners, researchers and householders (Tchobanoglous, 1993, p.18; Wilson, E., 1998; Wilson, D., 2007). Municipal solid waste (MSW) is produced by households, institutions and commercial businesses. Street cleaning, the cleanup of public areas and other cleaning-related municipal services also generate waste (Nguyen Ngoc 2009). The quantities of MSW generated are a result of population growth, accelerated consumption of natural resources, the rise in living standards and technology. Landfilling is the most commonly implemented method for MSW disposal in most developing countries (Mahar, 2007).

Environmental impacts of landfills can result from the penetration of toxic compounds into surface water, groundwater, soil, and the gaseous emissions entering into the atmosphere (especially methane) that contribute to global warming (Mahar, 2007). In addition to global warming gases, VOC gases (e.g. benzene and toluene) that are generated and released into the air add to photochemical reactions in the atmosphere and lead to adverse health implications (Urase, 2008). The escape of gas and leachate, and subsequent entry into the surrounding environment, poses critical environmental issues, and these concerns exist at both new and existing waste facilities. These environmental concerns include several issues such as health hazards, vegetation damage, fires, explosions, landfill settlement, noxious odours, global warming, and groundwater and air pollution (NORDTEST, 2004).

The research aims to identify the obstacles and opportunities of planning and implementing an integrated and sustainable municipal solid waste management (ISMSWM) system. For this purpose, a conceptual framework for ISMSWM was developed and analyzed in this research through the complementary conceptual and methodological lenses of the ISWM framework (stakeholders, sustainable development drivers and solid waste management relevant technologies, operations and approaches), the incorporation of IEM approaches and the support of ESA tools (see figure 1.1).

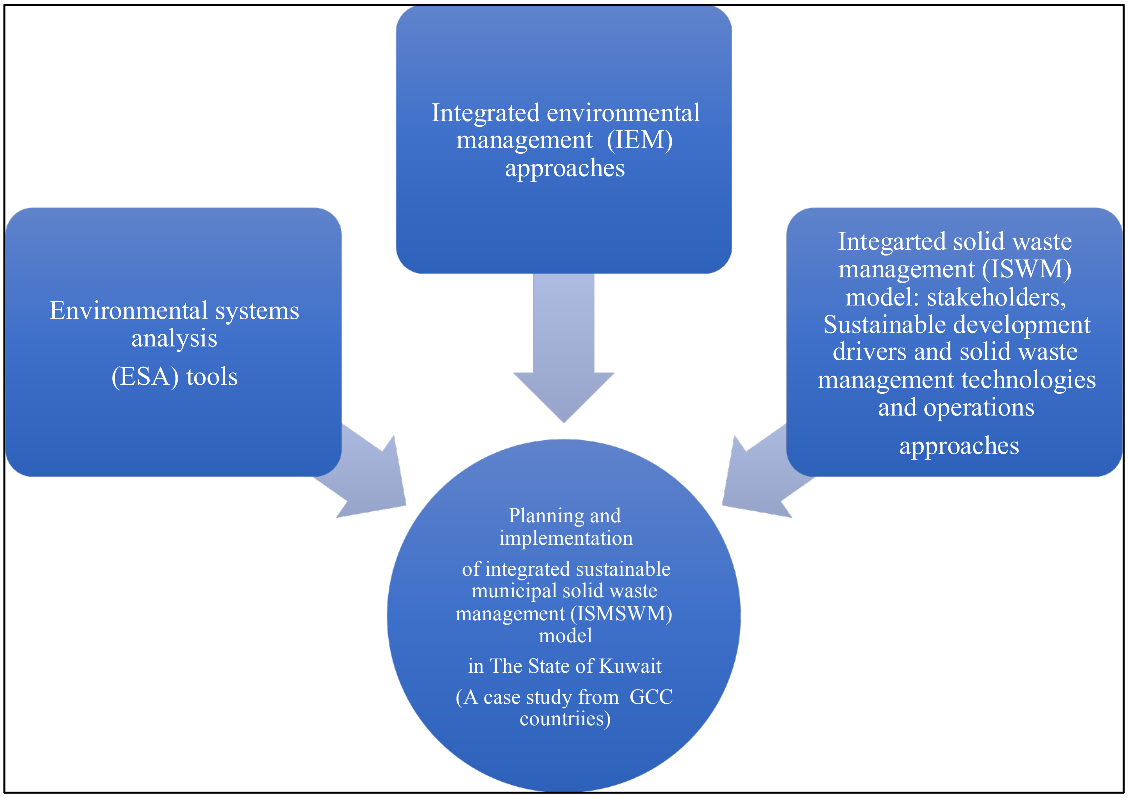

Figure 1.1: Focus of the research

The foundations of an IEM approach in the literature evolved based on the application of such examples as natural resource management and environmental management including water resource management, watershed management, forestry resources management, fisheries management, integrated coastal zone management. It was not until the mid-1990s that the application of IEM approaches was adopted to manage MSW. Examples of IEM processes and perspectives affecting the evolution of MSW management are collaboration (ISWA 2012, Srivastava, 2005, UNEP 2009, Waste 2010), community-based MSW management (Manomaiviboola 2018, Raharjo 2017), and decentralized MSW management (Okat-Okumu 2011).

A concept that has been instrumental to the evolution of IEM, and in emphasizing society's responsibility for nature, is sustainable development (SD). The Brundtland Commission described sustainable development as "development that meets the needs of the present, without compromising the abilities of future generations to meet their own needs" (WCED 1987). The sustainable development (SD) concept promotes the formulation and clarification of the goals of integration by engaging the legal, institutional, technical, political, environmental, social and economic sectors (Hanna, 2007, p.22). From this guiding principle, IEM has become a promising model for approaching environmental and resource management problems from a holistic perspective and has been accompanied by sustainable development targets (Hanna 2007, p.24).

Waste management, which includes MSW management, is a wide field, and is considered a central theme in SD (Cherubini 2009, Williams 2005). To promote SD, resource management was included within a holistic understanding of waste management. This change includes the careful handling of raw materials, waste minimization, and emission reduction (Wilson 2007, 2012, Zhang 2010). In addition, a more integrated approach is required to unite the political, legal, institutional, social, economic, financial, technical and environmental drivers that are key to sustainable development (Wilson E. 1998, Wilson 2007, 2012). Therefore, the MSW management concept can be broadened and modified through its incorporation into IEM conceptual and operational approaches. It is essential to understand how to operationalize the proper implementation of IEM approaches for the sake of sustainable MSW management.

An integrated solid waste management (ISWM) framework was developed by the Collaborating Working Group on Solid Waste Management (CWG) for low and middle-income countries (Waste 2010; Schübeler 1996; van de Klundert 2001; UN-HABITAT 2010, p.27). Integrated sustainable waste management (ISWM) incorporates three components of analysis for recycling and solid waste management systems: i) waste management elements, ii) sustainable development aspects, and iii) relevant stakeholders (also called actors) (Van de Klundert and Anschutz 2001).

The researcher specifically selected the ISWM framework based on various characteristics, most notably, the recognition that waste management is a complicated and multi-dimensional issue that cannot be solved by solutions that are based only on the technical features of the collection and disposal of waste. Integrated sustainable solid waste management (ISWM) relies on three 'dimensions' including various aspects (sustainable development drivers), stakeholders involved and solid waste management components that span the waste process from beginning to end (Van de Klundert and Anschutz 2001). The ISWM framework incorporates sustainable thinking via an integrative approach to solid waste management, especially for stakeholders such as producers, consumers, sellers and decision-makers who are responsible for waste management practices.

Moreover, from the mid-1990s onwards, environmental systems analysis (ESA) tools (e.g. life cycle assessment (LCA), cost benefit analysis (CBA), environmental impact assessment EIA and strategic environmental assessment (SEA)) have been used to help clarify and simplify the interrelationships and complexities of MSW management systems for researchers, planners, and waste managers. By seeking analytical tools to examine different MSW management options, the ESA tools are incorporated into the conceptual framework of ISMSWM.

There is increasing momentum to include waste management within the sustainable development goals of developing countries, especially in underserved communities that are challenged by a lower level of basic sanitation services. Many such communities could suffer from environmental and health challenges that are affected by insufficient drinking water, improper MSW collection, transport and disposal, and improper sewage facilities (Cohen 2006). For urban areas in developing countries, the priorities for sustainable development planning are still concentrated at the level of basic infrastructure such as sewage, electricity, water, roads; and basic services such as schools, transportation and health care (USAID 2014). Beyond the provision of basic infrastructure and services, municipalities in many middle- and high-income countries also prioritize the development of various types of sustainability such as renewable energy, improved electricity sources, water efficiencies, waste minimization, and improvement of waste collection and recycling systems (USAID 2014).

Another global classification of regions significant to this research study is that of highincome oil-exporting countries including the Gulf Cooperation Council (GCC) countries. Oil revenues have allowed GCC countries to subsidize the cost of water, oil, gas, electricity and food. These subsidies have led to some of the highest water and energy consumption rates, and waste generation rates on a per capita basis anywhere in the world (Ramadan 2015). Oil production also fuels the GCC's infrastructural and economic development (Al-Saqri 2014). This economic growth has aided the promotion of faster industrial and commercial growth, development in construction, rapid urbanization and lifestyle improvements, that when combined, led to changes in consumption patterns and excessive generation and dumping of MSW. These factors, in addition to the subsidies, are contributing factors as to why GCC countries show some of the highest waste generation rates in the world on a per capita basis (AlAnsari 2012, Ramadan 2015). Water scarcity, land degradation, and waste generation are major concerns at the national level for these countries (Al-Saqri 2014).

As a member of the Gulf Cooperation Council (GCC), Kuwait shares similar aspects with other member states such as geography, political issues, economic interests, social organization and religion (Al-Saqri 2014). Kuwait depends on oil production as its most valuable commodity and source of energy (Al-Saqri 2014). While Kuwait is classified as a high-income country, and highly ranked on the human development index, it continues to undergo environmental and sustainability challenges as a byproduct of the nation’s focus on oil-driven economic development goals (UNDP 2010, 2015, 2016, World Bank Group, 2016, p.131-132). The national government of Kuwait has been attempting to shift the national development plan toward SD. However, Kuwait’s goals for national development highlight this exploration of the critical importance of sustainable solid waste management within the larger context of Kuwait's challenging environmental issues. In this context, Kuwait is selected as a case study from the GCC countries to broaden the investigation of obstacles and opportunities for planning and implementing ISMSWM with the incorporation of IEM approaches and sustainable development targets within these countries.

1.1 Goals and Objectives of the research

The first goal of the research is to reach beyond the recommendation of “integration approaches” toward a better understanding and recognize how to operationalize the “integration approaches” for managing MSW. The second goal is to provide a systematic understanding of the obstacles and opportunities involved in planning and implementing ISMSWM within oil-exporting high income (GCC) countries.

As an example, from among the oil-exporting high income (GCC) countries, the research focuses on Kuwait as a case study. Accordingly, the objectives of the thesis are:

1. To develop a research framework that may help to understand the challenges of planning and implementing an ISMSWM system.
2. To investigate the current situation and practices of MSW management in Kuwait.
3. To investigate the ‘obstacles’ and ‘opportunities’ involved in planning and implementing an ISMSWM system through the lenses of IEM approaches including analysis of stakeholder engagement, ISWM framework (incorporation of multiple dimensions relevant to sustainable development (i.e. legal/regulatory, institutional, technological/operational, social, economic and environmental factors), stakeholders and solid waste management relevant technologies/operations/approaches), in accordance with ESA tools.
4. To discuss IEM approaches in planning and implementing an ISMSWM system.
5. To investigate stakeholder perspectives and contributions in planning and implementing an ISMSWM system.
6. To discuss the effectiveness of (ESA) tools in promoting research to aid in ISMSWM system planning.
7. To develop an ISMSWM conceptual framework to promote understanding and address the obstacles and opportunities of planning and implementing such a system.
8. To explore the feasibility of moving away from conventional MSW toward an integrated and sustainable MSW management system in order to provide an innovative and integrative perspective on ISMSWM planning, decision-making and implementation that could inform policy and decision-making in Kuwait and other oil-exporting high-income (GCC) countries.

1.2 Research questions

According to the stated objectives of this thesis, the research questions are as follows: what are the obstacles and opportunities of planning and implementing an ISMSWM system in an oil-exporting high-income country such as Kuwait?.

Regarding the Kuwait case study, more detailed questions framing the research study are:

1. What is the current situation, including practices of MSW management?
2. What are the "obstacles" and "opportunities" of planning for an ISMSWM system in accordance with the multiple dimensions of sustainable development, SWM elements and stakeholders' perspectives?
3. How are environmental systems analysis ESA tools effective in promoting research set-up and planning by being a part of an ISMSWM framework?
4. What are the "obstacles" and "opportunities" of planning for an ISMSWM system from the perspective of IEM approaches and how might the currently implemented approach of MSW management be improved toward planning and implementing an ISMSWM model?
5. What are the characteristics/components of the conceptual framework for the planning and implementation of an ISMSWM system?
6. Based on the research findings, how might the ISMSWM conceptual framework be applied to improve the waste management situation in the oil-exporting high-income GCC countries?

1.3 Significance of the study

This research study is significant for many reasons. It provides a comprehensive overview of contemporary approaches to environmental and resource management, and this is accomplished by combining IEM principles, sustainable development and ESA tools in one research framework. This framework demonstrates a refreshing and advanced way of thinking about, understanding and addressing complex environmental problems. In particular, the study integrates holistic thinking, sustainable development aspects, technical factors, local stakeholder perspectives and social considerations. Therefore, it offers a broad understanding of the full range of actors, dynamics, interests, activities, and interrelationships that affect waste management systems in Kuwait. The case study of Kuwait illustrates a unique experience of planning and implementation of ISMSWM within the context of the particular challenges and resources that characterize many GCC countries.

The study's outcomes also provide the ability to investigate the critical components for developing strategies at an operational level.

Furthermore, the research presents a unique opportunity for Kuwait and other GCC countries to investigate the obstacles and opportunities of planning and implementing integrated sustainable municipal solid waste management more comprehensively as compared to the majority of technically- and economically-focused waste management studies.

1.4 Thesis outline

The thesis is organized into five chapters. The current chapter presents the introduction to the overall research including the key concepts, objectives, and significance of the study. The literature review will be included in Chapter 2. Chapter 2 presents a historical background of the emergence of IEM and sustainable development as conceptual frameworks. It also discusses the interaction of IEM with various environmental and resource management fields through the introduction of relevant case studies from developed and developing countries. Moreover, Chapter 2 outlines the development of ISMSWM, waste-related approaches, and the implications of IEM approaches and sustainable development thinking for expanding the multidimensionality of an ISMSWM framework. In addition, it presents a summary of the ESA tools and the analytical and procedural analysis tools and their interpretations in MSW management. Chapter 3 presents the research epistemology, methodology, research framework and design. Chapter 4 provides the results of the analyzed research data obtained through a mixed methods research framework. Chapter 5 presents a discussion of the findings of the case study and the implications of these findings for the literature and the research objectives. Moreover, the conclusions of the research and the recommendations will be included in Chapter 5.

Chapter 2

Literature Review

2.1 Introduction

The beginning of this chapter presents a historical overview of the development of the integrated environmental management (IEM) approach. IEM supports sustainable development and considers the many competing issues involved in environmental management. Case studies from both developed and developing countries are presented to demonstrate how relevant IEM approaches can assist in overcoming the conflicts between stakeholders that are inherent in issues of environmental policy, and how to reach effective solutions that satisfy groups having differing priorities.

It is recognized that besides MSW being an environmental problem, it can also be considered a man-made resource. This, plus the impacts of improper MSW management, and its relevant socio-economic impacts, demonstrate the need for "integrated and sustainable management" and involvement within a framework of IEM approaches. The next section of this chapter includes a brief review of the development of the integrated solid waste management (ISWM) model and relevant MSW management relevant approaches and technical solutions. Moreover, the next part of this chapter presents the necessity of a holistic approach to work in an integrative perspective across the multi-sectors of economic, social, environmental, policy, regulatory and institutional systems in relation to MSW management. Moreover, it includes an explanation and examples of the implications of IEM approaches and SD to develop planning and implement a framework of integrated and sustainable municipal solid waste management (ISMSWM).

2.2 Environmental planning and management models

The field of environmental and resource management began in the early twentieth century, and several different models were developed to promote the implementation of best practices of solving problems that are determined by the vagaries of the situation (Mitchell 2002, p.43). Table 2.1 presents brief definitions of key planning and environmental management models. For example, Briassoulis (1989) states that unless combined with participatory planning, the incremental approach by itself is not a satisfactory or effective approach with regards to solving environmental problems. Many environmental managers now use a holistic approach that takes into account not only ecological, but also sociological concerns, and their effect on environmental management. Environmental managers now seek an approach that integrates different interests, jurisdictions, social and ecological systems, in the context of available information (Hanna 2007, p.1-13).

Table 2.1: Examples of Planning and Environmental management approaches

NO.	Approaches	Definition and Preferred Framing	Reference
	Planning		
1	Comprehensive rational model (CR)	CR is the dominant planning model. It requires mathematical models in order to understand the main problems in the context of the system created to manage them. It relates objectives to resources and constraints and relies on numbers and quantitative analysis. CR process consists of defining the problem, establishing goals and objectives, assessing the options and monitoring and evaluation.	(Hostovsky, 2006; Hudson, 1979; Mitchell, 2002)
2	Incremental	Based on finding solutions through gradual changes and compromise, rather than attempting optimal solutions.	(Mitchell, 2002, p.40-41)
3	Adaptive	Flexible management strategies that can be adjusted to deal with sudden changes.	(Briassoulis, 1989)
5	Advocacy	Believes society consists of diverse groups with conflicting needs, and all factions should be taken into account.	(Briassoulis, 1989)
6	Transactive	Considers the experiences of those who will be most affected and directs efforts toward these groups.	(Mitchell, 2002, p.42-43)

7	Participatory	Prioritizes collaboration. Believes that by resolving contentious issues, it is possible to find a solution that satisfies all parties, not just the majority.	(Margerum, 2002)
	Environmental management approaches		
1	Ecosystem approach	The study of living species and their physical environment as an integrated whole.	(Bocking, 1994; Mitchell, 2002)
2	Precautionary	Managers and decision-makers should anticipate the potential harms to the environment, and make decisions that help avoid such harm, rather than waiting for complete understanding or scientific proof.	(Mitchell, 2002, p.33-35)

2.3 Integrated environmental management (IEM) – Introduction

The term Integrated environmental management (IEM) is flexible enough to meet the needs of the developer or institution involved in the planning. Therefore, the definition of IEM is constantly changing and becoming more inclusive. According to Born, S. in a 1995 paper, integrated environmental management was developed after the traditional method of managing natural resources was found to be reactive rather than proactive and incapable of handling multiple systems or priorities. Margerum, R. (1999) states that "[I]ntegrated environmental management is based on the concept that environmental regions, whether defined by the boundaries of catchments, bioregions, or other criteria need to be managed holistically." In 2007, the European Commission defined IEM as "[I]ntegrated approaches that include long-term strategic vision that link different policies at administrative levels to ensure coherency. Integrated environmental management also means tackling related issues together such as urban management and governance, integrated spatial planning, economic wellbeing and competitiveness, social inclusion, and environmental stewardship".

IEM is an integrated approach; here, the physical and social system is taken into account in its entirety. In the interest of connecting theory to practice, multiple approaches and techniques associated with the IEM framework have also been under development to facilitate successful planning, assessment and implementation processes. The literature on IEM includes the concepts and theories that are incorporated in the IEM framework, approaches to support successful implementation of IEM and environmental systems analysis (ESA) tools that are chosen by the planners and environmental managers for better analysis of the systems.

2.4 Integrated environmental management (IEM) approaches

Formalized integrated environmental management approaches emerged as a new paradigm in the 1990s (Born 1995, Margerum 1997). It involved people with a personal stake in environmental management, such as government officials, people whose livelihoods depended on natural resources, scientists, and other policy experts considering everyone`s needs and goals (Margerum 1995, 1997, 1999). These practitioners developed terminology, such as ecosystems management, integrated environmental management and integrated resource management (Margerum 1997, 1999). “Integrated environmental” options have become the most preferred/desirable approaches to manage environmental resources such as water and soil and man-made resources such as waste (Hettiarachchi 2016, p.3). In addition, IEM was adopted with the target of identifying environmental impacts, reduce negative environmental impacts and promote resource management with respect to the products, activities and services of any organization (Pošiváková et.al 2018).

IEM practices are adopted for many reasons. These include new scientific information becoming available, the need for greater stakeholder involvement, or increased awareness about the complexity of the environmental and sociological systems involved (Margerum 1997; Slocombe 1993, 1998). Traditional environmental management approaches, as described by Born (1995), have been largely reactive (rather than proactive), disjointed and based on limited goals. As demands on resources increased, conflicts formed. Resolving them required considering the underlying issues involved. (Mitchell 1990, Margerum 2001). For technical systems, science and engineering are needed in addition to the available integrated environmental approaches to link the knowledge and technical aspects with the relevant stakeholders, actions, and better implemented decision-making tools (Grigg 2016, p.2).

Born (1995) and Margerum (1995) present a conceptual framework of IEM that meets four conceptual criteria. The solution must be comprehensive and include all elements that stakeholders consider critical. It must be interconnective and identify linkages among all aspects of the environmental system. It must be strategic/reductive, meaning that only the most critical issues are given immediate priority. Moreover, it must be interactive and coordinative in its process of implementing management solutions (Born 1995, Margerum 1995). For environmental management systems that include technical systems, the integrated management approaches should be applied at three levels: the technical level, management level involving decision-making and broader level to include the intersection with other relevant sectors such as health, economics, energy and industry (Grigg 2016, p.3). IEM approaches are modified in real-world operations in different fields of environmental management to transfer from conceptual IEM approaches toward successful implementation (Margerum 1999). Researchers, practitioners and analysts utilize IEM approaches consistent with their development targets (see table 2.2).

Table 2.2: Examples of different environmental and resource management fields where IEM has been utilized

Environmental Field	Author
Integrated water resource management (IWRM)	Mitchell (2005), Giggs (2016), UNEP (2012), Merry (2005)
Integrated Coastal zone management (ICZM)	Stojanovic (2004, 2009), Zagonari (2008), Ballinger (2010)
Ground water management	Jakeman et.al (2016)
Integrated natural resource management	Hanna (2007), Mitchell (2002)

In the field of integrated water resource management (IWRM), key concepts such as integration, decentralization, participation, and economic and financial sustainability were emphasized as conduits for operationalizing IWRM principals (USAID 2006). In the field of integrated coastal management (ICM), Stojanovic (2004) listed nine approaches for successful ICM: comprehensiveness, participation, co-operation, contingency, precautionary, long termism, focusing, incrementalism and adaptability. These approaches can also be applied to other fields of integrated environmental management (Stojanovic 2004, Taljaard 2011).

2.4.1 Holistic “systems” approach

The holistic or systems approach is generally desirable for resource and environmental management because it is important to understand the big picture when addressing the different components and relationships of an environmental system at strategic and environmental levels (Mitchell 2005, Griggs 2016, p.119).

A system “is a group of interacting, interrelated, or interdependent elements forming a complex whole coordinated to achieve a stated purpose or goal” (Franchetti 2009, p.12). The resource and environmental management systems include complex social-environmental systems that have multiple interconnected components that interact in diverse ways (Matson 2016, p.55). The systems approach contends that when the internal system linkages are removed from an environmental system and viewed in isolation, the component parts of a system will act differently. The only way to fully understand the cause of a problem occurrence and persistence is to take a holistic approach (Franchetti, 2009, p.22). Therefore, it is essential to look for and understand the systems to be managed, the procedures, the institutions, the decision-making tools, and the interrelationships among the systems (Grigg 2016, p.120).

A systems approach helps to understand the human elements, i.e. the social, cultural, and political elements. A systems approach provides a holistic framework that can solve key management issues from multiple perspectives. By bringing together different viewpoints, a multidimensional and rich understanding of the situation can be constructed, and this can lead to the creation of sustainable policies (Elsawah in Jakeman et.al 2016, p.622).

There are two basic interpretations of a holistic or systems approach: comprehensive and integrated (Mitchell 2002, p.103, 2005). A comprehensive perspective is useful in identifying a broad array of variables to understand a complex environmental issue. However, focus on the entire, complex system may interfere with implementation goals. Integrated perspectives are more focused, yet they can overlook one or more key variables. Contemporary IEM promotes a holistic approach that incorporates both comprehensive and integrative perspectives (Margerum 1995). In addition, a holistic approach for IEM can be characterized by interdisciplinary (Griggs 2016, p.22, Pošiváková 2018) and transdisciplinary principles (Jørgensen 2016, p. 11, Mauser et al. 2013). The interdisciplinary perspective for environmental management is the process of integrating the knowledge of human and natural science to combine two or more disciplines and understand the interactions at diverse scales within the focused environmental problem (Brondizio et al. 2016,

Grigg 2016, p.126, Goring et al. 2014, Palmer et al. 2016). Transdisciplinary "is used to point to the need for researchers to work together, across boundaries of academic disciplines and field practice, in order to address complex environmental challenges" (Landstörm 2017, p.1-15).

2.4.2 Collaboration approach

A holistic approach, integration, collaboration and participative decision making are the main principles "…to seek sustainability, balance economic, environmental, and/or social outcomes and promote economic development and protection of ecosystems without to harm the quality of life, safety, or security" (Nakagami 2016, p.12). The collaborative approach recognizes that a range of physical, ecological, social and economic interconnections must be addressed in sustainable IEM. As environmental problems are typically complex and have wide-ranging consequences, solutions require multiple perspectives and people with different areas of expertise. They also need to be flexible enough to adapt to changing and challenging circumstances (Reed M. 2008). Therefore, solutions for environmental problems should involve the affected parties such as government agencies, institutions and the general public (Margerum 2001).

Collaborative approaches encourage broader stakeholder involvement by engaging with each other in a spirit of collaboration and reconciliation in which all positions are accorded respect (Gray 1989, Healey 1997, Innes 1994, 2003, Mandarano 2008, Margerum 2001, Susskind 1987, Wondolleck 2000). The collaborative approach identifies solutions that meet the mutual interests of all parties (Frame 2004, Gunton 2003, 2007, Susskind 1987, Wondolleck 2000), and thus minimizes potential stakeholder conflicts. The diverse perspectives among different stakeholders are more likely to produce innovative ideas (Frame 2004, Gunton 2003, 2007, Mandarona 2008, Susskind 1987) and create multiple problem-solving alternatives (Nakagami 2016, p.38). The stronger relationships among stakeholders can build effective partnerships and reduce future conflict and affect policy in ways that could not be achieved individually (Frame 2004).

Margerum (1999) described two successful incidences of collaborative IEM. In Queensland, Australia, the committee responsible for the Johnstone River Catchment developed a management plan that listens to stakeholders from agriculture and industry, and formulates standards that respects the needs of both groups. The stakeholders committee consists not only of people across all levels of government, but also environmentalists and representatives from different areas of the agriculture sector. This was accomplished via improved coordination between stakeholders. Similarly, the Wisconsin Department of Natural Resources developed the Lake Winnebago Comprehensive Management Plan in concert with ordinary citizens and representatives from all government bodies. These case studies found that the collaborative approach produced additional benefits, including improved stakeholder relations and skill development. A large number of studies and case studies (e.g: USEPA 2003, Grigg 2016, p.175 and 406, Hittiaraclchi 2016, p.28 , 100 and 195, Niesten E. et al. 2017, Nakagami 2016, p.41) provided that the collaboration approach in the various fields of environment and resource management provides a beneficial contribution to the environment, society and the economy, which can pursue sustainable development challenges and promote sustainable society over a long period (Niesten, E. et al., 2017).

Despite the advantages, there are limitations to the collaborative process (Brower 2016, Frame 2004; Goodspeed 2016, Gunton 2003; Innes 2003; Susskind 2000; Wondolleck 2000). These include stakeholders that do not possess the needed collaboration and negotiation skills (Knootz 2006, Margerum 1995). They also lack the ability to predict the results of their planning or evaluate the outcomes of the process itself (Frame 2004, Mandarano 2008). Stakeholders must recognize that some conflicts cannot be resolved through collaborative processes (Brower 2016, Margerum 1999). Ideological differences, constitutional issues, inherent hostility and unilateral action can constrain the interaction between stakeholders and thus create barriers to collaboration (Goodspeed 2016, Gray 1989; Margerum 1999). This is most likely to occur when local stakeholders, whose livelihoods and interests are most affected by future management decisions, are excluded from the collaboration and decision-making process. To promote effective participation, all stakeholders should be compelled to be involved in the different planning stages (Brower 2016; Nakagami 2016, p.38).

Even if full consensus cannot be achieved and despite the potential conflicts, the collaborative approach can better support the decision-making process by defining problems, providing better information, identifying and analyzing possible solutions, and narrowing the scope of issues (Frame 2004; Grigg 2016, p.174, Gunton 2003, 2006; Susskind 2000). For better outcomes with respect to collaborative practices, collaboration "should proceed through phases, from assessing the situation, to designing the process, to deliberation and decision, followed by implementation, learning, and adapting." (Grigg 2016, p.175). For better collaborative practices, the collaboration practitioners should understand the requested outcomes through the action, organizational and policy decision-making levels in addition to the type of stakeholders that should be involved, the management practices to perform implementation and the adopted approaches to achieve the expected changes (Margerum 2008).

Collaboration promotes a transfer from the top-down (command and control) approach toward the bottom-up approach and provides better opportunities for stakeholder participation in decision-making (Cheng 2006). The geographic scale and the preferred practices of collaboration have led to the development of different approaches relevant to integrated resource and environmental management (table 2.3). Community-based management (CB) and co-management were developed to promote a decentralized approach within the realm of local communities. At the same time, the co-management approach promotes the bringing together of bottom-up and topdown approaches by sharing the responsibilities between stakeholders at the level of local communities and nation states. Furthermore, public participation in environmental management was adopted to educate and empower community members about issues that affect them, share responsibilities with governmental agencies and increase confidence in government decisions.
These approaches are presented in more detail in the following sections.

Table 2.3: Examples of integrated resources and environmental management approaches and the relevant level of collaboration

Approaches	Level of collaboration:	Promote:
Decentralization	Local- level	Bottom-up

Community-based management (CB)	Local-level	Bottom-up
Co-management	Sharing of responsibilities between stakeholders of local communities and the nation state	Balance between Bottom-up and Top-down
Public participation	Public participation educates and empowers community members about issues that affect them, shares responsibilities with governmental agencies and increases confidence in government decisions. Public participation encourages public collaboration in environmental decision-making.	Balance between Bottom-up and Top-down

2.4.3 Decentralization approach

During the last few decades, the traditional top-down approach for nature and natural resource conservation management has been strongly criticized (Fauchald 2014, Hongslo 2016). This led international organizations to adopt the idea of decentralization. International organizations (e.g.: United Nations (UN), The World Bank, European Union (EU)) have all adopted a decentralized approach towards natural resource conservation management (Hongslo 2016). Decentralization is a "process through which authority and responsibility for some functions are transferred from the central government to local governments, communities and the private sector**.** This process involves that decentralized institutions, either local offices of central government or local private and civil organizations (entrepreneurs, farmers, communities, associations, etc.) be provided with higher power in policy making and decision taking" (Cistulli 2002, p.30).

Decentralization has the potential to provide the opportunity for many developing countries to establish systems and processes that promote sustainable development. Thus decentralization has become an essential tool of democracy promoted all over the world, including developed countries for the purpose of promoting participation and local development (Braimah in Dick 2016, p.1). Decentralization has become a worldwide trend implemented by planners, researchers and decision-makers in many areas of nature, natural resource and environmental management such as: forest management (Lane 2003, Larson

2002), watershed management (Steel 2001), Wetlands (Valipour 2016) and coastal zone management (Siry 2006, Kearney 2007).

In Southeast Asia, coastal zones support transportation, mining, tourism, fishing, and communications (Pomeroy 1995, 1997; UNEP 2001). Larger populations in these areas have greatly impacted coastal and marine resources. Siry (2006) and Dahuri (1996, 2000) have found that these coastal zones are damaged by centralized and inadequate management that ignores the needs of the local community. In response, Southeast Asian governments transferred the decisionmaking power from central to local government. (Pomeroy 1995, Dahuri 2000). As an example of developed countries, Norway and Sweden have implemented decentralization for nature conservation management.

In addition to nature conservation and natural resource and environmental management, latterly, the decentralization approach has been recommended for technical systems within environmental management systems such as: wastewater treatment (Brenner in Wilderer 2016, p. 149, Massoud 2009, Garrido-baserba et.al 2018) and waste management (Bauer in Wilderer 2016, p.152, Beall 1997, Kumar 2016, p.130, Srivastava 2005). Massoud (2009) discusses the advantages of the decentralized approach to wastewater treatment in developing countries. (The study emphasizes that centralized management can ensure that inspection and maintenance are conducted regularly). Decentralized wastewater management is a less resource-intensive and more ecologically sustainable form of sanitation (Massoud 2009, Tchobanoglous 2003, 2004).

"Decentralized and centralized approaches are not "either-or" conditions" (World Bank 2002 a, b). Not all approaches are able to be managed in a decentralized manner (Siry 2006). This is because decentralization requires significant political will by those in power since a key condition is the effective and efficient functioning of relevant governments. Therefore, the central government must play a critical role in order to effectively achieve decentralization. For example, to facilitate decentralized functions, local governments, non-governmental organizations and private companies should be offered technical assistance with respect to planning, financing and management (The World Bank, 2002). For the mentioned examples of Norway and Sweden, both countries have similar institutional structures, but each country had implemented different perspectives for decentralization (Hongslo 2016). The political-administrative style of each country influenced the pattern of decentralization practices. “The actors that participate in the policy process and the arenas in which deliberations and decisions take place influence the choice of type of decentralization” (Hongslo 2016). For natural resource and environmental management, and even for technical systems within environmental management systems, when decentralization is requested, an optimistic balance between centralization and decentralization should be insured (Bloesch in Wilderer 2016, p.76).

Community-based environmental management and co-management are important decentralization approaches as they may be useful in developing sustainable natural resources management practices and engaging shared responsibility among various stakeholders. These approaches may achieve better results compared to central government-dominated styles of management (Siry, 2006**).**

2.4.4 Community-based environmental management

The UNHCR (2008) defines “community” as “a group of people that recognizes itself or is recognized by outsiders as sharing common cultural, religious or other social features, backgrounds and interests and that forms a collective identity with shared goals”. Community can refer to an ethnic, religious, or cultural group, a neighborhood, or the city as a whole (Muller 2001, El Asmar 2012). Lane (2005) defines community-based approaches as “the deliberate, programmatic decentralization of authority and resources to communities for the purpose of environmental management and planning.” They promote equitable planning processes by enabling the involvement of local knowledge (Lane 2005). Community-based management designs must respect identities based on gender, ethnicity, class, and age. The failure to do so can marginalize certain social groups and perpetuate injustice (Lane 2005, Sandercock 1998). There are many benefits of community-based environmental management and they can be observed in a wide range from improved plan formulation through to implementation (Gray 2001, Delgado-Serrano 2017). These approaches can minimize state-directed planning and negative impacts on local stakeholders. This helps conceptualize problems from a local point of view, more nuanced than the more simplistic vision held by centralized bureaucracies. In addition, they benefit to provide greater efficiency of environmental management implementation by recruiting local communities while government agencies, scientists, and planning and management organizations may lack the information and ability to enact change (Lane 2005).

Adopting community-based solutions is a participatory approach that often results in equitable decision-making, context-relevant innovations, and the effective implementation of plans and strategies (Wismer 2005). The community-based management approach has been adopted and implemented in various natural resource and environmental management fields all over the world (e.g: Cooke 2016, Delgado-Serrano 2017, Mountjoy 2016, Riehl 2015) to promote the incorporation of many environmental goals such as biodiversity conservation, sustainable resource management and control of environmental degradation to improve the socioeconomic well-being of local communities (Riehl 2015). In addition, CBM has become a recommended approach to promote sustainable practices in solid waste management (Sekito 2013, Wynne et.al 2018) and MSW management (Challcharoenwattana 2015, Abdoli 2016, Manomaivibool 2018, Raharjo 2017, World Bank Group 2018, b).

2.4.5 Co-management approach

Co-management "entails shared management authority between the government and communities or user groups" (Berkes 2010). It creates a system where municipal and regional governments work together. Local-level management provides experimental knowledge, customs, cultural traditions, and self-regulation. State agencies are run in a centralized and hierarchical style, with experts determining the overall policy and regulations, and regional agencies implementing them (Mitchell 2002, p.227).

The World Bank (1999) stated, "the sharing of responsibilities, rights and duties between the primary stakeholders, in particular, local communities and the nation state, a decentralized approach to decision-making that involves the local users in the decision-making process as equals with nation-state" represent co-management. A state agency, with the authority to make policy and regulatory decisions, develops a partnership with local residents and resource users. Comanagement can begin with the sharing of knowledge and information between different groups of stakeholders and managers (Berkes 2009; Carlsson 2005), and proceed to the level of formal partnership (Carlsson 2005; Pomeroy 1997). The participation process can generate opportunities for contribution and balanced sharing

(Stojanovic 2004). This assumes all parties recognize the unique contributions each brings to the partnership.

Co-management includes multi-stakeholder arrangements, with agreements between different levels of government, and government and individuals. It also involves consumers of resources respecting the natural world they use (Berkes 2009). Local natural resource users often possess experiential and cultural knowledge of the multiple dimensions of environmental systems. Yet, even with their nuanced understanding, local stakeholders cannot always autonomously manage natural resources in an increasingly complex contemporary world. A functioning comanagement system can protect resources from environmental damage, enforce regulations, gather data, engender more inclusive decision-making, and enhance long-term planning (Pinkerton 2011, p.273, Carlsson 2005). Co-management shares management responsibilities such that the strengths of centralized and decentralized governments, and state and community institutions are respected, leading to greater success than each stakeholder group could achieve alone (Singleton 2000).

2.4.6 Public participation

Nowadays, public participation has become known as a vital approach for environmental management (Xie 2016). Public participation, in terms of environmental management, is defined as "a process that involves the public in problem solving or decision making and uses public input to make decisions. It includes all aspects of identifying problems and opportunities, developing alternatives and making decisions. It uses tools and techniques that are common to a number of dispute resolution and communication fields" (IAP2 2010, p.20). The goal of public participation is to encourage meaningful input to contribute to the decision-making process. Therefore, public participation offers the opportunity for communication between the public and the decisionmaking agencies. This communication can alert decision makers to public concerns, provide accurate and timely information, and can result in sustainable decision-making (Wouters et.al. 2011, p.20).

There are several studies discussing the incremental interest in public participation practices in environmental management all over the world including, Australia (Ross 2016), Canada and Denmark (Marzuki 2015), China (Chen 2015, Deng et al. 2016, Huang 2015, Li 2018, Sun 2016, Xie 2016), Germany (Drazkiewicz 2015), United Kingdom (Fritsch

2017, Voss 2014), and developing countries (Odhiambo 2017, Dungumaro 2003, Marzuki 2015). Public participation has played a significant role in achieving sustainable development goals in developed countries (Li 2018). Public participation in environmental management is important because it helps provide resources to government agencies, increases confidence in government decisions, and educates and empowers community members about issues that affect them (O'Rourke 2003, Wouters et al. 2011, p.17).

In a study to examine the success of public participation practices in four different areas in Germany in terms of quality of decision-making and implementation, Drazkiewicz 2015 indicated that increased participation resulted in better environmental decisions in three cases, but it produced reduced environmental protection when there was an increased participation of more predevelopment stakeholders. In all the cases in which at least part of the goal was to resolve conflict, increased participation improved implementation. Another example, from China, indicates that "China is facing great environmental challenges that have compelled the central government to realize the urgent need for the mobilization of broad social support for environmental protection and management" (Chen 2015). Although the public participation approach was not adopted until the last few years, it has been utilized in various fields including air pollution control (Haung 2015), water management (Deng et al. 2016, Hird 2017) and watershed management (Chen 2015). Although Public participation is not a traditional approach in China, it continues to involve public values and needs in the decision-making process as well as modified environmental management decisions (Deng et al. 2016, Xie 2016). Latterly, public participation involved as an essential factor to promote success on MSW management systems by accounting for the social dimension of MSW and not only the innovations in technical solutions (Dururu et al. 2015, Fritsch 2017, Garnett 2014, Hird 2017, Kirkman 2017, Lynch 2018, Abdoli 2016, Xiao 2017).

All countries face various challenges while dealing with environmental concerns, but developing countries are confronted with extra challenges as they place a lower priority on environmental protection compared to economic growth. The focus is on the investment development, production, marketing of goods and services and the success of business unless environmental concerns threaten this success. Then, environmental protection will be of concern to the society. One main approach to avoid these difficulties in securing environmental protection is to provide the opportunity for both the concerned and affected parties to participate in the process of making decisions (Voss 2014). The public's values are incorporated into decisions via effective public participation and ultimately affect the outcome (Wouters et al. 2011, p.17).

Successful public participation promotes efficient decisions in environmental management (Huang 2015). Success may mean reaching good environmental outcomes, or it may lead to increased trust and positive working relationships. Either way, the decision-making process can be improved by an informed approach to stakeholder and public engagement (Reed et.al. 2017). Promoting successful public participation requires a number of essential factors. At the beginning, it is essential to raise the awareness among both the public and decision-makers regarding the critical nature of public participation in environmental protection planning and management and decision- making (Armeni 2016, Deng et al. 2016, Huang 2015, Wouters et.al. 2011, p.8). A legislative and administrative framework should be established to promote the implementation of a public participation approach and to define the detailed procedures and mechanisms for public participation (Armeni 2016, Deng et al. 2016, Li 2018, Llopis-Albert 2015, Marzuki 2015, Ross 2018, Xie 2016). It is important to provide support for both the public and competent authorities, and offer training for participation, decision-making, design of the process itself and implementation so that both the public and competent authorities can be included as active stakeholders during the public participation process (Deng et al. 2016) while the process of participation can be performed in different ways including: inform, consult, involve, collaborate and empower (Wouters et al. 2011, page 17).

2.4.7 Bottom-up approach versus top-down approach

All of the aforementioned approaches are integrative and collaborative environmental management strategies. Choosing which management strategy is best for each situation can be determined by the variables of the situation, the levels of collaboration, and the ultimate goals. For example, community-based and co-management approaches are suited to local resource management when the resource consumers will be involved (Lane 2005). These strategies are evolutionary, participatory and locale specific (Siry 2006).

The creation of “bottom-up” (local and community-driven) approaches in environmental management projects was established after the failure of strictly “top-down” approaches in many cases of environmental and resource management (Fraser 2006), which have been consistently seen as prioritizing expert scientific knowledge over local and qualitative knowledge (Smith 2008). Top-down approaches fall short since environmental management and associated decision-making should never be exclusively scientific or technical in nature. These paradigms cannot address all of the context-specific facets of environmental issues (Smith 2008). The move from top-down toward community-based involvement is believed to have improved environmental monitoring and management (Fraser 2006).

There is a world-wide progress in acceptance of bottom-up approaches to environmental management that incorporates stakeholders, knowledge, needs, experiences, and skills, particularly at the local level (Smith 2008). However, they have limitations, and should be critically analyzed. Given that environmental problems are complex and dependent on community participation, it is necessary for planners and environmental managers to integrate holistic, participatory approaches and management solutions. An effective participatory process relies on the technological solutions of the experts, and the holistic remedies of the community. The most effective solutions involve a continuum between these two approaches (Ball 2001). A collaborative approach to putting solutions into practice is usually done at the local level and does not require significant involvement from large organizations or governments. On the other hand, these often take place in the context of involvement by these national or international institutions. In the real world, bottom-up and top-down approaches often work in concert (Koontz 2014).

Top-down processes can be enriched by incorporating the input of community stakeholders at all stages of planning and management processes. The political will of decision-makers and project administrators is characteristic of a top-down approach, but still requires the engagement of the locals (Gaymer et al. 2014). To promote a successful balance between top-down versus bottom-up approaches and achieve the relevant goals, it is necessary to understand the purpose and context of stakeholders and public participation to determine the appropriate public participation practices for the specific purpose and context (Reed M. et.al 2018).

2.5 Development of sustainable municipal solid waste management – relevant approaches

"Waste is generated either by human beings, animals, or plants or from any natural or artificial process. Waste takes many forms, such as municipal solid waste (MSW), biodegradable waste, non-biodegradable waste, chemical waste, construction and demolition waste, electronic waste, biomedical waste, wastewater, sludge, toxic waste, industrial waste….and so on" (Kumar 2016, p.11). This section and the rest of the chapter attempts to explore opportunities and challenges related to the integrated and sustainable management of municipal solid waste (MSW) management. The OECD (2008) defines MSW in the following manner:

> Municipal waste is collected and treated by, or for, municipalities. It covers waste from households, including bulky waste, similar waste from commerce and trade, office buildings, institutions and small businesses, yard and garden, street sweepings, contents of litter containers, and market cleansing. Waste from municipal sewage networks and treatment, as well as municipal construction and demolition is excluded.

The Intergovernmental Panel on Climate Change (IPCC) (2007), included more items to the OECD definition of MSW. Types of solid waste include discarded food, garden clippings and leaves, paper products, fabrics, disposable diapers, rubber and leather, plastics, metal, glass, ash, and household dirt. Municipal solid waste (MSW) mainly consists of three types (Kumar 2016, p.11): "residential waste that is generated by individual households located in inland areas, commercial waste generated from large single sources such as schools, colleges and hotels and waste form municipal services, such as streets, public gardens, and so on". Since MSW is varied and complex, then MSW management systems are difficult to analyze and implement (White, 1995)3.

Landfill traditionally is considered to be the most suitable MSW disposal option for most countries due to its low cost, availability and suitability for a wide range of waste (Williams 2005). Landfills are the most common disposal method in most developing

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[3] The thesis is focused on municipal solid waste (MSW).

countries (Mahar 2007, Willims 2005); however, they can be hazardous to nearby communities. Chemicals can leach into the water and contaminate the surface water, groundwater, soil and atmosphere (Mahar, 2007; Mor, 2006). Landfills can release landfill gas (LFG) and leachate (Mahar, 2007; NORDTEST, 2004; Urase, 2008), and global warming-causing gases such as methane and carbon dioxide. Disposal of MSW in landfills represents one of the highest anthropogenic sources of global methane emissions (Calabrò 2009, Powell 2016, Saunois et.al. 2016, Stocker et.al. 2013). Therefore, international policy approaches have thee target to significantly reduce these emissions to stand against climate change and greenhouse gas emissions (Calabrò 2009, Powell 2016, Stocker 2013). These foundations obviously indicate the urgent need to aim at open landfills to achieve a significant reduction in methane emissions (Calabrò 2009, Powell 2016, Stocker et.al. 2013, Saunois et.al 2016). In addition, the contribution of methane emissions from landfill to climate change can be considered as one of the main solid waste management drivers for developing a paradigm of integrated solid waste management (Marshall 2013).

Efforts to manage solid waste began in the 1800s, when people discovered poor sanitation was linked to infectious diseases such as cholera (Bilitewski 1997, p.2). This crisis led to the rise of public health as an important driver for solid waste management (Bilitewski 1997, p.23; Wilson, D. 2007), even leading to technological innovations in SWM in the 1900s. Landfills correlate with poor public health, environmental concerns, and resource scarcity, and alternative waste management strategies are needed. Table 2.4 lists the main alternative technical solutions to landfills for disposing of MSW.

Table 2.4: General overview of the main alternative techniques to landfills for disposing of municipal waste management:

Waste management technique	Description
Recycling	Converts waste materials into usable items (Tammemagi, 1999). Used for common household waste such as newspapers, metal or glass containers, some plastics, organic materials comprised of garden waste and food waste (Williams, 2005, 2013, p.130).
Composting	"Composting is the controlled microbial decomposition of the organic fraction of solid waste, under aerobic conditions, where microorganisms convert waste into a stable end product such as compost." (Kumar 2016, p.58)
Incineration	Waste is burned to minimize the volume of waste to be disposed of. It may be considered a form of recycling when accompanied by energy production. (Tammemagi, 1999).
Mechanical-biological treatment (MTB)	The processing, or conversion, of biologically degradable waste from a human settlement (e.g. households) through a combination of mechanical and biological processes (Soyez, 2002, Bayard et al. 2008). It produces reusable materials, including minerals and organics (Brandl, 2006). The organics are then treated such that they produce biogases, which can be used for heating or as an energy source (Brandl, 2006; Williams, 2005, 2013, p.49).
Material recovery facility (MRF)	"Material recovery facilities (MRFs), often referred to as recycling facilities, can be considered a special type of transfer station, given that they also serve as an intermediate stop before advanced or final waste treatment. To facilitate material recycling and energy recovery, MRFs process materials manually, by automated sorting systems, or by a combination of the two. Some MRFs are designed for special purposes, processing specific materials such as e-waste, construction and demolition waste, or plastic waste" (Ai 2017, p.37)
Sanitary landfill	Not all waste material can be recycled. Landfills will still be needed. Best landfill practices include separate disposal of hazardous and non-hazardous waste; and proper controls for leachate and methane (USAID, 2014).

In addition to the necessity of technical solutions for MSW management systems, MSW management-related approaches are adopted to ensure sustainable solutions and to promote the achievement of sustainable development goals (SDGs) (see section 2.6.5). A proper MSW management approach can be incorporated in the regulatory political strategies that can contribute to mitigation of GHGs emissions, improve environment and public health, provide economic and financial benefits and encounter for the social dimension of the MSW management systems (Elagroudy 2016, p.38-40).

The zero-waste approach is considered a holistic approach that encompasses the entire life cycle of a product, from the stage of taking out the raw materials to the final disposal of the product (Zaman 2014). “The world, today, is focusing on the concept of zero-waste and zero landfill” (Kumar 2016, p.18). The Zero Waste International Alliance (2018) defines zero-waste as “The conservation of all resources by means of responsible production, consumption, reuse, and recovery of products, packaging, and materials without burning and with no discharges to land, water, or air that threaten the environment or human health”. The zero-waste approach encourages the resources/products life cycle to be redesigned so that all products of various types are recycled, and none of the waste is sent to landfills or incinerators (Song 2015). Diversion of the waste from landfill or the zero-waste to landfill concept alone may not be sufficient to achieve the long-term goals of the zero-waste approach. One of the main concepts for zero-waste is waste prevention. For moving societies toward zero-waste, the implementation of waste prevention requires proper integral consideration for local and national social, industrial, business, technical, policy and regulatory elements (Zaman 2017).

“Zero-waste studies focused on a number of life cycle phases including: extraction of resources, design, production, consumption and waste generation, waste management, treatment, regulatory framework and evaluation of waste management performance” (Zaman 2014). The zero-waste approach could present economic and environmental benefits and alternative solutions with respect to environmental resource utilization (Song 2015). By developing national strategies of zero-waste and by implementing zero-waste initiatives in waste management policy, countries may have better opportunities to achieve their zero-waste goals (Zaman 2014, 2017).

Zero-waste strategies should design processes pre-manufacturing, and the analysis methods can be used to describe the first level. This mainly covers eco-design, new technology, LCA, product stewardship, and closed-loop supply chain management. These methods will reduce material and energy usage, improve the function of the product, and define the producers' responsibilities (Song 2015). This process requires committing to three objectives (Innes, H. 2013). The first is designing and manufacturing products, and educating consumers, such that a minimum amount of waste is generated. The second is incentivizing products designed to be used a long time and repaired rather than disposed of. The third is maximizing the recovery of what resources have been used, usually via alternative waste disposal systems (Innes, H. 2013).

Energy from waste (EFW) is an innovative concept that is being applied to waste disposal. It is being implemented in many developed countries with positive results and has emerged in some developing countries as a new concept (Kumar 2016, p.21). EFW is considered as the 4^{th} "R" ("recover") in the waste management process, after "reduce", "reuse", and "recycle". EFW recovers energy from waste sources after recycling in the form of heat, steam, or electricity, except for source-separated organic material, which usually uses anaerobic digestion (CCME 2014, p.40).

Recycling and EFW technologies can significantly reduce the amount of landfill waste by transforming it into different types of energy and valued materials such as electrical power, organic fertilizers, fuels, heat, and chemicals (Franchetti 2014, Ouda et.al. 2016, Sadef et.al. 2016). While EFW has usually addressed only the thermal process and excluded the biological process for waste disposal, currently, AD is considered by many researchers (e.g. Franchetti 2014, Sadef et.al. 2016, Tan 2015) as a complement to EFW techniques. Several EFW technologies are available such as pyrolysis, gasification, incineration, RDF depending on the type of waste, as well as quantity, biochemistry, available infrastructure, and possible end uses (Sadef et.al. 2016). Incineration, AD and RDF should be chosen based on analysis of the physical, chemical, and biological characteristics, the MSW energy values, and the pros and cons of each EFW technology (Sadef et.al. 2016).

An efficient strategy of municipal waste management should be established involving techniques and tools that will allow stakeholders to reach consensus on solutions that are sustainable and can be practically implemented (Soltani 2016). To select the most feasible MSW treatment options, Soltani (2016) recommended a decision framework that can include stakeholders' different (conflicting) perspectives and priorities through sustainability criteria (i.e. environmental, social and economic). The decision framework should be able to compare the impacts of the selected options including EFW technologies based on stakeholders' preferences (Franchetti 2014, Soltani 2016). The selection of the most efficient and feasible EFW technology requires implementing assessment tools to promote detailed environmental, technical, and socioeconomic assessments (Sadef et.al. 2016). LCA (Sadef et.al. 2016, Soltani 2016) and life cycle costing (Soltani 2016) are recommended tools to help stakeholders utilize advanced sustainable MSW options such as EFW technologies.

Social considerations are an important part of the sustainability criteria and should not be neglected when developing a decision framework (Soltani 2016). Policy targets can vary greatly both inside and outside economic and environmental spheres, depending on a country's society and development level. The implementation of EFW can either be promoted or restricted due to local policies, public perception, or even political entanglements, which are common in the waste management environment (World Energy Council 2016, p.40). Therefore, the decision framework should be established with the ability to combine the environmental and economic assessments with the social considerations based on stakeholder priorities (Soltani 2016).

Due to the various effects of global climate change and the challenges of solid waste management, the sustainable consumption of goods and a strategic waste management system have become critical worldwide requirements to prevent further extensive depletion of global natural resources (Song 2015). Effective environmental strategies that promote successful environmental performance are dependent on resources not being separated, but instead brought together in a holistic approach that promotes the combination and effective coordination to enable the achievement of sustainable competitive and complementary advantages (Martensson 2016). During the last decades, waste tactics have emphasized both sustainable development and sustainable resource management (Thorneloe 2007, Wilson, D. 2007, Wilson, E. 2001 Zhang 2010, Elagroudy 2016, p.16). MSW management focuses on the careful handling of raw materials, the reduction of harmful emissions, and the protection of climatic and ecological systems (Zhang 2010). Resource managers decide whether it is more important to manage waste with the ultimate goal of producing energy, or whether it is a greater priority to recover the original material for reuse (Wilson, E. 2001).

Therefore, the perspective of dealing with MSW should be changed from focusing on 'garbage' toward viewing MSW as being a potential resource to generate economic activity and create jobs, while improving human welfare and the health of the environment (Elagroudy 2016, p.10).

A successful SWM plan requires a system approach rather than separated individual subsystems to evaluate MSW system components in an integrated and holistic manner, so that the economic, environmental and social benefits can be optimized (Elagroudy 2016, p.16, Martensson 2016). This holistic approach involves prioritizing waste avoidance and minimization, implementing segregation, utilizing safe waste transportation, promoting "Reuse, Recycle, and Recover", proper and safe treatment, reduction of GHG emissions, and the safe operation of disposal facilities (Elagroudy 2016, p.18). Multiple economic and ecological benefits of successful SWM plans for MSW generation and the future include but are not limited to: energy savings; natural resource protection; job creation; agricultural compost production; energy production from waste; reduced GHG emissions; poverty mitigation; and improved health and health-related costs (Elagroudy 2016, p.10)

In moving from a landfill system to an alternative and sustainable system, waste managers need assessment tools to analyze the environmental impacts of waste materials and processes and assist decision-makers in identifying more sustainable solutions (Thorneloe, 2007). Developed countries have created the idea of closing the loop, ensuring that all material is put back into the system and reused in some way (Wilson, D. 2007). This strategy aims to improve the recyclability and reusability of materials. LCA is an environmental analysis tool to analyze the environmental impacts of a product's lifespan, from the time it is produced from raw materials to its final disposal. The goal is to prevent waste materials and by-products from leaving the loop during manufacturing or consumption. This can minimize solid waste by preventing its generation in the first place (Franchetti, 2009, p.12).

In Canada, the government of British Columbia has presented a strategy based on the integrated resource management of municipal waste streams and water systems. It was developed in part to help combat climate change (BC Ministry of Community Services, 2008). The Ministry of Environment of British Columbia provides a guide for SWM planning utilizing reduction of waste, reusing materials, recycling, zero-waste to landfill, organic waste management and waste authorization for industrial activities (Ministry of Environment – BC 2016). In its optimal deployment, IRM can potentially result in the achievement of the ultimate goals of zero-waste approach (BC Ministry of Community Services, 2008).

Integrated resource management focuses on resource recovery and extracting maximum value with minimal burdens and adverse impacts on the socio-ecological system. The IRM model is "based on a net highest and best use and value assessment, which considers environmental factors that are consistent with the valuation principles that underlie the Vancouver Valuation Accord" (BC Ministry of community Services, 2008). Integrated Resource Recovery is another way of thinking about waste. This paradigm believes that waste is not a liability; that it has its uses for the community (BC Ministry of Community Development, 2009). IRR considers that waste generated by households and industry can be used as raw materials in other contexts. It is also a closed loop system. Its environmental benefits include the generation of carbon-neutral forms of energy as well as reductions in greenhouse gasses, methane emissions from landfills (BC Ministry of Community Development, 2009, BC Ministry of Environment 2016, p.97). IRR promotes producing biomethane and nutrient recovery. This occurs via the collection and diversion of food waste and farm waste towards anaerobic digestion (BC Ministry of Community Development, 2009).

2.6 Implications of sustainable development for solid waste management

The notion of sustainable development (SD) came to global prominence in 1987 via the World Commission on Environment and Development (WCED) (Mebratu 1998). As was introduced earlier in chapter 1, 'sustainable development is guided by the principle that 'sustainable development is development that meets the needs of the present, without compromising the abilities of future generations to meet their own needs' (WCED 1987). Agenda 21 emerged as the core knowledge platform and action plan for sustainable development during the 1992 Rio de Janeiro Earth Summit (United Nations Conference on Environment and Development). Agenda 21 has been influential in solid waste management, especially in promoting a holistic and systems approach to integrated and sustainable solid waste management (SWM) (Diaz et al., 1996). It addresses the interplay of environmental, social and economic factors active in the waste management process.

In conventional waste management approaches, waste generation, collection and disposal are considered to be independent separated operations; however, these systems are interconnected and have social and environmental implications for communities and local ecologies. Hence, these WSM systems require balanced, interconnected planning between their underlying subsystems (i.e. manufacturing, transport, urban development, land use, and public health) (Seadon, 2010). Many categories of solid waste management systems demonstrate complicated interconnections: (1) Integration within single medium/multimedia (air, land, water); (2) Tools (regulatory, economic, voluntary and informational); and (3) Agents (governmental bodies, businesses and communities) (Seadon, 2006; Wilson, E. 1998).

During the 1990s, a reflection of conventional practices and mechanisms for waste management demonstrated that one-dimensional regulatory, planning or decision-making approaches for waste management were insufficient. Instead, a more integrated approach was deemed necessary, one that considers political, institutional, social, economic and financial aspects alongside technical and environmental issues. These issues are also informed by the drivers4 of sustainable development (Wilson, E. 1998, Wilson, D. 2007). Pawtowski (2008) represented seven dimensions of SD: moral, ecological, social, economic, legal, technical and political. These are the type of issues and future challenges and opportunities recommended to be addressed by community decision-makers (Tchobanoglous 1993, p.18; Wilson, E. 1998; Wilson, D. 2007). Tables 2.5 and 2.6 offer an overview examples of the SD concept implications on the solid waste management relevant approaches and practices in developed and developing countries (organized according to drivers of SD).

Through the SD lens, waste management has been promoted as a holistic concept of

[4] In the thesis will refer to the drivers of SD as SD dimensions.

"resource management" in many developed countries (Cherubini 2009, Williams 2005). Waste management is one of the central themes of SD (Cherubini 2009). To move toward sustainable development, all dimensions of the paradigm should be considered. Therefore, the failure to consider all SD dimensions in an integrated manner can contribute to unsuccessful SD initiatives (Cherubini 2009). The following parts of sections (2.6.1 – 2.6.5) will present descriptions of the SD dimensions and their contribution in the field of SWM and MSW management in some detail in addition to the developed sustainable development goals (SDGs).

Table 2.5: Examples of areas of concern in implementing SD practices for SWM in "developed" countries

SD dimensions	Areas of concern in implementing SD practices in developed countries
Policy, legal and institutional structures	• Create a holistic paradigm of resource management rather than just focusing on waste in isolation. New concepts include closing the loop, waste minimization, and production of energy from waste and zero-waste to landfill. • Integrate the adopted policy into regional or national legislation: The Kyoto protocol in Japan (Shekdar, 2009); The Sixth Environmental Action Programmes in the EU (2001-2010) (Williams, 2005, 2013); International commitments such as the Kyoto Protocol, and Basel Convention; International trade (e.g. plastics from Europe imported to China and India).
Operational demands and constraints	• The EU established a goal of decreasing landfill waste by 20% by 2010, and then 50% by 2015 (Williams, 2005, 2013). • Japan is experimenting with EFW technology (Willson, D. 2007). • England has set benchmarks for percentage of household waste to be recycled. They are aiming for 40% as of 2010, 45% as of 2015, and 50% as of 2020 (DEFRA, 2007).

Economic strategies	• "Extended producer responsibility (EPR) is an environmental policy approach in which a producer's responsibility, physical and/or financial, for a product is extended to the post-consumer stage of a product's life cycle" (OECD, 2001). • The manufacturers of a given product are responsible for minimizing that product`s impact upon the environment. This system has been used in Canada and Australia. • Consumption taxes based on total landfill usage (Wilson, D. 2007). • Consumers pay a fee out of pocket based on how much household waste they dispose of. This is known as "pay as you throw" (Wilson, D. 2007).
Social considerations	• Public awareness and education supporting a move toward better resource management (Wilson, D. 2007). • Cooperation between universities leading to new curricula and training activities in sustainable development and waste management (Agumathu, 2009).

Table 2.6: Examples of areas of concern in implementing SD practices for SWM in "developing" countries

SD dimensions	**Areas of concern in implementing SD practices in developing countries**
Policy, legal and institutional structures	• In the developing world, non-functioning governmental and social institutions are the biggest roadblock. • Organizations like the World Bank, which affect monetary policy, can provide financing for investment in new infrastructure (Wilson, D.C, 2007). • International Financial Institutions promote the involvement of the private sector under the Kyoto protocol. • International trade: e.g. plastics from Europe imported to China and India
Operational demands and constraints	• Developing countries still dispose of most of their solid waste via landfilling (Mahar 2007; Mor 2006). • Landfills are mainly unsanitary.

Economic constraints	• Recovery of saleable materials from waste provides economic benefits in poor parts of the world. • Recovering saleable material creates an industry of street and landfill scavenging. • International Financial Institutions attempt to involve the private sector in waste management and clean development mechanisms in new infrastructure.
Social considerations	• Poverty-related challenges prevent waste management from being a significant public concern. • Health problems can promote the development of local solid waste management systems (e.g. a plague outbreak in Surat, India in 1994) • Poor public awareness of waste management can cause public resistance to new facilities (Wilson, D. 2007)

2.6.1 Policy, legal and institutional arrangements

Institutional arrangements for solid waste management involve delineating the responsibilities and roles of the actors responsible for SWM. These include interagency coordination, procedures, the participation of private-sector organizations, and available resources. It also includes the legal, regulatory and political systems under which participating agencies plan and manage their activities in accordance with their SWM mandates. It is the goal of institutions to preserve the public health (and therefore environmental quality) of the regions they serve, and they therefore must promote practical, effective and sustainable practices in solid waste management (ADB 2014). A waste management system cannot be implemented without the support of the political and institutional actors with power in the region (Marshall, 2013). Schübeler (1996) stated that "….the creation and management of SWM systems are affected by the relationship between central and local governments, the role of party politics in local government administration, and the extent that citizens participate democratically in policy making processes". Institutions must be transparent, accountable, efficient, and effective. Countries with effective local and national governments tend to have more effective SWM institutions. It is difficult to ensure all levels of government co-operate with each other (ADB, 2014).

The existing institutional and administrative structure for MSW management in a specific context directly influences the types of available options. For instance, MSW management alternatives will vary according to the level of institutional responsibility, resources and capabilities. The organizations and individuals who hold the power, either directly or indirectly, can choose to take a proactive approach in creating a sustainable MSW management system (Wilson, E. 1998). Unclear organizational hierarchies, as well as lack of accountability, make it difficult to evaluate and monitor the performance of waste management agencies, especially in terms of the coverage and quality of SWM service provision (ADB, 2014). The responsibilities for the different institutional and organizational bodies must be made explicit. Conflicting stakeholder interests make this challenging to implement (Wilson, E. 1998).

It is important that clear roles are delineated within institutions and government bodies in order to avoid conflicts, inefficient actions, negligence, and political instability (Marshall, 2013; Schübeler, 1996). For instance, an effective legal and regulatory framework that promotes environmental protection and sustainability is needed to define the roles, responsibilities and rights of diverse decision-makers and stakeholder groups. Government agencies, public and private sector organizations, and community members should all be aware of their responsibilities, skills, and assets. Effective legislation around SWM must be clear, and it must be possible for the institutions in charge to enforce it and provide the infrastructure to maintain it (ADB, 2014).

This is challenging for many reasons. Primarily, as urban populations increase, the waste management demands can overwhelm the local governments – particularly in regions of political instability where the governments are seen as weak. The perceived legitimacy of the institution is paramount (Halla, 1999). In emerging and developing countries, institutions beset by conflict are a major constraint to effective environmental management and sustainable development. As an example, in 2015, residents and activists from across Lebanon protested their government's perceived failure to address a mounting municipal solid waste-management crisis. (Al Jazeera 2015). Municipal solid waste had accumulated on the streets of Beirut following the final closure of the main landfill without a ready alternative. Since the landfill closure, the main wastemanagement company stopped collecting MSW, explaining that it had no alternative place to dispose of it (Hilal 2015). The politicians, divided by local and regional conflicts, were unable to implement a solution or create needed recycling and composting programs (Al Jazeera 2015).

Strengthening institutions leads to integrated and sustainable SWM systems (Wilson, 2007). To facilitate the proper establishment of ISSWM strategies, many emerging and developing countries must develop accountable, transparent and unambiguous legal and regulatory frameworks that have viable evaluation and are backed by governments with the power to ensure compliance (Coffey, 2010; Schübeler, 1996).

Appropriate institutional and regulatory arrangements can also enable successful private sector participation, but without strong institutions, and regulatory and monitoring mechanisms, private sector involvement will be ineffective and cost-prohibitive. Private-sector participation in SWM collection, transportation and treatment has long been viewed as a method for improving solid waste management in cities (Wilson, D.C., 2012a). In particular, private-sector participation can transfer responsibilities to private firms for collection, transportation, and disposal operations; financing operations; and compliance with environmental regulations (Kollikkathara, 2009).

Both laws and economic incentives must be developed to ensure that the public sphere, the business world, community institutions, and any partnerships between these groups (UNEP/IETC, 2013) manage solid waste disposal effectively and reliably. Each group has its own goals and strengths. Governments must enact laws and establish regulatory oversight, while providing funds to ensure waste disposal is a priority. The private sector provides technological innovation and local management.

2.6.2 Operational demands

The location (rural or urban), population size, available disposal space, and land costs are factors that affect MSW policy options and operational demands. Waste stream composition, demographic and locational factors, institutional arrangements, and cost all affect which treatment technologies can be used for a given waste management system. Stakeholders also need to consider the scale of the project, the level of public acceptance, and available financing (Wilson, 1998). The availability of this data itself is an important factor, one that makes MSW management in developing countries a particular challenge (UN-HABITAT, 2010).

Of primary consideration are the types and amount of waste materials (the waste streams). This will affect decisions about the type of waste collection, specific material recovery targets, and the technology used (Wilson, E. 1998). Trends in waste management (such as recycling and waste minimization) are influenced by the quantity and type of waste. Trends in waste production will likely change depending on the season and the longer-term development of the region. The waste composition affects the type of energy from waste (EFW) technology, as well as determining the necessary investment (Williams, 2005, 2013, p.326-342).

2.6.3 Economic factors

Legal and economic concerns regarding MSW management are inextricably linked. The particular international economic instruments that influence environmental protection policy include fees, taxes, grants, subsidies, investments, the creation of a deposit market, and the creation of market incentives to support the implementation of environmental laws (Pawtowski, 2008). The law and local policy initiatives, operational infrastructure, and the socioeconomic factors in a particular community will affect the economic and financial outlook. The availability of funding or subsidies for MSW influences whether alternative technologies and integrated and sustainable approaches are possible (Williams, 1998).

Economic tools used in creating waste management systems include taxes (particularly eco-taxes, landfill taxes, and packaging taxes), deposit schemes, and market demands for various kinds of recovered materials. These have been implemented in a wide range of European countries (ETC/SCP, 2013a,b) and Canadian provinces (CCME, 2014). Twenty European countries, including the UK, Sweden, and Austria (or regions within these countries) have introduced a tax on the waste sent to landfills (ETC/SCP, 2013a,b). Economic barriers to establishing alternative waste management systems include a lack of established markets and facilities for reprocessing, and depressed prices (OECD, 2013; Williams, 1998).

2.6.4 Social considerations

The social environment may be under pressure in the same way as the natural environment. The social environment includes traditions, culture, spirituality, interpersonal relations and living conditions (Pawtowski, 2008). Increasing urbanization trends correlate with an increase in the per capita generation of waste as urban populations have higher average incomes, higher consumption levels, and consequently, higher levels of waste generation. Increases in population also lead to increase per capita generation of waste. In addition, changes in socio-cultural habits and life-style may influence per capita waste generation, and the type and quantity of MSW. Population trends and patterns of solid waste generation will be different from country to country (Williams, 2005, p.74 -75).

Social considerations for MSW decision-making often focus on public involvement in MSW planning. The channels for public engagement in MSW management planning and decisionmaking require consultation and for community members to take active roles in creating and managing waste systems. In order to involve the public in a meaningful way, they must be educated about MSW management, possess information about the proposed options of MSW management, and share and negotiate priorities with each other. Participation of public stakeholders in committees may provide a more active role in planning and decision-making processes (Wilson, E.1998).

2.6.5 Sustainable development goals (SDGs)

The achievement of sustainable development goals faces many obstacles that prevent satisfactory achievements in terms of environmental sustainability. One of the main obstacles is considering the environmental dimension of sustainable development as a consequence of the process rather than proactive action that requires the consideration of social and economic dimensions. Another main obstacle is neglecting the linkage between "environmental, social and economic aspects and the lack of coordination between design, implementation and monitoring" while dealing with environmental problems (UNEP 2013, p.26). Regarding previous approaches to sustainable development, the lack of integration across sectors has long been seen as one of the main drawbacks. The lack of balance across sectors has produced poor policies, adverse policy impacts, and divergent results (Le Blanc 2015).

The UN Conference on Sustainable Development (Rio+20) resulted in the call for the development of a set of sustainable development goals (SDGs) that would be universally applicable in balancing the social, economic and environmental aspects of sustainable development (UN 2013). “World leaders at the 2012 United Nations Conference on Sustainable Development (Rio+20) reaffirmed their commitment to sustainable development which embraces economic progress, social development, and environmental protection for the benefit of all” (UN 2013).

The United Nations General Assembly adopted 17 Sustainable Development Goals (SDGs) in September of 2015 as a key part of the 2030 sustainable development agenda (Biermann 2017, UN 2015). After many attempts among worldwide international, regional and local actors to integrate social and economic development with environmental factors to achieve sustainable development targets, these 17 goals were developed to replace the MDGs from 2016-2030 (Arfvidsson 2017, Biermann 2017, Hák 2016, Holden 2017, UN 2016 a). Some SDGs incorporate new ideas while others build on Millennium Development Goals (Hák 2016). By the beginning of 2016, SDGs began to be implemented and transferred to a plan of action worldwide to address the global challenges and to incorporate the economic, social and environmental dimensions of sustainable development —into a global vision (UN 2016 a,b).

Even after this progress to develop and implement the SDGs, experts and researchers presented various fears and provided different approaches and suggestions to prevent the lack of operationalization and achievement of SDGS. The developed SDGs include a combination of the three SD dimensions with various degrees of focus on addressing environmental issues (Biermann 2017, Gupta 2016). The SDGs include eleven of the 17 goals that address the environmental issues, but (Gupta 2016) indicated that these goals mainly focus on scientific solutions and technology (Gupta 2016). One of the main fears is that the large number of goals, targets and indicators and the interlink between them may make them ambiguous and unclear for the policy-makers, which may cause difficulties when transferring these goals to local strategies and operationalizing them in reality (Gupta 2016, Holden 2017, Le Blanc 2015).

Successful implementation of SDGs is recommended through the “connection between the goals and the ways in which they are integrated into global society. This requires conceptual coherence between the SDGs themselves and how they are applied.” (Gupta 2016). The integration of the goals is essential and required on international, national and local levels (Biermann 2017, Le Blanc 2015, Gupta 2016). The integration of goals is required to protect local systems and secure the access and ownership of resources and good management of the resources, ensure the sustainability of the ecosystem and prevent harm between neighbor countries (Gupta 2016). SD is currently a major topic with regards to IEM (Sdiri 2016). Integration, coordination (Singh 2016), cooperation and communication (Mårtensson 2016) are needed to promote harmonious linkage between SD dimensions and establish development plans that promote environmental protection.

It is necessary to promote effective mechanisms for stakeholder participation to promote successful SDGs (Le Blanc 2015, UN 2016,b). It is critical to promote the involvement of academic support to combine social, economic and environmental factors (Biermann 2017). Researchers can help promote social learning, stakeholder collaboration, researcher training and knowledge governance (Clark 2016, Ioppolo 2016). To promote successful achievement of the SDGS, the policy framework should not neglect public communication, education and raising awareness, consultation and decision-making participation on SD relevant topics (Hák 2016, Ioppolo 2016, UN 2016,b). The private sector usually has the resources and sometimes has the desire to participate in solving environmental problems (Harangozó 2015); therefore, the private sector participation and cooperation should be promoted with well identified and regulated environmental and social responsibilities (Biermann 2017, Gupta 2016, Harangozó 2015).

As a concluding remark, to promote the achievement of SDGs and develop an operational framework for sustainable management, serious and extensive efforts should be made to facilitate the integration of key stakeholders, resource users, community members, and private sector groups to share interests, knowledge and values. Such integration practices could significantly contribute to generating understanding, new options, cooperation, harmony, problem solving, enlightenment, as well as the production of fair and effective solution packages that promote consensus and decision-making. Moreover, these efforts would help to incorporate public input and preferences into the management process as well as include technical experts (Ioppolo 2016).

Solid waste management (SWM) spans many fields, and its effects and impacts can be linked to 12 out of 17 UN SDGs (Rodić 2017). The driving forces for the SDGs are the same as SWM driving forces (Rodić 2017). With the aim of linking SWM to the SDGs, it is essential to address the challenges for the SWM systems within a holistic or integrated approach that incorporates all relevant segments and actors within a holistic strategic planning process (Arfvidsson 2017). To address these challenges, it is important to promote the awareness of the plans and policies and capacity building required to encourage key actors in order to ensure realistic and applicable incorporation of the goals linking SWM and SDGs into policy and planning practices. (Arfvidsson 2017). "For the SDGs to become effective policy tools for ensuring and monitoring sustainable development, the availability of reliable and robust data at comparable scales is crucial" (Arfvidsson 2017). In addition, to the need of the development in the main services encompassing waste collection, transportation, waste treatment and disposal, and economic instruments, it has become essential to consider the social instruments (Rodić 2017). Various social instruments have been invented or developed, essentially to develop the communication skills with the public and other actors. This means that in addition to the traditional role government of the administration agencies as law-maker, they involve in frame development, communicating, educating, and negotiating. Environmental awareness campaigns can be in different forms, from conventional such as information posters, to innovative such as social media messaging services (Rodić 2017).

In terms of SWM governance and to launch the SWM targets within the 12 SDGs, Rodić (2017) concluded that instead of considering and focusing only on "one of the categories of policy instruments, a mixture of complementary and coordinated measures from each of the three categories (direct regulation, economic instruments, and social instruments)" is needed to implement and maintain such services.

2.7 The contribution of "integration" and "IEM" concepts to the development of integrated sustainable municipal solid waste management (ISMSWM)

Conventional solid waste management approaches deal with waste-related subsystems as independent operations. But in reality, they are interlinked and mutually influence one another. Thus, planning for these operations requires an interdisciplinary and multi-sectoral systems approach. It should consider manufacturing and transportation infrastructure, the usage of the surrounding land, growth patterns, urban density, and public health systems.

Any proper MSW system will be composed of complex interactions between integrated social, economic and environmental systems. Conventional SWM approaches are not complex enough to handle the realities of multiple interconnecting systems (Seadon, 2010). They are limited; they can only conceptualize one format of waste management, or one technological solution, at a time. They ignore the whole, integrated, waste management system, so while one problem is solved with a categorized solution, another problem emerges in its place (Dijkema, 2000).

The need to develop an integrated sustainable municipal solid waste management (ISMSWM) model, which will be explained in more detail in the following section, was a response to a demand for solid waste management systems that take into account the human element, that recognize the needs of the local culture, the limits of the political system, and the unique environmental needs of each region. It engages all stakeholders, from the planners to the ordinary citizen, and encourages them to understand waste systems through integrative perspectives. These include solutions based on proper and affordable technology, the power of governmental and private institutions to implement a complex system, and the co-operation that comes from personal agency between different stakeholders and other effected and affect stakeholders (Dijkema, 2000; Marshall, 2013; McDougall, 2001; Seadon, 2006 and 2010; Wilson, D. 2007; Zarate, 2008).

In 1991, the European Council Directive on waste management proposed the waste hierarchy (Figure 2.1). It provides a framework for prioritizing responsible environmental stewardship in concert with responsible developmental practices (Gervais, 2002; Williams, 2005, 2013, p.30). Prevention methods, such as waste minimization and cleaner technologies, will do more good than post-consumer waste management initiatives and should be the focus of reform. The waste hierarchy is considered to be a blueprint for the integration of solid waste management (Wilson, D. 2007) and has guided SWM in many countries.

Controversy lies in the issue of whether the waste hierarchy is based on scientific principles, or on presumptions and values. This hierarchy paradigm has shortcomings. Namely, it does not examine waste management systems in the context of its effect on the environment, and it does not take into account local variables (e.g. long distances for recycling) (White, 1995). However, it does provide steps to determine the most valuable management system, even assuming there is only a small amount of data available to assess the environmental impact. The hierarchy is not ideal for ensuring that the best waste management system will be implemented. Any proposed MSW management approach must recognize regardless of which management option is chosen, it will be a part of an integrated conception of MSW management (White, 1995).

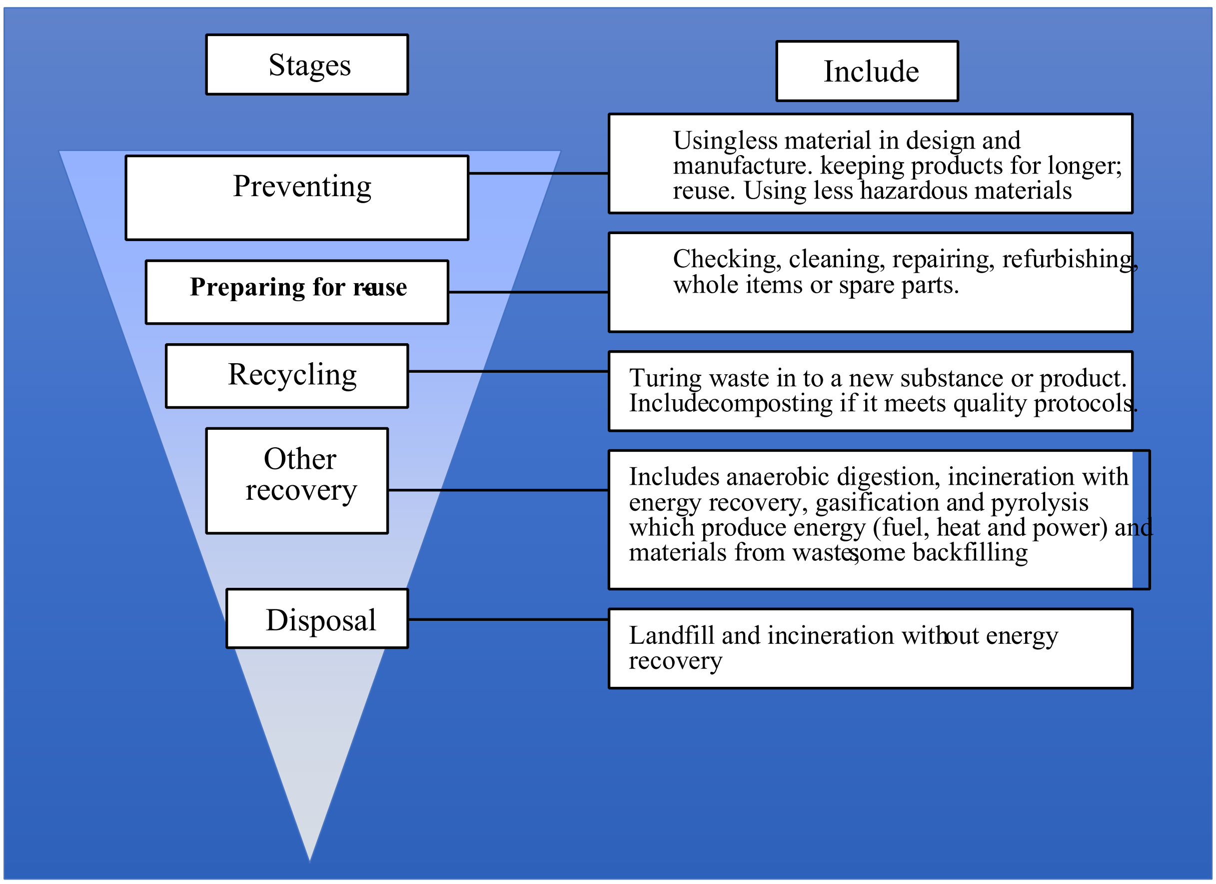

Figure 2.1: Waste hierarchy (Adapted from: DEFRA, 2011)

White (1995) and Williams (2005, 2013, p.368) explain that any MSW management system must consider a combination of different sub-systems. Depending on the waste stream type and diversity, it is impossible to manage all types of waste with the same strategy or technology. An ISSWM approach would include a combination of all available strategies. These include techniques such as materials recycling and composting which have been widely adopted, as well as more esoteric methods, such as anaerobic digestion/biogasefication, thermal treatment (e.g. incineration with or without energy recovery, RDF burning), and landfill (see table 2.2). Planning for an integrated and sustainable waste system should involve a comparative assessment of the environmental impacts and economic costs of different schemes. According to McDougall (2001), ISSWM should prioritize disease prevention, protect the safety of workers, minimize malignant emissions, ensure the system is cost-effective for the public and private sectors, and meet the objectives of stakeholder groups and the community.

Integrated waste management, or (IWM) was designed to tackle the drawbacks inherent in the waste hierarchy model (figure 2.2). It is a process to determine the most energy-efficient, and least polluting, ways to manage solid waste streams (Stokoe 1995). “Resource management” is a holistic paradigm. It was created to handle the most pressing environmental concerns of the modern era. This includes the changing global climate that results from unchecked carbon being released into the atmosphere, as well as more sustainable development (Wilson, D. 2007). All waste management initiatives should consider specific sustainable development measures such as those pertaining to the environment, resources, economy or social acceptance.

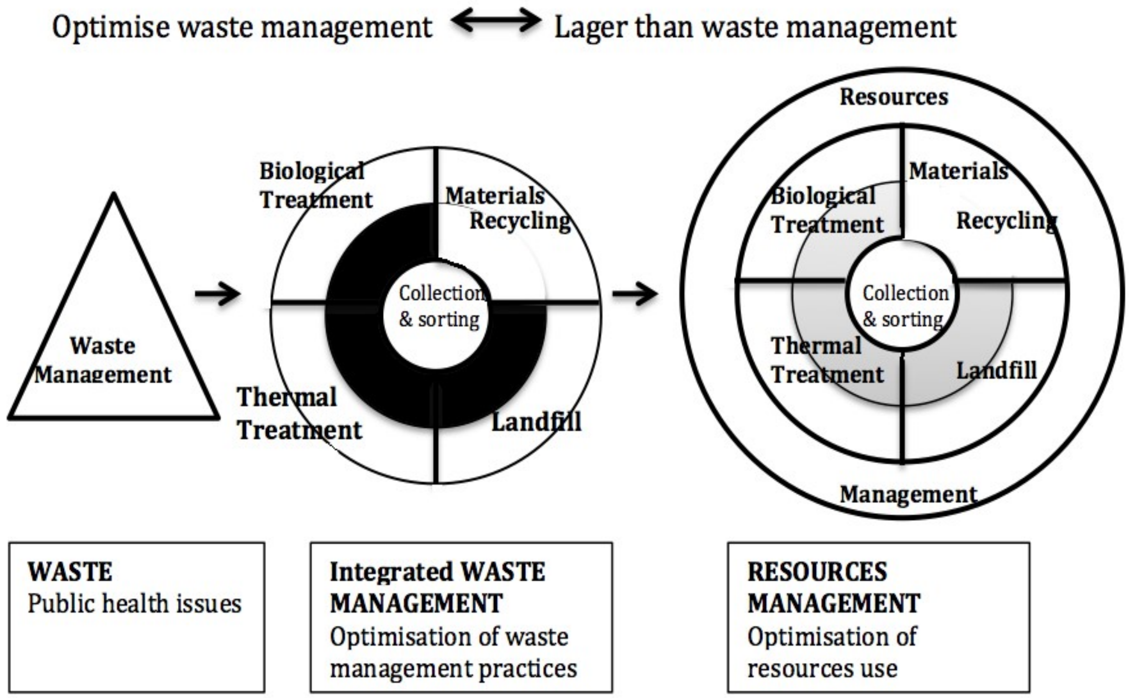

Figure 2.2: Sample evolution for IWM program development (Adapted from: Wilson, E. 2001)

Sustainable waste management practices are a cornerstone of sustainable development (Cherubini, 2009; Shekdar, 2009). Effective waste management can provide many benefits in terms of improved public health, better safety, a decrease in harmful emissions and pollutants, a sustainable system of resource usage, and the implementation of a renewable energy system (Cherubini, 2009). However, all systems must adapt to local needs and conditions. People must remember that the geographical features of a given region, their demography, the legal and political systems in place, as well as existing infrastructure, must be taken into account (McDougall, 2001). The Collaborative Work Group (CWG), which manages waste in emerging and developing nations developed ISWM, or integrated sustainable waste management. It is designed to help stakeholders with conflicting priorities develop a system that meets everyone`s needs (Waste, 2010; Schübeler, 1996; van de Klundert, 2001; UN-HABITAT, 2010) (figure 2.3). It illustrates that a contextappropriate methodology for ISSWM should prioritize designing a sustainable long-term system, one which is not stymied by international borders and takes a systems approach (Seadon, 2006; Seadon, 2010).

Waste management systems that neglect sociological concerns have a higher rate of failure. It is important to take into-account the cultural values of the community, consumption patterns, traditions of civic involvement, and the degree of public support (Carabias 1999; Marshall 2013). These are equally as important to the success of ISSWM as technical and economic considerations (Carabias 1999, Henry 2006). Social acceptance of SWM policies by local authorities and the public is vital to their effectiveness and must be sought through participatory methods that go beyond traditional consultative methods with external so-called experts. Such superficial and strategic consultations are often designed to secure public validation for solutions that have been developed and decided upon prior to public involvement (Henry, 2006). More genuine forms of public participation and social acceptance are achieved through the informed and empowered participation of stakeholders. It is important that the process be fair, aboveboard, allow for mutually-satisfactory action, and be based on data that is available to all stakeholders (Zarate, 2008).

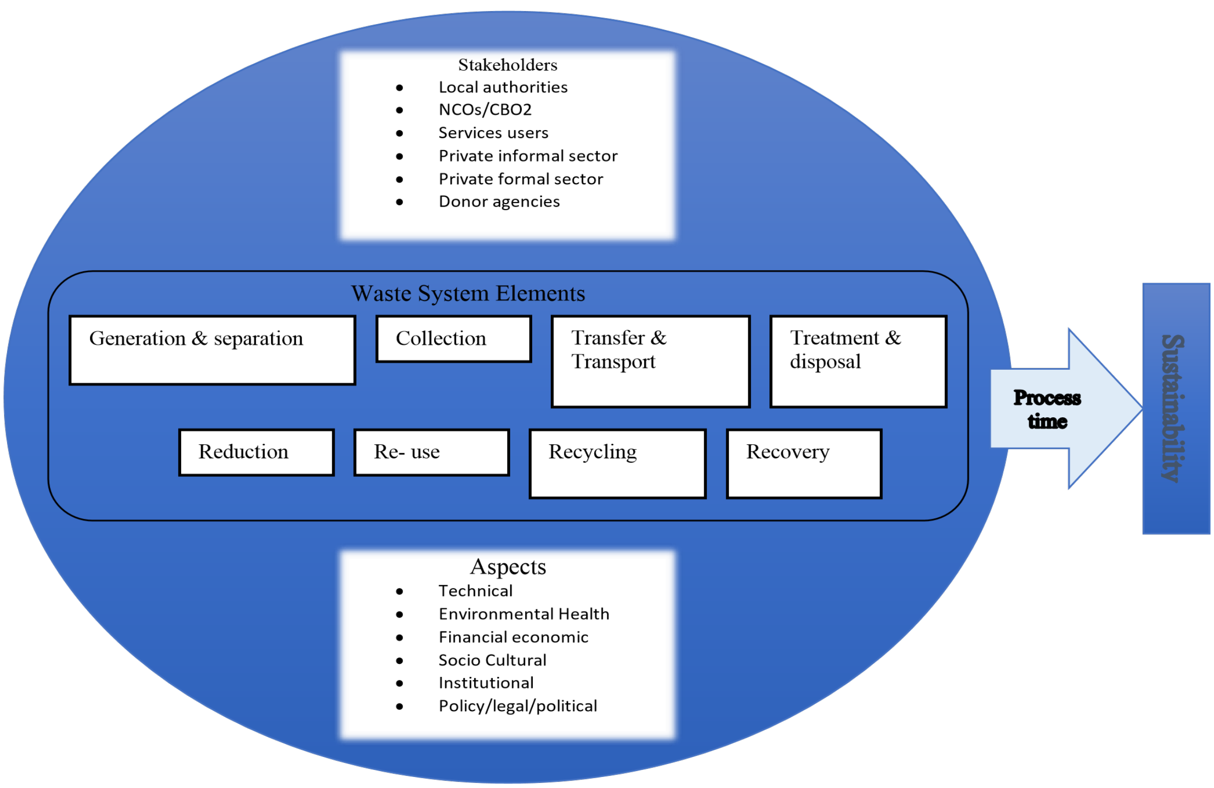

Figure 2.3: Integrated sustainable waste management (ISWM) framework. (Adapted from: WASTE 2010, the Netherlands; van de Klundert, 2001; UN-HABITAT, 2010)

Another model for ISSWM, developed by Shekdar (2009), found that Asian countries have the potential to develop sustainable SWM systems through an integrated approach (figure 2.4). Shekdar proposed an action plan for both long- and short-term improvements of SWM systems in Asia, as they transition toward ISSWM. An important feature of his model is that stakeholders from divergent interest groups participate at different levels in decision-making and raising awareness. For example, institutions responsible for developing needed technology would have a clearly delineated role among the waste management chain, as would the policymakers and the general public.

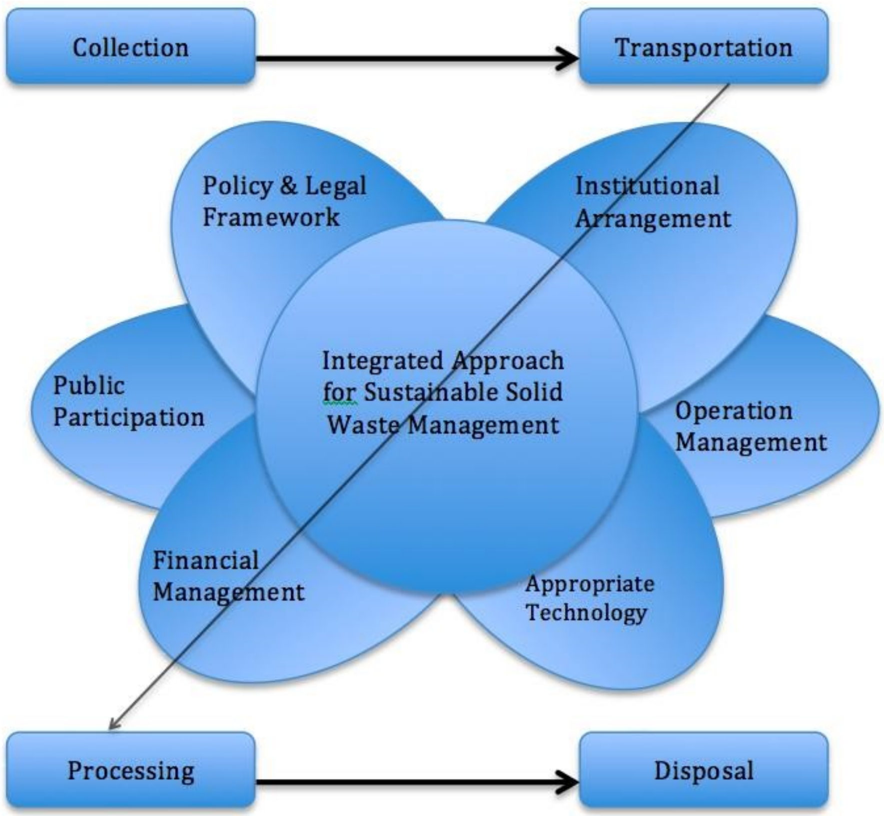

Figure 2.4: Integrated sustainable solid waste management system (Adapted from: Shekdar 2009)

2.8 Contribution of IEM approaches to ISMSWM – case studies

The development of integrated waste management was used mainly in the context of technological integration in developed countries (Wilson D. 2013). Techniques for dealing with waste mainly focus on specific type of waste at a time; this leads to centre the attention on technologies rather than holistic waste management systems (Marshall 2013). A proper management of solid waste that can handle the difficulty of waste management implies the need for careful considerations of "interdisciplinary and multi-sectoral considerations" to handle this complexity of solid waste management (Marshall 2013). Waste should be dealt with as a part of the system and the planning in need of balance among the subsystems to encounter "the interaction and complexity between the physical components of the system and the conceptual components that include the social and environmental spheres" (Seadon 2010). Accordingly, it became well identified that solid waste management is a critical concern for "SWM approaches that recognize the social, cultural, political and environmental sphere; that engage with a broad community of stakeholders; and that consider the large system through holistic, integrating methodologies" (Marshall 2013).

Integrated sustainable solid waste management (ISWM) was developed with a holistic perspective that integrates the three SWM system dimensions to consider comprehensively the physical elements in addition to the governmental aspects, the involved stakeholders, and the planning and management methods (Wilson D. 2013). The shift from technological integration of IWM concepts toward the development of ISWM to promote a broad systems perspective of SWM did not ensure successful achievement of the holistic and integrating concepts. It was clearly understood that the ISWM concept requires holistic, integrated methods to address the interconnectedness of economic, technical, social, cultural and environmental factors and how these interconnections are related to emergent behaviours (Marshall 2013).

The transition from traditional SWM toward integrated approaches (Lakioti et al. 2017) and to operationalize the ISWM approach required the participation of multiple stakeholders (López-Toro 2016). SWM stakeholders include municipalities, industries, governments, experts and the public (Lakioti et al. 2017). In addition, MSW management acquires greater importance in connection with SD (López-Toro 2016, Pires 2011). The social, economic, and environmental impacts are affected by the perspectives of the stakeholders and their interaction within the SD dimensions (López-Toro 2016). Therefore, to efficiently implement sustainable SWM actions, it is important to promote the participation of the stakeholders to include economic issues, environmental impacts and social acceptance and awareness (Lakioti et al. 2017).

In section 2.6, it was illustrated that IEM approaches emerged in different fields of environmental management to integrate knowledge, sectors and stakeholders. IEM approaches promote operationalizing a successful implementation of the systems approach that incorporates a full range of activities and strategies for proper management of the analyzed components of the system. In addition to sources such as water and soil, IEM approaches have become the most favourable tools for waste (liquid and solid) (Hettiarachchi 2016, p.3) considering that waste is a resource even though it is a man-made resource (Hettiarachchi 2016, p.3, Ikhlayel 2017). Various IEM approaches were adopted all with the ultimate goal of creating sustainable and integrated solid waste management systems. Table 2.7 presents examples of the IEM approaches that have influenced contemporary SWM studies.

Table 2.7: Examples of IEM approaches in solid waste management research

IEM approaches	Author	Year
Community-based MSW	WASTE	2010
Community-based MSW	Mongkolnchaiarunya, J.	2005
Community-based MSW, Collaboration, Bottom-up, Decentralization	Srivastava, P.K.	2005
Stakeholders participation, Community partnerships, Public participation	Scheinberg, A. (WASTE)	2001
Collaboration	Joseph	2006
Collaboration, Private sector involvement	UN-HABITAT	2010

Developing countries are exploring the concept of ISWM and it is becoming popular as an approach to reach better, more sustainable solutions to MSW (Ikhlayel 2017, Premakumara 2011), but it is rarely used in developing countries, whereas developed countries use it regularly (Ikhlayel 2017). The current systems in developed countries have been developed in a series of steps (Marshall 2013). In developed countries, not only governments, but also residents understood the need for proper MSW (Kumar 2016, p.120). More resources were invested into stakeholders and public participation within the MSW management process. In particular, public participation is sought when siting a waste management or disposal facility, and when conducting education regarding increased source separation for collection and recycling or waste prevention (Marshall 2013, Wilson D. 2013). Multi-stakeholder participation between government, (NGOs), community groups and private industry was promoted for good governance and would be effective in advancing SWM practices (Ai 2017, Elagroudy 2016, p.10, Marshall 2013). Coordination "is required to ensure consistency between different levels of government. Many governments also struggle with overlaps in responsibilities across agencies or gaps in responsibilities, since activities related to solid waste management often cut across multiple departments" (World Bank Group 2018, a, p.93).

In developing countries, ISWM has potential to be locally relevant, innovative and community-driven. In certain developing countries, SWM technologies failed, due to inadequate governance systems that were unable to properly implement and manage them. For ISSWM, the focus should not only be on the physical system or the promotion of advanced technologies, but on creating local governments that are capable of using the necessary resources. It is important to explore the most context-appropriate and cost-effective technologies for local waste composition (Wilson, D. 2012b). Community engagement in waste management decision-making is a key feature of sustainable IEM practices (Visvanathan et al. 2004). In order for ISSWM to be successfully implemented in developing countries, there needs to be full participation by all stakeholders, including the ordinary residents (Marshall, 2013).

One case study, in Lucknow, India, illustrates the importance of public participation in sustainable SWM (Srivastava, 2005). Srivastava found that young people in particular needed to participate in decision-making. Community awareness campaigns, education and training in proper SWM practices helped ensure a high degree of community adherence to proper MSW management. Waste management experts promoted separating household waste and doorstep collection. They also encouraged community-based organizations (CBOs) and microenterprises targeting community. Partnership-building between public sector agencies, CBOs and private enterprises can facilitate decentralized MSW management and enhance bottom–up planning by generating community-based initiatives. This leads to more democratic and consensus-based processes for communications, decision-making and strategy setting among stakeholders.

Moningka (2000) defines community participation “as a process in which community members are involved at different stages and degrees of intensity in the project cycle, with the objective to build the capacity of the community to maintain services created during the project after the facilitating organizations have left.” Community participation in MSW management engenders a sense of responsibility for maintaining waste management services, which contributes to their long-term adoption (Imperator 1999, Muller 2001). Furthermore, community participation can foster cooperation between different stakeholders, which can minimize delays and overall costs (Moningka 2000). It promotes community empowerment and involvement in SWM and MSW management decision-making. Other benefits include improving local knowledge, increasing the likelihood that local stakeholders are seen as equals by institutions and governments, and ensuring that the community’s needs are met by the project’s objectives (Imperator 1999). It may also offer people possibilities for broader local development, as well as job and income opportunities within the small-scale economy (Moningka 2000, Muller 2001).

There are many different ways local community actors can take the initiative in creating sustainable waste management systems in developing countries. Some may work for micro- or small-enterprise organizations, while others may manage households and other places that generate waste activity. Stakeholders may be responsible for providing local services, or they may have roles in local government organizations. Ultimately, householders form the largest and most important group of stakeholders, at least where implementing a waste management system is concerned (Moningka, 2000; Muller, 2001). Much of their responsibility in waste management occurs at the individual level. Waste management strategies they can use include proper waste storage, separating recycling and organics, disposing of waste at the official sites, reusing materials when possible, and participating in community clean-up activities (Moningka, 2000; Muller, 2001). In contrast, governmental and non-governmental organizations would take the lead on the implementation and enforcement of environmental legislation (Moningka, 2000).

Community members, however, can be more involved in waste management by raising awareness in the public sphere. They can participate in stakeholder committees, meetings, and public debates. This provides a greater sense of ownership and responsibility (Joseph, 2006). Active community involvement increases the likelihood that a waste management initiative will succeed (Moningkac, 2000). This can include micro- and small-waste service enterprises, local organizations which provide low-cost recycling or waste collection. The small size of these enterprises allows them to tailor MSW systems based on the immediate needs of the community. Some examples of these organizations are waste pickers, itinerant buyers, enterprises that collect garbage for a fee, enterprises that recycle materials (plastic, paper, metal), and enterprises that manufacture new products for sale (Moningka, 2000, USAID, 2014). They provide differentiated services that the public sector may, due to limited resources, priority obligations or political pressures, struggle to provide.

Joseph (2006) postulates that bridging bottom-up and top-down approaches provides the key to minimizing how much waste is disposed of in a non-sustainable way. A case study in Zouk Mosbeh in Lebanon found a collaborative approach led to sustainable urban development. Topdown approaches are useful in the context of integrated, community-based strategies. The higher level (governmental) institutions or agencies have the resources (financial, administrative, legal, technical, and human), and institutional capacity to support local-level institutions in their planning and operationalizing of the policies (El Asmar 2012).

A bottom-up approach to ISWM can be effectively coupled with a top-down style of management through the development of public-private partnerships. Executing agencies should implement and monitor the planned MSW management systems and take advantage of the financial and technical support offered by higher-level planners. Not only would a bottom-up approach contribute to identifying waste management problems, but it may also provide the inclusive and supportive spaces for stakeholders to articulate innovative solutions (El Asmar, 2012).

In view of the above, we presented the need for the involvement of IEM approaches while planning and implementing the ISWM approach. IEM approaches would promote the understanding of interconnectedness of the system components (social-cultural, environmental, economic and technical sphere). Moreover, IEM approaches would promote the operationalization of the ISWM model considering the local circumstances. Although progress has been made to promote the adoption of IEM approaches within SWM, there is a lack of studies to understand this interconnection. Studies are needed to understand the importance of stakeholders and relative degree of consensus (López-Toro 2016) and how IEM and collaboration could reach the required level of consensus among stakeholders to promote ISWM.

MSW management social dimensions reports are inequitable and the research is insufficient (Abdoli 2016, Véron et al. 2018). Social dimension studies are important to help foster positive public participation, attitudes, behaviors and policies (Abdoli 2016, Véron et al. 2018). Another part that should be involved in the social dimension studies is the contribution of IEM approaches to promote the understanding and implementation of ISWM for MSW. It is important to understand the level of action of MSW management to understand the level and practices of integration (e.g: decentralization, CBM, co-management). Moreover, studies should highlight the best practices to operationalize the IEM (e.g.: collaboration, co-ordination, communication, conflict resolution) within MSW management to integrate knowledge, sectors and stakeholders from different levels and promote the achievement of integrated and sustainable MSW management.

2.9 Environmental systems analysis tools

Understanding the interrelated environmental, economic and technological systems through an integrative environmental management and sustainable development lens requires a set of analytical tools that can facilitate deeper understanding and evaluation. Many ESA tools have been developed to analyze how different systems respond to different environmental impacts (Finnveden, 2005; Höjer, 2008) (See table 2.8). These tools provide system-relevant values and information and are thus important to the decision-making process (Höjer et al. 2008).

Environmental systems analysis (ESA) tools refer to the method by which systems of manufacturing, consumption, and waste management are determined to be the best practice in a given situation. As an example, strategic environmental assessment (SEA) and environmental impact assessment (EIA) tools are considered procedural. They focus on the governmental or organizational strategies for implementing a particular system or for shaping policy goals.

The strategic environmental assessment (ESA) is a procedural ESA tool used in sitespecific procedural analysis, and is used for plans, policies, programs and projects in the beginning of a decision-making process (Finnveden, 2007). ESA a is defined as "a systematic process for evaluating the environmental consequences of proposed policy, plan or program initiative in order to ensure they are fully included and appropriately addressed at the earliest appropriate stage of decision-making on par with economic and social considerations" (Nilsson et al. 2005, 2009).

The SEA framework aims to provide an integrated environmental assessment at a strategic level (Höjer et al. 2008, Salhofer 2007). It should influence the goal formulation of the whole waste management system, identify alternatives, and listen to all stakeholders (Höjer et al. 2008). Participation is essential to the SEA process (Salhofer 2007). Since environmental, economic, and social impacts are examined, the participant stakeholders must analyze the quantitative results and convert them to qualitative assessment in order to make decisions (Salhofer 2004).

In contrast, analytical tools include LCA, cost-benefit analysis (CBA), life cycle costing and material flow analysis (Höjer et al. 2008). They are designed to analyze the technical aspects of environmental systems or policies. In general, the analytical methods are used within the framework of procedural methods (Buytaert et al. 2011; Finnveden 2007). The classifications of ESA tools according to the type of application that the tool is best suited are presented in table
2.8.

Table 2.8: Examples of ESA procedural and analytical tools

ESA tools	Procedural/ Analytical tool	Application	Reference
Environmental impact assessment (EIA)	Procedural	Used to evaluate emissions in alternative locations of the planned project.	Finnveden (2005)
Strategic environmental assessment (SEA)	Procedural	Used for plans, programs and policies, at the pre-implementation phase.	Finnveden (2005)

Life cycle assessment (LCA)	Analytical	Indicators for the environmental impacts of the manufacture, consumption, and disposal of a product.	Finnveden (2005)
Material flow accounting	Analytical	A tool that focuses on material flows, especially regarding inputs.	Finnveden (2005)
Sustainability assessment	Analytical	Helps decision-makers and policy-makers decide which actions help make society more sustainable.	Buytaert et. al. (2011)
Cost-benefit analysis (CBA)	Analytical	A way to determine whether the benefits to a project (cost, environmental impact, job creation) outweigh the drawbacks.	Finnveden (2005)

2.9.1 Life cycle assessment

The LCA method is designed to address environmental factors within the context of sustainable development (Liikanen 2018). The goal of an LCA study is to develop a broad sustainability assessment of a product, technology or service by quantifying multiple environmental aspects over the life cycle, from "cradle to grave", thus being able to present tradeoffs between environmental performance and economic, geopolitical, and social considerations (Das, 2005; Finnveden et al. 2009). LCA helps decision-makers who are seeking to find ways to decrease the harmful effects on the environment that the creation, use and disposal of their product or service may cause. LCA determines how the total product system interacts with the environment, from when the resources are extracted for its production, all the way to after it is discarded. As such, LCA assesses these processes from cradle to grave (ISO 2006, US EPA 2006, Ross 2002). As a methodological framework, LCA aims to anticipate and assess environmental concerns such as air and water pollution, climate change, loss of natural resources, loss of habitable land, changes to local ecosystems, and effects on human physical and emotional health (Rebitzer et al. 2004). LCA includes multidimensional impacts not examined in other assessments, such as how the raw materials are manufactured, how the product is shipped, packaged, and sold, and what happens to it once it becomes waste (ISO, 2006; US EPA, 2006).

Accordingly, many governments utilize LCA methods by designing case studies with the life cycle approach in mind, using data and analytical methods created to support this assessment (Rebitzer et al. 2004). Ideally, this leads to processes that have a minimal negative effect on the environment. Decision-makers analyze the way in which the environment is affected as the product or service enters at different life cycle stages. Researchers undertake an LCA study because it is a methodological and objective way to determine how deleterious a product will be on the environment. LCAs can help researchers quantify the environmental impact of pollutants created by the manufacture and consumption of a product or service. They assess the human and ecological effects, and compare these effects between two or more alternatives (DAS, 2005; ISO, 2006a; US EPA, 2006).

The methodological framework of LCA includes four steps: goal and scope definition, life cycle inventory (LCI) analysis, life cycle impact assessment and interpretation (ISO 14040, 1997). Once the goals of a project are defined, the data is gathered, and the analyses are made, the results are interpreted, and all aspects of strategic planning become possible. LCI "consists in the collection and analysis of all the material and energy inputs and outputs that cross the border between the product or service system and the environment over its whole life cycle" (Arena 2003).To account for LCI for waste management, the environmental interventions should consider the interventions that generated with the waste management operations, with the providing materials and energy to the waste management operations in addition to the activities that recover materials and/or energy from waste (Arena 2003, Wilson, E. 2002). The phase of life cycle impact assessment "aims at quantifying the relative importance of all environmental burdens contained in a LCI and at aggregating them to a small set of category indicators, or, in some cases, to a single indicator" (Arena 2003). Possible categories of environmental impacts indicators include consumption of natural resources, air pollution, water pollution, quantities of solid waste generated land use (Arena 2003, Pennington et al. 2004; Rebitzer et al. 2004). The fourth phase of the LCA process reflects on every stage of the LCA. In the life cycle interpretation stage, waste managers and decision makers use data generated by the inventory and life cycle impact assessment stages to make a conclusive assessment (Rebitzer et al. 2004, Wilson, E. 2002).

2.9.2 Applying life cycle assessment to solid waste management

Seadon (2006) suggests that studying the interdependent factors of ISSWM systems necessitates the adoption of a holistic, systems-based assessment approach to create the most useful SWM protocols. The LCA for SWM schemes are systems-focused and aim to assess the environmental impact for all interdependent waste management systems beginning with the type and amount of waste generated and ending via alternative solutions of waste disposal and landfill (De Feo 2016, Gentil et al. 2010, Maalouf 2019). The systems perspective of LCA makes it a powerful tool to compare competing plans for sustainable SWM, depending on the context of the waste and the goals of the system. It allows for the fact that different solutions and relevant scenarios may be adopted based on the shifting goals, resources and data available (Ekvall, 2007).

LCA methodologies can deliver an analysis of all possible waste management plans. These can then be compared based on their environmental footprints and a decision can be made for the one that best suits the community (Cherubini, 2009; Del Borghi, 2009, Maalouf 2019). As in any modeling approach, the quality of data in an LCA affects the accuracy of the final results (DAS, 2005; EPA, 2006; ISO, 2006a). Poor data quality and data uncertainty can particularly affect the accuracy and effectiveness of an LCA in decision-making processes (Coulon, 1997).

2.9.3 Life cycle assessment models for waste management

Waste management systems that necessitated software models and proprietary databases first came into use twenty years ago (Del Borghi, 2009; Finnveden et al. 2009). A waste LCA model has the advantage of being able to analyze environmental factors across multiple dimensions (Gentil et al. 2010). These include environmental performance measurements for different variables; emissions dependent on, and independent of, the waste products; the emissions generated by other systems; and the LCA of a SWM system with combined technological units and operations (Haupt 2018, Mali 2016).

Table 2.9 lists LCA models that researchers, policy makers and industry in developed countries have chosen to use. These models help illustrate the value of waste management and treatment technologies. They include recovery and recycling technologies for different waste streams, biological waste management (such as composting and biofuel synthesis, thermal treatments such as incineration, disposal, or a combination of any of these (Del Borghi 2009, Winkler 2007). They also factor in waste collection, transportation, and mechanical-biological waste treatments (Del Borghi 2009). These data-based models aim to analyze complex systems and enable stakeholders to make strategic decisions about policy. The models illustrate how changes in their particular waste system affects the surrounding environmental systems through detailed analysis of proposed SWM scenarios. It is possible to make this analysis even if the details of the models are not known (Winkler 2007). Utilizing these models for different waste management scenarios provides an opportunity to determine which method provides the best results for different variables and has the smallest negative environmental impact (Maalouf 2019, Mali 2016, Winkler 2007). Among the many tools for ESA, LCA is one of the more commonly used because it can help to expand the waste management perspective beyond the waste system. It is important to consider the system holistically, examining not just the environmental impact but socioeconomic situations as well. This is necessary, since waste management systems create a ripple effect where wide-ranging systems are indirectly affected, beyond the obvious environmental impact of the product life cycle (Ekvall 1999, Mali 2016, Maalouf 2019, Zaman 2009).

Table 2.9: Life cycle assessment models for solid waste management

No.	Model	Country	Reference
1.	Integrated Waste Management Model (IWM-Model)	Canada	(Haight, 1999, 2004)
2.	IWM-2	UK	(McDougall et al., 2001)
3.	EASEWASTE	Denmark	(Kirkeby et al., 2006)
4.	LCA–IWM	EU	(Den Boer et al., 2005 a,b, 2007)
5.	MSW-DST	USA	(Thorneloe et al., 2007)
6.	ORWARE	Sweden	(Eriksson et al., 2002, 2012)

LCA is used in a wide range of contexts, both small and wide-ranging (Ekvall 2007). Many studies were conducted in Sweden to evaluate different strategies to manage solid waste. One study, conducted by Finnveden (2005), discovered that if a community encouraged a local recycling scheme for paper and plastic, they could decrease total energy consumption and emissions, especially when using plastics made from virgin materials and recycled plastics (Finnveden 2005). Another study by Chaya (2007) focused on the environmental impact of energy management in Phuket, Thailand. Chaya found negative environmental impacts were mitigated by implementing anaerobic digestion (AD), which also produced fertilizer. A similarly-themed study conducted by Liamsanguan (2008) showed that incineration (with energy production) is better than landfilling with respect to GHGs emissions and energy consumption. These studies help to indicate that LCA is useful in assessing the affect of SWM protocols on ecosystem. They are also useful for finding ways to improve those systems. Winkler (2007) and Gentil et al. (2010) performed a comparative evaluation study of different SWM paradigms and concluded that each evaluated system has its own benefits and drawbacks and therefore, no single model is perfectly suitable for assessing the full range system conditions capabilities. In order for LCA models to be effective, researchers must clearly identify the goal, scope, and methodological assumptions of the study, as well as the data quality (Cleary, 2009; Gentil et al. 2010; Winkler, 2007). LCAs are more effective when integrated with ESA tools (Jeswani, 2010, Salhofer et al. 2004), due to increased transparency, documentation, and consultation with stakeholders. And like all studies, LCAs must account for economic and social factors and potential conflicts of interest.

As an analytical method from the ESA toolkit, LCA is used to analyze and compare different suggested scenarios for MSW management. They help researchers, managers, stakeholders and decision-makers select the operations that minimally impact the environment through analysis of how the different stages of a product`s life cycle will impact resource management and air and water quality (Mali 2016, Maalouf 2019). This requires a comprehensive understanding of how a product or service is designed, built, sold, consumed, and disposed of.

2.10 ISMSWM Conceptual framework

This chapter presented various fields that should be well understood by planners, managers, decision-makers, experts, and researchers while investigating the obstacles and opportunities with respect to the planning, decision-making and implementing of integrated and sustainable municipal solid waste management (ISMSWM).

The continuous increase in the amount of waste generated is one critical issue surrounding global economic and social development as indicated by the Global Waste Management Outlook (UNEP 2015, Abdoli 2016). Extreme quantities of MSW lead to complicated environmental, social and economic problems. Excess MSW threatens public health due to improper management practices (Ikhlayel 2017). Factors driving waste-related problems include: population increases, urbanization, growing industrial revolution and consumption patterns (Ikhlayel 2017).

The traditional waste management approach is no longer effective and cannot cope with the fast pace of development of modern societies (Ikhlayel 2017). Today's societies require a waste management approach that can provide solutions to overcome difficulties and deal properly with issues such as the prevention of environmental damage, streamlining of economic costs and improvement in social acceptance (Ikhlayel 2017, Véton et al. 2018). Moreover, MSW is involved in eight out of seventeen SDGs, and it could contribute to the achievement of SDGs (Elagroudy 2016, p.26).

This new trend means that MSW management cannot rely only on technology; it requires participation by all stakeholders: government institutions, private businesses, product manufacturers, and householders. Thus, to be successful, MSW management systems must take into account the social, psychological and economic circumstances. These include policies, participation by the public, and public attitudes and behaviours. Therefore, researchers must necessarily consider the social dimensions perspective while understanding, designing, and evaluating MSW management systems (Abdoli 2016, Véton et al. 2018).

The literature indicates that sustainable MSW systems support the increasing need for SWM approaches that consider the social, cultural, political, and environmental factors related to a wide range of stakeholders, and that consider the entire system via holistic and integrated approaches and methodologies (Dijkema 2000, Hettiarachchi 2016, p.3, Ikhlayel 2017, Marshall 2014, McDougall 2001, Seadon 2006, 2010, Wilson 2007, Zarate 2008).

ISWM was developed with a focus on developing countries (Wilson 2012b). Waste, 2001, discussed some details of the IEM approaches (e.g. CBM, collaboration, public participation and private sector participation) that can offer opportunities for various stakeholders in planning and implementing ISWM. International institutions (e.g. The World Bank) have made many attempts to implement ISWM in developing countries to solve MSW problems. The CBM approach was one of the main approaches to be implemented since the ISWM model was introduced to local communities (Muller 2002). A bottom-up approach would not only assist in identifying problems, but may also help with articulating solutions, and when combined, has significant potential to improve quality of life (El Asmar 2012).

Although the CBM approach provided many advantages in some case studies, it was not able to be sustainable without improvement in management practices. Effective and widespread participation by stakeholders provides support for policies that will help citizens to take full ownership of development policies, which will result in effective implementation. Top-down command and control methods are beneficial because they represent the major stakeholders that are involved in the decision-making process; however, a bottom-up approach to deal with urban management is required.

Joseph (2007) suggested a phased approach to move from open dump practices in developing countries to sustainable waste management based on bridging "bottom-up and topdown" approaches. The focus of the bottom-up approach is to promote public private partnerships, commitment by executing agencies and the necessary financial support, with the technical focus on dumpsite rehabilitation. The mission of a top-down approach is based on policy intervention to minimize the waste reaching landfills, and to enhance waste stabilization at landfills (El Asmar 2012). In developing countries, ISWM has become an accepted paradigm that focuses on both physical elements and governance aspects (Wilson 2012b). Although the CWG formulated the ISWM concept by focusing on developing countries, the principle can be applied universally (Wilson 2007). Ikhlayel (2017) indicated that the "concept of ISWM is being explored in developing countries, but it is rarely utilized, whereas it is regularly implemented in developed countries."

It has been widely recognized that when developing countries use strategies and policies that are intended for developed countries, the efforts prove unsuccessful or may provide unsatisfactory results (Marshall 2014). Researchers in developing countries (e.g., South Africa) prefer not to return to the past in which environmental management was characterized by topdown, sector-to-sector approaches regardless of the environmental impacts and competing uses of resources (Lankford 2007, Merry 2008). The researchers promote starting with IEM and applying more effort to the action phase according to the local conditions and circumstances (Lankford 2007, Merry 2008).

Adopted approaches should be owned by the community of concern and be locally sensitive, creative and critical (Coffey 2010, Marshall 2010, Schübeler 1996, UN-HABITAT 2010). It is necessary to increase the democratic process in planning, decision-making and formulation of strategies for MSW management for the city, enhance comprehensive and appropriate communication between government and community, and attain mutual consensus among stakeholders for the best solution and appropriate strategy for MSW management. Public participation and empowerment, co-operation and co-ordination, decision transparency, networking, information accessibility and communication are key elements for the success of these programs (Zarate 2008).

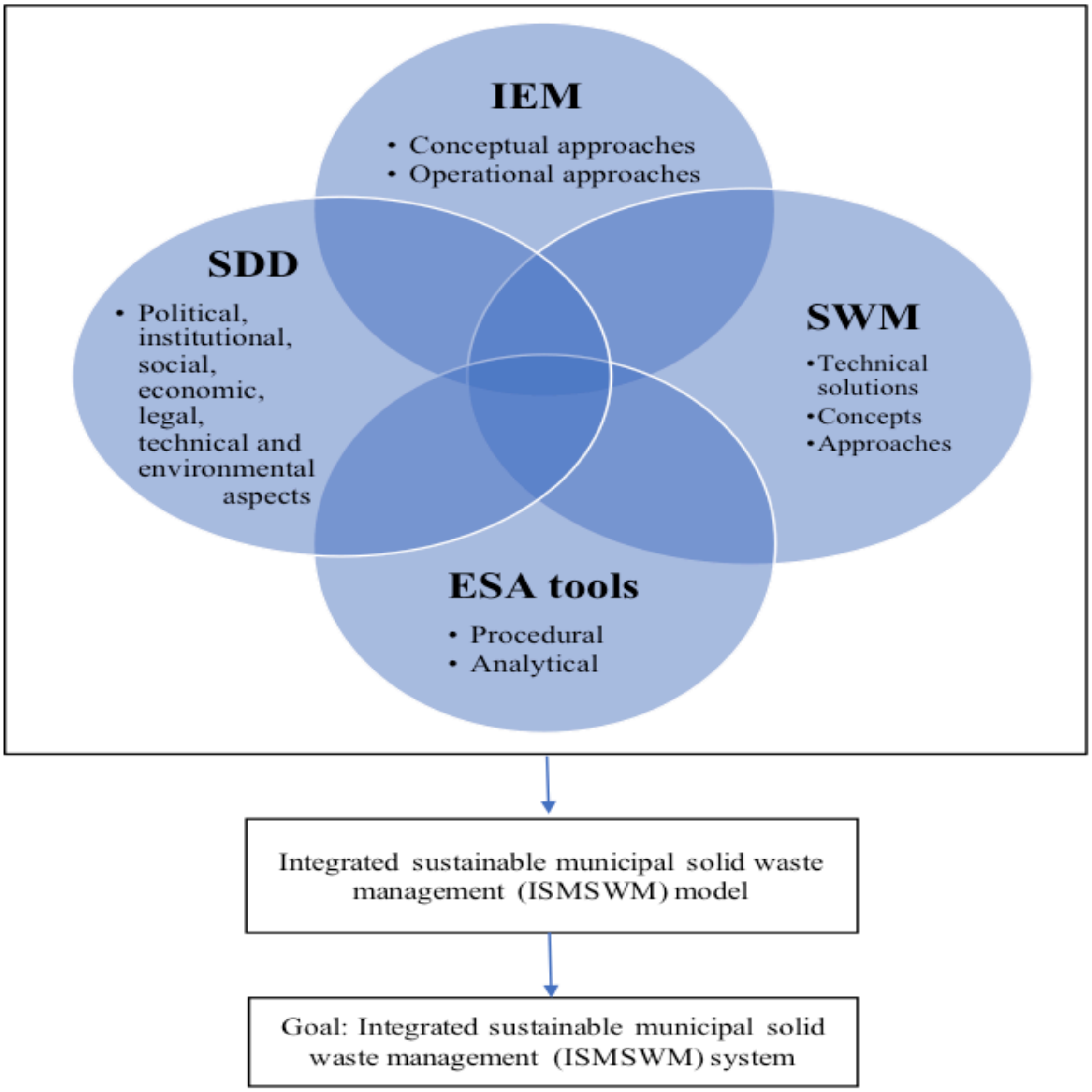

Figure 2.5: Conceptual framework for integrated sustainable MSW management (ISMSWM). (Developed by AlManssoor, 2014)

The conceptual framework of integrated and sustainable municipal solid waste management (ISMSWM) (figure 2.5) has been developed to assist in the investigation of the challenges and opportunities of planning and implementing MSW management systems in GCC countries (Kuwait as an example) and thereby understand how to operationalize the "integration" term to achieve a sustainable MSW management system. The conceptual framework for (ISMSWM) includes the IEM approaches, ISWM model's three dimensions

(WASTE 2010, the Netherlands; van de Klundert, 2001; UN-HABITAT, 2010) that demonstrate the technical, economic, social and environmental dimensions and ESA tools.

Margerum (2001) indicated that "the purpose of IEM is to integrate management activities through stakeholder committees composed of government and nongovernment representatives". Moreover, Burhs (1995) considered "integration practices" as a key element of IEM and Integrating institutional arrangements is practiced through the involvement and participation of multiple stakeholders. Effective waste management must be completely supported and embraced by the public and local authorities and transcend traditional consultative methods that need experts to develop solutions before public involvement (Henry 2006). Accordingly, in the ISMSWM framework the "stakeholders" as a key factor of IEM is not presented in separate of IEM, instead it is joint within the IEM approaches in the framework.

Until approximately the beginning of the current decade, MSW management was absent from the IEM field of research and implementation. Solid waste was considered to be a "problem" and MSW management was thought to deal with this problem by selecting proper technological solutions (Hettiarachchi 2016, p.3). Within the last decade, the IEM literature has started to include IEM approaches within SWM and MSW management. "Integrated management options have been the most favorable tools used to manage environmental resources such as water, soil and waste" (Hettiarachchi 2016, p.3). Municipal solid waste has started to be known as a resource that should be managed by IEM approaches even though it is a "manmade resource" (Hettiarachchi 2016, p.3, Ikhlayel 2017).

Although it could be new for the IEM field of study to promote involving MSW management in its fields of study and research (Hettiarachchi 2016, p.3). The IEM approaches may be able to provide a comprehensive explanation for the conceptual approaches, operationalization approaches and ESA tools in promoting planning and implementation of ISMSWM. As can be seen in table 2.10, IEM and ISWM are not contradictory or overlapping. ISWM framework could be useful and applicable for waste managers, waste experts, waste actors and other relevant experts that have practiced the implementation of 'integrated approaches' in their research and field studies such as framework developers or international institutions (e.g: The World Bank and UNDP).

ISMSWM that involves IEM in the model should be useful for Kuwait, GCC countries and countries in the same global context that do not deal with 'holistic' or 'integrated' approaches in the management of environmental fields in general, and in MSW management specifically.

The ISMSWM model does not ignore the ISWM model; instead, it is an attempt to include the advantages of the ISWM dimensions in addition to the IEM approaches and ESA tools that will better clarify the situation and help local environmental managers, waste managers, researchers, decision-makers and waste actors to operationalize the 'integrated approaches' for managing MSW according to a specific local situation. The literature review in this chapter is expected to be a good start to understand the development of IEM approaches, relevant case studies and the strong and weak points of implementation and the interpretation of IEM for SWM and MSW management.

Table 2.10: Comparison of selected factors between IEM and ISWM approaches

Factors of comparison	IEM	ISWM
Definition	"An approach to environmental management which requires recognition of the linkages between different parts of the environment and adopts a range of tools to identify and manage environmental effects across the different parts, and to ensure co-ordination across institutional barriers such as agency barriers" Frieder (1997, p.20).	"Integrated waste management planning is a dynamic tool including aspects that range from policy-making and institutional development to technical design of integrated solutions for the handling and disposal of waste. The concept of ISWM differs a lot from the conventional approach towards waste management by seeking stakeholder participation, covering waste prevention and resource recovery, including interactions with other systems and promoting an integration of different habitat scales (city, neighborhood, household). ISWM does not cope with waste management as just a technical issue, but also recognizes the political and social factors as the most important" (ISWA 2012, p.15)
Key elements	- Integration - Environment - Management (Burhs 1995)	- Stakeholders - The waste system elements - Aspects of sustainable dimensions (Klundert 1996, ISWA 2012, p.14)
Relevant approaches	- Conceptual approaches - Operational approaches - ESA tools (discussed in the next paragraphs)	- Waste (2001) discussed in some detail the adopted approaches such as holistic approach, CBM, collaboration, public participation and private sector participation.
The countries of concern	Developed countries (e.g.: Margerum 1995, 1999, Mitchell B. 2001). But for developing countries: the complicated situation of water management, researchers in developing countries prefer not to return to the past in which water management was characterized by top-down, sector-to-sector approaches regardless of the ecological impacts and competing uses of water (Lankford 2007, Merry 2008). The researchers in South Africa promote starting with IEM and applying more effort to the action phase according to the local conditions and circumstances (Lankford 2007, Merry 2008).	Developing countries (Schübeler 1996, van de Klundert 2001). Although the CWG formulated the ISWM concept by focusing on developing countries, the principle can be applied universally (Wilson 2007).
Area of concern	Examples of different environmental and resource management fields where IEM has been utilized are presented in table 2.2. In addition to sources such as water and soil, IEM approaches have become the most favourable models for waste (liquid and solid) (Hettiarachchi 2016, p.3) considering that waste is a resource even though it is a manmade	Solid waste management (SWM) and Municipal solid waste (MSW) management

	resource (Hettiarachchi 2016, p.3, Ikhlayel 2017).	

Adopting IEM approaches to manage MSW will address the social dimension and help to strike a balance between economic, social and environmental considerations (Kumar 2016, p.126). Implementing IEM approaches may assist in the integration of the following areas: integration of knowledge, approaches, technologies and tools relevant to solid waste management and sustainable development dimensions, as well as promoting the engagement of various stakeholders. In addition, IEM approaches may encourage the planning and implementation of ISMSWM on the ground.

Understanding the conceptual approaches of IEM such as the holistic approach, comanagement, CBM, decentralization and public participation would help the policy-makers, decision-makers planners, experts and researchers to illuminate the existing SWM situation for national, provincial and local government to identify the critical requirements of ISMSWM planning: the level of action and the proper practices and management approaches within top-down versus bottom-up approaches. These IEM approaches will assist policy-makers, decision-makers, planners, experts and researchers to identify the institutional framework, regulatory frameworks, responsible authorities and the role and responsibilities of the key stakeholders in addition to the broader groups of stakeholders and their role and power in planning, decision-making and implementing of ISMSWM systems.

The implementation of the operational approaches of IEM including collaboration, cooperation, co-ordination and communication can help build relationships and communication between stakeholders and promote their participation in the planning and management process. The participation of the stakeholders will better facilitate the process while planning for sustainable MSW management to account for critical details such as: gathering the required data for MSW and deciding the technological measures considering the environmental impacts; understanding the financial, economic and investment opportunities; the roles of private sector participation and the informal sector (if relevant); and the existing economic and regulatory instruments. With respect to social considerations, stakeholder participation can help in understanding many specific details such as local population growth, consumption patterns, waste disposal behaviours, and the type and level of public participation in MSW management. In summary, adopting IEM approaches is beneficial in two ways: first, in understanding why, what and how to integrate, and the level of action required; and second, understanding who should be involved in the process for the operationalization of the integration and in what capacity.

Understanding the detailed structure of the existing MSW management subsystems for the purpose of planning and implementing an ISMSWM system implies considering the legal, political, technical, environmental, social and institutional aspects. Implementing analytical/procedural ESA tools can support decision-making and promote the involvement of environmental and economic aspects in the research, planning and management process. Therefore, IEM approaches, sustainable development dimensions, and ESA tools in addition to the SWM-relevant technological solutions, concepts and approaches were included in the conceptual framework for ISMSWM. Applying the ISMSWM conceptual framework should be capable of addressing the obstacles and opportunities of planning and decision-making, and also set the required objectives for planning of an ISMSWM system.

The next chapter presents the research framework design in detail, which is a case study based framework established in accordance with the ISMSWM conceptual framework. The case study research framework was designed using mixed methods (qualitative and quantitative) as viewed through the lenses of: IEM, ISWM model, stakeholders, SD dimensions and MSW management relevant approaches and technologies, as well as the LCA model that will allow for comparison between different MSW management operations and technologies. These will be integrated within the research framework.

Chapter 3 Methodology

3.1 Introduction

This chapter presents the research methodology used to examine the challenges and opportunities of planning for and implementing an ISMSWM system in Kuwait. Kuwait was selected as an example of an oil-exporting high-income country. A post-positivist epistemological approach was adopted as a framework, which combined both qualitative and quantitative data collection and analysis. In this chapter, the underlying epistemology, methodological framework and research design components are discussed. In addition, the qualitative and quantitative methods used to conduct the research in Kuwait are outlined.

3.2 The case study background – The State of Kuwait

Kumar (2016, p.120) stated that "high-income nations developed their systems approaches for SWM in the nineteenth and twentieth centuries; not only governments but residents also understood the need for proper SWM". This description does not apply well to the oil exporting high-income Gulf Cooperation Council (GCC) countries. Although the GCC countries are highincome countries, they still practice traditional MSW management at the national level for waste collection, transportation and final disposal, relying on unsanitary landfills. In this research, the case study; The State of Kuwait; is selected as an example of one of the oil-exporting high-income Gulf Cooperation Council (GCC) countries to investigate the obstacles and opportunities of planning and implementing ISMSWM system. Especially that the time of the research is exactly the time that the Municipality of Kuwait is promoting studies to transfer from the current situation of conventional MSW management practices toward planning and implementing ISMSWM system in Kuwait.

The case study chosen for this research covers MSW management in Kuwait. Kuwait is an Arabian Gulf country with one of the highest income levels in the world.

Despite its economic standing, the country is not yet considered a developed country by international standards (UNDP 2010, UNDP 2019). Starting with the Third Millennium, and prior to the adoption of the Sustainable Development Goals (SDGs) that present Kuwait Vision 2035, The State of Kuwait had maid critical achievements in most goals and targets of the Millennium Development Goals (MDGs). GSSPD (2019, p.11).

While Arabian Gulf countries share many characteristics, challenges and barriers, each country has its own unique and specific conditions, circumstances, perspectives and national objectives. Until the last two decades, the environment was not considered an important issue in the Gulf Cooperation Countries (GCC) countries. In particular, solid waste management was not a prime concern for environmentalists or governmental agencies. Environmental concerns were brought to the attention of governmental authorities in Kuwait when certain environmental groups such as the Kuwait Environmental Society and Green Line Group highlighted problematic issues regarding the country's municipal waste services (Alhumoud, 2006). The occurrence of environmental problems and disasters in Kuwait signaled the attention of governments, academics and the public to the infrastructural, socioeconomic and health impacts that were affecting the country. Examples of these environmental problems were: burning oil wells and spilled oil lakes; accumulated waste during/after the Gulf war as a consequence of the Iraqi invasion of Kuwait in 1990; and fish mortality and accumulation along the coast in Kuwait from the summer of 1999 until 2001 (Al-Awadhi, 2002). In addition to these hazards, there was an explosion of some houses in AlQurain city in 2001 due to methane gas emissions from a nearby closed landfill site (AlYaqout, 2002).

In general, the Kuwait Municipality – a national agency – is responsible for collecting, transporting and disposing of solid waste generated throughout the country. Kuwait Municipality is a central governmental institute under the supervision of the Ministry of Public Works and

Municipal Affairs. According to Law No.5, Article No.1, "The Kuwaiti municipality is an independent organization with a juristic personality whose location is the city of Kuwait. It shall be defined by a decree from the minister who supervises the municipality's affairs" (2005).

The Municipality of Kuwait and the EPA sought alternative options to the disposal of municipal solid waste in landfills due to challenges such as: restricted land use; environmental and social impacts of landfills; light levels of biodegradable waste within municipal solid waste composition; and illegal dumping. During this transition stage, these agencies continue to work through issues such as the required technology to prevent biodegradable and recyclable waste from entering landfills, and opportunities to offer products from recyclable sources that supply market demands.

The study focuses on understanding the obstacles and opportunities of planning and implementing integrated sustainable municipal solid waste management in Kuwait through an integrated vision of stakeholder participation, sustainable development and ISSWM-related approaches. The ESA tools are useful for analyzing the environmental impacts of proposed ISSWM scenarios that factor into strategic decision-making. An in-depth focus on a single case study can generate detailed knowledge about the conditions, challenges and opportunities for ISSWM in a specific setting. However, the outcomes of this case study can also expand knowledge about the implications, interconnections and benefits of IEM, sustainable development, ISSWM and ESA tools in other GCC countries. What is significant about this case study is that its research framework adopts analytical ESA tools as well as qualitative and quantitative research methods.

3.3 Research Epistemology

The post-positivism assumes that besides the scientific method, there are numerous ways of conducting meaningful research. Unlike the testing of a pre-formulated hypothesis, a postpositivist research paradigm uses inductive reasoning to generate research premises that are plausible (Kelly 2016, p.19). Scholars attempt to examine and understand why phenomena operate in the ways they do (McGregor 2010). The post-positivist approach supports the notion that research does not need to be value-free and unbiased; rather, it should be subjective, based on values and may even be value-driven. Here, both the roles and the voices of researchers and participants hold value. People are seen as central, rather than isolated. They are participants in the process rather than being studied and controlled and may even benefit from the research(Kelly 2016, p.20-21). With the preceding points in mind, the present research is structured under the post-positivist framework to include mixed qualitative and quantitative methods to explore waste management research.

In recent years, there has been better understanding for the increased rigour and comprehensiveness of combining qualitative and quantitative approaches (Creswell 2009, van den Hoonaard 2012). The main purpose of using mixed methods within a single study is to better understand the complexity of the social phenomena being studied. For instance, mixed methods can provide better understanding of focal issues and contexts by collecting data that is broader, deeper, more inclusive, and that highlight the complexity and contingency of human experiences (Greene 2007, p.20-21). They support the political and value dimensions of research by engaging diverse and even discordant perspectives (Greene 2007). Moreover, mixed methods enhance the validity and credibility of research findings. Table 3.1 includes examples of qualitative, quantitative and mixed methods of research as presented by Cresswell (2009). The mixed method strategies can be categorized as three general methods (Ibid, p.14-15): sequential mixed methods, concurrent mixed methods and transformative mixed methods (see table 3.1). From the listed qualitative and quantitative research methods that are listed in table 3.1, the methods used in this research include interview and observational data, instrument-based questions, statistical analysis, combined open-ended and closed-ended questions, and analysis across the database.

Table 3.1: Examples of qualitative, quantitative and mixed methods of research

Research methods	**Qualitative**	**Quantitative**	**Mixed methods**
	• Open-ended inquiry • Emerging methods • Interview and observational data • Analysis of images and text	• Instrument based questions • Pre-determined methods • Performance data • Observational data • Attitude data • Statistical analysis • Interpretation of statistics	• Combination of openended and closed-ended questions • Mixture of pre-determined and emerging methods • Analysis of statistics and text • Analysis across databases

Adopted from Cresswell (2009, p.15 and p.17).

3.4 Research design - research framework

While the methodology utilized in this study integrated a mixture of techniques and approaches, the predominant method is case study. Yin (2003, p.13; 2009, p.18) defines case study as “an empirical inquiry that investigates a contemporary phenomenon in depth and within its reallife context, especially when the boundaries between phenomenon and context are not clearly evident.” A case study is a detailed examination of a specific phenomenon, set time period and within a defined setting (Yin, 2009, p.18). In general, the case study follows a comprehensive and holistic form of inquiry into the nature of the phenomenon (Gerring, 2007, p.17). As an allencompassing method, the case study approach to research covers design of the research, approaches to data analysis as well as the actual data collection techniques. Therefore, it is best able to provide a richness of individual settings of a specific case that are too complex to be studied solely through experimental methods or surveys alone (Yin, 2009, p.19).

Case study is often employed as qualitative method but it is also recognized among strategies of quantitative research (Gerring, 2007, p.11) and can therefore be used as a mixed method (Cresswell, 2009, p.206). Gerring (2007, p.11) states that case studies can accommodate formal mathematical methods, which can help to elucidate the relevant parameters that are operative within the particular case under study.

Kuwait is currently undergoing development in its MSW management sector. In particular, the country is exploring the possibility of transitioning from conventional MSW management (i.e. collection, transportation and dumping) to a more sustainable management system. Accordingly, the holistic systems approach adopted by this study has enabled a comprehensive investigation of the obstacles and opportunities associated with planning and implementing an ISMSWM system in Kuwait. Beyond technical issues, ISMSWM system differs from conventional MSW management by the incorporation of social and political factors that influence actions. In addition, the planning for an ISMSWM system promotes the stakeholder participation and interactions that promote integration at the national level. Accordingly, the research methodology framework includes: IEM approaches, stakeholders, waste system components, sustainable development dimensions and LCA.

Using mixed qualitative and quantitative methods, this research has been designed as a post-positivist single case study. The research framework was developed to guide the six phases of the research, as well as the methods used (see figure 3.1). **Phase one** of the framework included development of the research objectives, which were identified by reviewing literature sources (i.e. peer-reviewed, government and institutional documents) and key informant interviews. **Phase two** entailed developing an understanding of the recently implemented solid waste management approaches in Kuwait, as well as its current practices through a review of relevant literature, government and World Bank documents and key informant interviews. In **phase three**, the aim was to connect the conceptual framework of the research to the empirical methods and tools in order to map out the path for ISMSWM planning. This phase involved the use of a more refined literature review (i.e. peer-reviewed literature, governmental policy, and World Bank documents) and analysis of the research objectives than those set out in phase one. This is not clear

Research questions were also established in phase three to guide the study, and phrased within the context of "who", "what", "how" and "why" as recommended by (Tellis 1997) for the purposes of determining the research strategies to be established. Multiple data sources were used as recommended by Yin (2009, p.15) so that the approach is comprehensive and inclusive, and therefore not limited to a single data source. Yin (1994, p.27) found many examples of evidence from case studies: "archival records, documents, interviews, direct observation, and observation by participants" that were elements of this research framework. These sources may be seen as complementary rather than one having an advantage over another (Tellis 1997).

Stakeholders are defined as "parties in a project/product/process/service—the people who affect and influence it, as well as those who will be influenced by it" (Taelman 2018). Muller (2001, p.12) states that stakeholders refers to "people and organisations (natural and legal persons) having an interest in good waste management, and participating in activities that make that possible, including enterprises, organisations, households and all others who are engaged in some waste activity. Stakeholders may generate waste, function as service providers or participate as state or local government departments, non-governmental organisations and other organisations concerned with certain aspects of waste management. Their interest in waste activities in the neighbourhood gives stakeholders a stake in improving local waste management".

For the present investigation of the Kuwait case study, the stakeholders that are involved in the research are the waste actors and relevant householders. In this research, waste actors refer to the people who were involved in recent years or still working in the projects or studies relevant to MSW management in Kuwait (Municipality of Kuwait, EPA, Governmental institutions, educational and research institutions and consultation companies). The householders are the individuals, families and residential persons who possess the various characteristics of the Kuwaiti population. A waste actors' questionnaire and a householders' questionnaire were used in this study to obtain an understanding of the different stakeholder perspectives and experiences related to a transition from conventional MSW management to an integrated and sustainable MSW management system.

Waste system components refer to the handling of solid waste and where it is finally deposited. Priorities in waste management (see figure 3.1), are fundamental to the ISMSWM approach, and are focused mainly around waste prevention/minimization, waste source separation, reuse of waste, zero-waste, energy from waste (EFW), composting, anaerobic digestion (AD) and recycling. In this phase of the study, an investigation was conducted into waste system elements included within the waste actors' questionnaire, householders' questionnaire, IWM-Model and a focus group discussion.

Sustainable development dimensions that are defined as the multiple aspects (i.e. environmental, sociocultural, economic, political, legal and technical) which can be used to assess the existing waste system (ISWA 2012 b, UNEP 2009). The waste actors' questionnaire includes questions about all of these dimensions, whereas the householders' questionnaire concentrated on the sociocultural dimension. The IWM-Model focuses on environmental and technical dimensions. Table 3.2 presents the contribution of the research methods to the ISMSWM model.

Phase four utilized several qualitative and quantitative methods, in addition to the IWM-Model (see Appendix A), as an analytical environmental system assessment (ESA) tool in three parts (A, B and C) (see tables 3.2 and figure 3.1). In phase four - part A, different MSW management elements and scenarios are assessed using the IWM-Model, according to the available MSW data in Kuwait. Comparisons between the different scenarios are then established. A paper was prepared using the results of the IWM-Model and the available MSW management options and scenarios to support planning for ISMSWM system. This paper is significant to the research design as it includes a brief introduction about the research goals and objectives and clarifies tables and diagrams. The paper was used particularly to present and discuss the research elements in a focus group discussion. The particular group that was involved in the focus group discussion was made up of members of the SWM decision-making committee in Kuwait.

Phase four - part B involves the householders' questionnaire. In part C of phase 4, the waste actors' questionnaire is used to ask questions of different waste actors about: the IEM approaches (based on stakeholder engagement); and the relevant perspectives of Kuwaiti waste actors regarding the relevance of MSW approaches. The participants of the waste actors' questionnaire represent different governmental institutions, academia, environmental institutions and employers in the field of solid waste management in Kuwait. The participants in the waste actors' questionnaire were selected as they contributed either to the planning, decision-making process or both.

Phase five combined the conceptual framework of the research with the empirical case study findings. For example, the results of the household surveys are discussed from the perspective of public participation in ISMSWM planning and decision-making. In light of the study's research objectives and questions, **phase six** includes discussion of the research findings, addressing a summary of the obstacles and opportunities of planning for ISMSWM, discussion of the contribution of the research as an example for the GCC countries and the conceptual contribution to body of broader knowledge and the final conclusions.

Table 3.2: Sustainable development dimensions and the research methods applied in this study

<table>
<tr><th>ISWM aspect</th><th>Areas to investigate</th><th colspan="3">Research method</th></tr>
<tr><td>Technical and operational</td><td>1. Waste quantities, waste composition
2. Waste management related technologies, operations and approaches</td><td rowspan="2">IWM-Model</td><td rowspan="3">Householders' questionnaire</td><td rowspan="6">1.Waste actors' questionnaire
• IEM approaches
• ISWM elements
Sustainable development dimensions
2.Focus group discussion
3.Key informant interviews</td></tr>
<tr><td>Environmental</td><td>1. Environmental implications of the technology
2. Implications on recycling and re-use.
3. Factors that affect adopting technical options</td></tr>
<tr><td>Socio-cultural</td><td>1. Willingness and ability to pay
2. Population's level of awareness
3. Cultural attitudes related to waste handling and separation
4. Demographic factors affecting management of waste within the household</td><td rowspan="4"></td></tr>
<tr><td>Financial-economic</td><td>1. Funding
2. Policy instruments</td><td rowspan="3"></td></tr>
<tr><td>Institutional</td><td>1. Institutional arrangement
2. Responsible institutions</td></tr>
<tr><td>Policy/legal/
Political</td><td>1. Political priority
2. Policy and regulations regarding technologies and equipment
3. Strategy and monitoring
4. Education
5. Collaboration
6. Decentralization
7. Public participation
8. Private sector participation</td></tr>
</table>

General research framework: a case study

Research methods: mixed qualitative/quantitative methods

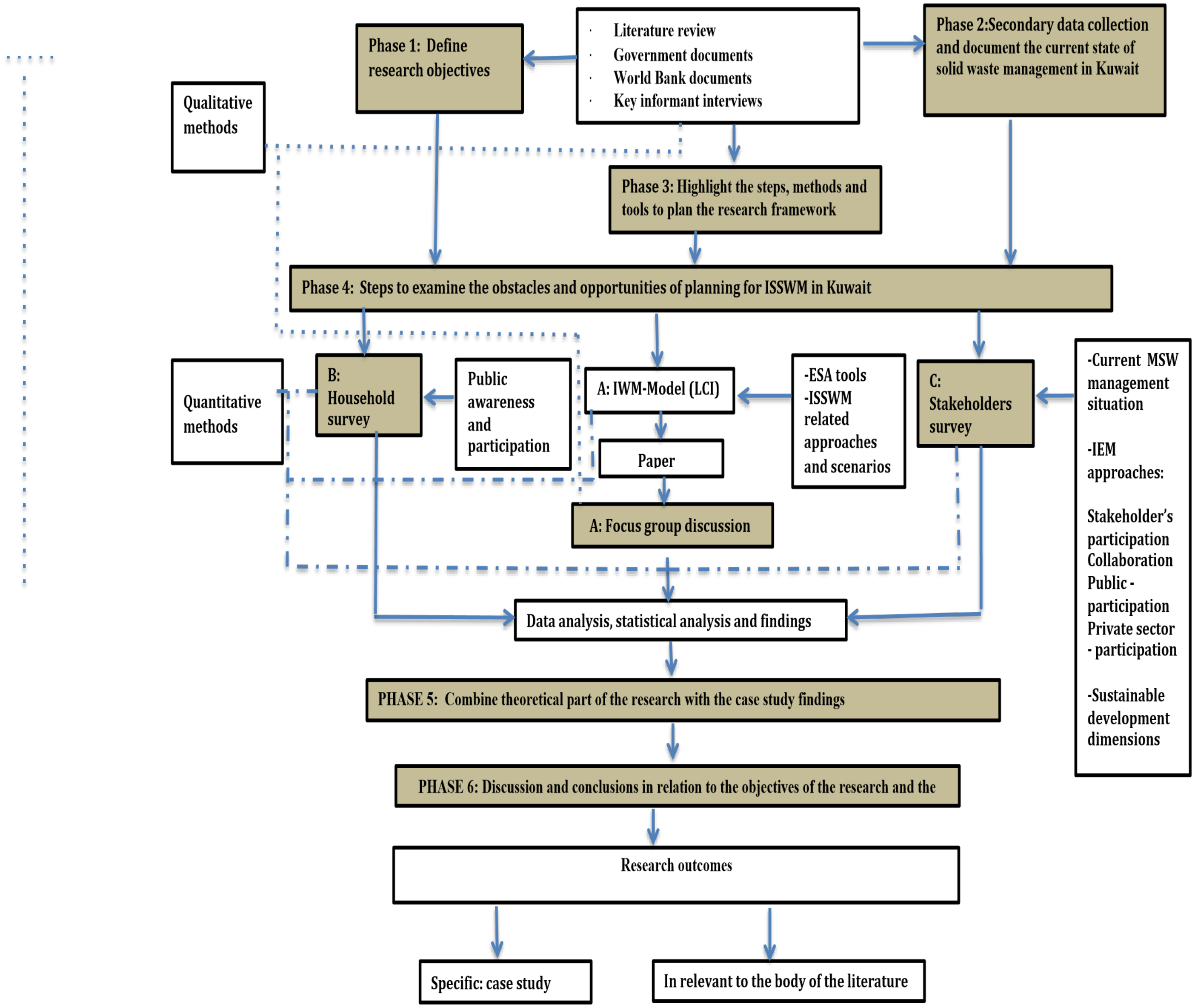

Figure 3.1: Research framework

3.5 Research methods and data collection

3.5.1 Secondary data collection

Secondary data is collected usually either from the research conducted and analyzed by other researchers and government agencies, or from private official documents (Bryman, 2012). Document analysis involves a review of records, guidelines, official publications and surveys (Patton 2002). In this research, the analysis of secondary data provides an examination of the relationships between variables that have not been previously considered, promoting a reconsideration of the data's relevance (Bryman 2012). In this study, secondary data collected were analyzed throughout the process including information from peer-reviewed journal articles, online sources, government publications and institutional documents. The official documents include those from KEPA (2002a), KEPA (2002b), and a The World Bank report (2009) about the waste management investments of small and medium-sized enterprises (SMSE) in Kuwait (with cooperation from the Industrial Bank of Kuwait).

3.5.2 Key informant interviews

Conducting key informant interviews means interviewing individuals with specialized expertise in a particular subject. Only a small number of key informants are selected for an interview because they possess specific ideas that can be uncovered by the researcher. The researcher can identify which groups the key informants should be drawn from depending on the inquiry, then a certain number of individuals are drawn from each group (Krishna 1999). Furthermore, key informant interviews are considered to be qualitative interviews and address the topics the researcher wants to cover. These can offer important information along with unexpected aspects that may or may not verify the satisfaction with the qualitative responses and analysis of the research (Driscoll 2007). The interviews are informal conversations in which the interviewer gently draws out information. Copious notes are taken, which are later developed. The interviewer can go back and verify or elaborate the data with the key informant if not all information is covered in the session. The interviews are unstructured, and this fosters special meaning and relevance for the research study (Krishna 1999). In this research, key informant interviews were held at the beginning of the research period to investigate the current situation of MSW management in Kuwait, and to curate the relevant studies, projects, and the available data about the quantity and quality of MSW. The waste actors that were selected as key informants for the study are government employees with direct connections to current studies in MSW management in Kuwait. There were seven (n=7) key informant interviews conducted with staff from: the Kuwait Municipality (i.e. Department of Environmental Affairs – section of waste management and Department of Transportation and Public Cleansing – section of waste transportation); the EPA (Department of Industrial solid waste management); and the Industrial Bank of Kuwait. The interviews took 30-90 minutes, depending on how the conversation developed. Interviews were repeated with three of the informants: two interviewees from the Kuwait Municipality (Department of Environmental Affairs – section of waste management) and one interviewee from the EPA (Department of Industrial solid waste management) for four times over a period of 6 months – one year, to highlight the latest updates relevant to current studies, adopted policies, modified strategies, and stages of decision-making. Appendix C includes the semi-structured questions used in the key informant interviews.

3.5.3 Questionnaire

The difference between questionnaires and interview methods of addressing research questions is that interviews involve an ongoing question-and-answer conversation between researcher and respondent, while questionnaires involve written responses to a document that is prepared ahead of time (Palys, 2008). The main advantages of questionnaires are that they help to gather a substantial amount of data quickly (Bryman, 2012; Palys, 2008), and they can offer respondents anonymity. Moreover, the structured type of questions in the questionnaire makes data coding and compilation more streamlined for the researcher (Plays, 2008). In this research study, two types of questionnaires are used: the householders' questionnaire and the waste actors' questionnaire that will be explained in more detail in sections 3.5.4 and 3.5.5, respectively.

The questionnaires were translated and used in both Arabic and English languages depending on the request of the participant (data recorded in Arabic was translated into

English). Notes were used to record the data collected from the interview participants and all data was saved in digital form on the researcher's computers and secondary storage systems. Statistical data was first tabulated and later analyzed using SPSS software. The analysis includes methods such as frequencies (i.e. means and percentages). The results obtained from statistical data were interpreted in the form of graphs and tables. Notes taken during the interviews were organized in a table form using SPSS software and Word software. In order to ensure the anonymity of the informants, householders or any participant in the research, neither their names nor any potentially identifying information were used while writing the thesis.

3.5.4 Householder questionnaire

In waste management, householders represent the largest numbers of stakeholders and they act as waste generators, receivers of education and awareness service, and proponents for consistent waste management (Muller, 2001). Examples of the general areas to investigate that are relevant to social aspects of ISWM planning as indicated by van de Klundert (2001) are: awareness of the population, willingness to participate, ability to pay, and cultural attitudes.

The aim of the householders' questionnaire (see Appendix B) is to examine the householders' awareness about local environmental problems and MSW management. In addition, the householders' questionnaire seeks householders' opinions about the current practices of MSW management and the particular activities of source segregation, collection and transportation, as well as their willingness to participate in any activities that may be developed from the implementation of new solid waste management policies, such as:

a. Conforming to source separation of wastes (e.g. separate plastic wastes in blue bins, separate food waste in green bins, and separate metals).
b. Payment of a tax to implement environmentally sustainable projects.
c. Reporting of illegal environmental practices and the enforcement of fines when environmental practices are violated.

Accordingly, the questions for the householders' questionnaire were developed to investigate the areas of interest as described in table 3.3.

Table 3.3: Areas of interest and examples of the relevant questions within the householders' questionnaire

Areas of interest			Examples of questions
1	a.	Environmental awareness of the householders toward the environmental aspects and problems in Kuwait.	7, 8, 9, 17, 18.10
	b.	Environmental awareness of the householders about the solid waste management relevant approaches. Activities such as: source segregation, collection and transportation.	9, 10, 11, 12, 13, 14, 15, 16, 18.3, 18.4, 18.5, 18.7, 18.8
2	a.	The opinions of the householders about the current practices of MSW management and the particular activities of source segregation, collection and transportation.	9, 16, 17, 18.1, 18.2, 18.6, 18.9
3	b.	Willingness of the householders to respond and accept the new environmental management system that could lead The Municipality of Kuwait to adopt mandatory new practices or regulations.	18.3, 18.4, 18.5, 18.6, 18.7, 18.11, 18.12
	c.	The tendency of the householders to suggest and promote initiatives that could help to solve environmental problems, especially problems related to municipal solid waste management.	16, 17.6, 18.10, 18.13, 18.14, 18.15

For a quantitative /qualitative mixed research method, if the objective of the research is to generalize the findings to the population under study, then a random sample for that component should be selected (Kremelberg 2011, p.8, Onwuegbuzie 2007). Random sampling "means that every person in your population has an equal chance of being selected for participation in your study" (Kremelberg 2011, p.7). The main goal is to obtain a representative sample that resembles the population (Fox 2007, Kremelberg 2011, p.8). If the population consists of subgroups, some stratification will be required to obtain a more representative sample (Dane 1990, p.304, Taherdoost 2016).

Stratified sampling involves the population being divided into strata (subgroups), and a random sample is taken from each. This type of sampling is frequently used when there is wide variation within a population. The purpose of stratified sampling is to ensure that every subgroup is fairly represented (Taherdoost 2016). Stratified random sampling was selected because it ensures that in terms of the stratifying criterion, the sample is distributed in the same manner as the population (Bryman, p.214). Stratified sampling is a method of ensuring that various subgroups or categories are well represented during the sampling process and that the sample is representative of the population frame (Bryman 2012, p.214, Fox 2007). Accordingly, the population for the required sample for the householders' questionnaire was divided into the six provinces in Kuwait: Al-Kuwait (Al-Aasema), Hawalli, Mubarak Al-Kabeer, Al-Ahmadi, Al-Jahra and Al-Farwania.

For any empirical study that aims to make inferences from a sample about a population, the sample size is a very important feature (Taherdoost 2017). The sample size is just as important as the sampling scheme, as the sample size also determines the statistical and/or analytical generalizations that the researcher can make (Onwuegbuzie 2007). The householders' questionnaire was an adult questionnaire (18+). From the population of 3.06 million in Kuwait, the population of the adults (18+) was calculated to be 77.3% of the total population (i.e. 2.37 million) (Kuwait Annual Statistical Abstract 2012, p.46, 2014, p.62).

To calculate population sample size, Cochran's formula (1963) (Bartlett 2001, Lehmann 2013, Singh 2014) was used to calculate the sample size since it is the most convenient for largesized populations (Singh 2014).

$$N = \frac{Z^2\, pq}{e^2} \tag{1}$$

N is the required sample size. Z corresponds to the level of confidence needed. Typical confidence levels employed are 95% (for $\alpha = 0.05, a\ Z$ value equal to 1.96). The implication of a 95% confidence level is that 95 out of 100 samples will show the true population value within the specified margin of error. A 5% margin of error (e) is acceptable for social research (Gill et al. 2010, p.101, Taherdoost 2016, 2017). Furthermore, $\alpha = 0.05$, $a\ Z$ value equal to 1.96 and 5% margin of error was chosen by Aljarallah (2013) for the baseline study in Kuwait. The p is the variance or heterogeneity of the population relevant to the sample size, p = 50% (Fox 2007, Gill et al. 2010, p.101, Taherdoost 2016, 2017). In addition, q equals (1- p).

$$N = \frac{(1.96)^2\ (0.5)(0.5)}{(0.05)^2} = 384 \tag{2}$$

Regarding questionnaires as a research method, Bryman (2012, p. 218) recommended a margin of 20% extra questionnaires to be distributed to account for refusals or non-contactable members of the sample. In discussion with the statistical office of the University of Kuwait in May (2014), they recommended to increase the number of questionnaires to get better analysis since the answers for the questions have many choices (e.g: questions 14 and 15 of the householders' questionnaire have 9 choices for the answers with an option to choose all relevant answers). Accordingly, the questionnaires sample size raised to 400 and approximately 480 questionnaires were distributed with a target of 400 usable questionnaire.

The period for collecting data for the study was from May to September 2014 (Kuwait's summer season). In the summer season, it is not uncommon for citizens to vacation outside of Kuwait to avoid the hot climate, and the social and urban activity mainly begins at night during this high temperature period. The researcher and the assistances started to distribute the questionnaires.

One problem is that the weather causes health concerns. For most of the households; the servants received the questionnaires, the householders were not at home, and we could not retrieve all the questionnaires (2 out of 50). I discussed these problems with the statistical office of the University of Kuwait. Their opinion was that the winter or spring seasons would be better if we want to follow the random sample list. They suggested that we could benefit from the occurrence of the holy month of Ramadan, a month in which practicing Muslims fast religiously (i.e. refrain from eating, drinking and regular entertainment) from dawn until dusk, which began at the end of June and ended in July during the summer of 2014. The timing of the month of Ramadan in the summer coincides with the social norm of beginning social activities at night, a cultural tradition during which there are gatherings all over the six provinces to socialize and offer greetings during the whole month. Therefore, visiting the gathering stations in the different areas in each province would offer good opportunities to meet the householders, since it was difficult to meet them at their homes. Moreover, these gatherings are active the whole time after fast-breaking until dawn with a continuous movement of visitors. In the month of Ramadan, people usually try to visit many gathering places each night.

While choosing the gathering places, the researcher tried to ensure that the gathering places covered the north, south, east, west and middle areas of each province. It was aimed to visit a mixture of gathering places: male, female and multigender locations. The distributed and collected questionnaires from each gathering location from the range of 5-12 forms. The population percentage and residential areas for each province are listed in table 3.4.

Table 3.4: Characteristics of householders' questionnaire distribution and collection

Province:	Percentage of population (%)*	Minimum requested questionnaires/ 400	Number of residential areas/ province*	Number of visited gatherings (Diwaniya)	Gatherings: Male/Female/ Multigender
The capital: Al-Kuwait (Al-Asema)	11	44	26	7	3/3/1
Hawalli	22	88	15	9	4/3/2
Al-Ahmadi	19	76	20	9	5/4
Al-Jahra	13	52	13	6	3/3
Al-Farwania	27	108	13	9	6/3
Mubarak Al-Kabeer	8	32	9	5	2/2/1

*Sources: Kuwait Annual Statistical Abstract 2014, p: 58-61.

The householders' questionnaire was initially written in the English language. However, since English is currently taught in Kuwait as a secondary language, most citizens are not fluent in reading or writing English. The questionnaire was subsequently translated into Arabic. A brief explanation was added in the Arabic version of the questionnaire to better standardize the English and Arabic-written questionnaires. Moreover, participants were asked to indicate questions that may be unclear to them. After the collection of 400 usable questionnaires, SPSS statistical analysis software was used for coding the data in the questionnaires. The responses of the open-ended questions in the questionnaires were entered directly into tables in Microsoft Word.

As mentioned, the summer time was not a suitable time for the implementation of stratified random sampling in Kuwait. Therefore, the suggested option that was discussed with the statistical office at the University of Kuwait was implemented with excessive efforts to cover all residential areas and obtain a householders' sample that represents the whole population.

3.5.5 Householders' sample characteristics

Evaluation of the householder sample characteristics helps to uncover the representativeness of the sample with respect to the population of interest. An analysis of the gender, age distribution, property ownership, property function, number of household residents and the educational background are presented in table 3.5.

Statistical data from the Kuwait Annual Statistical Abstract (2012) was used to analyze population demographics. Of the total participants, 57% (i.e., 228/400) identified as male and 43% (172/400) identified as female (see table 3.). The Kuwait Annual Statistical Abstract (2012, p.46, 2014, p.62) shows that the total adult (+18) population of citizens in 2012 was 2.37 million with a gender breakdown of 1.38 million males (58%) and 0.99 million females (42%). The age distribution of the population outlines the following percentages per age category: 18-29 years at 35%, 30-39 years at 31%, 40-49 years at 20%, and 50+ years at 14% (Ibid) (see table 3.). Confirming a high correlation between the actual age segments of the society with the age distribution of the participant sample helped to confirm that the study sample is an accurate representation of the population in this dimension.

Table 3.5 demonstrates that 41% of the participants are owners of their properties and 59% are not the owners of the properties. In addition, table 3.5 presents that 92% of the buildings function as a household dwelling. These results parallel statistical data on the residential areas in Kuwait. Of the number of people currently living in a single household, 42.3% were in the range of 4-6 people, followed by 18% in the range of 7-8 people (see table 3.5). A recent published study shows that the average number of family members in a Kuwaiti household is estimated to be 7, (Al-Jarallah 2014). However, considering that household servants and non-Kuwaiti relatives were included within the family household numbers of the published study, the results of this doctoral study (see table 3.5) would parallel the aforementioned study if these two groups were removed from the calculation.

Moreover, in table 3.5, a breakdown of the level of education across the participants is as follows: 1% have only primary elementary level, 14 % have only secondary school level, 10% have only high school level, 60% have university/college level, and 15% have a PhD or equivalent. Kuwait Annual Statistical Abstract (2014, p.36) does not have the same classification of categories of the level of education exactly as presented in this study, but as presented in table 3.5, it is relatively close. Accordingly, as discussed previously, the characteristics of the participants of the householders' questionnaire represents the population reasonably well.

Table 3.5: Characteristics of the sample of householders who participated in the questionnaire

Category:	Householders' sample categories	Sample Characteristics	Kuwait population characteristics	Reference
Gender	Male Female	57 % 43%	58% 42%	Kuwait Annual Statistical Abstract (2012), p.46
Age	18-29 30-39 40-49 50+	36% 36% 17% 11%	35% 31% 20% 14%	Kuwait Annual Statistical Abstract (2012), p.52
Property ownership	Property Owners	41%	--------------	----------
The building's function	Home Business Both	92% 4% 4%	86% (houses)	Kuwait Annual Statistical Abstract (2012), p.85

Number of people living in the house	2-3 people 4-6 people 7-8 people 8-10 people 10+ people	16% 42% 18% 13% 11%	5-7 persons (49%) 4-8 persons per household, with a mean of 5.9	Koushki (2004) Al-Jarallah (2013)
The highest level of education	Primary elementary Secondary school/technical vocation High school University/colleges PHD or equivalent	1% 14% 10% 60% 15%	4% 7% 16% 43% 19%	Kuwait Annual Statistical Abstract (2012), p.55

3.5.6 Waste actors' questionnaire

In transitioning toward an ISMSWM model, and navigating both opportunities and challenges in the process, the following factors are addressed in the waste actors' questionnaire: SWM elements, stakeholders, IEM approaches and sustainable development dimensions that were selected in line with the ISMSWM conceptual framework. Consideration of these factors could provide a comprehensive study that would systematically investigate the obstacles and opportunities associated with planning and implementing ISMSWM in Kuwait. Moreover, these factors could help to determine the short-term and long-term targets and plans that would facilitate an ISMSWM system. Questions related to various waste actors groups (see figure 3.2, figure 3.3 and table 3.6) and IEM approaches are included in the questionnaire (see Appendix B).

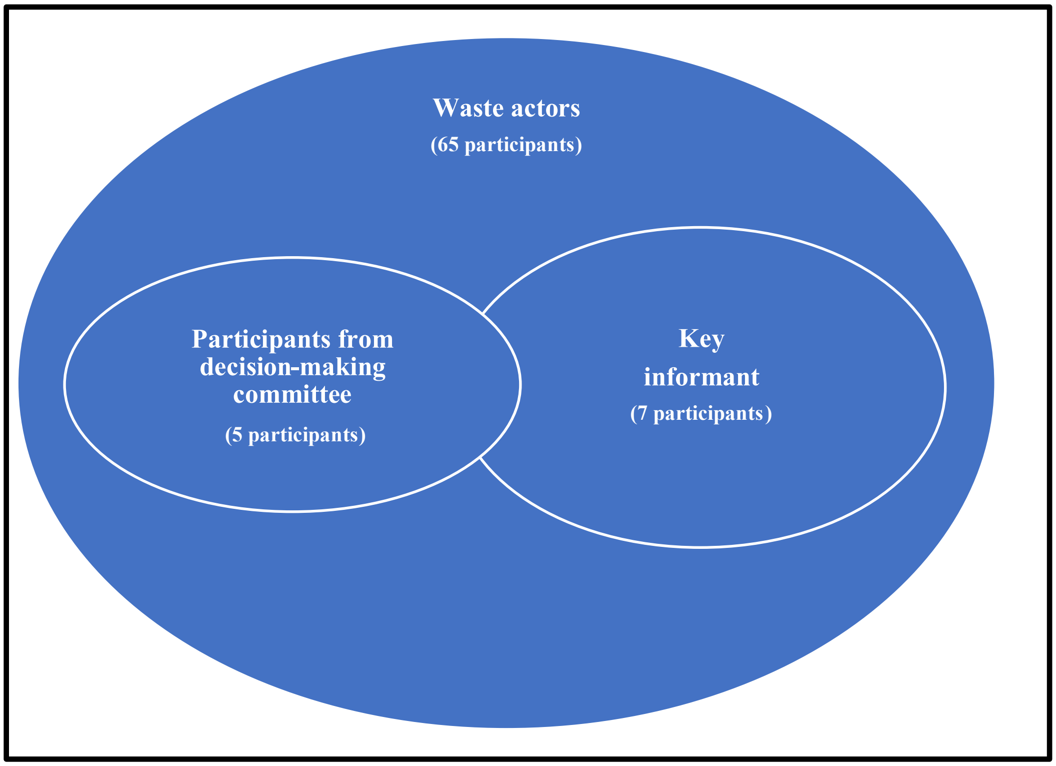

Figure 3.2: Distribution of the participant in the waste actors' questionnaire

Table 3.6: Relevant factors and examples of question for each discussion category of the waste actors' questionnaire

NO.	Categories	Relevant questions
1	Current situation	Q5, Q6, Q7, Q8, Q12, Q13
2	Integrated environmental management (IEM) approaches	
	Collaboration	Q8.E, Q8.F, Q31.1, Q31.2, Q32
	Bottom-up approach	Q31.2, Q31.5
	Decentralization	Q28, Q29, Q30
	Private sector participation	Q8.R, Q9, Q10, Q27.6, Q27.12
3	Integrated sustainable solid waste management (ISWM)	
A	Stakeholders	

	Waste actors[5]	Q3, Q4, Q8.O, Q19, Q20, Q31.1
	Householders	Q8.S, Q31.3, Q31.4, Q31.5
B	Solid waste management (SWM) elements	
	Data	Q7.C, Q7.D, Q7.E, Q8. Q11
	Technology	Q8.A, Q8.B, Q12, Q13, Q16
	Solid waste management related approaches	Zero-waste Q15, Q27.1 Waste-to-energy Q27.5 Source separation Q7.B, Q12, Q13 Waste minimization Q6.E Reduce GHGs Q6.B, Q27.2, Q27.3, Q27.7 Resource management Q6, Q14
C	Sustainable development dimension (SDD)	
	Policy, legal and institutional structure	Q8.G, Q8.H, Q17, Q18, Q24.1 Q8.I, Q8.J, Q24.1 Q8.A, Q8.K, Q8.L, Q17, Q24.1, Q24.5
	Strategy and monitoring	Q8.M, Q8.N, Q8.P, Q17, Q19, Q20, Q21, Q22, Q23, Q24.4
	Economic	Q8.C, Q24.2, Q25, Q26, Q27.9, Q27.10, Q27.11
	Education and awareness	Q8.T, Q27.13, Q31.4, Q31.6, Q31.7, Q31.8
	Social considerations	Q8.T, Q27.13, Q31.4, Q31.6, Q31.7, Q31.8, Q8.S, Q31.3, Q31.4, Q31.5

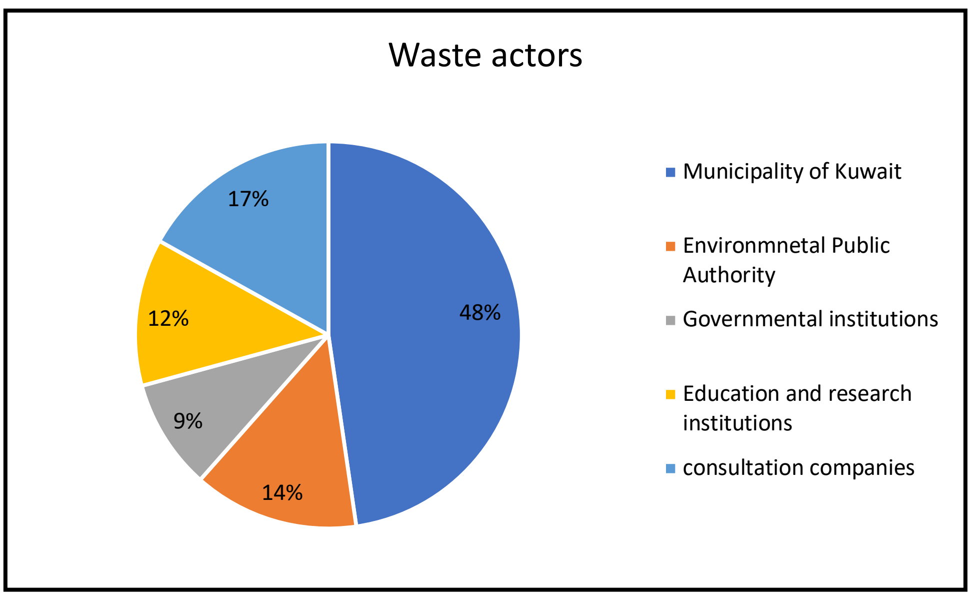

Figure 3.3: Institutions and relevant waste actors that participated in the questionnaire

The Snowball method is a non-probability sampling method often used in qualitative research frameworks (Bryman 2012, p.220, Etikan 2017, Fox 2007). Snowball sampling seeks detailed information about other 'information-rich cases' from key informants. (Suri 2011). Snowball sampling is usually done using networks and it is very effective when the researcher does not know much about a group or organization because contacting a few individuals will lead the researcher to another group. It is useful with regards to communication and decision making (Etikan 2017). In Snowball sampling, the researcher initially makes contact with a small number of people relevant to the research and then uses them to make contact with other potential participants (Bryman 2012, p.220). "Snow sampling involves starting with one or two people and then using their connections, and their connection's connections, to generate a large sample" (Palys, p.126).

Regarding the waste actors' questionnaire, the researcher started the data collection by contacting three waste actors: two from the Municipality of Kuwait and one from the Environmental Public Authority (EPA). Meetings with the three waste actors provided information about relevant institutions and other waste actors involved in projects aiming to transition from conventional MSW management practices toward sustainable MSW management systems. There were 65 participants in the waste actors' questionnaire and their characteristics are presented in figures 3.2 and 3.3. Key informants and participants from the national SWM decision-making committee are also included in the waste actors' questionnaire (figure 3.3). The questionnaire was distributed through the following institutions: the Municipality of Kuwait, Environmental Public Authority (EPA), three governmental institutions, research and educational institutions and consultation companies that are working on SWM and they were involved in projects to transition from conventional MSW management toward sustainable MSW management systems.

After the collection of 65 questionnaires, SPSS statistical analysis software was used for coding the responses in the questionnaires. The responses to the open-ended questions in the questionnaires were entered directly into tables in Microsoft Word. The statistical analysis was done for the questionnaire data, while the overall analysis was done within a qualitative research framework.

3.5.7 LCA: IWM-Model

The LCA tool employed provides essentially an accounting framework for tracking air, water and other emissions from different life cycle stages of a product or process. To assess the burdens of MSW management strategies on the environment, models are needed so that environmental emissions and energy consumption can be calculated for each process in the solid waste system with respect to scenarios composed of combined units and process including processes related to collecting, separating, recycling, treating, and landfilling of waste. The Life Cycle Inventory Assessment method can be used for multiple assessments based on different factors, such as greenhouse gas emissions, energy production or consumption, economic cost/revenues, land use burden and investment/operating costs (Thanh 2012). In order to compare environmental emissions and energy consumption/production against various alternate MSW management strategies, these unit process models can be incorporated into a larger model (Harrison 2000).

For the Kuwait case study, the LCA software tool (IWM-Model) that has been designed by EPIC/CSR for MSW was used to assess the environmental burdens associated with various life cycle stages (Haight 2004). The version used in this research is Version 2.0.6 (2004) and is available from the University of Waterloo web-site (www.iwm-model.uwateloo.ca). The LCA study was completed separately and a white paper that includes the results was written as presented in Appendix A. The white paper and results from the analysis were utilized as part of the method and were used by the researcher to assist with the focus group discussion described in the next section.

3.5.8 Focus group discussion

The selected group involves a target sample or purposively sampled participants. They are brought together because of their involvement with or connection to the issues under discussion that are of interest to the researcher. Such discussion may help to develop interpretations for better understanding and additional perspectives on which to focus subsequent research (Palys, 2008). For this study, the focus group discussions concentrated on the results of the IWM-Model with participants of the national MSW management decision-making committee. The aim of the focus group discussion was to clarify to what extent the participants accept ESA tools as a method to support ISSWM decision-making.

The focus group discussion included five members from the decision-making committee. First, a presentation was held for 20 minutes, beginning with a brief explanation of ESA including LCA. After the introduction, this part was followed by an explanation of the results of the IWM-Model and the comparisons between different scenarios of MSW management. After the presentation, the participants asked about the actual model, the application of data, the assumptions for missing data, the proposed MSW management pathways, and the LCA model. After discussing all these aspects, the participants were asked questions as listed in table 3.7, Part 1 and Part 2. Part 1 included questions about the ESA tools and LCA model (IWM-Model) and Part 2 included more broad questions about planning and implementing ISMSWM in the country.

Table 3.7: The questions asked during the focus group discussion

Question	Part 1
1.	According to the current adopted policy for solid waste management (i.e. zero-waste, energy-from waste, recycling), did you implement any environmental system analysis (ESA) tools to evaluate different technologies/operations as relevant to the adopted policy?
2.	Did you ever use LCA tools in any of your SWM projects?
3.	In your opinion, which environmental impact is the most important to consider while evaluating these different scenarios? Why?
4.	Which solid waste management scenario do you think is the most suitable for planning for sustainable solid waste management in Kuwait? Why?

5.	How do you evaluate LCA as an environmental systems analysis tool? Do you think that LCA can support decision-making for planning for sustainable solid waste management in Kuwait?
6.	How do you evaluate LCA as an environmental systems analysis tool? Do you think that LCA can support decision-making for planning for environmental management projects in Kuwait?
7.	What do you think about integrating LCA with other environmental systems analysis (ESA) tools? Would that improve the decision-making process? e.g. integrating an economic assessment tool (e.g. cost benefit analysis - CBA) with LCA environmental impacts results to involve both environmental and economic factors when planning for sustainable solid waste management?
8.	Is there any comment or question you would like to add?
	Part 2
1.	Do you think that technical/operational solutions are enough for planning for sustainable (municipal) SWM?
2.	Do you think technical/operational solutions should be part of an integrated framework that includes sustainable development dimensions (policy, law/regulations, institutional framework, environmental, economic, social) for planning for sustainable (municipal) SWM?
3.	What are the challenges for planning and implementing integrated sustainable municipal solid waste management (ISMSWM) in Kuwait?
4.	Finally, is there any comment or question you would like to add?

3.6 Research ethics

Prior to the commencement of the case study research, ethics clearance was obtained from the Office of Research Ethics at the University of Waterloo (ORE # 30263). The approval process involved an extensive review of the research proposal, including research tools for collecting data such as the survey questions and interview questionnaires. Thus, this research study was conducted according to the ethics standard required by the Office of Human Research Guidelines for Research with Human Participants.

3.7 Data management

Results from the IWM-Model were tabulated and organized using Excel software and the same software was used to create graphs and tables of the results. The collected data were organized and analyzed using various strategies. “Data analysis consists of examining, categorizing, tabulating or otherwise recombining the evidence to address the initial propositions of a study” (Yin, 1994). Tellis (1997) states that a “researcher needs to rely on experience and the literature to present the evidence in various ways, using various interpretations.” The various strategies used for organizing the collected data during the research to simplify the data analysis and the interconnection between the data that is collected from different research methods are included in the following paragraphs.

The following criteria were employed to judge the ‘rigour’ or ‘trustworthiness’ of the qualitative data with respect to such factors as: dependability confirmability, credibility, and transferability, (Connelly 2016, Guba 1981, Korstjens 2018). Shenton (2004) discusses a range of strategies that may be adopted by the researcher in response to these four proposed criteria. To ensure trustworthiness in the research, the credibility criterion covers the compatibility of the findings with reality (Guba 1981, Mohajan 2017, Shenton 2004). With respect to establishing trustworthiness, the ensuring of credibility is one of the most important factors (Guba 1981, Connelly 2016). In the context of this study, credibility was promoted through a number of methods such as the triangulation process, which was used to verify the information provided, and to ensure the collection of high-quality data from different sources.

To ensure honesty during the data collection process, participants were given an opportunity to refuse to participate without any pressure from the researcher. Great efforts were made to get 65 participants to complete the waste actors’ questionnaire since the number of waste actors and the people who are interested in being involved in the waste management field is limited. The IWM-Model results were analyzed using the latest data for MSW quantity and composition, and then analysis was repeated using the updated data for 2014. The rigour and credibility of the analysis were ensured by the implementation of the previously explained steps.

Transferability can be defined as the level to which research results can be generalized (Lincoln 1995, Korstjens 2018). Focusing a research study on a single case study is often criticized as it may have limited to no generalization value. Determining whether or not generalizations can be made from a case study can be challenging. Yin (2009, p.38-39) mentions two different types: statistical generalizations and analytical generalizations, whereby the latter type is appropriate for case study research. Therefore, Yin (2003) argues that the analytical findings of case studies can be generalized, but not the statistical results. Analytical generalizations depend on the theoretical framework of a study to establish fundamental concepts that may be applicable to other situations. The aim of generalizing findings is a two-step process in both case studies and experiments (Yin 2012, p.18): researchers demonstrate how their findings have informed a particular set of concepts, sequence of events, or theoretical constructs; and they apply the same theoretical framework to other situations, where similar concepts, sequences or constructs may be relevant.

In light of this expanded understanding of the possibilities for generalizing analytical research outcomes based on a case study, this study demonstrates a analysis of the theory, methodology and findings that may be useful for ISSWM planning in similar contexts. Furthermore, it should be noted that this doctoral study did not aim to present universally generalizable statements. The goal is to present findings "that may be transferred from one context to another depending upon the degree of 'fit' between the contexts" (Guba, 1981). Furthermore, "for case studies, the generalizability is determined by the strength of the description of the context. Such descriptions are one of the cornerstones of the studies and allow the reader to determine the level of correspondence of this particular case to another similar situations" (Patton, 2003).

Dependability for the positivist research paradigm employs techniques to show that similar results would be obtained if the work was done using the same methods (Shenton, 2004). For postpositivist research, however, the changing nature of the research issues and context makes this kind of replication problematic for qualitative researchers to ensure dependability. Rather, "dependability in qualitative studies refers to the stability or consistency of the inquiry processes used over time" (Guba, 1981). Therefore, a qualitative study may be seen to have achieved dependability through an exact description of the data gathering, analysis and interpretation methods, and the employment of overlapping methods. An in-depth description of the process within the study helps to enable future researchers to repeat the work, even if not for the purpose of gaining similar results (Krefting 1991, Shenton 2004). Here, the framework of the research, research objectives, assumptions, and methods of data and sampling, and findings are reported in detail to allow the study to be repeated.

Confirmability refers to the qualitative researcher's concerns about objectivity (Guba 1981, Krefting 1991, Shelton 2004). Yin (1994) indicates that the researcher must exhibit the ability to pose relevant questions, possess good listening skills, adaptability and flexibility, be free of bias and be knowledgeable of the issues. Thus, the findings must not be the researcher's preferences, but rather, the ideas and experiences of the research participants (Shelton 2004). As the key investigator for this research study, I acknowledge that I share the Kuwaiti culture with the participants of the present research. Furthermore, I was employed by an environmental institute in Kuwait during the period of 1998-2005. Three years were spent in Canada before departing to Kuwait to start the first stage of the research. During that time, many investigations were undertaken to uncover alternatives to conventional MSW management. During my visits and informant interviews in Kuwait, I was investigating new perspectives and strategies related to ISMSWM. The informant interviews were repeated to understand the details and the latest progress in the current studies and adopted policies for MSW management. This was for the purposes of remaining as objective as possible. In addition, triangulation and the acknowledgment of study limitations were reviewed to ensure rigour through actions to achieve confirmability and suppress personal bias.

Triangulation was discussed in section (5.2) according to its significance in increasing the reliability of data and the data collection process as well as the viability of the data and the analysis of the data. Here, triangulation was used with different data collection methods and different sources of information as presented in the research framework (see section 5.3.1). An example from this research of the triangulation of a mixture of qualitative and quantitative methods is the use of the IWM-Model. While the results of the model were not considered as a rigid reality due to the limitation of the model and data availability and quality, the results were used in a paper presented for decision-makers and accompanied by focus group discussion to validate and compliment the results of other research methods that were implemented in this research such as waste actors' questionnaires and key informant interviews.

3.8 Limitations of the study

With regard to the design of the questionnaire, rather than including a wide range of questions starting from more general questions and moving toward specific focused topics, in the future the questions can be developed to be more objective and relevant to specific topics, which may lead to a condensed questionnaire. This would encourage even more participants to answer the questionnaire. In addition, due to the large number of questions, some results (e.g.: in the waste actors survey, question 8: parts H, N and O) may mislead the focus of the research framework, therefore they were excluded from the list of results and the discussion. The extra details could be a good source of information for future studies.

The period of the research was May-September 2014, therefore the implementation of stratified random sampling for the householders' questionnaire was struggling due to weather and season implications. Although the householders' questionnaire participants are from different provinces in Kuwait, this point was not considered carefully during data entry.in the SPSS software. It was preferred to separate the data entry for each province to investigate if there is a different pattern of behavior or reaction toward MSWM that could vary by different regions in Kuwait.

Flyvbjerg (2006) states that because the case-study is very close to real-life situations and their implicit nuances, this is important for a researcher in terms of developing the skills needed to do good research. These stated limitations are useful for guiding future research on this topic. In particular, they encourage the researcher to deal carefully in future research with further consideration of aspects of the research methodology that may be challenging or should be avoided.The implementation of the

IWM-Model was repeated nine times due to technical problems, a change in the IWM-Model version, and to apply the updated data of MSW management in Kuwait to the proposed scenarios in the model.

Chapter 4
Results

4.1 Overview of MSW management in Kuwait

4.1.1 Introduction

Kuwait geographically occupies the northwestern section of the Persian Gulf delineated by Iraq in the northwest, Saudi Arabia in the southwest, and by the Arabian Gulf in the east. The distance from north to south totals 200 km (124 miles), and the distance from east to west along a parallel of 29^{O} is approximately 170 km. Since the location of Kuwait is between a latitude of $28.30^{O} – 30.06^{O}$ to the east of Greenwich, the weather is typical of the geographical region of the Sahara (Kuwait Annual Statistical Abstract 2012, 2014).

In 2011, the registered population was approximately 3.06 million and the population density was 172.1 per km^2. In 2011, 1.09 million were considered Kuwaiti citizens while 1.976 million were non-Kuwaiti citizens. The population growth rate for 2011 was reported as 5.7 % per year (Kuwait Annual Statistical Abstract 2012). In 2014, the registered population was approximately 3.77 million (Kuwait Annual Statistical Abstract 2014).

Until the last two decades, the environment was not considered an important issue in the Gulf Cooperation Countries (GCC) countries. In particular, solid waste management was not a prime concern for environmentalists or governmental agencies. Environmental concerns were brought to the attention of governmental authorities in Kuwait when certain environmental groups such as the Kuwait Environmental Society and Green Line Group highlighted problematic issues regarding the country's municipal waste services (Alhumoud 2006). The occurrence of environmental problems and disasters in Kuwait signaled the attention of governments, academics and the public to the infrastructural, socioeconomic and health impacts that were affecting the country. Examples of these environmental problems were: burning oil wells and spilled oil lakes; accumulated waste during/after the Gulf war as a consequence of the Iraqi invasion of Kuwait in 1990; and fish mortality and accumulation along the coast in Kuwait from the summer of 1999 until 2001 (Al-Awadhi 2002). In addition to these hazards, there was an explosion of some houses in AlQurain city in 2001 due to methane gas emissions from a nearby closed landfill site (AlYaqout, 2002).

In general, the Kuwait Municipality – a national agency – is responsible for collecting, transporting and disposing of solid waste generated throughout the country. Kuwait Municipality is a central governmental institute under the supervision of the Ministry of Public Works and

Municipal Affairs. According to Law No.5, Article No.1, “The Kuwaiti municipality is an independent organization with a juristic personality whose location is the city of Kuwait. It shall be defined by a decree from the minister who supervises the municipality’s affairs” (2005).

4.1.2 Municipal solid waste quantity and composition

Municipal solid waste generation in Kuwait is approximately 1.4 kg/ day on a per capita basis: one of the highest in the world (AlFares 2009, Al-Jarallah 2014, Alhumoud, 2002, AlYaqout 2003, Koushki 2002). The Cleaning Department at the Municipality of Kuwait describes municipal solid waste (MSW) as including: natural organic matter, plastics, paper, construction materials, household objects and appliances, various metals, and animal-related wastes. This waste can come from commercial, households, institutional and non-hazardous waste of industrial sources (AlYaqout 2003, AlJarallah 2014) and agricultural waste (Kuwait Annual Statistical Abstract 2012, 2014). Quantities of MSW during the years 2003 to 2014 represent an annual increase in the generation of the categories agricultural and commercial waste, household and institutional waste, and the total annual MSW (represents the combination of previously mentioned waste categories) (table 4.1). The year 2008 had the highest increase in MSW generation (table 4.1) and, as explained by an interviewee in the Municipality of Kuwait, is due to a number of national industrial and urban expansion projects that were established in this specific year. Examples of the MSW categories and the composition of such categories are presented in table 4.2.

Table 4.1: MSW quantities in the years 2003 – 2014

Year	Agricultural and commercial waste (tonnes)	Household and institutional waste (tonnes)	Municipal solid waste (tonnes)
2003	320180	976185	1296365
2004	267944	840005	1107949
2005	261288	851865	1113153
2006	301084	987295	1288379
2007	556408	1020610	1577018
2008	864696	1310036	2174732
2009	570428	1153230	1723658
2010	534191	1408433	1942624
2011	476492	1357395	1833887
2012	503623	1425023	1928646
2013	531037	1487265	2018302
2014	607537	1490235	2097772

Source: Kuwait Annual Statistical Abstract (2012 and 2014)

Table 4.2: Waste categories and examples of the composition of such categories

Category	**Description**
Sanitary	Diapers, sanitary napkins, and tissues
Paper	Office paper, newspaper, magazines and paper bags.
Corrugated fibres	Milk, juice, fruit and vegetable containers, cardboard, and paper cups and plates.
PET bottles	Containers (e.g., soft drink, milk, water containers)
Film	Packing plastic (e.g., bags, sacks, wraps)
Organic waste	Food waste, yard waste and tree leaves
Wood	Wooden furniture, and fruit and vegetables boxes.
Metals	Durable goods, such appliances and furniture, in addition to containers and packaging such as soda cans, food cans, pots, and clothes hangers.
Glass	Containers (soft drink bottles, jars for food, cosmetics, and other products)

Adapted from Al-Jarallah (2014)

Large monthly fluctuations in household solid waste were found with respect to quantity and composition. These fluctuations follow a seasonal pattern (Koushki 2004, AlJarallah 2014). The quantity of waste was found to be higher during the spring, fall, and winter seasons, and in particular, during major holidays (Kuwait Annual Statistical Abstract 2012, 2014). Quantities decreased during the summer months when people were working less and travelling to vacation spots outside the country (Koushki 2004). An example of the monthly fluctuations for the years 2013 and 2014 is shown in figure 4.1. Fluctuations in the seasonal composition of MSW follow a similar pattern (figure 4.2). Estimations of the MSW classified categories and composition are provided by different sources for the years 2002, 2011 and 2014 (table 4.3). The largest portion of the MSW is the organic waste for the various estimations. In 2014, the estimations of MSW composition show that plastics and metals waste have increased to represent 16% and 9.9%, respectively.

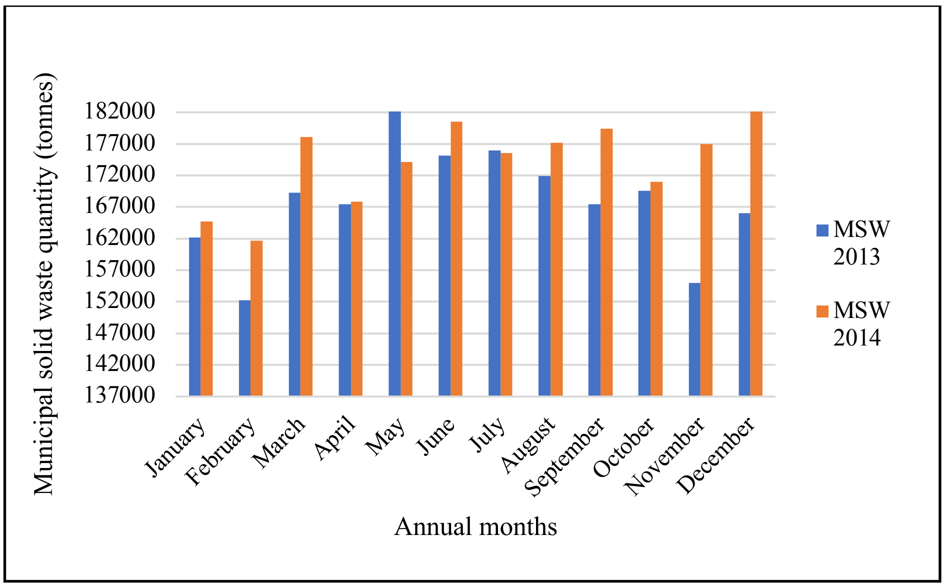

Figure 4.1: Monthly generated MSW during the years 2013 and 2014. (Source: Kuwait Annual Statistical Abstract, 2014)

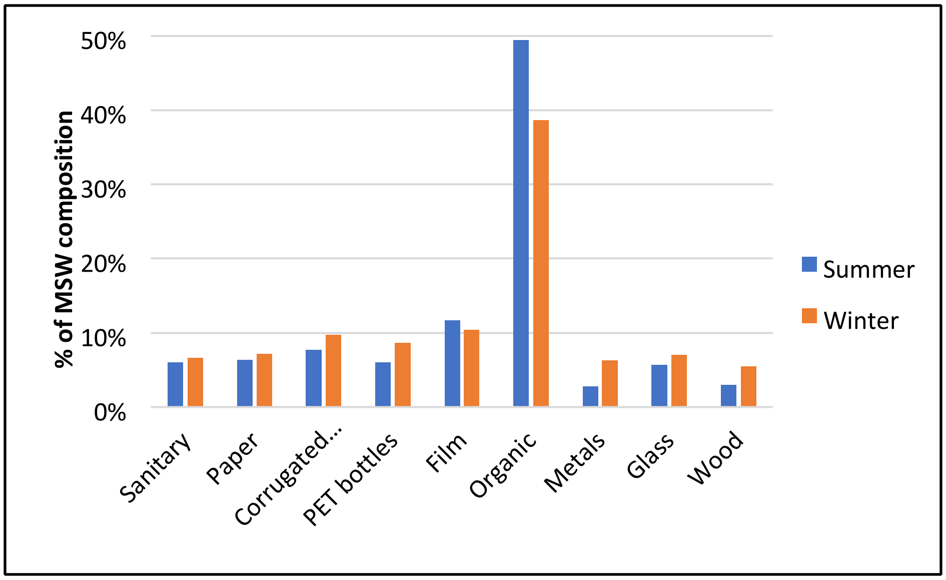

Figure 4.2: MSW composition percentage with respect to season: summer and winter (2012-2014). Source: Al-Jarallah (2014).

Table 4.3: Estimations of MSW classified categories and composition as provided by various sources for the years 2002, 2011 and 2014

Waste	Composition* (%)	Composition** (%)	Composition*** (%)
Sanitary	6.23		
Paper	6.67	21	14.5
Corrugated fibers	8.40	5	
PET bottles	6.89	13	16 (mixed plastics)
Film	11.3		
Organic	45.8	50	45.6
Metals	3.95	3	9.9
Glass	6.09	3	4.7
Wood	3.82		
Other waste		5	9.3

* Adapted from Koushki (2002), Alhumoud (2006).
**Adapted from The World Bank (2011)
***Adapted from Al-Jarallah (2014)

4.1.3 Current municipal solid waste management practices

Until the middle of the 1970s, waste in Kuwait was collected by hand and disposed of in "open dumps" outside the city. Rapid economic and infrastructural development after the oil discovery enabled the Kuwait Municipality to develop waste collection, transport services (public sector only) and landfill practices (Alhumoud 2002).

In 1977, National Decree No. 2111 was issued and allowed private contractors to collect waste. The use of plastic garbage bags for waste collection was made mandatory for all domestic householders in early 1978. Waste collection became a major issue for the Municipality of Kuwait due to the uncooperative activities of the public with the waste collection team such as the refusal to use the black bags or to put waste on the curbside. In 1980, as part of a contractual agreement to promote greater public cooperation, private contractors distributed free 240 litter waste collection containers to be placed in front of houses for each household (Alhumoud 2002).

Since then, the majority of households began to follow the rules, and over time, waste collection operations have become easier to operate. Waste bags are collected from the curbs in front of the houses by rear-loading compacting trucks (Alhumoud 2002). Seven private companies were contracted to collect and transport waste to disposal sites and they continue to be active in MSW services (Koushki 2004). Currently, sixteen private companies have been contracted to collect, transport and dispose of households' waste into non-engineered sites (AlJarallah 2014). Even to this day, MSW collection is a daily operation in Kuwait (Alhumoud 2002; Koushki 2004; AlJarllah 2014; Alsulaili et al. 2014). Collection, transportation and disposal services are provided free of charge to all residential areas and can be as frequent as one or two times a day, with four to five workers working on each truck (Alsulaili et al. 2014).

No formal source segregation exists in the country, but informally, small amounts of recyclable materials such as cans, metals and cardboards are separated by scavengers. Scavengers are mainly the official workers (3-4 workers) on the curbside municipal waste collection trucks that practice informal activities in addition to their formal job of waste collection. Key informant interviews with the Municipality of Kuwait indicated that this type of waste collection is illegal. Only small amounts of recyclable materials are collected by scavengers from residential garbage containers or collected personally by some householders and dropped off in recycling containers at community centres (Koushki 2004, Aljarallah 2014). There is no central or large-scale recycling program in the country (Alhumoud 2008, Alsulaili et al. 2014, Koushki 2004). There are a few recycling companies and their activities are limited to small scale operations (Aljarallah 2014, Alsulaili et al. 2014). The absence of governmental policies to promote recycling and reuse of waste leads to limited contribution of recycling; therefore, most of the recyclable materials are sent to landfills (Aljarallah 2014, Koushki 2004).

The only option that is provided by the Municipality of Kuwait for MSW management is the disposal of wastes into non-engineered sites, referred to as “landfills”, but are mainly nonengineered dumps (Alhumoud 2002; Koushki 2004; AlJarallah 2014; Alsulaili et al. 2014). The country has 16 waste disposal sites (Al-Yaqout 2003) (figure 4.3). Kuwait Municipality operates five landfills (Al-Jarallah 2013; Alsulaili et al. 2014; Al-Yagout 2002, 2003; Koushki 2004) and currently, three locations are assigned for MSW dumpsites: Mina Abdullah, AlJahra, and Seventh Ring Road Site - South (Al-Jarallah 2013, 2014; Alsulaili et al. 2014). The Municipality of Kuwait also operates two sites that are used for the disposal of construction and demolition waste. Some of the reasons why they have closed or abandoned some landfill sites are that the facilities have reached capacity, their proximity to residential (Alhumoud 2002) and military areas (Alsulaili et al. 2014).

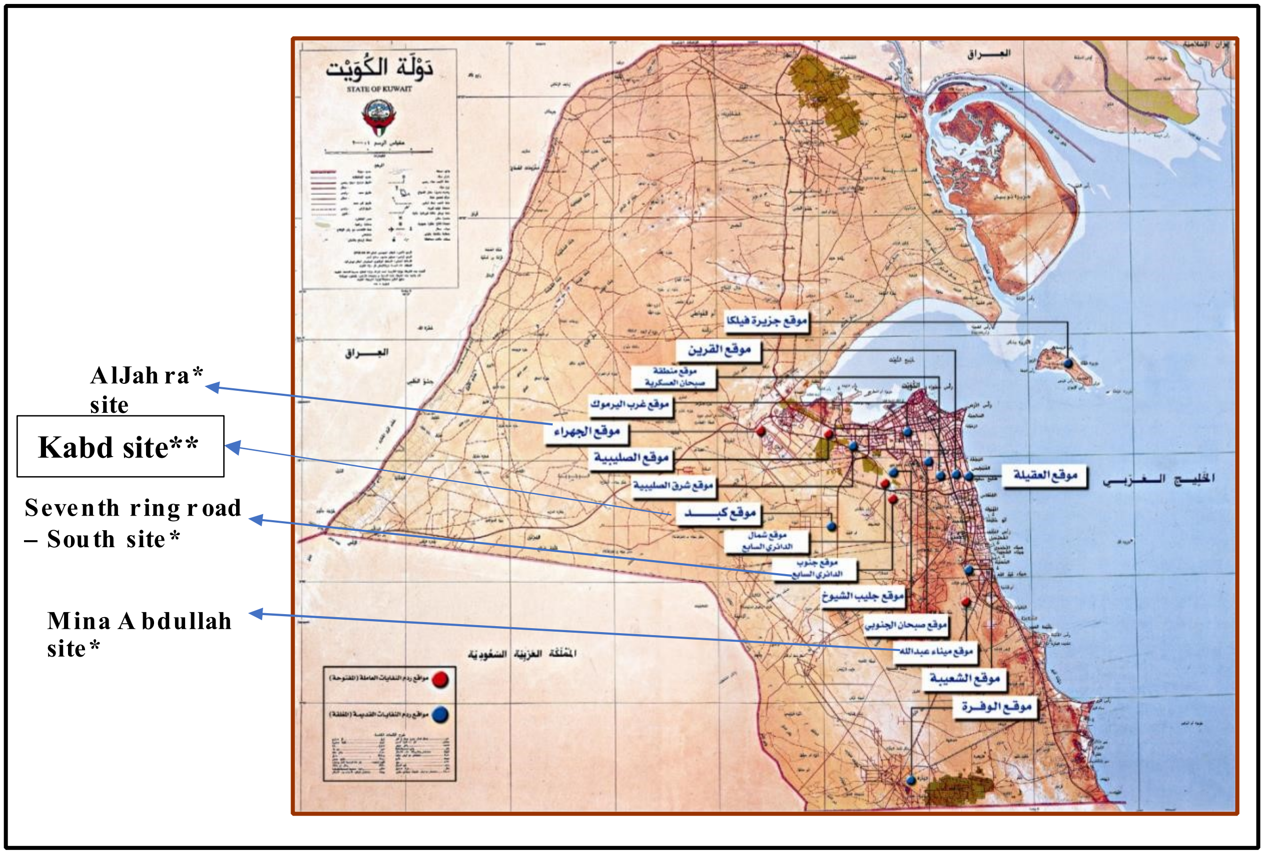

Figure 4.3: Landfill sites located in Kuwait. (Source: Al Rashed, 2018).
***Locations of current landfilling practices.**
****Location of the current project of MSW management in Kuwait.**

Landfill sites are generally empty quarries and are unsanitary and unsafe, and the companies operating them do not follow safe engineering practices or procedures (Alhumoud 2002; Al-Yagout 2002). Alsulaili et al. (2014) stated that "there is not one landfill that meets the criteria of a sanitary landfill". As an example, the seventh ring road site – south for MSW (figure 4.4). Disposal sites are subjected under regulations and standards. the Environmental Requirements and Standards (ERS) as outlined under EPA Law No.210/2001 (Kuwait Al-Youm, 2001). However, these regulations are not being fulfilled, leading to recent landfill scenarios such as Al-Yagout (2002):

1. Illegal dumping and unauthorized entry.
2. No sites have weighing stations.
3. Sites receive all kinds of waste.
4. Sites generate higher amounts of gases, mainly CO_2 and CH_4, along with trace amounts of other gasses and the absence of any site monitoring systems.
5. Absence of leachate collection systems.

Figure 4.4: MSW landfill site located in Seventh Ring Road – South: a and b: Landfill site view. c and d: MSW loading. e: Trucks used to push the dumped MSW to side. f: Sand is collected to be heeled on top of MSW as layers. (Source: Municipality of Kuwait: Department of Environmental Affairs - section of waste management)

The Municipality of Kuwait and the EPA sought alternative options for the disposal of municipal solid waste in landfills due to challenges such as: restricted land use; environmental and social impacts of landfills; light levels of biodegradable waste within municipal solid waste composition; and illegal dumping (AlJarallah 2013, 2014; Alsulaili et al. 2014). Currently, these agencies continue to work through issues such as the required technology to prevent biodegradable and recyclable waste from entering landfills, and opportunities to offer products from recyclable sources that supply market demands (personal interviews in The Municipality of Kuwait and EPA).

4.2 Sustainable development dimensions

4.2.1 Operational demands and constraints

In this section, the results relevant to the MSW management system in the country are presented in terms of data, waste collection and transportation, and technology and waste management related approaches.

4.2.1.1 Data for generated MSW

In a key informant interview, personnel from the Cleansing Department in the Municipality were asked how they calculate the daily, monthly and annual quantities of waste being generated. The amounts are calculated by summing the number of trucks times the capacity of each truck entering the landfill sites to determine whether the truck is operating at full capacity or not. The source of waste is recognized through periodic reports that are provided by the private companies contracted to collect waste.

The surveyed waste actors were in one hundred percent (100%) agreement concerning the importance of having accurate waste generation and composition data for ISMSWM planning. The added comments include promotion and suggestions to involve accurate databases when planning for ISMSWM. The majority of the participants commented that the basic step for ISMSWM planning and decision-making is to establish accurate and updated databases for waste generation, composition and sources. These databases will essentially help to understand how to reduce waste generation and the feasibility of reuse, recycling, treatment and disposal of waste. The databases will aid decisions related to better methods and trucks for waste collection and transportation. In addition, the databases will help to better identify the landfill life span. It was suggested to establish solid waste databases that can be interconnected electronically on a national level to be available for individuals, authorities, private sector and all sectors. Such databases will help in many fields such as data forecasting and predicting, research, providing the private sector with ideas of the types of businesses to be involved with, and it could promote public participation opportunities.

A breakdown of groups of waste actors that are satisfied with the current methods to collect data with respect to: the quantities, composition and sources of generated solid waste are presented in table 4.4. The groups of waste actors are not completely satisfied with the implemented methods to collect data, even the Municipality of Kuwait and the EPA, who are the institutions responsible for the planning, implementing and monitoring of MSW management.

Table 4.4: Waste actor responses about their satisfaction with the implemented methods used to collect data about solid waste sources, quantities and composition considering their specific institutions

Waste actors' groups	No. of surveyed Participants	Satisfaction with the methods implemented to collect data for waste generation		
		Sources	Quantities	Composition
Total	65	32 (49%)	33 (51%)	25 (39%)
Group 1: Municipality of Kuwait	32	44%	50%	34%
Group 2: EPA	8	13%	25%	25%
Group 3: Governmental institutions	6	33%	33%	17%
Group 4: Research and Educational institutions	8	75%	50%	38%
Group 5: Consultation companies	11	83%	82%	73%

4.2.1.2 Waste collection and transportation

Around 69% of the householders were mainly satisfied with the current municipal waste collection services, 24% evaluated services as "excellent", 45% evaluated them as "good", and 31% as "bad" (figure 4.5). Regarding current municipal waste collection services, 61% of the householders responded that they were satisfied with the daily collection of the generated MSW (tables 4.5 and 4.6). This satisfaction was mainly due to the daily curbside collection of MSW that is offered by the Municipality (table 4.5). Figure 4.6 presents the householder responses about what they disliked about the current waste collection services. Results show that many factors are disliked by the householders such as: containers are small and always full and people are using the containers properly.

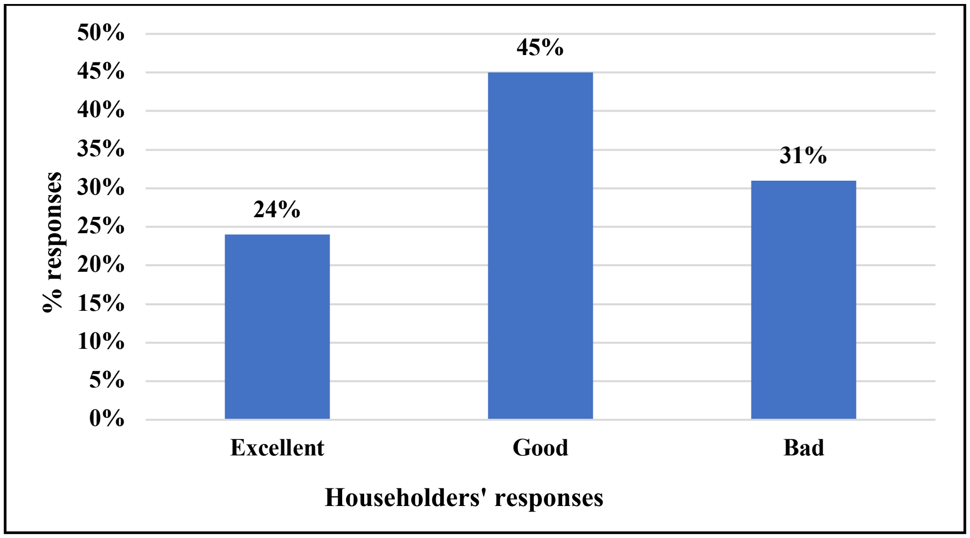

Figure 4.5: Householders' responses about rating the current waste collection service

Table 4.5: Householders' responses about what they liked about the current waste collection services (Gender)

What householders liked about current waste collection services / Gender	Easy for householders	Streets are Clean	Daily waste collection	Free of charge	Total
Male	12	25	**110* (64.7%)**	12	157 (57.4%)
Female	12	42	**60* (35.3%)**	4	118 (42.6%)
Total	24	67	**170**	16	277
Percentage (%)	8.7%	24.4%	**61.4%**	5.8%	100%

*Bold refers to the highest percentage (%)

Table 4.6: Householders' responses about what they liked about the current waste collection services (Age)

What householders liked about current waste collection services / Age	Easy for householders	Streets are Clean	Daily waste collection	Free of charge	Total
18-29	8	27	**63* (37%)**	0	**98 (35.4%)**
30-39	9	28	**56* (33%)**	5	**98 (35.4%)**
40-49	6	9	29 (17%)	9	53 (19.1%)
50+	1	3	22 (13%)	2	28 (10.1%)
Total	24	67	170	16	277
Percentage (%)	8.7%	24.4%	61.4%	5.8%	100%

*Bold refers to highest percentage (%)

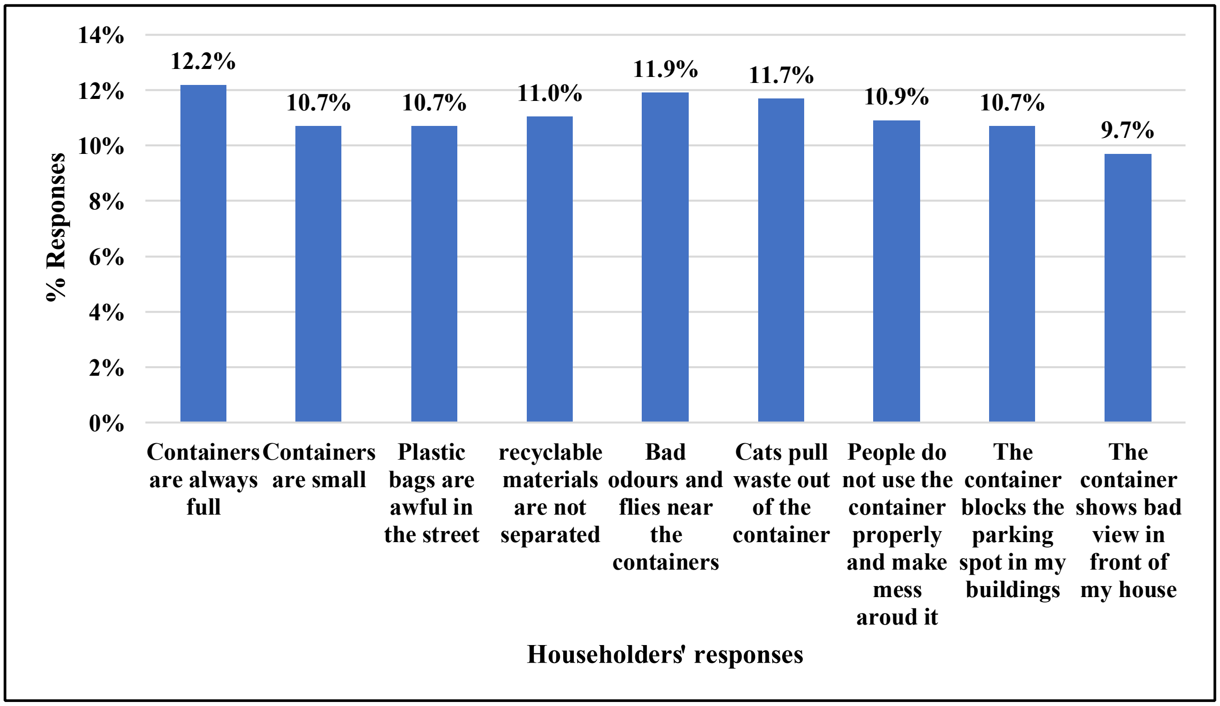

Figure 4.6: Householder responses about what they disliked about the current waste collection services

Participants of the householders' questionnaire were questioned about how they dispose of different types of waste (table 4.7). The majority of waste is disposed of by the municipality's garbage trucks. As examples, garbage truck collection is the favoured method at: 88% of food waste, 87% of yard trimmings, and 63% of paper/cardboard (table 4.7). While recyclable waste from households such as glass, plastic and metal are collected by MSW garbage trucks, there are also efforts for recycling and reuse (table 4.7):

1. Plastics: 65% of householders disposed of plastics to be collected by garbage trucks, while 30% separated plastics for recycling, and 5% reused plastic waste.
2. Metals: 67% disposed of metals to be collected by garbage trucks, while 29% separated metals for recycling, and 4% reused metal waste.
3. Glass: 68% disposed of glass to be collected by garbage trucks, while 29% separated glass for recycling, and 5% reused glass.

Not all of the participants answered the question about how they disposed of used appliances, furniture and clothes. The garbage collection was the favoured option at: 37%

disposal of used appliances, 31% of used furniture, and 26% of used clothes. In addition, there were efforts by the householders to recycle and reuse appliances, furniture and clothes. The results show that these recyclable items were being sold (at almost the same percentage of responses for each type of used item – 47-48%) to either individuals or businesses that come to the door to collect recyclable waste (figure 4.7).

Table 4.7: Householders' responses about how they dispose of different types of waste

Waste type **type**	**Disposal**	**Garbage truck**	**Recycle**	**Reuse**	**Compost**	**Not answered**
• Organic	Food waste	88%	---------	5%	1%	6%
	Yard trimmings	87%	3%	2%	6%	2%
	Paper/cardboard	63%	26%	11%	-------------	----------
• Recyclable	Plastics	65%	30%	5%	-------------	----------
	Metals	67%	29%	4%	-------------	----------
	Glass	68%	26%	5%	-------------	1%
• Used household goods	Used appliances	37%	8%	7%	-------------	48%
	Used furniture	31%	8%	6%	-------------	55%
	Used clothes	26%	6%	7%	-------------	61%

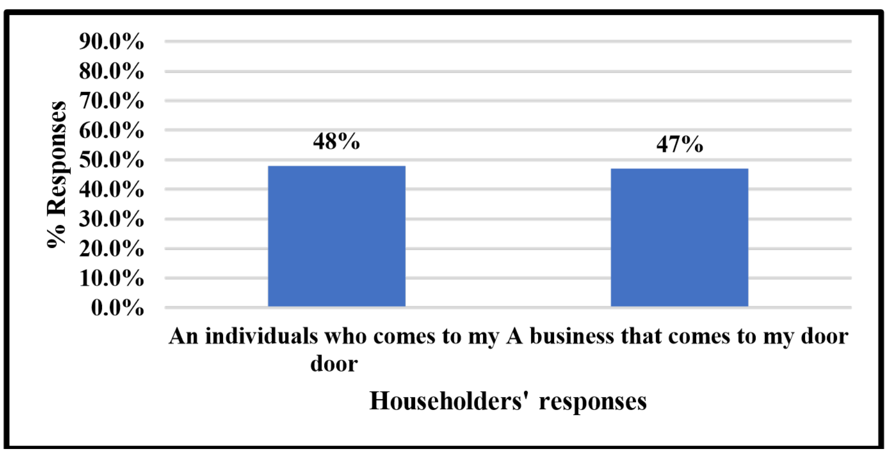

Figure 4.7: Householders' responses: to whom do they sell their reusable waste

Householders responded about the suggestions on how to improve the current municipal waste collection system; the main suggestions selected by householders were: proper use of waste containers (19%), offering more waste containers (18%), and promoting public education about recycling (14%) (figure 4.8). Moreover, 11% supported providing fees to promote waste separation, 11% supported awareness through media and advertisements, 9% of the participants supported providing better trucks for waste separation to improve the waste collection system and 9% supported applying fees for waste services. The least support was for offering training courses about waste separation (figure 4.8).

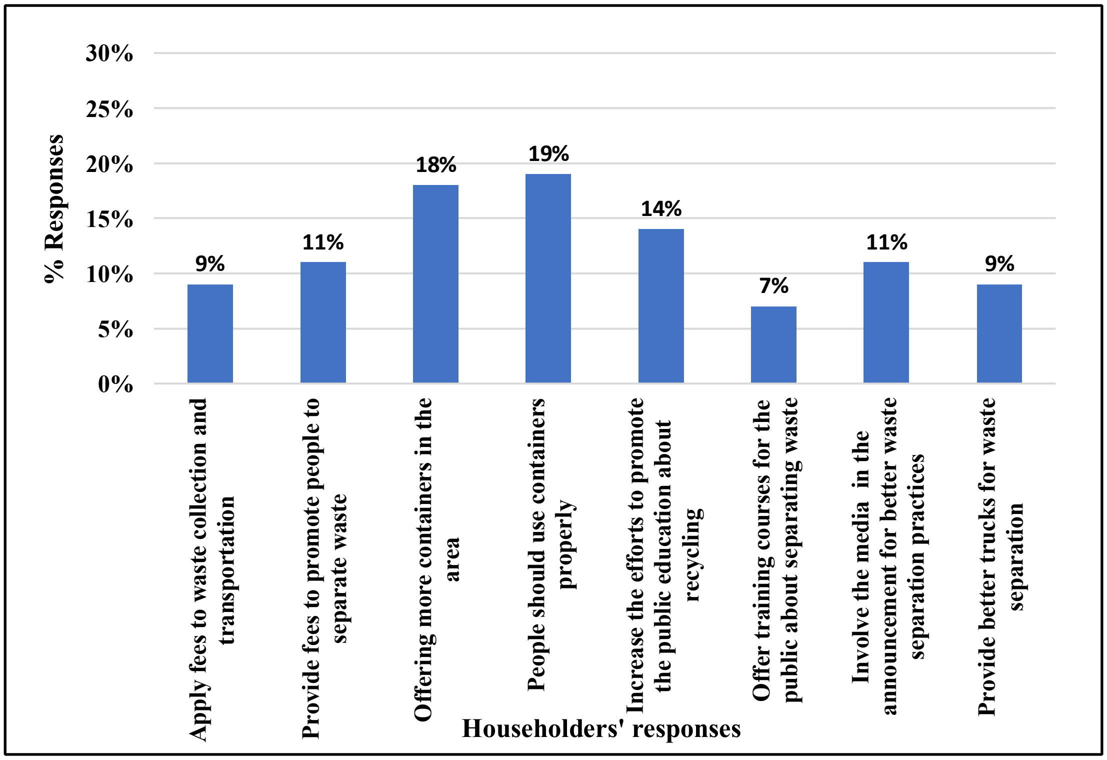

Figure 4.8: Householder responses about suggestions to improve the current municipal waste collection system

Some examples of the current MSW management practices such as MSW collection trucks, curbside containers, household mixed waste (includes yard waste) and even commercial waste containers (includes mixed waste) are presented in figure 4.9. The majority of the surveyed waste actors, 92%; were satisfied with the existing daily curbside waste collection and transportation (table 4.8). At the same time, 72% of the waste actors were unsatisfied with the source separation (table 4.8). The waste actors (group 1) who are responsible for planning, implementing and managing MSW were even satisfied with MSW collection and transportation as well as being unsatisfied with source separation options availability (table 4.8).

Figure 4.9: Some examples of the current MSW management practices: a. Municipal solid waste collection truck, b. Curbside container presents household mixed waste, c. Curbside container presents household mixed waste, includes yard waste and d. Commercial waste container includes mixed waste. (Photos by AlManssoor, 2018)

Table 4.8: Waste actor responses concerning their satisfaction with the collection and transportation and source separation of MSW in Kuwait considering their specific institutions

Waste actors' groups	No. of surveyed Participants	Satisfaction with the collection and transportation of MSW in Kuwait	Satisfaction with the source separation of MSW in Kuwait
Total	65	60 (92%)	18 (28%)
Group 1: Municipality of Kuwait	32	97%	25%
Group 2: EPA	8	75%	25%
Group 3: Governmental institutions	6	83%	33%
Group 4: Research & Educational institutions	8	88%	25%
Group 5: Consultation companies	11	100%	36%

In terms of the possibility to improve the current situation, 71% of the waste actors agreed that there currently are plans that have been adopted to improve MSW collection and transportation (figure 4.10) and only 48% participated to recognize the current adopted plans (table 4.9). Among the listed options, the focus was on the distribution of communal containers all over the provinces (48%) and offering blue bins for recyclable waste (46%).

Based on key informant interviews, participants stated that the Cleansing Department is currently exploring different approaches to improve waste collection and separation. Communal containers have been distributed in some residential areas in different provinces to collect separated paper and cardboard waste, plastics and aluminum containers. An example is shown in figure 4.11. Moreover, they added that although the communal containers are not always used properly and are not well known to the public, their implementation throughout the country is an advanced step in MSW separation in Kuwait. Moreover, the communal containers engage active participation by the public in practising MSW separation.

According to interviews with personnel in the Cleansing Department in the Municipality of Kuwait, the companies contracted to collect and transport MSW were introduced to the idea of adding new waste collection trucks that would be equipped with facilities to separate organic waste from other wastes. The contracted companies shared their concerns that to implement this idea throughout Kuwait's provinces, a governmental subsidy would be required due to the high added costs that are beyond what these companies can afford.

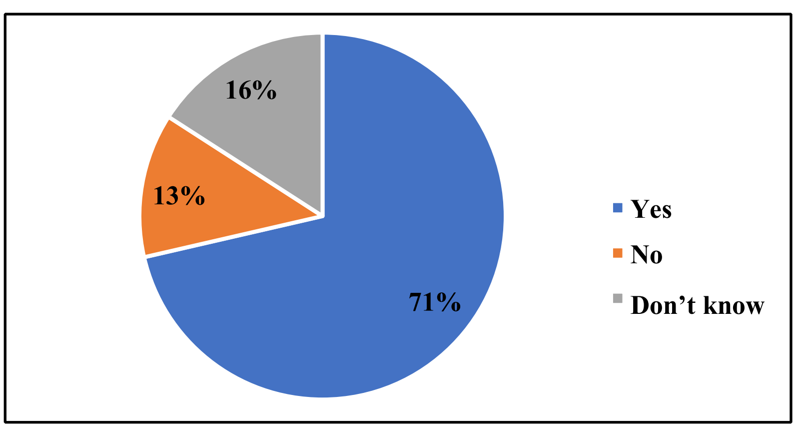

Figure 4.10: Waste actors' responses about whether there are current plans in place to improve solid waste separation in Kuwait.

Figure 4.11: Communal containers for separated MSW. (Photo by AlManssoor, 2016)

Table 4.9: Waste actors' responses about the suggested options to improve MSW collection and separation

Waste actors' groups	**NO. of surveyed Participants**	**Communal container**	**Blue bin (recycling)**	**Green bin (organic waste)**	**New trucks**	**Material recovery facility (MRF)**
Total	65	31 (48%)	30 (46%)	23 (35%)	18 (28%)	14 (22%)
Group 1: Municipality of Kuwait	32	44%	47%	41%	31%	31%
Group 2: EPA	8	25%	50%	13%	38%	13%
Group 3: Governmental institutions	6	33%	17%	17%	0%	17%
Group 4: Research & Educational institutions	8	38%	75%	50%	13%	0%
Group 5: Consultation companies	11	91%	36%	36%	36%	18%

4.2.1.3 Technology and waste management related approaches

The householder survey involved questions concerning their knowledge of waste management related technologies and approaches, and their willingness to participate. As to whether they had heard about composting, only 21% of the participants responded “Yes” while 79% of the participants responded “No” (figure 4.12). When asked whether they had heard about recycling, more than half of the participants were knowledgeable; 53% responded “Yes” while 47% did not know about recycling. About 81% of the surveyed participants agreed to separate organic waste if green bins were offered.

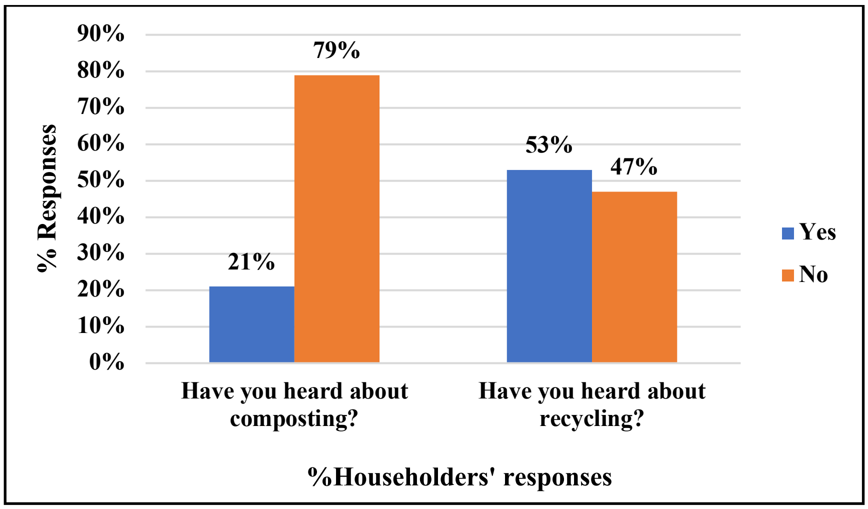

Figure 4.12: Householders’ responses about their knowledge of composting and recycling programs

The majority (80%) of the surveyed householders answered favourably that they would agree to participate in activities promoting recycling activities (figure 4.13). For more clarification of an example of the expected activities if a recycling program is to be set up, 85% of the surveyed householders agreed that they would separate recyclable wastes if specific bins were offered. Results show that there is a significant relationship between willingness to separate recyclable waste (table 4.10) and the age of the participants, building function and number of people living in the house (table 4.10). The ages of the participants in the interval (30-39) exhibited the highest percentage, 38%, option (a.home) for the function of the occupied building exhibited the highest percentage, 92% and the option (4-6) for the number of people living in the property exhibited the highest percentage, 41%.

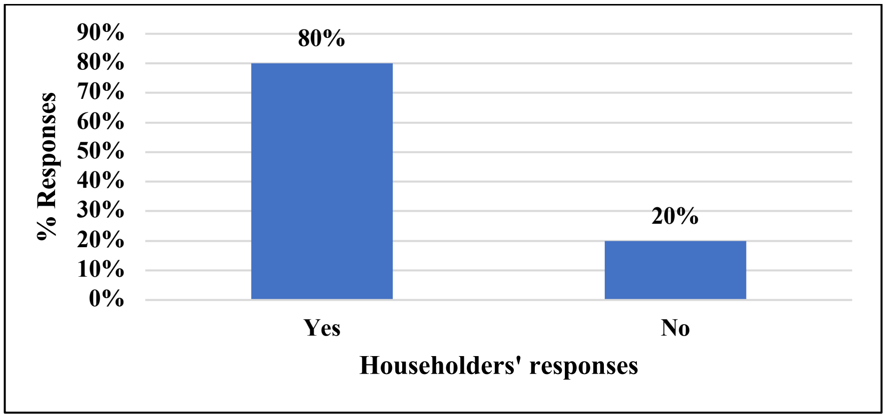

Figure 4.13: Householders' responses about their willingness to participate in recycling programs: If a recycling program was set up, would you be willing to separate waste for collection purposes?

Regarding a suggestion to separate waste and put the different separated types of waste into communal containers, 85% of the householders agreed. About 71% agreed to participate in returning the plastic bottles if they were paid upon returning them to the grocery store. For purchasing less throwaway products (such as, plastic bottles) and using alternative long-life products to reduce the amount of waste, 80% of the householders agreed to participate. For the preference of the householders to get more information about how, and what types of waste can be composted, reused and recycled in order to reduce the amount of disposed waste, 75% of the householders preferred to get more information.

Between 1984 and 1986, MSW management practices were re-evaluated by the Municipality of Kuwait. With support from various educational and research institutions, th Municipality of Kuwait made several attempts to plan and implement alternative options. Recycling and composting were recommended (Alhumoud 2002). For the past thirty years, the Municipality of Kuwait and municipalities in the GCC region have concentrated their efforts on composting as one of the favoured alternatives (Alhumoud 2002). In 1992, two composting plants were proposed, one in north and one in south Kuwait, each with a capacity of 700 tonnes/day (Alhumoud 2002). Kuwait Municipality started a pilot plant with the assistance of a French company, but it was abandoned eventually because of the poor performance, lack of professional operators, insufficient technical support, high maintenance and operational costs, and poor management (Alhumoud 2002, 2004). All these factors contributed to a systemic failure of composting plants and caused the operations to stop by 1998 (Alhumoud 2004).

Regarding the currently existing MSW management facilities in Kuwait, surveyed waste actors were aware of the following facilities operating in the country: dumping (55%), landfill (54%), recycling (51%), incineration (26%) and composting (9%) (table 4.0). Key informant interviews and a literature review (AlJarallah 2014, Alsulaili et al. 2014, Alhumoud 2006) reveal that the only existing operation for MSW management is dumping into non-engineered sites. Results showed that the waste actors are not well-acquainted with existing facilities for current MSW management (table 4.10).

In Kuwait, governmental recycling policies and organized recycling programs are not available. The main recycling activities are informal and recyclables such as cardboard and metal are gathered by scavengers from residential garbage (Alhumoud, 2003). Figures 4.14 presents different types of household waste that are collected by scavenging activities on residential streets (e.g: cardboard, papers, plastics and metal cans). Some types of plastics (e.g: PP twisted ropes and PVC hoses) are shredded and exported to other countries such as England and China (p.c. with head of ISWM section in EPA July, 2016), or to Arab countries such as Egypt and Lebanon (Alhumoud 2005).

Table 4.10: Waste actor responses about existing facilities for MSW management in Kuwait considering their specific institutions

Waste actors' groups	No. of surveyed Participants	Dumping	Landfill	Composting	Recycling	Incineration
Total	65	36 (55%)	35 (54%)	6 (9%)	33 (51%)	17 (26%)
Group 1: Municipality of Kuwait	32	38%	53%	9%	50%	13%
Group 2: EPA	8	75%	63%	0%	38%	63%
Group 3: Governmental institutions	6	83%	83%	17%	50%	50%
Group 4: Research & Educational institutions	8	63%	63%	0%	63%	13%

Group 5: Consultation companies	11	73%	27%	18%	55%	36%

Figure 4.14: Types of recyclables that are collected by scavengers: a. Cardboard b. Papers c. Plastics and d. Metal cans. (Photos by AlMAnssoor, 2018)

In Kuwait, incinerators were only used to burn infectious and/or contaminated waste such as hospital waste. Hospital incinerators were used on a daily basis for this purpose. Expired, unused and unwanted pharmaceuticals and non-hazardous wastes from hospitals were dumped directly into landfill sites (Alhumoud, 2002). At present, all of the hospital incinerators have been closed and the infectious and/or contaminated waste is burned in two new incinerators located in a desert area in the north of the country (p.c. with head of ISWM section in EPA July 2015).

Waste actors were asked for their perspective on the effectiveness of the existing MSW management practices with respect to the factors listed table 4.11. The majority of respondents stated that current MSW management practices are ineffective. For example, they believed that practices were ineffective in supporting: resource recovery (85%), reduction of GHGs emission (86%), prevention of penetration of leachate to soil from landfill sites (89%), recycling (81%) and waste reduction (86%) (table 4.11).

Table 4.11: Waste actor responses about the importance of the current implemented practices for MSW management to support the mentioned factors

Waste actors' groups	No. of surveyed Participants	Promote resource recovery	Reduce GHGs emission	Prevent leachate from soil	Promote recycling	Promote waste reduction
Total	65	10 (15%)	9 (14%)	7 (11%)	12 (19%)	9 (14%)
Group 1: Municipality of Kuwait	32	16%	19%	6%	16%	13%
Group 2: EPA	8	13%	25%	0%	25%	13%
Group 3: Governmental institutions	6	33%	17%	17%	33%	17%
Group 4: Research & Educational institutions	8	13%	0%	50%	0%	25%
Group 5: Consultation companies	11	9%	9%	0%	38%	9%

Waste actors were questioned in order to understand the future possibilities of the government to adopt waste management-related approaches that are oriented toward a sustainable and integrated municipal solid waste management system (ISMSWM). In total, no category exceeded 30%. In addition, 25% of respondents stated 'no opinion' and 23% indicated that none of the listed approaches were adopted. Surveyed waste actors who represented the Municipality of Kuwait selected mainly EFW and resource recovery by 31% each (table 4.12).

Table 4.12: Waste actor responses about the currently adopted SWM approaches that are oriented toward ISMSW management

Waste actors' groups	No. of surveyed participants	EFW	Resource recovery	Zero-waste	Waste reduction	Waste separation (MRF)	Not applied	No opinion
Total	65	19 (29%)	15 (23%)	13 (20%)	9 (14%)	2 (3%)	15 (23%)	16 (25%)
Group 1: Municipality of Kuwait	32	31%	31%	16%	6%	3%	25%	22%
Group 2: EPA	8	13%	13%	13%	13%	0%	25%	38%
Group 3: Governmental institutions	6	0%	0%	0%	0%	0%	17%	50%

Group 4: Research and education institutions	8	25%	25%	25%	50%	0%	25%	0%
Group 5: Consultation companies	11	54%	18%	46%	18%	9%	18%	27%

In addition to the waste management-related approaches, it is necessary to understand the perspective of the waste actors regarding technologies that would be suitable as the country moved toward ISMSWM. Composting and thermal treatment exhibited the highest percentage: 46% and 42%, respectively (table 4.13). The waste actors who represent the Kuwait Municipality selected the options of composting and thermal treatment as the maximum percentage: 56% and 34%, respectively. These two options were the most selected by EPA. Although composting was the option that was selected by the maximum percentage of the waste actors who participated in the survey, it is not the option that is discussed currently by decision-makers to promote ISMSWM in Kuwait (p.c. with head of ISWM section in EPA July 2016). The main reasons to restrict composting as a waste management option are the previous failed experiences and the lack of local marketing of the produced compost. Thermal treatment at an MRF was the preferred treatment option. This selection confirmed that interviewees preferred thermal treatment of the whole stream of MSW in order to obtain the highest amount of energy - electrical - as recommended by the consultation companies.

The reasons mentioned by waste actors for supporting EFW and AD approaches are included in table 4.14, and the reasons for restricting the implementation of EFW and AD approaches are included in table 4.15.

Table 4.13: Waste actors' responses about the suitable technology to move toward ISMSWM considering their specific institutions

Waste actors' groups	**Participants**	**Composting**	**Thermal treatment**	**MRF + thermal treatment**	**AD**	**MRF* + AD**	**No opinion**
Total	65	30 (46%)	27 (42%)	25 (39%)	20 (31%)	14 (22%)	10 (15%)
Municipality of Kuwait	32	56%	34%	31%	28%	25%	16%

EPA	8	38%	38%	13%	25%	25%	38%
Governmental institutions	6	17%	33%	33%	67%	33%	17%
Research & Educational institutions	8	50%	50%	50%	13%	13%	0%
Consultation companies	11	36%	64%	73%	36%	9%	9%

*AD (aerobic digestion); MRF (material recovery facility)

Table 4.14: The reasons and suggestions for promoting EFW and AD approaches in Kuwait

SI* No.	Institution	Waste actors' responses	Suggestions
1, 2, 3, 4, 7, 17	1-Consultation company, 2- EPA, 3Governmental institution and 4- Kuwait Municipality	To promote renewable energy and environmental protection.	________________________
21	Kuwait Municipality	To limit the use of landfill sites. Recently, this is the best approach that is adopted worldwide for MSWM.	________________________
31, 35	Kuwait Municipality	The EFW approach is preferred since recently, waste generation is increasing and there are health and environmental effects and no economic revenues. Implementing such approaches will provide economic revenues and will limit the use of landfill sites.	The lands of the country will be invested for other useful projects.
36	Kuwait Municipality	___________________________	An essential factor for successful implementation of this approach is deciding on the best choice of technology depending on the waste quantity and composition.
13, 27	EPA	This approach is environmentally friendly from many sides since it can provide a renewable energy source, high quality compost and restrict the use of landfill sites.	___________________________
43	Research and education institution	Has economic revenues and can reduce CO_2 emissions to comply with international goals.	____________________________
16	Research and education institution	Although EFW could result in air emissions, it may be the best choice with the fewest disadvantages. Therefore, EFW is preferred to restrict the use of landfill sites and the problem of land scarcity in Kuwait.	____________________________
24	Research and education institution	This depends on the project and circumstances as well as the availability of a legal basis.	In Kuwait the waste is mixed waste and thus to apply the anaerobic digestion (AD) technology the organic waste input to AD plants needs to be separately collected in order for plants to be feasible and produce a high quality compost. Therefore, the thermal treatment where the mixed waste is fed into the incinerator would be a favourable choice due to the existing conditions of the waste market in Kuwait.

48	Consultation company	It is vital since a significant portion of municipal solid waste is rich in organic material.	___________________________
52	Consultation company	Anaerobic digestion is a better option to extract energy.	Anaerobic digestion is a better option to extract energy since it can be mixed with sewage that is completely decomposed, which leads to biogas and fertilizer. The sludge that remains can be incinerated.
56	Consultation company	Anaerobic digestion is preferred because it is environmentally friendly.	_____________________________

*SI NO.: serial number of the questionnaire

Table 4.15: Reasons for restricting the implementation of EFW and AD approaches to SWM in Kuwait

SI* No.	Institution	Waste actors' responses
18	Kuwait Municipality	Because of the cheap price of electricity in Kuwait
29	Kuwait Municipality	More useful to promote resource recovery by implementing recycling and reuse.
45	Research and education institution	The need is greater for compost to apply to desert lands.

*SI NO.: serial number of the questionnaire

4.2.2 Public health and environment

Heightened national awareness of environmental and environmental health issues over the past couple of decades has led to greater concern over solid waste management. Due to pressure from national environmental organizations to take environmental management issues seriously, SWM practices have become a particular area of focus for the Government of Kuwait.

Results from the householder survey demonstrate the increase in public concern for SWM issues commensurate with the national government's expanded focus on environmental management. About 76% were concerned about the current environmental situation in Kuwait, while 13% were not concerned, and 11% had no opinion (figure 4.15). When householders were asked about their personal opinions about the importance of the issues currently affecting the natural environment (table 4.16), the biggest concern was about air emissions from petrochemical industries (81.5%) and factories (74.5%). The second greatest concern was about contamination by hazardous solid waste-like chemicals and waste from industries - and medical waste from hospitals and medical institutions: 71% and 69. Nearly half of the respondents (45.5%) ranked municipal solid waste management as the seventh most important issue currently affecting the natural environment (out of 8 listed issues) (table 4.16).

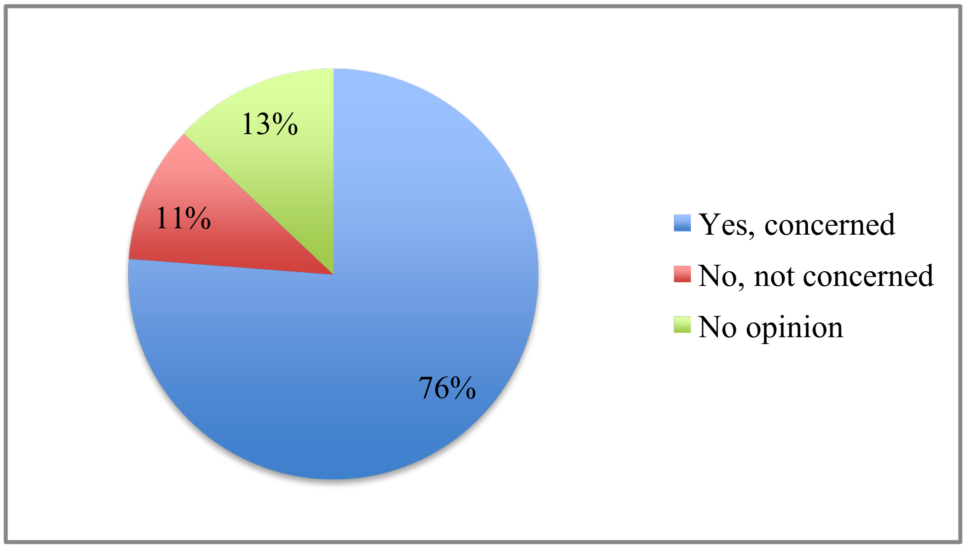

Figure 4.15: Householder responses about whether they are concerned about the current situation of the environment in Kuwait

Table 4.16: Householder opinions about the issues currently affecting the natural environment in Kuwait

Factors affecting the natural environment in Kuwait		Most important	Important	Slightly important	Not important
1	Air emissions from petrochemical industries	81.5%	17.3%	1%	0.2%
2	Air emissions from factories	74.5%	23%	2.3%	0.2%
3	Hazardous solid waste (e.g. chemicals, industrial waste)	70.8%	26.5%	2.7%	0%
4	Medical waste	69.3%	23.3%	6.3%	1.1%
5	Air emissions from automobile exhaust	68%	29.5%	2.5%	0%
6	Poor public behaviour such as littering and graffiti	56.8%	31.8%	10.5%	1.0%
7	Municipal solid waste management	45.5%	36%	17.5%	1.0%

8	Desertification	33.8%	31%	20.5%	14.7%

4.2.3 Policy, legal and institutional arrangements

In this section and the next, the results are relevant to the policies, strategies, laws, regulations and programs related to MSW management in the country. The national policy for SWM and MSW management was not well clarified by the responsible institutions until the World Bank (2011) issued the document "State of Kuwait – Solid Waste Sector – Assessment of Current Conditions: Report of Waste Management Investments of Small and Medium-Sized Enterprises (SMSE) in Kuwait (with cooperation from the Industrial Bank of Kuwait), 2011" that promoted alternatives for landfilling practices. In addition, Kuwait Vision 2030, which promotes the achievements of the SDGs, promoted the policy-makers in Kuwait to include the climate change and EFW targets in the National Policy (Kuwait voluntary national review 2019). The World Bank helped to improve The Environmental Law and relevant legislation to comply with Kuwait Vision 2030. These improvements include SWM and MSW management articles. Moreover, The World Bank also is helping in formulating the current National Environmental Strategy, which includes SWM and MSW management, to comply with current National Policy to provide the proper relevant plans and programs to implement the improved strategy. The details of this introduction are presented in the following paragraphs and the next section.

Kuwait was one of the first Gulf countries to enact environmental laws in 1964. Additional protective legislation has been introduced and amended to support development in Kuwait from a scientific and economic perspective (see table 4.19). Kuwait enacted a new law, No.62, in 1980 for the protection of the environment (Al-Awadhi, 2002). In this legislation, the Higher Council for the Environment replaced the Committee of the Environment. The Council was tasked with preparing the General Policy, as well as drafting legislation for environmental protection (AlAwadhi, 2002).

In 1990, Iraq's illegal aggression upon the State of Kuwait caused severe damage to the environment and depleted much of its natural resources. Following the liberation of Kuwait, concerned authorities examined the existing laws and regulations. Consequently, a new environmental law was issued in 1995 to replace the 1980 legislation, and this established the Environmental Public Authority (EPA). 21 Articles were included in the new law which consists of general legislation (Al-Awadhi 2002; EPA Law No.210/2001). Al-Awadhi (2002) argues that this law contains several shortcomings that hinder its effective application in the protection of the Kuwaiti environment. For example, one of the main critiques is that the law focuses on the Public Authority structure and functions, instead of the application and enforcement of environmental protection in Kuwait. Environmental legislation in Kuwait was expanded and strengthened by the issuance of the Environmental Requirements and Standards (ERS) (EPA Law No.210/2001) in September 2001 (Kuwait Al-Yoom 2001). The ERS are contemporary foundational laws that govern and promote waste management and they were amended in October of 2002 (Alhumoud 2008). The details of the Environmental Requirements and Standards (ERS) (EPA Law No.210/2001) are attached in Appendix C.

Accompanying the legislative progress in the general environmental context, and in solid waste management specifically, there has also been development in administrative institutions and defining of responsibilities. Kuwait Municipality has realized the need for governance of solid waste handling and generation management and established the Environmental Affairs Department (EAD) in 1996. This department can conduct research in various environmental fields (Alhumoud 2002). The Division of Waste Treatment and Disposal of the EAD is responsible for MSW management in Kuwait and has the following mandates:

1. Work to monitor the implementation of the adopted strategy of Kuwait Municipality for MSW management.
2. Work to improve the strategy to reach the target of environmental protection.
3. Siting landfills and preparing these locations for waste transportation and dumping.
4. Supervision and follow-up on private companies who are awarded waste disposal contracts.
5. Work to follow all operational procedures in coordination with all concerned institutes about the benefit, treatment and disposal of waste.
6. Establish and implement various environmental awareness programs in coordination with all stakeholders inside and outside the municipality to raise the environmental awareness among the public and the institutes (KMAF: Ch. 3, p.96).

Another department responsible for solid waste management is the Cleaning Department of Kuwait Municipality (Alhumoud 2002). The Cleaning Department has an office in each of the six provinces (AlAsma, AlAhmadi, AlFarwaniya, Hawalli, Mubarak-AlKabeer and AlJahra) in order to supervise the execution of private company contracts granted for MSW collection and transportation to landfill locations. The Cleaning Department monitors illegal solid waste disposal activities (KMAF: Ch.8, p.220). The EPA contains the Industrial Waste Management Section (IWMS), which in turn holds regulatory authority over industrial solid waste (Alhumoud, 2002). In particular, the IWMS has the authority to supervise and regulate different types of waste such as municipal, medical and hazardous wastes, and even wastewater treatment. The IWMS of the environmental public authority (EPA) is the primary regulating authority for disposal of expired, unused, and unwanted pharmaceuticals (Alhumoud, 2006). The historical progress of the environmental law and legislation is presented in table 4.17. In addition, table 4.18 presents the historical progress of the environmental institutions.

Table 4.17: Environmental Law and legislation progress in the State of Kuwait

Year	Environmental Law and Legislation progress in the State of Kuwait
1964	The Environmental Legislation (focused on marine environment)
1965	Law of Industries
1968	The 1964 Law was amended
1972	The Law of Kuwait Municipality
1973	Law Concerning the Conservation of the Petroleum Resources
1976	The 1964 Law was amended again
1980	Law Concerning Protection of the Fisheries Resources
1980	Decree Law No.62 regarding protection of the environment and general policy for the protection of the environment (consisted of 13 articles)
1995	The establishment of the Environmental Public Authority Law (replaced the 1980 Law), (consisted of 21 articles)
2001	EPA Law No.210/2001, Environmental Requirements and Standards (ERS)

2002	EPA Law No.210/2001 was amended
2002	EPA issued the Environmental Strategy for the State of Kuwait in cooperation with the United Nations Development Program
2014	Environmental Protection Law NO.42 of 2014
2015	Law NO.99 of 2015 amending some provisions of the Environmental Protection Law No.42 of 2014

Table 4.18: Historical progress of the environmental institutions in Kuwait

Year	Environmental administration progress in the State of Kuwait	The role of the institution/department
1972	Municipality of Kuwait: Law of Kuwait Municipality (Includes the Cleaning Department which was responsible for solid waste management)	Awareness and Sensitivity, waste management and waste recycling (UNDP 2011b)
1980	Higher Council of Environment: (Decree Law No.62 established the Higher Council of Environment)	Regulatory Authority (*Arab Law Quarterly* 1999)
1995	EPA: Establishment of the Environmental Public Authority (EPA) (Includes the Industrial Waste Management Section (IWMS))	Legislation review, international obligations, awareness and sensitivity, policies and strategies (UNDP 2011b)
1996	EAD: Establishment of the Environmental Affairs Department (EAD) (Includes the Division of Waste Treatment and Disposal)	The EAD is "an active department that has the potential to conduct research and studies in different environmental fields that will assist in the future decisions pertaining to MSW treatment and disposal" (Alhumoud 2006)

From an extensive survey conducted by Al-Awadi (2002) to examine the application of the existing Environmental Laws and Regulations between 1965 and 2002 indicates that while progress has been made over the last few decades in terms of environmental issues and solid waste management, these developments may be constrained by inadequate advances in environmental legislation enforcement (Al-Awadi 2002). In 2014, the improved Environmental Protection Law No.42 was issued with the aim of:

"protecting and maintaining the natural balance of the environment and its resources; combating the pollution and its damages, (both short and long term); banning any party whatsoever, whether a company or institution or consultation office from carrying out any work in this field without prior consent of the EPA; obliging all firm owners in the country to implement all the engineering and environmental requirements set by the EPA; planning programs for economic, agricultural, industrial, touristic and urban development to improve the level of livelihoods; guaranteeing a sustainable development and preserving the biodiversity; protecting the health of human beings and other organisms; and protecting the environment from the dangerous effects from neighboring countries" (EPA 2014).

In 2015, Law No.99 further amended the 2014 Environmental Protection Law No.42. Municipal solid waste management relevant Articles of Law No. 42 from 2014 Promulgating. The Environment Protection Law are presented in the next chapter (table 5.1). In addition, the listed articles in table 5.1 will be discussed in terms of the observed progress within the legal and regulatory system of the MSW management in Kuwait.

Waste actors were questioned about current practical official regulatory sources they used as a reference for MSW management, planning and decision-making processes. Waste actors preferred official regulatory sources: 62% preferred laws as their reference for planning and decision-making; 42% preferred strategies and regulations; 35% local guidelines; and 28% opted for national policy (table 4.19). Responses did not exceed 62%, which may lead us to understand that waste actors are not clearly aware of the regulatory references that should be used and implemented while planning and making decisions. Laws, local guidance and regulations are the maximum sources of references selected by the waste actors who represent the Municipality of Kuwait by 50%, 41% and 38%, respectively. The surveyed waste actors who represent the EPA, the regulatory environmental authority and are responsible for the environmental strategy, selected the Laws and strategy as sources of references by 50%. This selection by the waste actors who represent Kuwait Municipality and EPA confirmed the fact that the national policy, strategy and laws were not applied to revision and updates since 2001 until 2014, when The World Bank contributed to subject them to revision and updates.

Table 4.19: Waste actor responses about sources of reference currently adopted by waste actors for planning and implementing MSW management considering their specific institutions

Waste actors' groups	No. of surveyed participants	National policy	Strategy	Laws	Regulations	Local guidelines
Total	65	18	27	40	27	23

		(28%)	(42%)	(62%)	(42%)	(35%)
Group 1: Municipality of Kuwait	32	19%	34%	50%	41%	38%
Group 2: EPA	8	25%	50%	50%	38%	0%
Group 3: Other Governmental institutions	6	0%	17%	67%	17%	33%
Group 4: Research and education institutions	8	25%	63%	63%	50%	13%
Group 5: Consultation companies	11	73%	55%	100%	55%	73%

Regarding the current adopted national environmental policy and MSW management, the responses by waste actors were as follows: the highest responses (52%) were for recycling while the remainder of responses broke down into: 37% for reducing air emissions from landfills; 35% for promoting environmental education, 34% for both zero-waste and promotion of renewable energy approaches and environmental education, 31% for resource recovery approach, 25% were for promoting public participation, and 19% for implementing economic instruments to enforce environmental laws (table 4.20). Waste actors who represent the Kuwait Municipality selected: environmental education, recycling and resource recovery with the highest percentages of 53%, 50% and 38%, respectively before recommending a zero-waste approach. The results of the key informant interviews indicate that the zero-waste approach is one of the essential elements of the current adopted national environmental policy in Kuwait.

Table 4.20: Waste actors' responses regarding the adopted MSW related approaches for the current national environmental policy in Kuwait and considering their relevant institutions

Waste actors' groups	**No. of participants**	**Resource recovery**	**Recycling**	**Zero-waste**	**Reduce air emissions**	**Renewable energy**	**Economic instruments**	**Environmental education**	**Public participation**
Total	65	20 (31%)	34 (52%)	22 (34%)	24 (37%)	22 (34%)	12 (19%)	23 (35%)	16 (25%)
Group: Municipality of Kuwait	32	38%	50%	34%	31%	31%	16%	53%	22%

Group: EPA	8	25%	50%	38%	63%	13%	0%	38%	25%
Group 3: Governmental institutions	6	17%	67%	17%	17%	33%	17%	0%	0%
Group 4: Research And Education institutions	8	25%	63%	25%	25%	25%	0%	13%	0%
Group 5: Consultation companies	11	27%	45%	46%	55%	64%	55%	18%	64%

It is essential to understand whether existing laws and regulations have been effective in promoting the planning for ISMSWM and implementing the national environmental policy on solid waste management. That minority of waste actors, 23%, perceived existing laws and regulations to be effective (table 4.21).

Al-Awadi (2002) indicated that the main obstacle to strengthening environmental laws in Kuwait was the need for an independent environmental court. The traditional approach has been to address environmental cases through the Civil and Commercial Courts and decisions are legally viable, and not from an environmental management or ecological sustainability perspective (AlAwadi 2002). Only 28% of the surveyed waste actors trusted an independent environmental court to be effective to support the implementation of solid waste management policies, laws and regulations (table 4.21).

Table 4.21: Waste actors' responses about the effectiveness of existing laws and regulations and an independent environmental court to support the implementation of solid waste management policies, laws and regulations

Waste actors' groups	No. of surveyed participants	effectiveness of existing laws and regulations to support implementation of the national policy on SWM	effectiveness of an independent environmental court to support the implementation of SWM policies, laws and regulations
Total	65	15 (23%)	18 (28%)
Group 1: Municipality of Kuwait	32	28%	22%

Group 2: EPA	8	25%	25%
Group 3: Governmental institutions	6	33%	33%
Group 4: Research & Education institutions	8	0%	50%
Group 5: Consultation companies	11	18%	27%

4.2.4 Strategy and monitoring

In 2002, the EPA issued an Environmental Strategy for the State of Kuwait in cooperation with the United Nations Development Program (UNDP) (EPA 2002). The Environmental Strategy included strategies relating to water, air, coasts, land and soil, environmental economics, oil, health, environmental awareness and environmental education (EPA 2002 and 2010). Section 35-3 of the Environmental Strategy specifically related to the field of hazardous, medical and solid wastes management (Appendix E). The Environmental Strategy discussed the causes, problems and in two parts suggested measures for the management of hazardous, medical and solid wastes. The first part included the general causes of environmental health problems and in particular, those that stem from hazardous, medical and solid wastes management (EPA 2002, section 3-4-4, p.147).

These waste-related concerns are (EPA 2002):

1. Amounts of solid waste continue to increase due to population growth and the implementation of ambitious development plans, especially with the continuing high per capita consumption patterns in Kuwait, which are considered the highest in the world.
2. Absence of continuous media awareness programs directed at all citizen and non-citizen groups to encourage minimizing solid waste generation and encouraging segregation of waste at the source.
3. No provision by the Kuwait Municipality to provide the necessary tools and machinery at various locations to help waste segregation for recycling and reuse (i.e. houses, industrial and commercial facilities).

4. Total dependence on landfills as an option for municipal and construction solid waste disposal and incinerators for the disposal of medical wastes. Also, the absence of legislation and regulations within the authorities concerned with hazardous, medical and solid waste management, including the EPA, to monitor and properly dispose of such wastes in an environmentally suitable manner.
5. Insufficient manpower and financial capabilities required within authorities concerned with waste management and monitoring.
6. A continued increase in technological and industrial development has generated higher waste quantity and quality in the absence of certain data regarding the production rates and types of produced solid wastes.
7. Absence of using economic mechanisms, such as incentives, penalties, and taxes to preserve environmental health and to prevent violations.
8. Insufficient role of society and public participation.
9. Disorder of authority and absence of teamwork by authorities to protect the environment (i.e. EPA, Ministry of Electricity and Water, Kuwait Municipality, Ministry of Public Works, and the Public Authority of Agriculture Affairs and Fish Resources (PAAF)).

The second part included in section (3-5-3) of the strategy is related to the key suggested measures for improving the management of hazardous, medical and solid waste and considers (EPA 2002):

- Preparing and implementing a plan for organized data collection regarding the source, type and production rates of these wastes.
- Preparing a national action plan that encourages a campaign to increase environmental awareness and encourage people to decrease their product consumption, decrease waste production and start waste segregation at the source.
- Encouraging investment by the private sector.

- Preparing and issuing legislation and regulations for waste management and disposal that include all necessary measures for minimizing waste generation, packaging techniques and temporary storage and transportation to disposal sites.

When examining the national institutions responsible for establishing and implementing the national environmental strategy, the waste actors' questionnaire revealed that the Municipality of Kuwait and the EPA are the responsible institutions (table 4.22). International institutions (e.g. World Bank and UNDP), local research and educational institutes (e.g. Kuwait institute of scientific research (KISR) and the University of Kuwait), and consulting firms are the institutions that most typically supported and still provide their services whenever requested by the national institutions responsible for SWM in the formulation of a national strategy of MSW management (table 4.23). In terms of monitoring and evaluation of the national environmental strategy, the majority of the surveyed waste actors, 75%, responded that the institutions responsible for MSW management (i.e. the Municipality of Kuwait and the EPA) do not apply strategic monitoring, revision and remediation of the national MSW management strategy (figure 4.16).

Table 4.22: Institutions responsible for the establishment and implementation of an MSW management strategy in Kuwait

Waste actors' groups	No. of surveyed Participants	Municipality of Kuwait	EPA	University of Kuwait	KISR	Municipality of Public Work	Ministry of Finance	IBK
Total	65	57 (88%)	48 (74%)	8 (12%)	19 (29%)	11 (17%)	4 (6%)	10 (15%)
Group 1: Municipality of Kuwait	32	91%	59%	9%	16%	13%	6%	22%
Group 2: EPA	8	88%	100%	25%	50%	25%	0%	0%
Group 3: Governmental institutions	6	50%	83%	0%	17%	17%	17%	33%
Group 4: Research and Educational institutions	8	88%	75%	25%	63%	13%	13%	13%
Group 5: Consultation companies	11	100%	91%	9%	36%	27%	0%	0%

Table 4.23: Responses of waste actors about the institutions that support the institutions responsible for MSW management in formulating a strategy in Kuwait

Waste actors' groups	No. of surveyed Participants	International commitment	International institutions	Local research institutions	Local educational institutions	Local industrial institutions	Civil societies	Consulting institutions
Total	65	28 (43%)	44 (68%)	47 (72%)	34 (52%)	23 (35%)	25 (38%)	42 (65%)
Group 1: Municipality of Kuwait	32	44%	72%	66%	44%	28%	34%	63%
Group 2: EPA	8	25%	50%	75%	50%	38%	50%	50%
Group 3: Governmental institutions	6	17%	33%	50%	33%	33%	17%	83%
Group 4: Research & Educational institutions	8	25%	75%	88%	88%	38%	25%	63%
Group 5: Consultation companies	11	82%	82%	91%	64%	55%	64%	73%

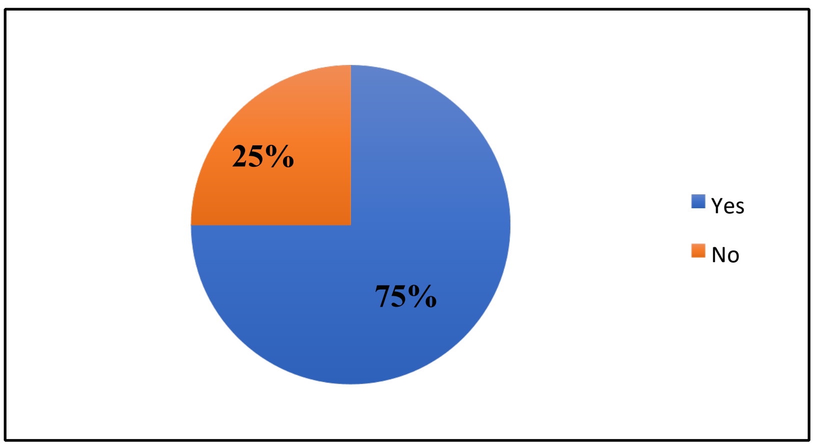

Figure 4.16: Waste actor responses about whether institutions responsible for MSW management in Kuwait apply monitoring for the national strategy for managing MSW.

4.2.5. Economic and financial factors

In an attempt to understand the preference of the householders to participate in the implementation and enforcement of economic instruments, householders were asked about their opinion and 65% responded favourably to enforcing taxes to implement new MSW management services, and 77% were in approval of enforcing fines for illegal practices of solid waste disposal in their area (figure 4.17).

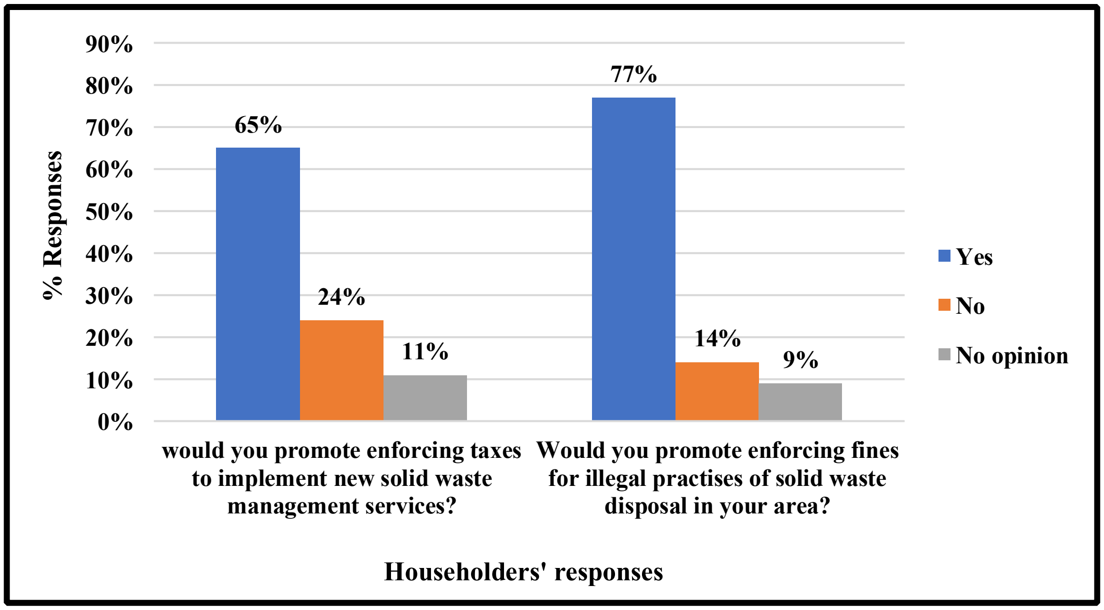

Figure 4.17: Householder responses about implementing economic instruments

Whether limited economic resources are important as obstacles to MSW management, 65% of the surveyed waste actors agreed, while 68% indicated that the private sector's minor role is an important obstacle (table 4.24). About 68% of the surveyed waste actors selected build-operatetransfer (BOT) as the expected funding system (table 4.25). The BOT system was the major option selected by each surveyed group of waste actors for the expected funding system for planning for MSW management. Although BOT is not known as a funding method, results from the key informant interviews indicate that BOT without governmental subsidizing arrangement is the preferred financial system for MSW management.

Table 4.24: Waste actor opinions regarding whether they consider limited economic sources and the minor role of the private sector as important obstacles to MSW management in Kuwait

Waste actors' groups	No. of surveyed participants	Important to be considered as obstacles to MSW management:	
		limited economic sources	the minor role of the private sector
Total	65	42 (65%)	44 (68%)

Group 1: Municipality of Kuwait	32	69%	75%
Group 2: EPA	8	63%	63%
Group 3: Governmental institutions	6	67%	33%
Group 4: Research and educational institutions	8	88%	63%
Group 5: Consultation companies	11	36%	73%

Table 4.25: The funding system for solid waste management in Kuwait as respondent by the waste actors considering their relevant institutions

Waste actors' groups	**No. of surveyed Participants**	**Tax**	**BOT**	**EFW revenues**	**Government subsidies**	**Governmental loans**
Total	65	8 (12%)	44 (68%)	14 (22%)	24 (37%)	13 (20%)
Group 1: Municipality of Kuwait	32	6%	72%	25%	31%	19%
Group 2: EPA	8	25%	63%	38%	50%	38%
Group 3: Governmental institutions	6	0%	50%	17%	33%	0%
Group 4: Research and educational institutions	8	38%	75%	0%	75%	13%
Group 5: Consultation companies	11	9%	64%	18%	18%	27%

Only 25% of surveyed participants indicated that the economic instruments are effective when implementing MSW management strategy (table 4.26). Participants who represented the EPA - the environmental regulatory authority - responded with 0% for the effectiveness of the economic instruments in implementing the MSW management strategy (table 4.26). Moreover, about waste actors' opinions of the most effective economic instruments (i.e. fees, fines, taxation and producer responsibility) to promote the implementation of the adopted policy of MSW management, participants recommended their preferred economic instruments in the following order: 63% for economic charges/fines, 38% for user fees, 31% for industrial taxation, 31% for producer responsibility, 22% for public taxation, and 20% for commercial taxation (table 4.27). The main focus of the participants who represent the EPA was on implementing industrial taxation and user fees while other waste actors' groups concentrated their selection on implementing economic charges/fines. An expected explanation for these results is that waste from industrial institutions is under the supervision and authority of the EPA.

Table 4.26: Waste actor responses about the contribution of current economic instruments to implement the MSW management strategy

Waste actors' groups	No. of surveyed participants	The contribution of current economic instruments is effective to implement the MSW management strategy
Total	65	16 (25%)
Group 1: Municipality of Kuwait	32	34%
Group 2: EPA	6	0%
Group 3: Governmental institutions	8	17%
Group 4: Research and educational institutions	6	38%
Group 5: Consultation companies	11	9%

Table 4.27: The most effective economic instruments to implement the MSW management policy

Waste actors' groups	No. of surveyed Participants	Public taxation	Industrial taxation	Commercial taxation	Economic charges/ Fines	Producer responsibility	User fees
Total	65	14 (22%)	20 (31%)	13 (20%)	41 (63%)	20 (31%)	25 (38%)
Group 1: Municipality of Kuwait	32	22%	19%	9%	66%	19%	28%
Group 2: EPA	6	25%	50%	25%	38%	25%	63%
Group 3: Governmental institutions	8	0%	17%	0%	50%	17%	17%
Group 4: Research and educational institutions	6	0%	25%	25%	75%	50%	50%
Group 5: Consultation companies	11	45%	64%	55%	73%	64%	55%

To better understand the motivation to select and establish MSW management facilities, waste actors were asked about the priorities of the listed criteria. The majority of them indicated that all criteria are important for the selection and establishment of MSW management facilities (table 4.28). The two most important selected criteria were the promotion of private sector involvement (77%), and the provision of more labor opportunities (72%). The survey participants who represent the Municipality of Kuwait concentrated more than other groups on preventing informal waste separation.

Table 4.28: Waste actor responses about the importance of the listed criteria to motivate the establishment of MSW management facilities

Waste actors' groups	No. of surveyed Participants	Preventing informal waste separation	Selecting a project on the basis of lowest initial cost	Selecting a project which provides best revenues	Selecting a project which provides labor opportunities	Promoting private sector involvement
Total	65	35 (54%)	36 (55%)	44 (68%)	47 (72%)	50 (77%)

Group 1: Municipality of Kuwait	32	69%	50%	66%	66%	78%
Group 2: EPA	6	38%	75%	75%	75%	63%
Group 3: Governmental institutions	8	33%	50%	67%	83%	67%
Group 4: Research and educational institutions	6	25%	50%	63%	75%	75%
Group 5: Consultation companies	11	55%	64%	73%	82%	91%

4.2.6 Social considerations

The social environment in Kuwait shows evidence of being under pressure that is similar to the pressure on the natural environment. Residences do not pay for waste collection, transportation or disposal as it is seen as a responsibility that should be carried out by the public sector. The Municipality of Kuwait has assumed full rights, without public involvement, to choose MSW management methods such as determining the location of landfill sites (Al-Yagout, 2002). Not-in-my-backyard (NIMBY) efforts have slowed or even prevented the siting of new waste landfills in some countries (Wilson, E. 1998; Agamutha, 2009). However, this type of public objection is not practiced in Kuwait (Al-Yagout, 2002). After the Al-Qurain landfill problem (see Chapter 2.1), Kuwaiti people became eager to learn more about these impacts. A study conducted in Kuwait by Al-Yaqout (2002) to evaluate public attitudes toward siting landfills indicated a low level of public awareness of the health and environmental impacts of landfill sites.

The unique cultural traditions of the GCC member states differ greatly from Western countries in Europe and North America – and this social context greatly affects waste generation, consumer attitudes and community program participation rates. For example, in Kuwait, a large quantity of food is provided at social ceremonies such as weddings. These events consequently generate a large amount of food waste (Alhumoud 2004). Moreover, in the GCC countries the economic price of goods often determines customer choice at the expense of environmentally responsible practice (Alhumoud 2002). Another cultural habit that affects solid waste trends is the existence of servants in most households. The household management habits of servants and decision-making household residents will determine the types of products bought and used in the home, and moreover, how the wastes of those products are collected and disposed of. Based on a householder survey, participants were asked who was responsible for collecting waste and taking it out of the house for daily waste collection. Figure 4.18 shows: 47% responsibility of servants, 36% both residents and servants shared the responsibility, and 17% responsibility of residents.

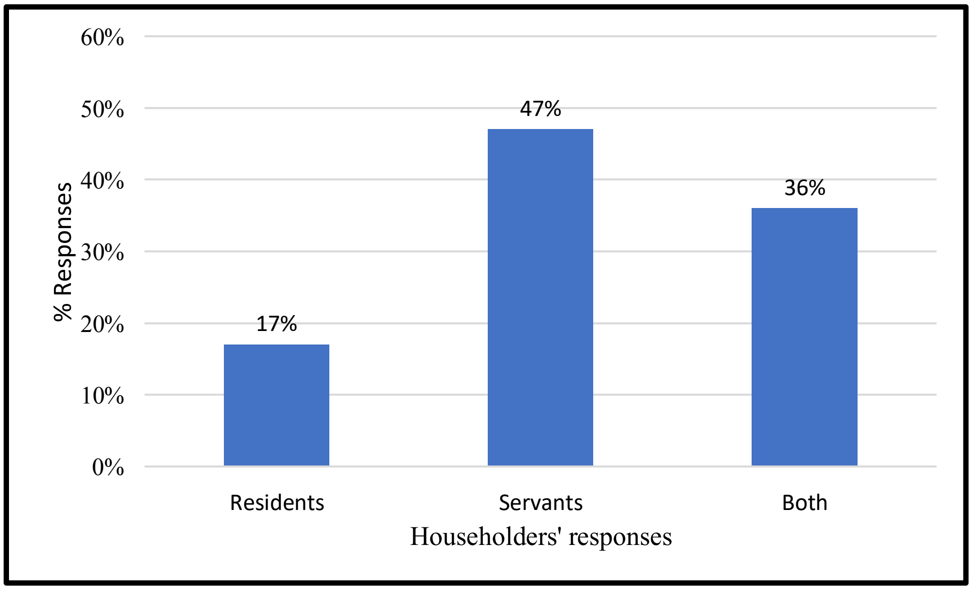

Figure 4.18: Householder responses about who is responsible to collect waste and take it out of the house for daily waste collection

4.3 Integrated Environmental Management approaches

4.3.1 Collaboration

The results from the waste actors' questionnaire about the effect of lack of collaboration in the formulation of policy measures and planning for ISMSWM indicated that: 91% perceived a lack of vertical collaboration between authorities at governmental, sectoral and public levels; and 80% perceived a lack of horizontal collaboration between responsible authorities (Municipality of Kuwait and EPA) for MSW management (table 4.30). The results from the waste actors' questionnaire presented that 92% of the surveyed waste actors promoted the integration of the stakeholders and collaboration and 80% promoted a proper adoption of top-down vs bottom-up approaches. Surveyed waste actors supported implementation of better communication tools to engage different waste actors and the public in planning, decision making and implementation of ISMSWM system (table 4.29).

Waste actor preferences for appropriate communication tools between waste actors and even other stakeholders for better planning for ISMSWM were: 77% promoted the establishment of collaborative committees; 71% promoted the periodic meeting of collaborative committees; 58% preferred communication tools through online media (e.g. web pages, facebook, twitter); 34% preferred communication by cellphone; and 28% by official papers (table 4.30).

Table 4.29: The importance of collaboration in developing a decision-making for planning for ISMSWM in Kuwait considering their relevant institutions

Waste actors' groups	**No. of surveyed Participants**	**Lack of coordination between governmental authorities, sectoral and the public**	**Lack of coordination between responsible authorities for solid waste management**	**Collaboration and integration of stakeholders**	**Starting with local communities, civil societies and employees to develop a plan that can be assessed by higher levels of decisionmaking (proper adoption of top-down vs bottom-up)**
Total	65	59 (91%)	52 (80%)	60 (92%)	52 (80%)
Group 1: Municipality of Kuwait	32	100%	84%	91%	72%
Group 2: EPA	8	88%	100%	88%	88%

Group 3: Other Governmental institutions	6	100%	83%	83%	67%
Group 4: Research and education institutions	8	88%	63%	100%	88%
Group 5: Consultation companies	11	64%	64%	100%	100%

Table 4.30: Waste actors' responses about the most appropriate communication tools for planning ISMSWM in Kuwait considering their relevant institutions

Waste actors' groups	**No. of Participants**	**Establishment of collaborative committee**	**The periodic meeting of collaborative committee**	**Communication through official letters**	**Cellphone**	**Internet (web page, facebook.. etc)**
Total	65	50 (77%)	46 (71%)	18 (28%)	22 (34%)	38 (59%)
Group 1: Municipality of Kuwait	32	78%	72%	31%	38%	50%
Group 2: EPA	8	88%	38%	25%	25%	75%
Group 3: Other Governmental institutions	6	33%	33%	17%	17%	33%
Group 4: Research and education institutions	8	75%	100%	0%	13%	63%
Group 5: Consultation companies	11	91%	91%	63%	55%	82%

4.3.2 Decentralization

Perspectives about whether waste actors would agree or disagree with the option to decentralize MSW management authority from the central national government to local provincial levels: 66% of waste actor participants favour a potential decentralization approach for planning for ISMSWM (figure 4.19). The reasons mentioned by waste actors for their agreement or disagreement are listed in table 4.3.

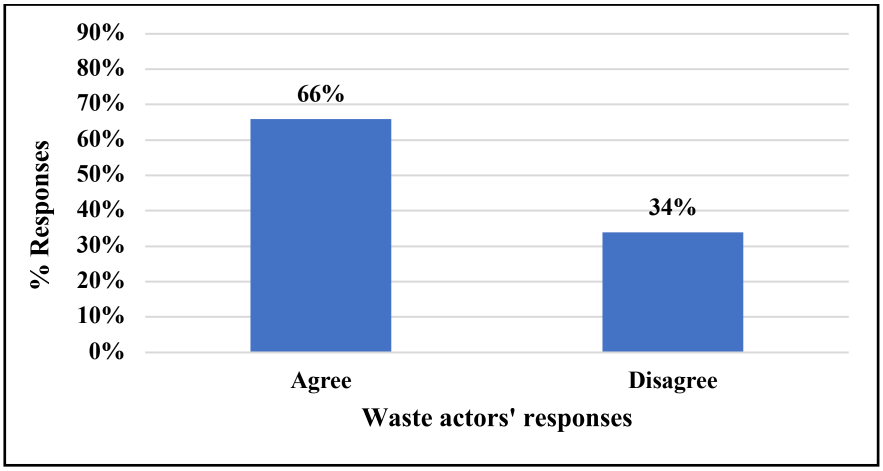

Figure 4.19: Waste actor responses about whether they promote/restrict decentralization as an option for planning ISMSWM in Kuwait

Table 4.31: Waste actor reasons and suggestions for promoting/not promoting a decentralized approach to MSW

SI* NO.	Institution	Reasons for promoting a decentralization approach
1,9	Consultation company, Kuwait Municipality	Help to make decision-making easier.
4	Governmental institution	Help to give the responsibility to more people and to committees for decision-making.
10	Kuwait Municipality	Prevent bureaucracy and the long-term administrative documentary cycle and delays in project implementation.
20	Kuwait Municipality	Provide an ability to control the implementation, supervision and monitoring of the waste management projects.
28	Kuwait municipality	Support citizens and community participation and responsibility in waste management projects.
SI* NO.	**Institution**	**Reasons for disagreement with a decentralization approach**
5	Governmental institution	Cheaper if one facility is used.
11	Kuwait Municipality	All provinces should have the same level of waste management services.
16	Research and education institution	Decentralization will cause an absence of control in the field of waste management especially for a small country like Kuwait.
19	Kuwait Municipality	Relatively small amount of generated waste

*SI NO.: serial number of the questionnaire

Waste actors were further asked about their perspectives about whether they agree or disagree with the decentralization of MSWM facilities as an option for planning an expanded and integrated program of sustainable solid waste management in Kuwait; 64% of the participants agree, while 36% disagree (figure 4.20). The reasons for the agreement or disagreement with decentralization of MSW facilities in provinces are listed in table 4.32.

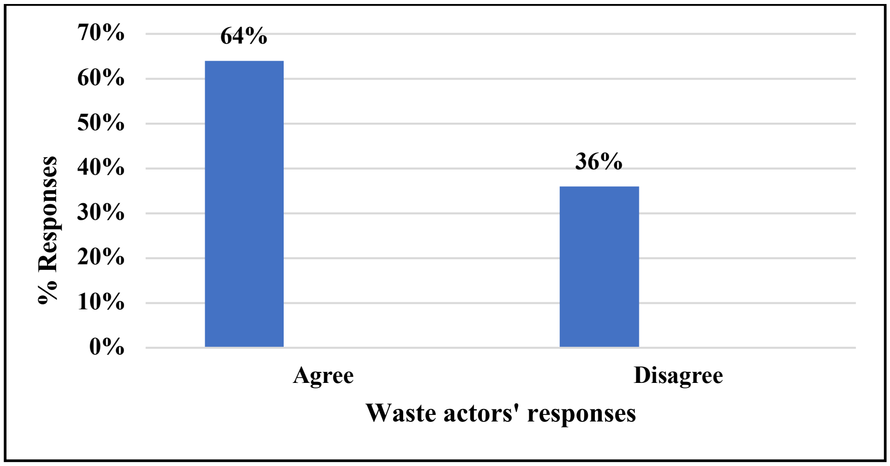

Figure 4.20: Waste actor' responses about whether they promote/restrict decentralization of MSW management facilities as an option for planning ISMSWM in Kuwait

Table 4.32: Waste actor reasons for either promoting or restricting decentralization of MSW management facilities to plan for ISMSWM

SI* NO.	Institution	Reasons for promoting decentralization of MSWM facilities
4	Governmental institution	It provides an opportunity to adopt different technologies for waste-to-energy and identifies the best to be implemented.
9	Kuwait Municipality	The work will be easier.
28	Kuwait Municipality	It will help the government to reduce their responsibility and support the participation of the private sector which will help to increase labour opportunities.
31	Kuwait Municipality	It will provide an opportunity for lower levels of employees to provide their ideas and identify their innovations which will improve the waste management field in general.
35	Kuwait municipality	It will increase the economic revenues.
46	EPA	The current adopted project for waste management in Kuwait recommends that Kuwait be divided in three parts: the north, the middle and the south, and each part has a centre prepared to serve its particular area.
		Reasons for restricting decentralization of MSWM facilities
1	Consultation company	Kuwait is a small country
19	Kuwait Municipality	It will create a problem between provinces

*SI NO.: serial number of the questionnaire

4.3.3 Public participation

As indicated in the previous chapter - among the public – the focus of the survey in this thesis was on the householders, due to their major contribution to the generation and complicated composition of MSW. Based on the householder survey in figure 4.21, 59% of the participants were in favour of participating in a committee to discuss environmental problems and solid waste management in their community, 25% of the participants disagreed and 16% had no opinion. Moreover, figure 4.21 shows that 57% of the surveyed householders agreed that they expect MSW management committees - at the community level - to be useful for solving environmental and MSW problems, while 21% of the participants disagreed and 22% had no opinion. Figure 4.22 shows that 64% of the participants in the householder survey were in agreement about whether they were willing to report illegal solid waste practices in their area, while 19% disagreed, and 18% had no opinion.

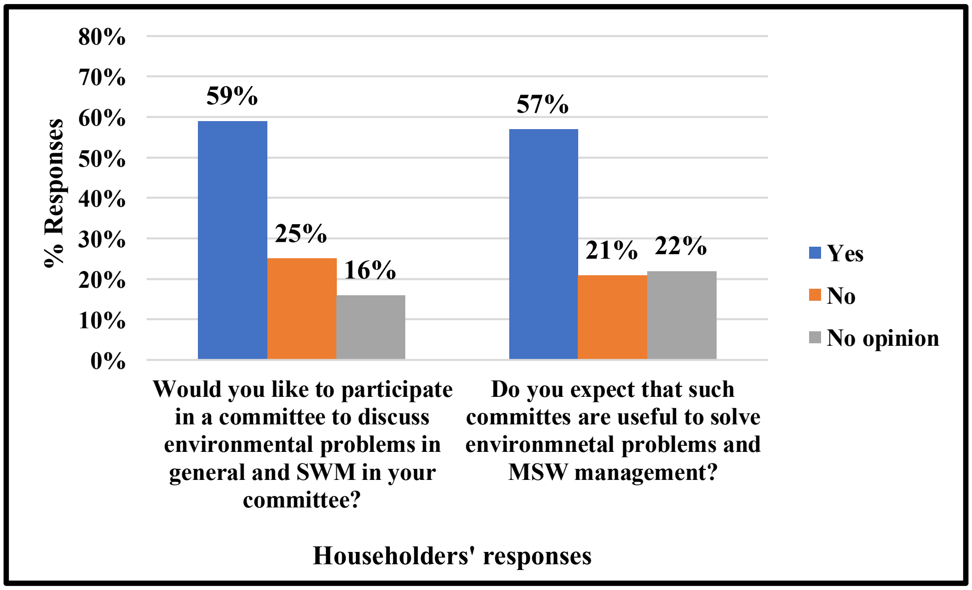

Figure 4.21: Householders' responses about their willingness to participate in an MSW management committee on the community level

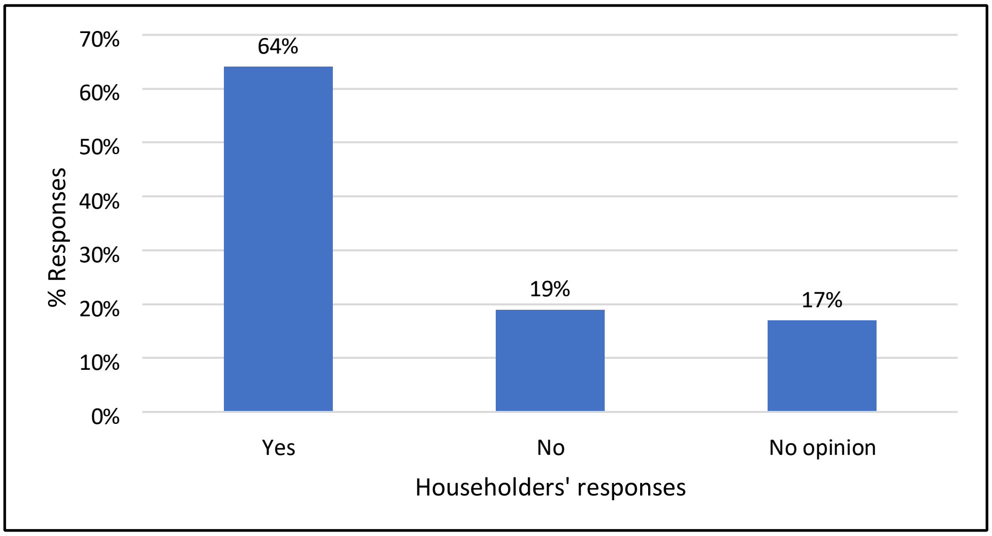

Figure 4.22: Householder responses about their willingness to report illegal solid waste practices in their areas

With respect to willingness of householders to participate on a committee to discuss environmental problems in general and solid waste management in particular, 60% of the surveyed householders agreed to participate. In addition, 57% of the surveyed householders responded that they trust such committees to be useful in solving environmental problems including MSW.

To understand the awareness of the householders to participate in the implementation of MSW relevant legislation, the householders were asked as to whether they were willing to report illegal practices of solid waste disposal in the community, and 64% of the surveyed householders agreed to report illegal practices. In order to understand whether the public participation is promoted or restricted in the planning and implementation of specific ISMSWM activities: 86% of the surveyed waste actors were in favour of public participation in waste separation and collection; 85% promoted training programs for the public to participate in waste separation; 80% promoted public consultation; and 89% favoured the inclusion of environmental aspects and waste management specific topics in the education curriculum at different educational levels (table 4.33).

Table 4.33: Waste actor responses about the importance of different ways of public participation and using different communication tools with the public to promote planning for ISMSWM

Waste actors' groups	No. of surveyed Participants	Expected ways of public participation in the planning and implementing of ISMSWM				It is important to use the following communication tool with the public to promote planning for ISMSWM	
		Public participation in the waste separation and collection	Training programs for the public to participate in waste separation programs	Public consultation	Inclusion of environmental aspects in the education curriculum	Advertisement and media	Social communication media
Total	65	56 (86%)	55 (85%)	52 (80%)	58 (89%)	54 (83%)	53 (82%)
Group 1: Municipality of Kuwait	32	81%	88%	78%	88%	81%	72%
Group 2: EPA	8	88%	75%	88%	88%	88%	88%
Group 3: Other Governmental institutions	6	67%	67%	50%	67%	67%	67%
Group 4: Research and education institutions	8	100%	100%	75%	100%	88%	100%
Group 5: Consultation companies	11	100%	82%	100%	100%	91%	100%

4.3.4 Private sector participation

Private sector firms are involved in MSW management mainly through recycling activities. The type of contribution of the private sector in MSW management is classified as the following: 66% for recycling activities, 46% for waste separation, 40% for waste reuse, and 32% for waste collection (table 4.34). With regarding to MSW management, 79% of waste actors promoted the participation of the private sector, while 21% disagreed with their involvement. The reasons that were given by surveyed waste actors for either promoting or restricting the participation of the private sector are listed in table 4.35.

Table 4.34: Waste actors' responses about the contribution of the private sector in MSW management considering their relevant institutions

Waste actors' groups	No. of Participants	Collection	Waste separation	Reuse waste	Recycling
Total	65	21 (32%)	30 (46%)	26 (40%)	43 (66%)
Group 1: Municipality of Kuwait	32	34%	53%	34%	53%
Group 2: EPA	8	38%	50%	25%	63%
Group 3: Other Governmental institutions	6	17%	50%	50%	100%
Group 4: Research and education institutions	8	38%	50%	38%	75%
Group 5: Consultation companies	11	27%	18%	64%	82%

Table 4.35: Waste actors' responses regarding the reason for either promoting or restricting private sector participation in MSW management

SI* NO.	Institution	Promote private sector participation in MSW management
19	Kuwait Municipality	The private sector has the ability to modify the MSW practises to involve recycling activities and other modern technologies. Moreover, the private sector could help to provide better economic revenues.
20	Kuwait Municipality	The private sector is active and develops the progress in MSW management practices better than the governmental institutions.
27	EPA	Private sector participation is recommended. In the same time, if the private sector is associated with scavenging activities, then this should be avoided and the scavenging activities should be prohibited. The scavenging activities reduce the amount of recyclable materials that would reach the investor. Moreover, scavenging is dangerous for the workers on the MSW trucks since they may be in danger of health and traffic problems.
31	Kuwait Municipality	Private sector participation could help to provide more environmental solutions and waste reduction.
54	Consultation company	Private sector participation should be monitored by the governmental institutions like EPA, Municipality of Kuwait and Ministry of Public work.
60	EPA	The private sector could provide more experts for the waste actors in the public sector to gain more expertise for future projects of MSW management.
		Restrict private sector participation in MSW management
9	Kuwait Municipality	There is no tangible role for the private sector.
10	Kuwait Municipality	The private sector's role is unstructured and its activities are focused on media attention.
28	Kuwait Municipality	Private sector participation should be legally organized before implementation to avoid the conflicts and problems of duplicate missions between the private and public sectors.
47	Consultation company	Before thinking of private sector participation, the scavenging activities should be prohibited.

* SI NO.: serial number of the questionnaire

4.4 Key informant[6] Interview' results

As part of the research process, waste actors involved in different waste-related institutions in Kuwait were asked to provide their assessment of MSW management. Of particular interest were their perspectives of obstacles, opportunities and possibilities for improving the current MSW situation in Kuwait. During the interview process, interviewees were initially given the opportunity to explain their point of view about the current situation of MSW management in an open-ended format. Thereafter, semi-structured questions were posed to interviewees with the intention that respondents provide their own assessment of the obstacles and opportunities for improving the current context through the ISMSWM planning and implementation processes.

The seven interviewees that were contacted face-to-face acknowledged both serious obstacles for planning for ISMSWM such as the current situation of overwhelmingly poor practices of MSW Management exemplified by: backfilling landfill sites with layers of sand, limited recycling and scavenging activities by daily waste collectors. Issues related to poor planning and weak administration were highlighted as major constraining factors to the future of waste management in Kuwait by waste actors in the Municipality of Kuwait and EPA during the focused group discussion, as well as by other waste actors as presented in both the key informant interviews and the waste actor survey.

Interviewees M2, M3 and EPA1 stated that The Industrial Bank of Kuwait (IBK) and the Ministry of Finance (MOF) commissioned the World Bank to assess the potential for waste recycling in Kuwait. This assessment ignited a movement by the Municipality of Kuwait to initiate a series of studies in partnership with the World Bank on how to transition from the current situation toward more sustainable approaches.

Interviewees M1 and M2 indicated that the new issued Law No. 42 of 2014 Promulgating

[6] Symbols for interviewees: Kuwait Municipality: interviewees 1 (M1), interviewees 2 (M2) and interviewees 3 (M3). EPA: interviewees 4 (EPA1) and interviewees 5 (EPA2). Educational and research institutions: interviewee 6 (ED). Governmental institution: interviewee 7 (GOV).

The Environment Protection Law includes modified articles relevant to SWM and MSW management. At that time, the environmental strategy was reviewed and revised in cooperation with The World Bank, the Municipality of Kuwait, and the EPA. They added that the relevant regulations and articles of the new law would include more details based on the new version of the national environmental strategy.

Interviewees M1, M2, M3, EPA1 and EPA2 indicated that one of the main obstacles to planning and implementing the outcomes of assessment studies and establishing strategies for MSW management is the absence of appropriate monitoring mechanisms that can track the effectiveness of existing assessments and strategies. In particular, they cautioned that the absence of monitoring creates difficulties for the implementation of the strategies and the long-term survival of implemented strategies. In addition, they mentioned that the absence of technical monitoring for the existing MSW management operations and facilities create difficulties for the maintenance and continuity of the relevant operations – as experienced from the composting factories in the 1980’s.

Interviewees M2, M3, EPA1 and GOV indicated that currently, decision-making of SWM technologies is based on the projected maximum revenues of the project so that the company – contracted for BOT - will be able to complete the contract. In addition, decisions are based on the maximum energy production of the selected technology as the Ministry of Electricity is supporting the project by buying the generated – electrical - energy.

All interviewees indicated that economic resource availability is not an obstacle for the planning and implementation of ISMSWM as these resources are available in Kuwait. Moreover, the interviewees concluded that economic problems can be discussed as two factors: the type of funding and marketing. The government prefers to implement the Build-operate-transfer (BOT) method instead of subsidizing SWM projects in order to reduce the responsibility on the government and rely more on the investor in many issues especially on operating the MSW management operation, the technical details such as maintenance and marketing of the recovered products. The availability of viable economic markets for recycled and reused materials is a problematic factor for the expansion of ISMSWM activities in the country. For example, the compost from wastewater sludge, and the compost imported from Saudi Arabia are cheaper for the customer in Kuwait than the compost produced from MSW management operations. Another example is that when recycled, the plastics produced by petrochemical industries, become weaker and lower in quality. Therefore, it is difficult to establish local markets for the recycled products in an oil country such as Kuwait where first-grade plastics are readily available. The export of used materials and goods is expensive and therefore does not attract external markets to buy recycled products that may cost more than the first-grade products. Another method implemented is the exportation of different types of shredded plastics to Lebanon, England and China.

Interviewees M2 and ED highlighted their concern regarding non-user fees. The free waste management services enjoyed by householders does not provide an incentive for householders to take responsibility to decrease waste generation – and may instead lead to increased amounts of the generated waste (Interviewee M2). Currently, there is no promotion to lead householders to separate waste or to use the communal waste separation containers properly. Interviewee ED indicated that non-user fees for commercial activities lead to an increase in waste generation, especially packaging waste. Interviewee ED explained that the increase of commercial activities through social media promising the delivery of products to customers with attractive packaging leads to increased packaging waste. Cultural practices and traditions were identified by all interviewees as a part of the reason for the current state of increase of waste generation.

All of the interviewed waste actors perceived the current non-collaborative practices in both the horizontal level (waste actors) and vertical level (top-down approaches) to planning and decision-making as major obstacles to effective ISMSWM. Interviewees M1 and M2 indicated that although there is a national decision-making committee that involves local waste actors, the government does not rely completely on this committee. Instead, the government prefers to involve international institutions and external consulting companies to present proposals to transfer from the current approach toward sustainable MSW management in Kuwait.

All interviewed waste actors agreed that the lengthy administrative documentation cycle as measured in years is one of the main obstacles to planning and implementing any new project. In some cases, this prolonged process causes a delay in a project's timeline or may even halt the project.

Interviewee ED, from an educational and research institute, stated that he no longer participated in any committee for MSW because his prior recommendations for a policy aimed to design a sanitary landfill were never implemented. In his opinion, his role in the committee was ignored and this meant that the government was not going in the right direction for planning sustainable solid waste management. In response, interviewees M1 and M2 reiterated that decision-making is always a complicated, lengthy process and it cannot consider only one perspective while ignoring the perspectives of others, especially due to the multi-dimensional nature of MSW management.

Interviewees M1, M2 and M3 perceived that the government does not promote MSW management technologies that include waste separation because the government does not trust proper public participation in waste separation. The government does not trust that the householders will separate the waste and follow the instructions completely in a manner that will justify investment in implementing the selected technology based on waste separation (e.g. recycling, AD). They added that the government believes that it would take a long time before the householders became accustomed to separating waste and this dynamic would fluctuate between areas and provinces.

The householder survey showed that participants were very enthusiastic about the opportunity to share their experiences and opinions about MSW management. Most of the participants were motivated to ask questions and discuss different points in the survey concerning the various types of waste and SWM technologies. The majority added comments on the questionnaire even if comments were not requested. Many of the participants insisted that they be able to contact the researcher after submitting the questionnaire. They wanted to have an opportunity to express: how they became aware of different types of waste, the necessity of waste separation, and how they began using the communal containers for waste separation after participating in the survey (despite ignoring them before due to their lack of awareness).

With regard to the improvement of the overall waste situation, the interviewees emphasized the following areas of concern: existing laws, regulations, monitoring and evaluation techniques, institutional arrangements, administrative documentation cycle, private sector participation, public participation, and education and media. All interviewees supported the need for the cooperation between different levels of government, and collaboration between governments and relevant institutions. All interview participants promoted the setting up of an independent waste management agency involving stakeholders and representatives from all levels of government, educational and research institutions, civil societies, the private sector and all stakeholders that have a role in MSW management. Moreover, they emphasized the necessity for all levels of government taking a more empowered role in planning, regulating and managing MSW management.

All of the interviewees thought that the private sector should participate in MSW management. The importance of expanding and strengthening the laws and regulations that organize private sector participation and establish markets – especially for small waste-based enterprises – was found to be of importance. To enable public participation in MSW management, all respondents indicated their support of outreach methods such as education, social learning and media. This agrees with the results from the stakeholders' questionnaire that the participants promote public participation in planning and implementation of ISMSWM in Kuwait. The interviewees also agreed on the need for a modification of existing communication tools and skills related to MSW management.

The perspectives of key informant interviewees on MSW management are summarized as follows:

- The environmental laws and regulations (EPA Law No.210/2001) related to MSWM are ineffectively implemented.
- The current national policy is to promote the zero-waste approach and energy-from waste and to promote small enterprises in the field of solid waste management.
- Scavenging activities is an obstacle to the establishment of recycling programs.
- There is a lack of regulations that organize the cooperation between the government and the private sector.
- The lengthy administrative documentation cycle is one of the main obstacles to planning and implementation of any new project

- The mandated regulations are not effective in promoting the implementation of the current policy. However, the plan is to modify the current laws and regulations after the establishment of the latest version of the national SWM strategy.
- The latest version of the SWM strategy will be established by the relevant institutions with cooperation from The World Bank.

4.5 Environmental systems analysis (ESA) tools

4.5.1 LCA: IWM-Model

Since the implementation of the IWM-Model of MSW management in Kuwait resulted in a tremendous amount of analysis, the inclusion of the entire results and analysis are attached in Appendix A. Appendix A includes two parts of analysis: part 1 includes different technologies and these technologies are compared to the MSW dumping in landfill sites as a base case, while part 2 includes various operations and scenarios, and these scenarios are compared to the base case, which is the MSW dumping in landfill sites. Each part of the IWM-Model results and analysis includes charts of the environmental indicators, a summarized analysis of each chart to clarify the lowest and highest results according to the applied technologies and scenarios, and at the end of each part, there is a concluding paragraph and chart.

The results of the IWM-Model were further organized by the researcher in a paper and presented to 5 members of the national waste management committee in Kuwait in a focus group discussion. The following section will present in detail the topics and the relevant results that were covered in the focus group discussion. In addition, the following section will present the questions asked during the discussion and the perspectives of the participants regarding the challenges for planning and implementing ISMSWM in Kuwait and the implementation of LCA tools to support MSW management decision-making. The results that are included in the paper are presented in Appendix A.

Despite the many gaps while entering the data in the IWM-Model model, the implementation of the life cycle inventory tool and integrated waste management model (IWMModel) in this research study provided an opportunity to present different scenarios for MSW management in Kuwait. The results of the IWM-Model were used by the researcher to develop a white paper. This paper includes a summary of the idea and the basis of the development of the IWM-Model, benefits of the model and the boundaries of the MSW management system in Kuwait that will be implemented in this model. With a careful consideration of the current national policy to transition from conventional MSW management toward an ISMSWM approach (e.g. zero-waste and EFW), different scenarios with a combination of SWM-related techniques and operations were established and implemented in the IWM-Model. The results of these scenarios were estimated based on the available data of MSW quantity and composition and the estimated data to fill the data gaps based on key informant interviews with waste actors about the current situation of MSW management in Kuwait, and the literature review.

In particular, there has been a chance to compare various technological solutions through established scenarios in different environmental impact categories of various pollutive gasses and heavy metals in the air and water) in addition to the energy consumption and residual waste to be disposed to landfill. Table 4.36 presents examples of scenarios and comparison factors that were evaluated by IWM-Model for MSW management in Kuwait, involved in the white paper (Appendix A) and presented in the focus group discussion.

Table 4.36: Examples of scenarios and comparison factors that were evaluated by IWM-Model for MSW management in Kuwait

NO. of proposed scenarios	Scenarios	Type of waste	Greenhouse gases CO2 equivalent (tonnes)	Energy consumption	Percentage (%) of waste sent to landfill
	Dumping (base case)	Total waste	1,100,000	90,000	100
1	Landfill*	Total waste	1,400,000	-960,000***	100
2	Composting – Landfill	- Food waste (45.8%) - paper (8.4%) of total waste	207,000	330,000	49
3	EFW (100%) – (zero-waste-tolandfill)	Total waste	-630,000**	-12,000,000	21

9	AD (food waste and paper) – Recycling 70% (plastics and metals) - landfill	- AD: Food waste (45.8%) and paper (15%) of total waste - Recycling: 70% (plastics: 18% of total waste) and 70% of metals (10% of total waste)	2,500,000	-35,700,000	17

* Landfill means engineering designed lined landfills with leachate collection systems

** Negative numbers relevant to the impact equivalents of net life cycle inventory in terms of reduction of emissions from relevant hundred cars for one year (EPIC/CSR 2004, Haight 2004. P.90). *** Negative numbers for the energy are relevant to the energy production in terms of electricity of homes for one year (EPIC/CSR 2004, Haight 2004, p.90).

4.5.2 Focus group discussion

For Part 1 of the questions in table 3.4, all of the participants admired the LCA as ESA tools and the IWM-Model. With the exception of Participant 3 who said that they were working on EIA projects, none of the respondents had any prior ideas about ESA tools. Moreover, all of the participants had no prior idea about any LCA tool except Participant 2 who stated that her LCA knowledge is limited to industrial products. She had not known that LCA could be implemented for waste management. The participants were therefore not in the practice of using ESA tools such as LCA while planning for ISSMWM.

While comparing different scenarios of SWM, all of the participants agreed that making a decision for sustainable MSW management must recognize the full range of environmental impacts as important and should not consider issues in isolation. The majority of the participants (80%) promoted the selection of the energy-from waste (EFW) scenarios after source separation for sustainable MSW management. Participants had different preferences for MSW management technologies. For example, Participant 1 supported the selection of the energy-from-waste (EFW) scenarios without source separation. Participant 1 elaborated that the option of source separation is not applicable since the government does not rely on public participation for source separation. Participant 1 also cautioned that if public participation for source separation of waste were to be applied, it would be a long-term process and would require training courses, appropriate advertising, and media participation.

All of the participants admired the usefulness of the implementation of LCA tool in MSW management to assess the situation in Kuwait. They indicated that LCA and other ESA tools would enable waste actors to oversee different technologies and options for MSW management scenarios and their associated environmental impacts according to their particular knowledge of the situation of MSW in Kuwait. They stated that the LCA tools could support decision-making as it will help the waste actors to be aware of and discuss different issues instead of only receiving information from external consultants. Table 4.37 presents the perspectives of participants 1 and 3 in terms of the usefulness of implementing LCA tools to support decision-making for planning ISSWM. Participants 2 and 5 echoed the perspectives of participants 1, 3 and 4. All of the participants indicated that they anticipate many obstacles from the government in terms of engaging local waste actors in the planning and implementation of ESA tools for ISMSWM.

For Part 2 of the questions in table 3.4, all of the participants felt that technical/operational solutions are not enough for planning ISMSWM in Kuwait and that this type of solution should be part of an integrated framework that includes sustainable development dimensions (i.e. policy, law/regulations, institutional framework, environmental, economic, social). Participant 1 indicated that looking for new technical/operational solutions would not solve the problem of waste management in Kuwait and would not lead to a sustainable approach to MSW management. In addition to considering an appropriate technology with high income-generating potential, decision-making should assess the potential long-term environmental and social impacts within an integrative and sustainable framework. Such comprehensive decision-making could not be achieved without expanding, strengthening and implementing relevant laws and regulations to support ISMSWM. Participant 2 outlined the main factors that s/he perceives as supporting planning for ISMSWM as the modification of existing laws related to general waste management and solid waste in particular and adopting economic tools to implement these laws and regulations. Participants 3, 4, and 5 strongly supported the mentioned opinions by interviewee 2. Table 4.38 presents the perspectives of participants about the challenges for planning and implementing ISMSWM in Kuwait.

Table 4.37: Interviewees perspectives regarding the implementation of LCA based tools to support MSW management decision-making

Participants and the relevant institutions	**Participant perspectives regarding the implementation of LCA based tools to support MSWM decision-making**
Participant 1: Kuwait Municipality	Participant 1 stated that the government does always trust external consultation institutes and there are not enough local experts in the various technologies. The need to understand different available technologies leads different environmental consultation institutes to offer relevant presentations. Understanding can be gained from their presentations and webpages but it is difficult to decide on the details that could suit the situation in Kuwait. At the same time, the external waste management experts do not know much about the details of the current situation. This makes the decision-making very difficult. Therefore, exchange programs are recommended, which can provide an opportunity to understand the actual conditions for best implementation of the suggested technologies. Other recommendations include the implementation of ESA tools and LCA tools to gain more details about the current situation. This can provide better understanding of the proper technology for sustainable MSW in Kuwait based on the current conditions such as the adopted policy, the regulations and the type and composition of waste. Participant 1 believes that this can fill the gap between the waste actors from Kuwait and the waste experts from environmental and consultation institutions. Always when there are different opinions, the discussion becomes worse since not all questions can be answered.
Participant 3: Kuwait Municipality	Participant 3 stated the importance of the LCA based tool in decision-making. It provides a better understanding of the environmental impact of different technologies and operations of SWM. The adoption and implementation of LCA should be integrated with other factors: economic, regulatory and administrative. Moreover, the adoption and implementation of LCA should be supported by the government although this may not happen due to obstacles.

Participant 4: EPA	Participant 4 stated that ESA tools must be implemented. These tools make the discussion and the communication in the meetings more productive. Participant 4 indicated how useful the implementation of CBA by the World Bank was to explain the opportunities for the private sector and specifically the investment opportunities by the establishment of small enterprises. It would be more useful if the waste actors in Kuwait have the ability to implement these tools to understand the environmental impacts, and economic revenues for any proposed plans for MSWM. Participant 4 agreed with participant 3 and indicated that such innovative ideas would face a lot of obstacles.

Table 4.38: The perspectives of participants about the challenges for planning and implementing ISMSWM in Kuwait as presented by the interviewees of the focus group discussion

Participants and relevant institutions	**Challenges for planning and implementing ISMSWM in Kuwait**
Participant 1: Kuwait Municipality	• Lengthy administrative documentary cycle • The risk of being responsible for decision-making • The communication between different responsible institutions, therefore the communication between stakeholders
Participant 2: Kuwait Municipality	• Lengthy administrative documentary cycle for the established studies and projects The existing laws and regulations are not obligatory. The responsible institutes do not implement reinforcing tools, such as fines or charges. The government does not have a comprehensive strategy and plans for long-term waste management in Kuwait. The communication between different responsible institutions, therefore the communication between stakeholders.
Participant 3: Kuwait Municipality	• The routine, i.e. lengthy administrative documentary cycle • The communication between different responsible institutions, therefore the communication between stakeholders

Participant 4: EPA	• Lengthy administrative documentary cycle for the established studies and projects • Governmental awareness, in terms of determining the priorities of planning and establishing long-term strategy involving all types of waste and determining the economic and environmental priorities. • The communication between different responsible institutions • Public awareness, since traditions and public practices lead to an increase in consuming products and generates different types of waste and sometimes the improper use of waste collection by waste management facilities.
Participant 5: EPA	• The established studies and projects never being completed or implemented due to: (1) the lengthy administrative documentary cycle for the established studies and projects between responsible institutes; and (2) the different opinions, contradictions and difficulties of communication and cooperation between stakeholders.

Chapter 5

Synthesis, discussion and conclusions

5.1 Introduction

This chapter provides a comprehensive synthesis and detailed discussion of the research and case study findings provided in Chapter 4. Also included in this chapter are recommendations and concluding ideas for improving the integrated environmental management (IEM) approach to municipal solid waste management and directions for future research. Divided into three parts, Chapter 5 comprises the following sections: 5.2 - 5.5 synthesize the case study findings and the results from various data sources in addition to the results updates where available; and 5.6 - 5.13 include the theoretical implications of the findings, and explore lessons from the literature review for how the obstacles to integrated sustainable municipal solid waste management (ISMSWM) can be addressed and transformed into opportunities for a more sustainable and effective MSW management system. Relevant conceptual discourse is also engaged as a means of deepening the analysis and application of research findings and recommendations for improving the IEM approach to MSW management. Finally, conclusions and the contribution of results to broader knowledge, and directions for future research, are presented in sections 5.14 - 5.17.

5.2 Addressing the waste management obstacles and opportunities from the SDD perspectives

5.2.1 Environmental awareness

Over the past 30 years, awareness of environmental issues and the need for expansion of Kuwait's legal, regulatory and policy landscapes have been growing among the civil society and public sector. Municipal solid waste materials, and the impacts surrounding human health and the environment, are key parts of this progressively detailed and complex understanding of national environmental issues. This central theme will be discussed in subsequent sections with respect to the legal, regulatory context; institutional arrangements, policy instruments and strategies; and economic and social factors. While there has been tangible progress in terms of legal, regulatory and economic factors in Kuwait that support MSW management, there is not yet an integrative platform for planning and implementing a sustainable management system.

5.2.2 Operational and technical performance

The quantity and composition of household waste produced was analyzed, and the results indicated a fluctuation from month-to-month within the calendar year. As mentioned in Chapter 6, these monthly fluctuations indicated lower waste production during the summer months, and higher waste generation during the rest of the year, especially during Christmas and Ramadan (Koushki 2004).

The composition of MSW in Kuwait was analyzed and the results indicate a mixture of different types of waste from agricultural, commercial, household and institutional sources, with biodegradable waste comprising more than 50% of this mix. A study by AlJarrallah (2014) indicates that the generation of biodegradable waste is still high. It is important to note that the lower percentages in previous studies were not due to a lower production of biodegradable waste, but rather, because the percentage of recyclable waste has now increased. This study also indicates that the plastics fraction of the mix has increased.

MSW generation rates and composition are typically affected by geographic distribution, climate, demographic and cultural factors. Studies indicate that MSW in developing countries is high in biodegradable waste, whereas in developed countries, the MSW is high in recyclable materials (AlJArallah 2014). Section (5.2) will discuss some details about these changes in the current MSW composition in Kuwait.

Waste actors agreed that while comprehensive and current data is imperative for ISMSWM planning, one of the main obstacles to planning is a lack of accurate detailed data on the quantity and composition of sorted waste. Of note is that this same obstacle has been highlighted since the Strategy of Kuwait was published in 2002. Since 2002, the data on waste composition was only updated by AlJarallah (2014) and although much effort was invested in this assessment, many MSW composition details were not accurate. For example, there are observed discrepancies in the quantities and types of recyclable waste – in particular, the fraction of plastics present. The World Bank's (2009) assessment of opportunities for investment into recycling programs in Kuwait indicates that while there are continued efforts by the government to improve and create opportunities for MSW management, limitations in the available data and projections were noted as obstacles.

Interviews with the cleaning department for the municipality of Kuwait confirmed that MSW collection is a daily operation in Kuwait (Alhumoud 2002, Koushki 2004). Survey results indicated that waste actors and householders are satisfied with MSW management daily curbside collection and waste transportation. However, householders were unsatisfied with the number of containers and their improper use, which leads to the spread of waste surrounding the containers and the attraction of animals interested in the refuse. Since the only method for MSW disposal in Kuwait is the dumping of unsorted waste, waste actors expressed dissatisfaction with the lack of waste sorting, and the unavailability of accurate methods to calculate composition and quantity of the waste. Waste actors also criticized the scavenging activities of MSW collection workers because their actions reduce the amount of recyclable materials that would otherwise reach a centralized recycling facility – if established. Currently, small business enterprises are using scavengers or private contractors to collect recyclable materials. All of the landfill sites in Kuwait are unsanitary because they act as dumping grounds rather than safe landfill areas, as presented in section (4.2.1).

Current landfill-related challenges to ISMSWM such as restricted land use, environmental and social impacts of landfills, biodegradable waste as a dominant fraction of MSW composition, and illegal dumping have led the Municipality of Kuwait and the Environmental Protection Authority (EPA) to look for alternative options to landfill disposal. These are some of the pivotal reasons, including "economic development, growth of population, urban expansion, industrial progress" (news.Kuwaittimes.net, 2018), that cause increases in all types of waste including MSW, and are motivating the Municipality of Kuwait and EPA to consider a new national policy for MSW management. During a long transition stage, the Municipality of Kuwait and EPA were negotiating the required operational and technological requirements for developing more sustainable and effective MSW management methods, including the ability to collect and process biodegradable and recyclable waste streams. These wastes will then be diverted from landfills and can be transformed into products that supply market demands.

The latest progress is the announcement by the Kuwait Authority for Partnership Projects (KAPP) for the Project that "...will utilize the latest technology to treat municipal solid waste in Kuwait. The Project aims to protect the environment and land resources, and to generate alternative power sources to be purchased by the Ministry of Electricity and Water" (www.kapp.gov.kw).

"The Project site is located south of the ground broadcasting station in the Kabd area, 35 km away from Kuwait City. The site dimensions are 1000m x 500 m, with a total area of 500,000 m2. The site will provide a number of services including treatment using incinerators for generating electricity and landfilling the ash from the remains of the incineration. The total volume of the remains after burning should not exceed 5% of the total volume of waste. The plant is expected to receive 50% of total municipal solid waste produced in Kuwait. The Project will be procured as a Build, Operate and Transfer model in accordance with Law No. 116 of 2014.” (www.kapp.gov.kw).

5.2.3 Policy

Policy makers and the banking sector in Kuwait are both very much committed to promoting investment in the recycling industry so that a smaller proportion of waste is designated for disposal in landfills. A reduction of landfill waste would lead to better use of scarce land, along with associated environmental, social and economic benefits (see sections 5.4 and 6.2.3). The incremental rate of waste generation in recent years is placing significant pressure on the municipal services in Kuwait. In addition to the environmental impacts of the unsanitary landfills on underground water, soil and air, it also limits the effective use of land for the establishment of infrastructure projects. Under this pretext IBK and MOF commissioned a project supported by the World Bank that aims to assess the potential for establishing both small-scale and national waste recycling programs in Kuwait (The World Bank 2009). The World Bank assessment (2009) presents the most significant economic and environmental potential, with a focus on different material streams (e.g. organic waste, paper product consolidation, plastic product consolidation and metal consolidation). In particular, it identifies economic investment opportunities for implementing a waste-recycling sector in Kuwait (e.g. building-operating-transfer (BOT)). While recycling is the focus of the assessment, it also demonstrates the wider objective of waste minimization by policy makers.

Until recently, Kuwait has focused its MSW management efforts on basic planning, collection, transportation and disposal services. It is therefore quite significant that the national government is now considering the adoption of a radically broadened approach (i.e. ISMSWM) with progressive statutory performance targets, including promotion of recycling, resource recovery and waste minimization (The World Bank 2009). As a general overview, the 2009 World Bank assessment on investment opportunities in recycling opens a new horizon of thinking vis-àvis the current status quo method of basic MSW management planning. In addition to a centralized recycling program, a variety of ISMSWM approaches are presented for discussion and planning such as: zero-waste, zero-waste to landfill, resource recovery, environmental education and energy-from-waste (EFW).

The results of the waste actor survey support this shift in policy focus toward a broader approach to ISMWSM, whereby more than half of the participants selected promotion of the recycling sector as the current adopted policy in Kuwait in the field of MSW management. With respect to MSW institutional perspectives, the surveyed waste actors stated that the focal policy issues of the 2014 national policy on MSW management would include a commitment to zero waste-to landfill through actions such as: promoting public participation, implementation of economic instruments, environmental education, and renewable-energy projects. However, the specifics of how these zero-waste-to-landfill actions will be operationalized are currently unknown. Of concern is that this vague policy being focused on by the government would override more viable recycling and resource recovery programs.

The national policy involves many approaches to comply with the Kuwait vision 2030 (Kuwait voluntary national review 2019). Regarding MSW management, the National policy includes zero-waste, zero-waste to landfill, environmental education and energy-from-waste (EFW). The International Alliance (2018) definition for zero-waste involves the avoidance of burning and discharges to land, water, or air that threaten the environment or human health as part of the zero-waste approach. Zaman (2014) criticizes the inclusion of EFW in zero-waste and considers it as being contradictory to the zero-waste approach.

The current trend in the GCC countries is to look for renewable sources of energy to reduce the dependency on fossil fuels in these countries (Abdallah 2018, Aleisa 2019, Ouda 2016). Kuwait is one of the GCC countries that promotes any possible renewable energy resources, including energy derived from MSW management. This contradiction in the national policy may be due to lack of knowledge and capacity in the responsible institutions, lack of communication and cooperation between the responsible institutions and the international institutions that are participating in the planning for ISMSWM, and it could be relevant to the priority of EFW over the zero-waste approach.

5.2.4 Legal and regulatory context

More than 50% of waste actors admitted that the existing laws and regulations are ineffective to support implementation of the national environmental policy on MSW management. The following regulations pertain to the collection, transportation and dumping of household waste in sanitary landfills: Chapter IV of the *Management of Household, Hazardous, Healthcare and Sludge Wastes* section of EPA Law No.210/2001; Environmental Requirements and Standards (ERS); and Articles 19 and 24, and Appendix No.11-4 of ERS (see appendix C). Despite the regulations, landfills in Kuwait are still identified by waste actors as unsanitary locations. AlAwadi (2002) emphasizes that the lack of enforcement of environmental law by the executing authorities leads to the discrepancy between SWM and MSW management regulations and the MSW management reality in Kuwait. The research findings of this study further indicate that while there has been tangible progress in the country's legal and regulatory instruments with respect to SWM, there are continued concerns about whether there are efficient tools available for their implementation and enforcement.

Amendments made to the 2014 Environmental Protection Law No. 42 include the provision of potentially more efficient instruments to those of the prior version of the Law. Section 2, Protection of Terrestrial Environment from Pollution, stipulates the following amendments:

- Chapter 1: Management of Chemical Substances and Hazardous wastes;

  Chapter 2: Management of Hazardous, Medical and Solid Municipal Waste and Sludge (for a complete list of articles related to MSW, see table 5.1).

The following list is a summary of the provisions related to MSW:

1. Shift in MSW collection by promoting the use of waste-specific containers, and education against littering.
2. Promote a recycling industry.
3. Commit to completing the recycling infrastructure within five years.

4. Couple the upgraded strategy with the necessary elements for implementation: work plans, monitoring programs, supervisory conditions, national organizational liability, and implementation tables.
5. Promote coordination and collaboration between relevant institutions to develop an ISMSWM program, including preparation, development and upgrading of the strategy.

What is significant about the progress observed within the legal and regulatory systems is that, for the first time, they provide a landscape for modifying Kuwait's current MSW management situation. First, there is a focus on introducing restrictions on waste collection. Second, the setting of an obligatory timeline for planning the infrastructure of the recycling industry is an indicator of a major shift toward serious ISMSWM planning, and in particular, for the prioritization of a national recycling program. Third, article 34 clarifies the idea that rather than continuing to follow the existing SWM strategy in the country, there should be an upgraded national integrated waste management strategy, along with the relevant implementation and management tools, and a scheduled timeline.

Fourth, the insistence to include targets for implementation within an established timeline is set out in articles (30 and 34). For example, Law No. 42 of the Environment Protection Law, 2014, establishes specific timelines for establishing the national integrated waste management strategy and the implementation of SWM codes included in these articles. Fifth, some of the articles listed in table 5.1 promote the involvement of waste stakeholders in collaboration with other competent authorities. For example, the articles promote coordination and collaboration between competent authorities for the establishment of the National Program for Integrated Waste Management. Moreover, they also call for the establishment of a specific plan to fix and manage all of the unsanitary landfills in Kuwait.

Despite the fact that most Arab countries have issued comprehensive laws and regulations since the 1990s to promote environmental protection, there are structural constraints affecting the competence of authorities to effectively interpret, implement and enforce existing environmental laws. This is considered one of the main obstacles to improving the SWM and MSW management context in Kuwait. The constraints are due to a national shortage of qualified cadres of judicial and technical officers, and environmental experts. Consequently, there are not enough highly skilled human resources available to effectively apply SWM, MSW management and other environmental laws and regulations. This situation is even more unfortunate as the country has prioritized national human resources development as one of their basic goals to reach sustainable development and preserve natural resources as part of their millennium goal targets (AlAwadi 2004; Alfeel 2011).

Another signal of progress in the regulatory and legal context is the establishment of the Kuwait Environmental Police (KEP). KEP is an important step in terms of both the coordinated practices of different SWM authorities (i.e. Internal Ministry, EPA and Municipality of Kuwait), and the enforcement of laws and regulations. However, KEP is relatively new in Kuwait and there are concerns that it is struggling with the capacity to apply legislative and technical instruments. These limitations may lead to conflicts, and failure to achieve the core KEP goal of clamping down on environmental violations 'with the power of law.' In this context, the KEP and EPA have promised to perform in a coordinated manner, where the police squad takes charge of the security matters, while the Authority handles regulatory issues. It should be noted that penalties and fines imposed on the offenders are not intended to generate financial proceeds but, rather, to instill awareness in the population that inconsiderate acts lead to environmental degradation. Some examples of a light offense categorized under KEP's mandate are: fishing in Kuwait Bay, littering, scooping up soil, and any other action that may harm wildlife (Kuwait Times 2015).

Table 5.1: Relevant Articles of Law No. 42 from 2014 Promulgating the Environment Protection Law

No.	Article

28	Collection, transportation, and disposal of solid municipal wastes, hazardous and medical wastes and the sludge resulting from sewage and industrial wastes are totally prohibited without getting the necessary license from the competent authorities. The Executive Bylaw of this law specifies the procedures and conditions of issuing such licenses as well as the mechanism of handling and dealing with such materials.
30	Solid municipal waste should be disposed of pursuant to the environmental regulations and standards specified by the Executive Bylaw of this law. The concerned authorities are required to complete the infrastructure necessary for recycling the solid municipal wastes within a maximum period of five years from the date of issuance of this law.
32	Throwing, treating, or burning solid municipal wastes is prohibited except in facilities allocated for this purpose, and it must be taking into consideration that such facilities shall be far away from human populations and environmentally sensitive areas. The Executive Bylaw of this law lays out the specifications and regulations related to these facilities and their locations.
33	It is strictly prohibited to throw out garbage or wastes of all types except in the containers allocated for this purpose.
34	The Authority is concerned with coordinating with other competent authorities for the preparation of the National Program for Integrated Waste Management, including the preparation, development and upgrading of a national strategy for the integrated management of solid municipal waste, medical, liquid and hazardous wastes, along with the necessary work plans, State organization liability, supervision and monitoring programs and scheduled tables for their implementation. The Authority shall present the said program to the Supreme Council for approval within three years maximum from the date of issuance of this law.
36	It is prohibited to construct new landfills in the State of Kuwait or to expand the existing ones without the approval of the Supreme Council. In all cases, environmental impact assessment studies should be carried out, and such new construction or expansion should abide by the regulations stated in the Executive Bylaw of this law. The competent authorities should set a detailed plan for the management, rehabilitation and restoration of all landfills in the country within one year from the issue date of this law, provided that this plan shall be submitted to the Supreme Council for approval.
39	The concerned authorities are obligated to set the necessary standard specifications for all recycled materials, the nature and type and utilization mechanisms in such a manner to ensure the safety and competence of such utilization. The government shall grant the recycled materials within its territory, which match the standard specifications, priority of use in its projects, in support of the recycling industries.

Note: Articles 28, 30, 32, 33, 34, 36 and 39 of Law No. 42 were chosen, as they are relevant to national municipal solid waste management in Kuwait. Source: www.epa.org.kw.

Moreover, the EPA launched a training and rehabilitation program for their staff to serve as environmental law enforcement cadres to apply the amended 2014 Environmental Protection Act (i.e. Law No. 99) (Alrayalaam 2015). The program is germane to the development of a new generation of judicial officers who are expected to have an appropriate level of specialized knowledge and experience with which to effectively administer the legislation set out in the revised Environmental Protection Act. The trainers for this program include university lecturers, environmental police, and professionals with legal and technical expertise. They will come from the Kuwait Institute for Judicial and Legal Studies, the Kuwait International College of Law, and the Ministry of Interior. The training program curriculum includes an integrated program of legal and technical themes focused on a full range of the administrative, judicial and legal competencies, duties, rights and powers that will be conferred to the law enforcement cadres. In addition, the training program includes the administrative and technical foundations of environmental inspection, methods of judicial practice, and an overview of examples of violations from environmental case law that were presented to the Kuwaiti judiciary (Alrayalaam 2015).

With respect to calls for an independent environmental court in Kuwait (AlAwadi 2002), the waste actors surveyed indicated that they were not aware of the effectiveness that such a court would have in examining environmental conflicts or crimes through the lens of environmental impacts. An independent environmental court would be significant in its ability to address the lack of capacity to effectively implement and enforce existing environmental protection laws and regulatory instruments. Moreover, the traditional approach to dealing with environmental cases through the civil and commercial courts does not allow for any examination of the environmental impacts or natural resource management perspectives of the cases brought before them (Al-Awadi 2002).

5.2.5 Institutional Context – capacity building

Connected to shifts in the legislative context of solid waste management is a historical overview of progressive changes in the administrative institutions and responsibilities related to SWM in Kuwait. The following are examples of institutional progress in SWM:

1. The EPA became a regulatory authority for SWM, including an industrial waste department.
2. The Municipality of Kuwait is responsible for municipal SWM. This is conducted by the following departments and includes collection, control, processing, utilization, and final disposal:

a. Department of Environmental Affairs – section of waste management control and disposal
b. Department of Cleansing – responsible for collection and transportation

The division of responsibilities typified by this type of institutional arrangement can often lead to fragmented or conflicting priorities, and delayed communication. For example, the Department of Cleansing in the Municipality of Kuwait was looking for contracts to facilitate a source separation program. However, the department of solid waste disposal in the Municipality of Kuwait focused instead on developing SWM thermal treatment as an unsorted stream method. This decision was made as a way to supplement the power grid, and to avoid the risk of public participation (specifically, householders) in source separation. While source separation of waste was identified as the goal, priorities related to energy generation and avoiding public participation were elevated above the stated goal. At the same time, an interview with the head of the EPA's department of industrial waste explained that they recommend composting as the best mechanism for sustainable MSW management in Kuwait. The previous examples from departments that are working in national MSW management projects present different priorities and actions since they are looking for the development of MSW management in Kuwait but through different routes.

Of the sample of surveyed waste actors, 79% of them work as engineers across the key MSW Management institutions: Municipality of Kuwait, EPA, governmental agencies, research and education institutes, and engineering consulting firms. Only 7% of the participants are environmental professionals. This overrepresentation of engineers can limit the type of integrated environmental planning and management knowledge since their concentration is on technical solutions. As a way to avoid a narrow focus on technical solutions for MSW management and instead promote a more integrative and multi-dimensional perspective, institutional arrangements should include multidisciplinary expertise.

Environmental professionals such as researchers, planners, environmental managers, waste managers, environmental engineers, and environmental lawyers, would provide a range of scientific, social, economic, regulatory and governance perspectives –

rather than only technical expertise. Training courses, seminars, workshops or research programs can provide opportunities for developing multi-disciplinary human resource capacity in SWM and MSW management and promote understanding of the local situation of MSW management. These capacity building settings also offer opportunities for collaboration and establishment of plans for ISMSWM models, i.e. integrated environmental management (IEM) and sustainable development dimensions (SDD). This is also an important way to mitigate the potential for conflicts arising from fragmented or divergent perspectives.

5.2.6 Strategy and monitoring

Although the Municipality of Kuwait and EPA are the institutions vested with the responsibility for the establishment and implementation of a SWM strategy in Kuwait, many other institutions support these processes. These institutions are:

1. International multilateral institutions (e.g. The World Bank and UNDP);
2. Research and educational institutes (e.g. Kuwait University and Kuwait Institute for Scientific Research); and
3. Consultation firms (their participation is dependent on either a determined need for their expertise by the SWM authorities, or by their own offer to provide presentations or seminars on specific topics).

The obstacles in the SWM sector (discussed in section (3-4-4), p.147 of the Environmental Strategy (see Appendix D) can be summarized as:

- Shortages of current data on: the quantities of solid waste derived from residential, commercial and industrial activities, and the production rates and types of solid waste;
- Dependence on landfills as the only option for SWM;
- Insufficient public participation;
- Inadequate public awareness programs;
- Absence of modified strategies such as waste minimization; and

- Absence of economic or regulatory mechanisms (e.g. penalties) to preserve environmental health and prevent violations.

These are common constraints for waste management that were discussed in the 2002 Environmental Strategy (EPA). Another core problem is the absence of collaboration between the central and supportive MSW management authorities (i.e. EPA, Ministry of Electricity and Water, Ministry of Public Works, Kuwait Municipality and PAAFR). To date, the Environmental Strategy document has not been revised to evaluate the progress made in terms of providing clear policy or tangible systematic processes to overcome these obstacles.

One of the main obstacles to Kuwait's MSW management sector is that policy strategies and environmental requirements and standards (ERS) exist more as rigid, rhetorical documents rather than as implementable plans, regulations and standards. While the 2002 Environmental Strategy discusses the aforementioned obstacles to MSW management in detail and with transparency, it has failed to establish plans with a defined timetable and long-term and short-term targets to avoid these obstacles with an associated program of evaluation and monitoring. The challenges and obstacles of shifting from a conventional MSW management system toward planning and implementing an ISMSWM system must be recognized, and in addition, it is also necessary to understand the structure, plans and mechanisms to avoid these challenges and obstacles and achieve the transfer toward a viable ISMSWM system in Kuwait.

5.2.7 Economic factors

The majority of surveyed and interviewed waste actors agreed that one of the most important obstacles to MSW management in Kuwait is limited economic resources. Participants indicated that the problem is not the scarcity of economic resources, but rather, the type of funding and marketing. For example, the government is pursuing the policy direction of build-operatetransfer (BOT) as a funding strategy for planned MSW management programs. This type of funding system places the responsibility mainly on the investor to decide what type of investment for MSW would best ensure higher revenues, and at the same time, best align with the achievement of the national policy of MSW management. The Ministry of Water and Electricity was cooperative in this regard by offering to buy the products of energy-from-waste, if it can be produced in the form of electricity, to promote the establishment of ISMSWM in Kuwait.

Accordingly, the selected options of the sustainable MSW management related mechanisms and techniques by the investors using the BOT system will be restricted by the priority of higher revenues and best marketing over better environmental impact reduction to ensure a satisfactory investment.

EFW revenues from the sale of energy will have to be competitive with energy prices from fossil fuels. Kuwait has relatively low energy prices, and this will affect the economic feasibility of EFW. The offer of the Ministry of Water and Electricity should be subject to extra studies and research to understand how sustainable this solution is, and how it can promote the implementation of an ISMSWM system. In Kuwait, the waste composition is mixed. If such mixed waste is fed into the incinerator, it will affect the efficiency of the facility and in turn the energy expected to be produced. Similarly to apply the anaerobic digestion (AD) technology, the organic waste needs to be separated if the goal is to produce a high-quality compost along side with energy recovery. With the different available options, the scale of implementation is an important factor that should be considered. Central units are not always the most favourable options for MSW management.

The results indicated that around 60% of the surveyed waste actors say that economic resources are an obstacle for planning for an ISMSWM system in Kuwait. On the other hand, 68% of the surveyed waste actors responded that the BOT system is a favourable funding system for solid waste management in Kuwait. In the key informant interviews and focus group discussions, the interviewees were asked about these results. They provided explanations indicated that the economic resources are not a problem. The economic problem is the refusal of the responsible institutions to subsidize the projects, and the dependence for external funding for the BOT system. Although the BOT system essentially is not a funding system, it is the most favourable option since the BOT system will include the responsibility for all stages of the project site location, and marketing of the products.

In the case of governmental subsidies, the government can provide for example: financial support, support in collection and transportation services (e.g. MSW source separation) and even marketing support. The governmental support could provide an opportunity for more options while selecting the sustainable MSW management by the investors and reduce environmental impacts during the process.

The current solid waste management system, including its regulatory and institutional dimensions, offers few opportunities for business development. The BOT investment includes the external investors since there are no laws that organize the relationship of the local investment (private sector partner) with the public sector partner. In particular, there are barriers facing the recycling industry such as: the absence of a national strategy to promote waste recycling and adoption of new waste management-related approaches in Kuwait; the lack of integrated SWM systems and incentives to promote integrated approaches. Moreover, business development opportunities related to recycling are affected by the absence of reliable and current data about recyclable waste, and there is no platform yet for exploring business opportunities (The World Bank 2009)

Another economic obstacle to implementing sustainable MSW management is the ineffective contribution of economic instruments to implement the MSW management strategy. According to the findings of the waste actor questionnaire, participants promoted economic charges/fines, user fees, industrial taxation and producer responsibility as more effective economic instruments for MSW management. Moreover, the majority of surveyed householders promoted the enforcement of both taxes and fines for illegal practices of MSW disposal as an effective way for providing the financial inputs needed to implement new MSW management services in their areas.

5.2.8 Social considerations

As a general trend, the government prefers to take full authority of MSW management planning processes, and therefore prevents public involvement (householders in particular). This preference is even more discernable during the current transitional stage from conventional to new approaches of MSW management. The national government does not appear to trust public cooperation and participation in MSW management projects for proposed projects that include one type or multiple types of recycling, AD or thermal treatment where the source separation would ensure better performance. Although

AlYaqout (2003) supports this perspective, research findings from this research and from AlJarallah's study (2014) show that householders demonstrate a relatively strong level of environmental and SWM awareness. Furthermore, the research findings from the householder questionnaire indicate that the public also have a strong inclination to participate in SWM programs.

More than 75% of the participants in the householder questionnaire expressed concern about the current environmental situation in Kuwait, especially citing the impact of emissions on air quality as one of the main problems. A study done by the UNDP (2011) also focused on high emissions and air quality as a key environmental challenge in Kuwait. In addition, the surveyed householders were concerned about waste management and in particular, MSW. This result of the householder's survey in addition to the discussion during distributing the questionnaire, the notes and suggestions on the questionnaire forms that were made by the participants, and the insistence of many of the householders to keep in contact even after finishing the survey are all indicators of the progressive status of the public awareness of environmental topics generally, and MSW management specifically.

While the participant householders indicated that they were not familiar with municipal or backyard composting, they expressed familiarity with recycling and waste sorting practices. The survey findings show that approximately one third of householders are separating one or more of plastics, metals or glass waste for recycling by individual collectors or contracted businesses. Moreover, the majority of householders show a willingness to participate in programs that will improve MSW management practices (e.g. 85% for separating recyclable waste, 80% for separating organic waste).

For instance, the majority of household participants agreed to get involved in: separating waste for recycling if an organized program is set up; separating recyclable waste if specific bins are offered; and separating waste into waste-specific communal containers. Moreover, the majority of householders were interested in participating in the separation of organic waste for composting if green bins are offered and a program is implemented to compost food and yard waste.

It is important to note that, in general, householders expressed their willingness to participate when different options for MSW management practices were presented to them.

Moreover, most of the participants were quite enthusiastic about participating in the household survey: discussing the survey questions with the researcher, trying to gain more information, and including extra information and suggestions wherever it seemed relevant. These participant observations confirm that social research provides a more comprehensive understanding of the social structure necessary for developing opportunities for better public engagement in ISMSWM.

These findings indicate that specific demographic groups in the society may be associated with higher levels of SWM and MSW management awareness and the necessity for householders' participation in MSW management activities. The results of the householder survey regarding interest in different levels of public engagement in MSW management are anticipated to encourage government and other waste actors and decision-makers to not ignore or refuse the inclusion of public participation in ISMSWM processes. Moreover, these statistical findings promote the involvement of extra factors of social characteristics that could better clarify the tendency of the public to participate in MSW management activities. For example, we may consider the population characteristics of the provinces in Kuwait as each province separately to understand how the population characteristics in each province is different from each other and whether or not this will affect the tendency and type of participation in MSW management activities. Another example is the consideration of the socio-economic class. The research was done at social public gatherings that mainly included participants from the middle socioeconomic class. Considering the socioeconomic class in the social characteristics of the sample population would help to demonstrate in more detail the relationship between socioeconomic classes and the other demographic groups in terms of awareness and tendency to participate.

Waste actors do not show the same level of awareness about the current situation in Kuwait. They do not have the same level of knowledge about the current revisions to the legal and regulatory instruments, or political and policy topics. In this study, waste actors from the Municipality of Kuwait were exceptionally active in their participation. For example, they answered the survey, added comments, joined discussions, participated in focus group discussions, read the white paper associated with the dissertation research, and encouraged others to participate in the survey. The comments of the waste actors from the Municipality of Kuwait about the reason for their active participation in the survey is that they face a problem of struggling MSW management studies or projects that stop in the middle if not in the earlier stages of their establishment. Therefore, they are looking for any opportunity that leads to practical steps toward an ISMSWM approach. They confirmed that they are ready to participate in any planning process to support ISMSWM.

5.3 Addressing the waste management obstacles and opportunities from the life cycle assessment model perspective: (ESA tools)

A key part of this research is to discuss the role of ESA tools in promoting the IEM model within the planning processes of ISMSWM. This research focus presents an attempt to integrate ESA tools with mechanisms such as cost benefit analysis, strategic environmental assessments (SEA) and life cycle inventories.

The previously mentioned The World Bank report (2009), which analyzes the potential for waste recycling in Kuwait, presented waste recycling investment profiles using a cost benefit analysis. With the available data, the CBA was used to present the following waste recycling investment profiles for relevant recyclable materials:

- Valorization investment in the recycling of paper, plastics and metals
- Waste modernization investment activity profiles (e.g. MRF and composting)
- Recycling of automotive waste (e.g. batteries, tires and car body scrap materials)

The report presented the most significant economic and environmental potential of many recyclable materials streams. Moreover, it discussed the economic feasibility of establishing a recycling business. Also highlighted were the common obstacles of shifting up the waste hierarchy toward recycling, composting, reusing and reducing waste. This report was a perfect opportunity for the government, policy makers and the Municipality of Kuwait to understand the necessary shift in the national waste management perspective from a “cleanliness-based approach” toward an integrated sustainable waste management approach. A key aspect of this shift that was captured in the report is the opportunity for local investments in recycling and composting that could bring significant environmental, economic and social co-benefits. This new perspective encouraged the Municipality of Kuwait to collaborate with the World Bank on multiple studies that examine the potential of sustainable MSWM practices to modify current disposal practices in ways that are environmentally sustainable and more efficient in land use.

The World Bank (2012) believes that SEA (strategic environmental assessment) is an important method of environmental and social integration into SWM and MSW management programs and legislation. Such an integrative perspective is particularly important to SWM and MSW management decision-making and sectoral reform. SEA has been implemented by The World Bank team as a supporting tool in conjunction with the established stages, targets and timelines of the current process of planning of MSW management in Kuwait. Accordingly, the waste actors that are involved in the planning of the ISMSWM process in Kuwait are required to submit periodic progress reports while the emerging assessment and outcomes are to be reviewed by The World Bank representatives. As a consequence, the current MSW management studies are more organized and it became easier for local waste actors to engage with the assessment process. For instance, even if the target of a specific stage was not achieved, there is an opportunity for waste actors to identify obstacles and revise their work plan to modify it in the next stages. This even helped to sustain the MSW management studies and prevented them from becoming stuck due to obstacles in the earlier stages or remaining incomplete due to the absence of monitoring and evaluation. During the interviews with waste actors, they insisted on identifying the absence of organized monitoring and evaluation as one of the main challenges that causes the established studies and projects of MSW management to struggle and even stop in the early stages. The struggling studies and lack of project completion was described by the waste actors to be a result of unclear stages of specific missions, absence of timelines to present the progress or the obstacles they exist, in addition to the absence of the follow-up programs of monitoring and evaluation by higher levels of responsibility. This leads such studies to be ignored after a while even if they started with a strong structure of targets and ambitious expected outcomes.

The results of the scenario comparisons show that changes in current dumping practices to embrace alternative MSW management options can lead to an observable reduction in greenhouse gas emissions, acid gases, smog precursors, heavy metals in air and water, and reduction in energy consumption depending on the combination of techniques to perform each scenario and the type of waste to be treated (see table A.7). The different scenarios also demonstrated the potential of alternative MSW management options to efficiently reduce the amount of residual waste, which means less demand for land to be converted into landfills and dumping sites.

The paper - with the IWM-Model results and the relevant discussion and comparisons of different scenarios of MSW management relevant to different environmental impacts - provided an opportunity for the researcher to obtain approval to lead focus group interviews, and to present specific IWM-Model-based technical solutions and scenarios for MSW management to the decision-making committee. The white paper opened the way for discussing the current situation of MSW management in Kuwait and different pathways for ISMSWM in Kuwait; and revealed the committee's perspectives about the implementation of an IWM-Model and associated ESA tools. Moreover, it was a good opportunity to discuss both the political issues framing MSW management, and the challenges to an ISMSWM approach (i.e. lack of available data for ISMSWM planning). The committee members were in favour of implementing ESA tools, with a commitment to understanding more about their development and implementation as a way to fill the gap between decision-makers' knowledge of the local SWM context, and the higher level of technical knowledge of external experts.

Although ESA tools do not always provide exact solutions, especially with the lack of current data, analytical tools such as LCA and CBA can help to open pathways for discussion and debate between different stakeholder groups. In this way, diverse perspectives of the environmental and economic characteristics of local MSW management contexts can be explored. Therefore, in response to the obstacles and the opportunities of ISMSWM planning, EAS tools can support a more comprehensive and multifaceted understanding and decision-making capacity. Procedural tools such as SEA can also help to organize and sustain the MSW management studies by creating a planning structure with sequential stages associated with specific targets and a monitoring and evaluation program.

5.4 Addressing the waste management obstacles and opportunities from an IEM perspective

Waste actor participants from across the research study (i.e. questionnaire, meetings and focus group) reflected that they are aware of many challenges for planning and implementing ISMSWM. For example, the division of institutional responsibilities for MSW management is causing fragmentation and thus affects the establishment of ISMSWM in Kuwait. MSW management authorities have divergent perspectives and priorities that can lead to conflicts and ignoring parties during the planning, implementation and enforcement stages of MSW management programs, sometimes resulting in the discontinuation of the program.

The surveyed waste actors identified the lack of collaborative relationships between waste actors as one of the main obstacles that has affected previous and current actions to plan for ISMSWM. All of the interviewed waste actors perceived the current non-collaborative practices in both the horizontal level (waste actors between responsible authorities - Municipality of Kuwait and EPA) and vertical level (authorities at governmental, sectoral and public levels) while planning and decision-making as major obstacles to effective ISMSWM. The majority of the surveyed waste actors perceived the same perspective.

In 2002, the Environmental Strategy of Kuwait had highlighted un-collaborative activities and relationships between MSW management institutions as an obstacle to progress in the MSW management sector. There is an absence of teamwork and disorder among authorities with regards to protecting the environment (i.e. EPA, Ministry of Electricity and Water, Kuwait Municipality, Ministry of Public Works, and the Public Authority of Agriculture Affairs and Fish Resources (PAAF)) and the role of society and public participation are insufficient. Moreover, there is an absence of continuous media awareness programs directed at all citizen and non-citizen groups to encourage minimizing solid waste generation and encouraging segregation of waste at the source. (KEPA 2002).

The importance of collaboration between waste actors and institutions is also stated in the Environmental Protection Law (2014) and its amended law No.99 (2015). Accordingly, different articles maintain the necessity of engaging all relevant stakeholders to act in a collaborative manner, as well as the cooperation between competent authorities. Waste actors present their need at the current stage for collaboration in multi-levels of planning for and implementing ISMSWM. Bringing together different stakeholders from the institutions relevant to MSW management system in Kuwait and the collaboration and coordination among all the stakeholders is essential for planning for and implementing

ISMSWM since the obstacles and challenges of planning that are listed in the Environmental Strategy of Kuwait (2002) should be comprehensively discussed and transferred to plans that can practically promote the transfer toward ISMSWM. Moreover, the collaboration and coordination among all the stakeholders is needed to engage the Environmental Protection Law (2014) and its amended law No.99 (2015) in supporting the planning and implementation process and obtaining the practical advantages of this legal and regulatory development.

The lack of collaboration discussed by waste actors in relation to planning and policy formulation was identified at both vertical levels (between authorities at national, local and sectoral scales) and horizontal levels (between parallel SWM authorities). Waste actors implicitly promote the synthesis of top-down and bottom-up approaches through integrative and collaborative relationships across and between stakeholders and government, private sector and local institutions. For example, this synthesis would entail the engagement of civil society organizations and waste sector employees in developing an MSW management plan or project that can be assessed and implemented by higher level authorities that have the decision-making, regulatory, financial and administrative capacities for ISMSWM in Kuwait.

Decentralization of MSW management authority and responsibilities from the national government to provincial or municipal levels was suggested in the waste actor survey as an option for ISMSWM. Decentralization would promote public participation in the implementation, management and monitoring of MSW programs – especially through initiatives that encourage civic responsibility and involvement of community actors in decision-making. The majority of waste actors recommended the decentralization of MSW management planning as a pathway for ISMSWM in Kuwait. Their responses showed not only a good level of awareness of the concept of decentralization, but moreover a strong analysis of the reasons to promote it.

Their arguments in support of decentralization include: prevention of delays in in MSW management decision-making and implementation due to bureaucratic slow-down and the longterm administrative documentation cycle; better capacity for easier planning and decision-making processes; and better governance of implementation and monitoring of MSW management projects. Another reason provided by waste actors was that decentralization would support public participation and provide an opportunity for the community to take on greater responsibility around MSW management in their respective communities.

Another suggestion that emerged from the findings of the waste actor questionnaire was the decentralization of existing MSW management facilities. The participants who were in support of decentralizing the MSW management facilities argued that it would provide an opportunity to adopt a variety of energy from waste (EFW) technologies in different provinces. They stated that decentralization would provide an opportunity for different levels of waste sector employees to contribute their ideas to improving the waste management sector. It was also reasoned that it would reduce the government's central authority and responsibility by promoting public and private sector participation. These inputs would also increase employment opportunities. Another opinion offered by waste actors was that decentralization might increase economic revenues since the division of areas in Kuwait as provinces or regions depending on the decentralization type will create a competition between the different areas to verify that they can provide better MSW management services with innovative MSW management approaches and technologies. These can serve to provide better byproducts (e.g. energy, compost) for better marketing opportunities of these products. One of the participants further explained that there is a current vision to divide Kuwait into three regions: the north, middle and south, and each one would have a central governance structure to serve that particular region. Some participants, however, expressed concerns about the absence of centralized control and organization if a decentralized approach is adopted.

Waste actor participants who were not in favour of a decentralized approach also provided reasonable explanations for their disagreements. They explained that a centralized authority of MSW management would adopt one facility to serve the whole country, which would seem to be more economically feasible. This was stated to be especially true since Kuwait is a small country, with a relatively limited amount of generated waste, and may not require multiple forms of MSW facilities and governance. Moreover, they argued that all provinces should provide the same level of MSW management services across the country. Yet, with less national governmental control, decentralization would lead to an absence of control over implementation and monitoring.

Another key challenge to collaboration in MSW management processes discussed by some of the waste actors was the lack of trust by government authorities of local experts and participation by public and private partners. In particular, the government systematically tries to avoid SWM options that require or propose increased public participation. Instead, the government will opt for consulting with external experts, or even private sector participation. Despite the unfriendly stance of the government toward engaging public actors in MSW management, the majority of waste actors promoted public participation through the following forms:

1. Public participation in waste separation and collection
2. Training programs for the public to participate in waste separation programs
3. Public consultation
4. Incorporation of environmental and waste management topics in the education curriculum at various levels of education.
5. Opportunity to participate in decision-making and taking on more civic responsibility with respect to MSW management systems established in participants' communities.

Moreover, surveyed waste actors indicated their preference for building communication channels with the public through communication tools such as advertisement, print media and social media. These forms of popular communication would promote public participation in sustainable MSW management in Kuwait by increasing public awareness and a sense of civic responsibility.

While some waste actors argued that there are no tangible private sector roles when it comes to MSW management, most of the participants advocated for governmental support of the participation of the private sector as this sector – especially recycling, repurposing and scavenging businesses – has an important role in the reuse, separation and recycling of MSW. Moreover, even the absence of regulations to organize and govern the practices of these businesses was identified as one of the main obstacles hindering the participation of the private sector with respect to MSW management.

Waste management actors who work in The Municipality of Kuwait are mostly engineers and were particularly in favour of expanding their knowledge base in waste management. They suggested exchange programs, workshops and courses as methods for including multidisciplinary perspectives and knowledge advancement in SWM, and to bridge the gap between their expertise and that of external experts and consultants. The participants further explained the necessity of developing advanced communication strategies in the MSW management sector, as the current communication methods are limited to official paperwork and long meetings (these also lead to a long documentation cycle). These methods can pose barriers to better communication between waste actors, and prevent a better exchange of dialogue and ideas instrumental to improved understanding and conflict resolution. Moreover, restricted communication methods prevent improved monitoring of MSW management processes, achievements and challenges. To remedy these obstacles to MSW management communication, the waste actors recommended adopting new strategies and communication tools such as establishing collaborative committees with planned periodic meetings, and the adoption of modern communication tools (e.g. web sites and social media platforms).

5.5 Summary of obstacles and opportunities for planning and implementing ISMSWM

Table 5.2 presents findings from the waste actor questionnaires, meetings and focus groups regarding the context of obstacles and opportunities related to ISMSWM planning in Kuwait.

Table 5.2: Obstacles and opportunities for ISMSWM planning in Kuwait

Field of investigation	Obstacles	Opportunities	Conceptual basis
Environmental considerations	• Restricted land use • Environmental impacts on water, oil and soil resources	• Collaborative approaches • Education • Social learning • Public participation • Private sector participation	• IEM • ISMSWM framework • Waste management approaches
Operational and technical constraints	• Dumping is the only practice for MSW • Unsanitary landfills • Inadequate usage of waste containers • Unsorted waste • Lack of data • Scavenging activities • Limited private sector recycling practices	• Collaborative approaches • ESA tools • Zero-waste-to landfill • EFW • Waste reduction • Resource recovery • Recycling • Composting	

Policy considerations	• Failure of previous policy to achieve ISMSWM • Current policy is not clear for the waste actors • Strategy not operationalized • Lack of system monitoring and evaluation	• Collaborative approaches • Co-management • Communication • CD • Public participation; Private sector participation • Inclusion of stakeholders • Clarify the current policy • Consideration of socioeconomic and political factors • Monitoring and evaluation	• IEM • Linking top-down to bottom up approaches • Co-management • ISMSWM framework • Sustainable development • Public participation • Social learning • Collaborative research • ESA tools as a support of planning for IEM and ISMSWM
Laws and regulations	• Ineffective to change the current situation and promote new policy of ISMSWM • Lack of enforcement of laws and regulations	• Collaborative approach • Capacity development (CD) • Enforcement tools • Environmental court • Monitoring and evaluation	
Institutional arrangements	• Fragmentation of responsibilities • Ignored stakeholders • Conflicts • Capacity • Communication	• Collaborative approach • Participation of all stakeholders • Never ignore any party • Building trust • Capacity building • Monitoring and evaluation • Education • Collaborative research	
		• Social learning • Communication tools • ESA tools	
Economic factors	• Funding system • Marketing of recyclable products • Economic instruments • Limited business opportunities	• Improve funding system and marketing opportunities • Involvement of industrial and commercial activities • Implement economic instruments for legal enforcement and promotion of waste reduction	
Social considerations	• Cultural traditions and habits • Packaging practices due to business from home • Participation is only on daily curb-side waste collection • Servants are the key actors responsible for household waste disposal	• Education • Social learning • Public participation • Communication	

5.6 Collaboration

As demonstrated in this study, an integrated environmental management (IEM) approach is the main pathway for the proper planning and development of ISMSWM in Kuwait. Applying IEM within the context of ISMSWM implies a holistic perspective when considering the entire interconnected waste system, as well as the interconnections within subsystems. Moreover, IEM considers the interrelationships between environmental and human systems. The approach focuses on determining strategic goals and adopting the appropriate tools to operationalize those goals. Using an IEM approach for planning MSWM in Kuwait will require technical options (e.g. sanitary landfill, recycling plants, incinerators, composting plants) *alongside* sustainable development dimensions (i.e. institutional, political, regulatory, economic, social and environmental). The ISMSWM model includes waste management elements, sustainable development dimensions, and diverse stakeholders as the main subsystems under consideration in MSW management governance.

As yet, there are no effective collaborative and cooperative mechanisms in place that link waste actor groups and institutions involved in planning and implementing ISMSWM. The fragmentation in the institutional arrangement for MSW management in Kuwait means that each authority is working according to their particular perspectives and priorities, and many key stakeholders are excluded from planning and decision-making processes.

In summary, the government's top-down approach has created a nationwide MSW management system comprised of daily collected curbside waste within provided containers, which ultimately ends up in landfill sites. Even within this limited system, there are still problems of mixed waste collection, improper use of containers, and final disposal in unsanitary landfills. The responses by waste actors indicate further obstacles with delays in planning processes created by the limited communication methods and lengthy documentation cycles that have been slow to improve. Although the amended regulatory articles promote collaboration at different points in the legislation, the meaning of and mechanisms to support collaboration have been vague.

Without explicit channels for collaboration between waste actors, public engagement, and integrated approaches for research, planning and decision-making, the differences in perspectives, goals and priorities between stakeholders will continue to fragment and constrain the MSW management system.

Therefore, a comprehensive assessment of the entire waste management system is an essential step to promoting the necessary processes of cooperation, collaboration and transformation within the sector. The assessment would include an examination of: system obstacles, interconnections with other systems, key opportunities and targets of integration, and anticipated outcomes. As demonstrated by Margerum (1999), regarding the transfer from the theory and concepts relevant to IEM toward strategic activation and operationalizing of IEM approaches, the key operational component of IEM is the collaboration among diverse stakeholders and with civil society. One of the main obstacles to an ISMSWM approach that was commonly expressed by the Kuwait Environmental Strategy of 2002 (KEPA 2002), the amended Environmental Law of 2014, the waste actor questionnaire, stakeholder meetings, and focus groups, was the lack of collaboration, cooperation and effective communication tools, and exclusion of many stakeholders from planning processes.

Consequently, the concept of ISMSWM implies the transition from a conventional waste management system toward one that is more participatory and collaborative, and interactive with other subsystems and sectors. ISMSWM does not deal with MSW management as just a technical issue, but includes multiple areas of expertise such as policy-making, institutional arrangement, and legal and political development; and a range of environmental, social and economic perspectives. This variety allows for the design of integrated solutions for the handling and disposal of waste that conform to sustainable development targets. These integrated and sustainable options include waste prevention, resource recovery, zero-waste-to landfill, and energy-from-waste.

As an integrative and collaborative approach, the adoption of IEM requires important considerations such as: a commitment to implementing IEM and collaborative management, the objectives of the collaboration, the proper process of collaboration and specific determination of the needed outputs and expected outcomes. These important considerations will be illustrated in more detail in the next paragraphs)

For the Kuwaiti government to get on board with ISMSWM, it will have to radically shift its perspectives and policies from a strictly top-down approach to one that is more collaborative. For example, the government must be open to involving stakeholders within the management processes of new waste management strategies and technologies. Waste actors and the public are key actors in the success or failure of MSW management programs, and as such, their input must be listened to, respected, and incorporated within the decision-making, implementation, monitoring and evaluation stages of the ISMWSM cycle. In creating space for public participation, the role of the government is essential to support collaboration between stakeholder groups in the initial stages, and to formalize collaborative and public engagement within institutional, political and legislative frameworks.

Moreover, the political will of governments is key to facilitating a substantive shift from the top-down system of environmental management to collaborative environmental management. Government commitment to adopting a new policy or approach not only motivates structural change but can also contribute to social acceptance of the change by the private sector and the public.

For stakeholder engagement to contribute to comprehensive and quality decisions on MSW management, it is important to focus on: the goals for collaboration, the selection of relevant actors that represent a variety of perspectives and input, and the methods for participation (e.g. negotiation, mediation, consensus building, developing agreements) (Margerum 1999, Knootz 2006). In particular, emphasis on the process requirements and effectiveness of participation, rather than on the dynamics of the decision-making process, can mitigate potential conflicts and the loss of stakeholder confidence (Reed, 2008). For instance, collaborative decision-making practices such as consensus building are time consuming and require skills and training by facilitators (Innes J. 2004). Moreover, it is essential to involve stakeholders in a collaborative process from the beginning, through to the end, so as to ensure high quality and robust decisions. It is therefore important to note that the process of participation represents both the most essential and the most challenging component of IEM (Frame 2004; Knootz et al. 2006; Margerum 1995, 1999, 2007).

IEM entails two forms of collaborative engagement among waste management authorities, waste actors and civil society actors: cooperation and coordination. Cooperation "lies on the identification of a common goal toward which all of the participants will work independently" (Margerum 2002). In this form of engagement, waste actors from the Municipality of Kuwait, EPA and other institutions interact in committees and meetings regarding common MSW management goals – yet approach their roles from their independent expertise, perspectives and priorities. Moreover, there are long periods between meetings, and communications between these authorities and other waste actors is quite bureaucratic, which leads to delays in planning, decision making and implementation.

For a genuinely collaborative approach to MSW management, continuous and maximized interaction is the key driving force for effective management processes. Therefore, the coordination approach is recommended as it "relies not only on a common goal but also on process of functioning together that allows mutual adaptation and adjustment" (Margerum 2002). Coordination can be divided into two core areas of analysis: communication and conflict resolution (Margerum 1995).

Communication is essential among participants to exchange and share information, analyses, goals and objectives (Margerum, 1995). In addition to the conventionally practiced communication mechanisms (e.g. scheduled meetings, coordinating committees and informal communication), the current revolution in communication tools must be aligned with the practice of coordination between waste management actors and the public. During interviews with stakeholders, they insisted on the necessity for better communication tools that would streamline waste management processes and make them more effective. Better communication mechanisms would therefore affect productivity in the collaborative process since it would promote continuous interaction between waste management actors and authorities. Moreover, there would be more opportunity for interaction with the public. In today's world, social media provides many platforms for communication and, in particular, institutions can choose the most appropriate option for facilitating official communication in more coordinated and efficient ways. This would promote better interaction, faster exchange of information, and maximization in the quantity and quality of stakeholder participation. Interviewed and surveyed waste actors promoted the establishment of collaborative committees and the periodic meeting of these committees as preferred communication tools.

Wall (1995) describes conflict as "a process in which one party perceives that its interests are being opposed or negatively affected by another party." Conflict resolution is therefore useful for coordination because multiple ideas, perspectives and biases can be negotiated and resolved among participants (Margerum, 1995). Even minor conflicts can frustrate the coordination process if not handled by appropriate instruments for the mediation and resolution of environmental conflicts. Environmental conflicts combine social complexities in addition to the ecological ones (Wittmer 2006).

An interviewee from an educational institution explained that he refused to participate in future MSW management meetings and committees because the decision-makers did not honour his suggestion to establish a sanitary landfill as an urgent priority. This illustrates a common and unfortunate consequence of a poor collaboration process whereby conflicts occur and lead to stakeholders feeling excluded from the planning process. Therefore, having various stakeholder perspectives represented is without meaning if they are not genuinely engaged in decision-making, and when appropriate facilitation and conflict resolution mechanisms are not in place.

Many research studies present the benefits of IEM and other collaborative approaches as an alternative to top-down models for managing environmental problems. However, a collaborative approach to environmental management is not a panacea. Rather, it is a pathway for policy makers, stakeholders and the public to bring their different perspectives and expertise together in an attempt to collectively overcome obstacles and move toward sustainable solutions and the achievement of sustainable development targets.

Highly skilled facilitation is particularly important for collaborative processes involving conservation, developing ground rules, resolving conflicts, negotiating with difficult individuals, and navigating group dynamics. As such, it is important that the facilitator be familiar with a varied and adaptable set of tools that can be applied to various situations as needed (Reed 2008, Chess 1999). A highly skilled facilitator (coordinator) is of particular importance in managing conversations, conflicts, group dynamics, assumptions, and problem individuals (Reed 2008). The facilitator must also be able to successfully choose the appropriate communication tools. As previously explained, the different waste actors from different institutions in Kuwait, with different perspectives, priorities and expected conflicts, need a facilitator to organize the coordination and the communication between them.

Also, important to note is that while the IEM approach and collaboration is a good framework for meaningful and effective MSW management processes, the structure of the collaboration should be established according to the local context. Although facilitators are very important to the collaborative process, local experts also play a critical role in ISMSWM planning in Kuwait, especially their ability to establish a strong practical structure of collaboration that is attuned to the local conditions. During the individual and focus group interviews, local experts explained that while they may have less technological knowledge than other stakeholders, they have more knowledge about the current realities, practices, obstacles and social attitudes relevant to MSW management planning. This emphasis on the importance of local expertise aligns with a key principle of IEM: the need to consider local knowledge, skills, practice and expertise when planning and making decisions regarding environmental problems (Hanna 2007; Margerum 1999; Margerum and Born 1995; Mitchell 2002).

The success of the collaborative process in IEM is measured by tangible environmental management outputs (i.e. plans, projects and policies) and outcomes (i.e. effects on changing social and environmental conditions) that are produced collaboratively by all of the stakeholders involved (Koontz et al. 2006, Mandarano 2008, Margerum 1999).

Unless collaborative outputs are combined with a commitment to implementation from the agencies with the resources to carry them out, they will not be operationalized on the ground (Margerum, 2001). Although environmental outcomes are the primary goal in environmental management processes, social outcomes are also very important (Knootz et al. 2006).

As collaborative and participatory approaches have become more common within the IEM discourse, the focus has shifted toward evaluation of collaborative planning outputs and associated outcomes for environmental and social issues (Knootz et al. 2006). Due to the integrated environmental and social dimensions of environmental management issues, it is important that evaluation methods assess whether collaboration leads to improved environmental outcomes and social conditions (Knootz et al. 2006, Mandarano 2008).

Collaborative planning requires not only a continuous coordination process, but also the flexibility to reflect on past learning and actions to constantly adjust, adapt, share information, and resolve conflicts (Margerum 2002). As the detailed process of implementation is clarified, collaboration must therefore be supported by different mechanisms to avoid discontinuous or hollow outcomes. The support should not be only to sustain the process itself, but to link between process and collaboration outputs, and sustainable environmental outcomes. To maintain the integrity of the process, stakeholder participation must be institutionally embedded (Reed 2008). It must be underpinned by ongoing research, education and social learning, building trust, monitoring and evaluation.

5.7 Building trust

Trust as defined by (Bellaby 2010) is “a feeling or belief that someone (or some institution) will act in your best interests.” In most government contexts around the world, trust is defined as “the confidence of citizens in the actions of a government to do what is right” (OECD 2013) and is interpreted as either social trust or policy trust. Social trust relates to a relational cognitive response between individuals and groups to facilitate cooperation and confidence within society (Petts 2008), while policy trust represents public confidence in the government and its institutions (OECD 2013). To understand the social functions of trust between waste stakeholders, public participation can be initiated through a focus on: relationships, knowledge exchange, enhancement of trust between parties, and ways they can exchange services and mutual benefits (Petts 2008).

The results of this study indicate that neither the government nor the stakeholders (waste actors and householders) demonstrate trust for the other group. The government does not trust the input of local stakeholders or the process of public participation. In terms of MSW management planning, the Kuwaiti government is dependent on input from international company partners, yet the national private sector partners have minimal opportunity to participate. Although Kuwaiti experts participate in MSW management at a level of formality (i.e. meetings, writing reports), stakeholders from the environmental institutions stated in the interviews and questionnaires that external experts are involved more substantially in MSW management planning. They attributed this dynamic to greater value given by the government to the higher level of experience and technical knowledge held by external experts vis-à-vis the local experts' knowledge of the local SWM context. Consequently, local waste stakeholders are not confident that the government is interested in or respects their input in the planning process.

Moreover, the available options for MSW management planning exclude public participation, even with regard to the source separation program. The government views this program as a long-term process that does not hold much value for MSW management, due to its lack of confidence in the public's appropriate participation in waste separation. The government believes that it would take long time before the householders become accustomed to separating waste and this dynamically would fluctuate between areas and provinces.

Building trust is essential to developing a culture of collaboration between the government and waste stakeholders. One factor in this process is identifying relevant stakeholders and what they will contribute to the planning process (e.g. economic, political influence, social status). Another relates to motivating them to participate in the planning process. The government will increasingly need stakeholders, especially under the Build-Operate-Transfer (BOT) contract whereby ownership of the entire waste management system in Kuwait will be transferred to the government after ten to twenty years of operation. If the government continues to negate the vital role and participation of interested stakeholders, the future of ISMSWM planning in the country is expected to be limited and marred by obstacles.

The participation of stakeholders entails that they play an active role in a variety of ways: producing necessary data, input into decision-making, promoting newly adopted policies, contributing to the attainment of ISMSWM objectives, acting as a self-correcting mechanism, and reporting illegal waste disposal activities. The responsibilities of each stakeholder must be clear and well defined, and each actor should have input in planning and decision-making processes while considering that stakeholders may have different levels of influence on the MSW management process). Despite the different interests and roles that are maintained by diverse stakeholders, they should have the ability to collaborate around their common goals for ISMSWM. A co-management approach would best capture this type of collaborative relationship building and shared responsibilities between the government and private and civil society waste actors in Kuwait.

Effective implementation of a collaborative approach further depends on how the issue is framed. If the collaborative engagement does not have a structured framing from the beginning for the type of stakeholder engagement, the process and the decision-making, then the stakeholders may lose significant trust in the process as well as the institutions involved (Petts 2008).

The collaborative partnership between the government and stakeholders would function best if formalized through a legal structure. For example, the main obstacle to private sector participation in partnerships with government, and opportunities for enterprise establishment at present, is the absence of laws and regulations that organize and protect their engagement in these collaborative arrangements. Private sector involvement may involve consultation companies, contractors of waste collection and transportation, and small enterprises. In terms of civil society involvement, there is no current acknowledgement of the role of environmental non-governmental organizations (ENGOs) as waste stakeholders. The active role of ENGOs in environmental awareness campaigns makes their participation in ISMSWM planning essential to addressing waste management challenges, providing linkage between environmental and social dimensions and therefore promoting sustainable development achievement.

Acknowledging the government's true intentions to respond to public opinions and suggestions will promote building trust within the government (Petts 2008). The Kuwaiti government appears to be pursuing a more trusting attitude toward public participation through their promotion of a better means of communicating MSW management issues with local stakeholders. A key communication tool being recommended is the establishment of a waste management board that would comprise stakeholders from civil society, and the private and nongovernmental sectors. A collaborative approach between government and waste stakeholders and communication platforms such as the waste management board are new structures, and therefore it is important to ensure that certain measures are in place to guard against ineffectiveness. For instance, the waste management board must hire expert evaluators to periodically monitor and evaluate these arrangements.

These various stakeholders may be invited to participate and share ideas in public deliberation forums. Public participation using deliberative processes is seen by both academics and policy makers as being an important trust-building and decision-making exercise (Petts 2008). If the participant stakeholders do not agree with the government actions, at least they will understand the limitations on official actions, and will understand the perspectives of others (Petts 2008). Accordingly, what is expected in the long term is an increase in trust on both sides: the governmental institutions, and the stakeholders' awareness and participation worthiness. The repeated interactions of the government and the stakeholders at different levels may promote an increased level of participation, since a greater understanding of others' perspectives could provide an opportunity to understand others and to be more responsible and understand what type of contribution can be practiced in the planning and implementation of ISMSWM in Kuwait.

Second, involve the advantages of the media by announcement through television and radio broadcasts. Third, take the advantages of social media such as 'twitter', 'facebook', 'Instagram', 'Whatsapp' and 'Snapchat' to promote and invite people to participate, knowing that the people in Kuwait are addicted to using social media. Before thinking of the different ways of invitation and informing the stakeholders, the government must use the previous mentioned communication tools to perform awareness campaigns for environmental issues, and particularly, MSW. As a consequence, stakeholders and public participation will be more effective, since it will be clarified why they need to participate in the planning process, the roles involved, and who the proper representatives are. In this context, social learning should be promoted to raise the awareness of waste separation, waste reduction, reuse, recycling, the need to promote the policy of zero-waste and to overall improve the public behaviour in dealing with MSW. This will promote the government to increase its trust in the worthiness of public participation in planning and implementing an ISMSWM system. Repeated interaction of stakeholders and the government and enabling social learning promote sharing understanding and building trust (Lebel 2006).

5.8 Monitoring and evaluation

Monitoring is defined as an ongoing process, involving a variety of operations, with the goal to collect and interpret a number of measurements or estimates that could present an understanding of a specific situation. The collected data is interpreted through a comparison of the element(s) being monitored, either with itself or with some external benchmark such as an environmental quality standard or a guideline value (IEMA 2011). The term monitoring applies to a diversity of environmental management methods and processes and can be exemplified by ecological surveys and bio-monitoring of human exposure to pollutants accumulated in the human body, air, water and land systems. There are different monitoring methods for observing and recording changing conditions, and the process can be conducted by one or more agencies such as government-based programs, non-governmental organizations, consulting firms, and even community members. Monitoring is usually established for one or more of the following reasons (Mitchell 2002, p.318): "to document general environmental conditions, to establish environmental base-line, trends and cumulative effects, to document environmental loading, sources and links, to test environmental models and verify research to educate the public about environmental conditions and provide information for decision-making".

During the research stages of this study, the absence of monitoring was recognized to be one of the main obstacles to ISMSWM in Kuwait. As an example, one of the main reasons for the failure of the composting plants that were established in the 1970s was the absence of monitoring and maintenance during the operationalization of the plants. MSW management monitoring involves data collection on the quantity and composition of municipal waste. A new monitoring study on waste composition was completed by AlJarrallah in 2014, updating the work that had not been done since 2002. Although a great deal of effort was invested in this study, i.e., to obtain new data on municipal waste composition at different yearly intervals, and comparatively analyze current and previous data on waste composition, the data shows inconsistencies.

For example, data about the types and amounts of plastics and metals in the municipal waste mix are not available. Yet this data is essential to assess the current potential of plastic and metal recycling in Kuwait. Furthermore, in the private businesses that recycle materials collected by scavengers' activities, there are no mechanisms in place to identify the collected amount of different types of recyclable materials (e.g. plastics, metals and cardboard). Landfill sites also do not have the capacity to monitor the amount and composition of leachate generated, and its contribution to generated air emissions including VOCs and CH4 or impacts on soil and underground water and air systems. The World Bank report that presents waste recycling investment profiles for Kuwait (The World Bank, 2009) found that accurate data on municipal waste was not available in the country, and therefore had to consult several sources (e.g. literature, industrial data, expert estimations) to estimate the quantities of recyclable waste in order to develop the report of The World Bank (2009). Consequently, reliable monitoring and data analysis processes are essential for evaluating the current situation of MSW management and, moreover, to understand the opportunities of ISMSWM planning.

Although technical environmental monitoring is an essential requirement for ISMSWM planning, it is not enough to actively promote this integrative approach. Rather, technical monitoring should be part of a broader framework of administrative monitoring and evaluation at the levels of both project management, and strategic national policy. Monitoring and evaluation efforts usually have concentrated on the assessment of inputs and the implementation process, but now the focus is on the assessment of multiple factors related to policy and management that contribute toward development outcomes. Program managers are increasingly asked to apply monitoring and evaluation data to help improve strategies, programs, etc. (UNDP 2002, p.5-6; Knootz 2005).

The 2002 Environmental Strategy of Kuwait promotes sustainable development in MSW management and other environmental fields, and yet it was never reviewed or monitored to identify how these recommendations could be realistically transformed into plans and projects. KEPA (2002). In 2014, the Municipality of Kuwait and EPA with the Aid of the World Bank started preparing a new national environmental strategy with new perspectives that adopt approaches such as zero-waste and energy-from-waste and obligate environmental regulations and economic tools. Even the revised environmental strategy of 2014, with its amended environmental laws, regulations and radical shift from conventional MSW management, will not survive without continuous monitoring and evaluation programs. Beyond generating current data, a comprehensive monitoring process helps to identify the available opportunities for ISMSWM, track the outputs of implemented programs, and identify the challenges to achieving planned outcomes.

According to the research findings, stakeholders clarified that many established MSW management programs do not survive due to the absence of monitoring and follow-up during the early stages of the projects. For example, the absence of monitoring combined with the long period of the documentation cycle (as an official communication channel between the government and stakeholders), has resulted in the inability to proceed with potentially effective waste management programs. Accordingly, it is essential to establish a monitoring program that is involved in the national strategy and is associated with the established projects.

In this context, monitoring at the plan and project levels can be defined by UNDP 2002, p.6, "as a continuing function that aims primarily to provide the management and main stakeholders of an ongoing intervention with early indications of progress, or lack thereof, in the achievement of results. An ongoing intervention might be a project, program or other kind of support to an outcome". Moreover, evaluation is defined by the UNDP as (Mitchell 2002, p.6, UNDP 2002, p.6):

"Selective exercise that attempts to systemically and objectively assess progress towards the achievement of the outcomes, evaluation is not a one-time event, but an exercise involving assessments of differing scopes and depth carried out at several points in time in response to evolving needs for evaluative knowledge and learning during the effort to achieve an outcome. All evaluation results – even project evaluations that assess relevance, performance and other criteria – need to be linked to outcomes as opposed to only implementation or immediate outputs. Monitoring and evaluation help improve performance and achieve results. More precisely, the overall purpose of monitoring and evaluation is the measurement and assessment of performance"

At the project level while planning for ISMSWM in Kuwait, there should be two stages of monitoring: monitoring by stakeholders and monitoring by the project managers. Moreover, they should cooperate to set the baseline for the monitoring program. Table 5.3 presents a description of various monitoring mechanisms and their associated monitoring tools (e.g. annual project reports, external assessments and stakeholder meetings) presented by the UNDP (2011a). Participants from the study agreed that a clear framework that is developed by key stakeholders is essential for successful monitoring and evaluation. This framework helps the planning and carrying out of these processes, and should clarify the following factors with respect to monitoring and evaluation (UNDP 2009, p.83): "subject of the monitoring and evaluation, required activities, responsibility for activities, timing of activities, methods and resources required and allocation".

Table 5.3: Monitoring programme mechanisms and tools

Categories of monitoring mechanism	**Reporting and analysis**	**Validation**	**Participation**
Description	Obtaining and analyzing documents	Verifying the accuracy of the progress	Collecting feedback from partners and beneficiaries regarding progress and proposed actions

Monitoring tools	• Project reports • Progress reports • Plans • Delivery reports • Project documentation	• Spot-checks • Assessment • Monitoring • Field visits • Client surveys	• Focus groups • Stakeholders meetings • Steering committees • Outcome groups • Annual reviews

Adapted from UNDP (2011a, p.36)

In Kuwait's MSW management system, stakeholder-led and project manager-led forms of monitoring involve both the stakeholders and the management board of the project. The results of monitoring studies should be reviewed and evaluated by the project manager and repeated periodically throughout the project cycle. From the evaluation outcomes, periodic project reports should be presented to the governmental board to allow for comment on: the current situation of the project, the alternative actions proposed, the required adjustments to the implementation strategy, and the required feedback provided to the project manager and stakeholders.

Every effort should be made to encourage broad-based and active stakeholder engagement in MSW management planning, monitoring and evaluation processes. Inadequate stakeholder involvement in monitoring programs is one of the most common reasons that projects fail (UNDP, 2009, p.25). The absence of monitoring may lead the partners to be dependent since each party put the responsibility in the other's basket, and not being committed to a certain mission results in a lack of information about implementation and achievement. The specificity and usefulness of monitoring and evaluation processes are dependent on how well they are: adapted to the characteristics of the local situation, inclusive of the local expertise of stakeholders, inclusive of stakeholder participation in all of the framework stages, able to identify the proper mix of monitoring and evaluation mechanisms and tools, and able to identify and analyze the changes that must be undertaken.

Without comprehensive information generated at key intervals of the project, it would be difficult to evaluate its effectiveness and achievements such as understanding what is working, why and how. Furthermore, project monitoring and evaluation should be continual and able to detect problematic or successful outcomes along the way. Outcome monitoring as defined by UNDP (2002) "is a continual and systematic process of collecting and analyzing data to measure the performance towards the achievement of the outcomes." The results of such monitoring include the reports and indicators that assess and document the work carried out and the achievements made during determined periods of time.

A core aspect of an integrated and sustainable approach to MSW management is the analysis of the social factors within the monitoring and evaluation processes that would affect MSW management development. Social factors greatly affect the planning, implementation and management of sustainable development plans. It must be noted that tracking and analyzing social factors is a complex and long-term process and must be allocated an adequate amount of space and time within a monitoring and evaluation framework. An example of a relevant social factor with respect to monitoring was apparent in the research results whereby the surveyed householders showed a tendency to participate in the new waste separation policy (either at home or using communal containers). From this information, it is possible to detect specific changes in public behaviour and how awareness campaigns contribute to those changes.

There is a need to assess the overall efficiency in facilitating implementation of the new national strategy for ISMSWM. For example, the national environmental police and the environmental court are in their beginning stages in Kuwait. The success or failure (and associated reasons) of these regulatory mechanisms must be monitored and evaluated as part of a broader assessment of the efficiency of the environmental regulation framework to prevent illegal environmental activities, and to contribute to sustainable development plans.

5.9 Institutional arrangement – Capacity building

In the literature, strong and transparent institutional arrangement is emphasized as an essential component for collaborative planning processes (Margerum 1999, 2001), and the planning and implementation of sustainable SWM systems (UN-HABITAT 2010). Furthermore, when institutions responsible for these SWM systems are well managed and sustainable over the long term, then decision makers, stakeholders and engaged citizens are better able to reach a successful level of interaction and results (UNDP 2009). This speaks to a need to address institutional capacity development as a means of sustainable planning and a reasonable motivation to adopt a collaborative approach.

Capacity is defined by The World Bank (2009) as "the availability of resources and the efficiency and effectiveness with which societies deploy those resources to identify and pursue their development goals on a sustainable basis." Although human, financial, and technical resources are required, they are not enough to achieve the multiple goals of ISMSWM with respect to development and the environment. High capacity depends on various factors that affect the behaviour of politicians and economic participants. These factors basically include socio-political, policy and institutional arrangement factors (The World Bank 2009).

Capacity development (CD) in an environmental management context is driven by local stakeholders that either engage in a management-related process or are significantly affected by it (Bhagavan 2004). UNDP sees describes capacity development as being "the process through which individuals, organizations and societies obtain, strengthen and maintain the capabilities to set and achieve their own development objectives over time" (UNDP 2009). The basic principal of CD is that it can transform management performance to a level where it can facilitate a shift in people's perspectives and attitudes (UNDP 2009). Moreover, CD can strengthen old institutions or facilitate the establishment of new ones.

Capacity development is viewed by some as being focused on training and education, which is a way to improve how things are done. In some cases, CD may enable the improvement of individual rights, access or freedoms (UNDP 2009). One of the main domains of CD action is the establishment of effective institutional arrangements, especially through stakeholder engagement (UNDP 2009). Furthermore, CD promotes integrated approaches, collaborative practices and stakeholder engagement. All the previously presented perspectives of CD should be involved while planning for ISMSWM, and strengthening the environmental institutional arrangement, and MSW management is an important component.

For almost two decades, international institutions (i.e. The World Bank and UNDP) have been assisting environmental institutions in Kuwait to develop a national environmental strategy, establish sustainable development policy, and develop the regulatory and institutional frameworks for different departments within the sector. The institutional framework was developed to involve these different departments under the Environmental Strategy of 2002. However, the established Strategy did not produce critical changes to systems such as MSW management. In time, many obstacles, struggles, assessment studies and attempts to affect institutional change emerged throughout the environmental sector. KEPA (2002) considered the "insufficient manpower and financial capabilities required within authorities concerned with waste management and monitoring" within the main causes of general environmental health problems and in particular those that relevant to solid waste management (KEPA 2002, section 3-4-4, p.147).

At this moment, current efforts are being directed toward national policy focused on sustainable development targets. In the context of waste management, current national policy is adopting more sustainable waste management approaches such as zero-waste-to landfill, energy from waste, waste reduction, the promotion of recycling, and investment in recycling enterprises. In addition, the Environmental Law was amended in (2014) with improved articles that promote collaboration, public participation, monitoring, regulatory enforcement, and diverse economic tools in SWM and MSW management. Based on the previous introduction and the research findings, the following questions are worthy of consideration by decision makers, waste actors and environmental managers in Kuwait:

- How can the current policy be clarified?
- How will the current policies improve the current environmental context in Kuwait?
- How will the selected policies protect the environment?
- How will the selected policies promote ISMSWM planning in Kuwait?
- What are the adopted policy tools?
- Have the policy tools been implemented?
- Are the policy tools effective?
- Is the national environmental strategy addressing the regulatory, institutional, economic, technical and social issues that influence the effectiveness of MSW management?

- Does the strategy include an integrated approach to waste management?
- Does the strategy include the perspectives, needs and capacities of a broad range of stakeholders?
- Before engaging other stakeholders, do active environmental institutions have the local capacity for implementing, monitoring and evaluating the ISMSWM approach?
- Are local stakeholders ready to implement the current strategy and policy targets?

In addition to the questions above, it is also worth asking:

- What is the purpose of capacity development?
- Is the development of environmental institutional capacity needed?
- Whose capacities should be developed and how will these capacities facilitate the achievement of development objectives?

These questions underline the key assessment issues that this study has explored and highlighted as important for improving the waste management situation in Kuwait. These issues include: addressing gaps in existing policies, institutional arrangements, implementation and regulatory tools, and the ability of local actors to participate.

Particularly important to improving the MSW management system is developing the capacity of the environmental institutions. These institutions should work hard to develop a collaborative structure that includes coordination and communication between the relevant stakeholders and decision makers to answer the previous questions. Through all stages an engagement of local national stakeholders, national systems and processes is fundamental (UNDP 2009). This implies the need to understand carefully the environmental institutional arrangement in Kuwait and how to strengthen this structure. Therefore, the fragmented units that are relevant to waste management and that are separated in different institutions should come to be incorporated into one unit.

The waste management department should move toward consolidation of its fragmented units into one comprehensive entity, either an independent agency or an entire department under the administrative framework of the KEPA. The KEPA is considered as the foremost environmental institution and legislation in Kuwait, and is therefore provided with a broad mandate, and a high level of jurisdiction and political power. The KEPA includes different environmental departments and has regulatory responsibility for the protection of marine and terrestrial environments, biodiversity, work environments, hazardous waste management, air pollution and impact assessments of development and industrial projects.

A central problem for planning for sustainable development projects in the environmental institutions in Kuwait, and therefore even for the MSW management responsible authorities, is the inability of local waste actors to mobilize or enhance existing institutional capacity. For capacity development efforts to succeed, the process and its outcomes must be invested in the workers within the waste management system who are on the front line of maintaining the system and implementing any changes to it (Bhagavan 2004). In particular, waste actors must be engaged and prepared for their responsibilities within planning, implementing, monitoring and evaluation processes. Relevant training and education opportunities can expand and diversify their knowledge base (and motivate their interest and commitment to MSW management). More than half of the research participants from the waste actor questionnaire were engineers and would benefit from integrating the perspectives of environmental managers, waste managers, environmental lawyers and environmental planners into their own knowledge base.

According to the research findings, it is found that for the purpose of development of new strategy that promote sustainable targets considering the current local policy and regulatory gaps. It is fundamental to consider local waste actors and waste experts in the process of planning and implementation, not as supervisors but as a human resource capable of participating effectively using their local knowledge in an integrated manner with the knowledge of other institutions (international institutions) to act according to the local circumstances. Furthermore, the surveyed waste actors acknowledged that there is a gap between their context-specific expertise and the technical solutions that are presented theoretically by external SWM and MSW management professionals in seminars and consulting and investor meetings. This presents a challenge for waste actors to participate in decision-making related to the selection of appropriate ISMSWM technical solutions. These issues were discussed in the meetings and focus group interviews whereby participants identified education and training options as a method for addressing this knowledge gap.

Their suggestions included exchange programs, workshops and field visits to countries where the technology is successfully operated. More specifically, they requested training opportunities that would integrate the practical application of technical solutions with local knowledge of MSW management to develop technologies that are best adapted to local contexts in Kuwait. The existence of institutional structure is fundamental for the planning and implementing of ISMSWM in Kuwait, but what is more important is the arrangement inside this structure that could interconnect the political-related (institutional) issues with the potential and capability of the people in these institutions to be able and confident to hold the responsibility of planning, implementation, monitoring and evaluation and sustain the process locally from inside these institutions.

5.10 Economic factors

With regard to financial and economic tools required to establish and sustain an ISMSWM approach in Kuwait, the recommended financing mechanism is build–operate–transfer (BOT). The BOT funding mechanism places the responsibility for waste separation (i.e. facility location, waste treatment and disposal, and marketing of recovered materials) on the private sector investor. Important to consider here is whether there are other available financing options that can be assessed in comparison with BOT to select the best funding mechanism for supporting an ISMSWM system. If BOT is the only option considered, this would greatly limit opportunities for improving MSW management in Kuwait. Therefore, a collaborative approach is essential to bring a diversity of stakeholders (i.e. local waste actors, private sector actors, civil society) to the table that have different perspectives on available financing options. A particularly important consideration in decisions made about financing ISMSWM is the identification of the local market conditions and measures that would secure access to stable markets. If by mutual agreement the stakeholders do choose BOT as the best option, then the strategy should involve precautionary steps to account for potential breakdown and malfunction of the system. Moreover, under a BOT agreement, waste actors would have to be prepared for the stage when the project is transferred to full government control.

The amended Environmental Law introduces more restricted economic tools than the previous version and the Kuwait Environmental Police (KEP) were established to enforce these restrictions. All these processes should be under monitoring and evaluation program to understand the worthiness and the activity and productivity of these economic tools and the KEP and their contribution to the planning and implementation of the ISMSWM system.

Commercial and industrial institutions must share the responsibility of promoting the establishment of ISMSWM with the government and the public since they contribute to growing municipal solid waste generation by selling their products to consumers, and the type of the generated waste is according to the type of use and quality of product. At the same time, it is not a simple demand to change commercial products or product lines in an industry to include environmental and waste management standards, especially when it may not be reasonable for the owners. Therefore, the commercial and industrial sectors should come to the table with the government and other stakeholders to be partners in the ISMSWM planning and discuss the possibility of changing their activities to minimize waste production in an affordable manner for the commercial and industrial sectors.

Waste management stakeholders and the private sector should pursue environmental goals with a focus on cost-effectiveness. As such, an established incentive structure could be developed that promotes environmental and economic benefits while minimizing costs through in-house solutions for environmental problems. Additionally, stakeholders can share the responsibility of reducing and managing waste with the use of more affordable methods and techniques.

5.11 Technical considerations

The data collection and analysis presented in AlJarallah's 2014 study states that the percentage of biodegradable waste has been reduced since the 2002 study. It is important to note that this finding is not due to a decrease in the generation of biodegradable waste, but rather, because the proportion of recyclable waste (i.e. plastic and cardboard) generation had increased. One of the main reasons for this change in waste composition and proportion is the phenomenon of home-based businesses (e.g. food, accessories, clothes, event coordination) through social media platforms (e.g. whatsapp, instagram, snapchat). For marketing reasons, business developers wanted to provide the most attractive packaging in order to be competitive in securing customers. These types of changes in socioeconomic practices and attitudes influence decisions on implementing the most cost-effective and sustainable MSW management technical solutions and therefore necessitate continuous monitoring and updating of SWM and MSW management data.

In this era of global commitments to reducing carbon emissions and air pollution, the main proposal for technical solutions is focused on revamping current incineration of unsegregated MSW practices with an energy-from-waste program. This option was criticized by some of the waste actors to be expensive, and it involves the air pollution control unit, which is also expensive and needs continuous monitoring and maintenance, in addition to the contaminated ash as a byproduct of this technology. The evaluation of the technology as the proper choice or not should be decided through a collaborative process that ensures the engagement of the interested stakeholders. Stakeholder engagement is important in making decisions on sustainable technical solutions since they should not ignore or be in contradiction with national environmental strategy and national waste management policy. It should also focus on the target of increased energy production revenues and shift the focus toward the investments and financial results that are advantageous to the investors.

Results from the stakeholder questionnaire indicated that participants had a high level of awareness of a decentralized approach and were able to rationalize their support for decentralized MSW management governance with localized perspectives. In light of a consensus among stakeholders that exclusive reliance on foreign experts is not practical or desired, participants argued that local expertise should be effectively integrated into decision-making and management processes.

In the Kuwaiti context, foreign experts operate projects according to their past experience, and expect results similar to their home countries. Even if foreign experts offer a reference model for Kuwait's MSW management system, the model should be adapted to local conditions and developed by national stakeholders. Projects launched by experts may disconnect from local goals and priorities and may ignore local realities. Moreover, depending completely on foreign expertise may prevent the expertise from being transferred from foreign experts to local experts (UNDP 2009). This issue reflects the importance of developing local human resource capacity (i.e. domestic institutions, local expertise, domestic technologies) to be integrated into an ISMSWM approach.

5.12 ESA Tools

The integration of diverse ESA tools into SWM research assessments and projects is highly recommended in different researches in the literature (e.g: Höger 2008, Moberg 2006, Rigamonti 2016, Zaman 2010). However, the type of integration is not yet clear. Use of the IWM-Model was advantageous for the research and for the participants in the focus group discussion. For the researcher, it was a good opportunity to include the available data of MSW in Kuwait, especially with respect to developing a better understanding of the data characteristics, gaps in waste composition data, and physical characteristics of the MSW management context. The tool also prompted an exploration of missing data, which must be collected and compiled for inclusion into the model.

The IWM-Model further provides an opportunity to build a comparison between different technologies and performance pathways for integrated MSW operations associated with each technology's anticipated environmental impacts (i.e. impacts of chemical emissions on air, water and soil systems; traces of metals in air, water and soil, energy consumption and production and residual). This information provides an opportunity for the researcher to prepare an academic paper and provided a viable reason for recruiting MSW management decision-makers to participate in a focus group. This prompted a broad discussion on many issues relevant to MSW management in Kuwait.

The researcher explained the data gaps (e.g. physical characteristics, plastics and paper types) and associated estimations so as to inform the participants of the focus group discussion that the IWM-Model results are not absolute answers, but rather, a general overview according to the available data relevant to the established MSW management scenarios. Despite the previous explanation, the participants were still interested in discussing the results of the IWM-Model. A discussion was established about the different technologies and operations used in the model, and how they compared with regard to associated environmental impacts. The participants concentrated on thermal treatment and anaerobic digestion (AD) as technical solutions to establish energy from waste (EFM) units.

The waste actors appeared to feel confident in transitioning from technical issues to questions related to institutional and regulatory considerations. They described their inspiration and their recommendation to use such a tool in their institution to implement the characteristics of a waste management system that deals with different variables according to their local knowledge. At that time, the participants described a gap between their knowledge of the current waste management situation in Kuwait, and the technical solutions that were presented by foreign experts.

Another example of the analytical ESA tools mentioned in both the focus groups and the literature review (The World Bank 2009) is that a cost benefit analysis (CBA) can be useful for establishing a detailed report about the potential of recycling investment in Kuwait. Even though the content of The World Bank (2009) report was not implemented, since it is not an easy task, the information presents stakeholders with the benefits of waste separation, different methods of separation (i.e. source separation and MRF units), the potential of recycling each stream of waste, the private sector opportunities in Kuwait and recommendations. The implementation of the SEA tool by The World Bank promotes better interaction with the local waste actors since the work is better organized and provided with time lines.

According to the research findings, the IWM-Model and ESA tools can be useful to waste actor participation in MSW model decision-making. They are also beneficial to other waste management processes such as planning, waste management, research and knowledge transference, and establishing new channels of communication with different waste actors and the public.

5.13 Education, research and social learning

Education is foundational to human self-development as we develop and evolve from our particular experiences, knowledge of the world and adapting and improving our practices in response to changes within our environmental, social and psychological contexts. For these reasons and more, education is a key to achieving a sustainable development mandate (Matson 2016). For example, the ability to solve problems, or design programs related to energy and environmental sustainability requires a comprehensive understanding of these complex and multifaceted topics. It is therefore important to promote energy and environmental education on environmentally sustainable actions such as: waste recycling and reduction, reduction in energy and resource consumption, minimizing environmental burdens, and energy from waste (Iwabuchi et al. 2004).

From the research findings, householder participants indicated that while they were familiar with recycling, the majority of them were not aware of composting, EFW, benefits of waste separation, and the existence of communal containers for recyclable waste. The surveyed householders and waste actors agreed upon the importance of an integration of environmental education on SWM-related issues in the curriculum of different levels of educational institutions across Kuwait.

Furthermore, the research findings demonstrated that public awareness and communication are critical points when drafting an SWM operational plan due to the need for planning processes to have public consent engagement. The public are the main stakeholders that will decide whether they will use waste services or abide by regulations, and thus determine the extent to which SWM programs succeed or fail (Kamarrudin 2013). For an ISMSWM approach to be effective in Kuwait, public education and communication are key to the approach's implementation and should include initiatives such as mobilizing public awareness, education campaigns, integrating an SWM curriculum across the educational system, and promoting social media.

While these are examples of preferred practices, they alone are not enough to improve public participation in terms of achieving successful ISMSWM and sustainable development programs. Education is not the simple act of transferring knowledge (Kelsey 2003), but rather, it also entails the enactment of knowledge (Matson 2016). Accordingly, it is essential that environmental management approaches are centered on stakeholder and public participation such as ISMSWM and address existing barriers to putting knowledge into action.

Matson (2016) discusses these barriers, the first one being that for the most important problems to be solved, the available options for solving them, and the criteria by which the alternatives to promoting sustainable development can be reliably evaluated, the scientists and engineers have radically different perspectives than do practitioners and decision-makers. A second barrier relates to the reliance of researchers and decision makers on a one-size-fits-all solution to environmental problems. What would be more effective is learning to deal with sustainability and MSW management issues in an adaptive, dynamic way that draws on previous experiences. Third, is the tendency of researchers to see the central challenge in environmental and sustainable development issues in technical terms only, when in fact these issues are inherently political. A final barrier discussed by Matson (2016) is that a reliance on formal and higher education channels to promote sustainable development is insufficient if the knowledge of stakeholders becomes limited to the academic domain. The knowledge base required for sustainable development action is diverse, and will benefit from experiential knowledge and practical training, as well as theoretical knowledge.

Moreover, there are limitations in the traditional higher education structure in Kuwait whereby environmental engineering courses do not provide the required skills for integrated and sustainable approaches to environmental management. Environmental professionals need to study and deal with environmental problems in new and more successful ways in order to chart a path towards sustainable development, including the interpersonal and technical skills required to undertake meaningful and active roles within a sustainability agenda. Moreover, professionals must develop open-minded and holistic perspectives to be able to understand ISMSWM problems and apply integrated solutions.

In particular, social learning and collaborative research are approaches that can achieve better communication, build bridges of knowledge, and promote sustainable development targets. This transformational shift toward a holistic and sustainable framework for MSW management through mechanisms such as social and institutional learning is indicated by Matson's (2016) statement that "Education is power and sharing knowledge is empowering."

Social learning is “a process of iterative reflection that occurs when we share our experiences, ideas and environments with others” (Keen 2005). In environmental management, social learning is increasingly promoted as a method for addressing the complex socio-political factors that shape environmental issues, rather than a narrow focus on biophysical factors (Keen 2005). For instance, in a systems-based approach to environmental management such as sustainable waste management, social learning is often facilitated, “around complex themes and understandings of participation, negotiation, integration and understandings between different actors” (Kamaruddin 2013). Social learning is also significant for shifting individual and collective perspectives, behaviours and attitudes toward a sustainability agenda, and can therefore positively impact environmental management (Simon 2004). This invaluable form of learning is enacted through participatory and collaborative processes with diverse actors (Kamaruddin 2013), which can improve environmental decision-making.

The research findings and discussion demonstrate the need to develop a social learning network in ISMSWM planning so as to facilitate more effective bridging and transfer of knowledge. An integrated learning network would allow decision-makers, waste actors, local and external experts, researchers and other stakeholders to exchange experiences, knowledge and skills development in response to the constraints affecting sustainable planning and implementation. This social learning network would also enable opportunities for building new understanding and developing strategies to overcome the constraints to ISMSWM planning, participation and collaboration processes. Moreover, the research of the education and scientific institutions should be integrated into the planning process.

As an overview of the scientific studies relevant to SWM in Kuwait: studies on waste composition (Alhumoud, 2002), recycling (Alhumoud, 2004 and 2005), landfills (Al Yaqout, 2002 and 2003), CO_2 mitigation (UNDP 2010), energy policy and international commitments (Alotaibi 2011), and institutional and legislative enforcement of environmental laws (AlAwadi 2002), demonstrate that in the past decade, environmental issues such as solid waste management are only under the scope of scientific institutions. These studies further indicate that MSW management in Kuwait is divided into unrelated subsystems. Until present, no efforts have been made by the various agencies to recognize the interrelationships between the subsystems, so that there can be a more robust and multi-dimensional understanding of the MSW management system.

Participants from the focus group discussion started the meeting with the exchange of technical information. Later, the discussion went on to cover a wider range of information regarding institutional and political factors. This example could be considered as the micro scale of social learning that implies the bridging and transfer of knowledge between the participants.

While Al Yaqout (2002) concluded that changing the habits of public stakeholders is difficult, the research findings aligned with AlJarralah's study (2014) that householders show a tendency to participate in waste separation and to promote new policies toward ISMSWM in Kuwait. The social components of this research (i.e. the interaction with participants, collection of questionnaires and focus group data, and emphasizing the perspectives of participants) provided a more holistic understanding of the current MSW management situation in Kuwait. Understanding of the social factors also demonstrated the dynamic of change in stakeholder perspectives and behaviours related to waste activities.

These findings indicate an important area of social inquiry within SWM to develop in terms of the tendency of householders to: change their social habits around waste practices; and to embrace more integrated and sustainable practices. More advanced research can be established on this theme of inquiry with the development of a better style of sampling, a larger sample of participants, and a provincial scale of data collection and analysis (to see whether spatial scale would affect the results).

The challenges of solving problems related to environmental management have sparked interest in collaboration between academia and industry as well as interdisciplinary research (Harris 2013, DEFRA 2011a). With respect to cooperation in this field in relation to goals and methods (Katz Martin 1997, Harris 2013) this cooperation and collaboration is needed "to share expertise, credibility, material and technical sources" (Hackett 2005). There are often a wide range of professionals on these research teams and they hold diverse perspectives, (Harris 2013).

It is important that environmental research be developed collaboratively and shared institutionally through a social learning network for ISMSWM planning. This will minimize occurrences of duplicating research or research that is irrelevant to local realities. Moreover, collaborative research would bring together a spectrum of relevant perspectives and develop a network of activities with well identified and context-specific goals and outcomes for ISMSWM.

5.14 Contribution of the research as an example for the GCC countries

Developed countries conduct many industrialized recycling activities, which include sophisticated curbside recycling programs consists of collection and segregation of waste for recycling (Kumar 2016, p.8). For developed countries, MSW has been characterized, including waste generation and recovery rates, by databases such as OECD 2015 and Eurostat 2018. Developed countries also focus on the specific tools and policy analysis methods that are required, laws, regulation, social-psychological and economic factors (Kumar 2016, p.8).

Unlike developing countries, developed countries already have waste management plans in place that consider the key issues and can usually manage waste adequately in addition to education and public awareness programs, waste separation at the source, adequate collection systems and particular waste disposal options (Ikhlayel 2017). Currently, developed countries are primarily focused on the planning and implementation of zero-waste and energy-from-waste
(EFW) programs (Ikhlayel 2017). Kumar (2017, p.18) stated that "the financial status of the country determines whether or not the particular options elected for MSW management will be sustainable". High-income countries can afford to spend more on the 4Rs (reduce, recycle, recover and reuse). Today, countries are focusing on the concept of zero-waste and zero-waste-to landfill. The achievement of these goals may be very expensive for financially limited countries to reach (Kumar 2017, p.18).

In terms of practical implementation of MSW management technologies, developing countries greatly lag developed countries (Kumar 2016, p.18). In addition, the economic conditions of developing countries may be so poor that they cannot afford the use of new technologies (Kumar 2016, p.18). Although cost effective technologies are available for developing countries, the effective laws are insufficient (Kumar 2016, p.18). The major concern in developing countries, particularly low-income countries, is centered on the collection of waste and the managing of landfill sites; this is the predominant and the most preferred method of waste disposal (Ikhlayel 2017). In developing countries, the main problems that have received attention are those related to waste collection and treatment (Ikhlayel 2017).

Developing countries; specifically, low-income countries; utilize the social sector to collect recyclable waste via scavenging activities; the collected waste is then sold to recycling shops, middlemen or exporters. These activities consist of labor-intensive, low-technology, poorly-paid and unregulated work (Kumar 2016, p.8). Some of the reasons behind the failure of the main SWM technologies in developing countries include: uncontrolled population increases, weak institutional abilities, inadequate legislation, lack of funds for infrastructure, and poor public behavioral patterns with regards to waste management (Kumar 2016, p.122).

According to the previous introduction about the MSW management in developed and developing countries, finding a country as a model that can be as an example for the implementation of ISMSWM in Kuwait within the global context is not an easy task and needs further research. The explained situation in the literature for developed and developing countries is not applicable for the situation of MSW management in Kuwait. Kuwait is a high-income oilexporting country but still possess challenges in terms of MSW management, and the conventional MSW management system of collection, transportation and disposal in unsanitary landfills are the main practices. The financial status of the country did not support the selection of particular options to ensure sustainable MSW management.

The six GCC countries share many similar aspects including geography, religion, and political, economic and social factors. To help find an example from among the GCC countries to be adopted and implemented in Kuwait, the following paragraphs discuss the current situation in the GCC countries regarding planning of ISMSWM systems.

In recent research about the current situation of MSW in Kuwait, Al Lahou (2019) stated that "the understanding of the full picture related to the MSW is still incomplete. There is a potential to adopt more waste-related practices and policies". In this research, the case study of Kuwait, as an example of one of the high-income oil-exporting GCC countries, will help readers understand the obstacles and opportunities of planning and implementing integrated and sustainable MSW management strategies that can be employed on a national, regional and worldwide level within the same context. Per capita, GCC countries produce the most waste worldwide. GCC countries still predominantly dispose of their waste in landfill sites that are all government-run premises (AlAnsari 2012). The analysis showed that the understanding of the full picture related to MSW is still incomplete.

Environmental and health impacts, increased waste generation rates, and land scarcity in the GCC countries are all factors that have spurred alternatives to landfill sites during the last five decades. Composting was one of the favourite options to deal with MSW in some of the GCC countries during the 1970s and 80s, but the composting facilities were not a satisfactory option as an alternative to landfill sites. For example, in Kuwait, the composting facilities were abandoned for technical and management reasons. Several facilities exist in KSA, that use conventional technology for the processing of food waste, but none of the compost produced is able to improve the fertility of sandy soils and stimulate crop growth, due to the poor quality of organic matter, poor water holding capacity, and lack of nutrients. Other factors include: excessive moisture content, the presence of ammonia, inadequate nitrification index, and contamination by weed seeds (Waqas M., et.al. 2018).

Next, recycling became one of the main priorities in the GCC countries. GCC countries have focused on recycling as the main solution to solid waste management, but many technical, management and marketing factors became barriers to the recycling process. The main viable program within the GCC member states is the recycling of paper and cartons. Regional or national recycling targets have never been implemented by the majority of GCC states. This is problematic in countries where land is limited, such as Bahrain and Kuwait.

GCC countries have also become involved in conferences, symposia, and initiatives to combat global warming. By leading initiatives to reduce GHG emissions, these countries will be able to enhance their public image. In addition, the interventions of international institutions to promote the achievement of the SD targets within the GCC region promoted the shift from composting and recycling toward EFW. Currently, the focus and the general perspective of MSW in the GCC countries is the implementation of EFW with different uses of energy recovery according to local perspectives.

GCC countries that were discussing plans to adopt zero-waste approach in their national policy for waste management (Abdelfatah 2011, Al Ansari 2012, Kuwait Voluntary National Report 2019, Munawwar 2014, Reiche 2010) directed their implementation strategies toward zero-waste to landfill (Clarke 2016,2017, Panicker 2016) and/or EFW (Abdallah 2018, Anjum, et al. 2016, Baawain 2017, Ouda 2016, 2017, Qazi 2018). Zero-waste to landfill is considered as a step in the broader approach to zero waste that focuses on resource extraction, consumption and disposal management to eradicate waste in all its forms and conserve resources along the entire cycle of a product. Also, zero-waste approach restricts the implementation of EFW that produces large amount of ash that must be either treated for material recovery and recycling of fly and bottom ash (Haupt 2018) or/and sent to landfills (Zaman 2017).

The EFW projects in the GCC countries are not yet established and are still under study and need further research. As presented in tables (5.4 a, b), the latest studies within the GCC countries focus on the technology, technical aspects and the financial aspects of planning for MSW management, and the shift from conventional MSW facilities toward EFW. In general, there is no clear vision on the ground among GCC countries about the current and future perspective of how to achieve an integrated and sustainable MSW management system.

Table 5.4a: The EFW perspective in the GCC countries: Bahrain and KSA

Country	Current practices	Current perspective	Technology	Obstacles	Opportunities
Bahrain		Landfill (Al-Joburi 2016)	Mapping new dumping sites (Al-Joburi 2016		

KSA	Dumping in landfill sites	EFW (Agboola 2016, Anjum, M. et al., 2016, demirbas 2016, Ouda 2016, 2017)	-Mass burn, mass burn with recycling, RDF with biomethanation (Ouda 2017). -AD and pyrolysis (Anjum, M. et al. 2016)	-Incineration requires treatment of air and waterborne pollutants and ash within incineration facility (Ouda 2016) -Recycling requires behavioural changes in people and society (Ouda 2016) -Mass burn with recycling reduces the energy capacity of MSW-EFW plants (Agboola 2016)	-Power generation, new business, job creation, alleviation of landfill costs and saving energy and natural resources (Ouda 2016). -Generation of electricity (Ouda 2017) -Mass burn scenario has a higher power generation capacity over the other two scenarios (Ouda 2017). -Mass burn provides power to seawater desalination plants (Agboola 2016). -EFW leads to economic and environmental sustainability (Anjum, M. et al. 2016).

Table 5.4b: The EFW perspective in the GCC countries: Kuwait, Oman, Qatar and UAE

Country	Current practice	Current perspective	Technology	Obstacles	Opportunities
Kuwait		EFW	Mass burn	Mentioned in detail in this research	

Oman		EFW (Baawain 2017, Qazi 2018)	AD and incineration (Qazi 2018)	-AD requires waste separation (Qazi 2018). -Incineration requires control of toxic emissions (Qazi 2018).	- Incineration provides power to seawater desalination plants (Qazi 2018).
Qatar		EFW, zero-waste, recycling, waste reduction at source, education (Clarke 20167	Not determined		-EFW provides power to seawater desalination plants (Clarke 2017).
UAE	Dumping in landfill sites	EFW (Abdallah 2018)	AD and incineration (Abdallah 2018)	-AD is infeasible due to the requirement to separate organic waste at source and market the products (Abdallah 2018).	- generate electricity from EFW (www.governmnet .ae)

The latest research within the GCC countries indicates that one of the major steps in changing the current situation is to improve the existing strategies and strategic planning regarding waste management (Abdallah 2018, Al Lahou 2019, Anjum et.al 2016, Clarke 2016). Technological solutions are not the only solutions (Abdallah 2018, Anjum et.al 2016, Clarke 2014, 2017). Accordingly, in addition to considering the technical aspects, it is essential to involve legislative and institutional actors, along with considering the social limitations and relevant recommendations for decision-making (Abdallah 2018). In order to achieve the transformation and implementation of technological solutions within sustainable planning for MSW management, changes in 'mindsets and behaviours' are needed in individuals, organizations, and at all levels in the country (Clarke 2017). It is essential to raise awareness and promote the establishment of a 'new set of overacting socially and environmentally driven principles' to promote local continuous achievement along the current development path (Clarke 2017). LCA studies are required to assess the proposed EFW projects with respect to direct and indirect impacts (Aleisa 2019, Al-Fadhl 2016). In addition, various combinations of EFW systems can be analysed and improved to create an integrated solid waste management strategy (Abdallah 2018, Aleisa 2019, Al-Fadhl 2016, Ouda 2016). Furthermore, "most of the environmental strategic plans are adopted from developed countries" (Al-Saqri 2014). The fact is that these countries have different environmental conditions than the GCC countries, and these differences must be considered carefully during the planning and implementation of environmental management in GCC countries (Al-Saqri 2014).

This current study is very timely and can present a comprehensive example to the GCC countries about what to consider when planning for integrated and sustainable MSW management. The planning for sustainable MSW management should be associated with the term: 'integration'. The integration concept should exceed the mere technical factors of the MSW management system in order to understand why, what, and how to achieve integration, and who should be involved in planning for sustainable MSW management systems. The conceptual framework of ISMSWM can guide the research, planning, decision-making and implementing of sustainable MSW management in GCC countries. It can be modified to highlight the specific weak points of a specific situation. The case study of Kuwait is a good opportunity to delve further into the width and depth of the research. The design of the research framework includes mixed qualitative and quantitative methods within different stages in an attempt to consider the different fields that affect the planning and implementation of integrated and sustainable MSW management. The IWM-Model was implemented to compare different technologies.

This research is not the final stage, and the research framework is not the perfectly completed framework. Instead, for the local level, it is a beginning stage, and the research framework can be enlarged and developed to modify the research methods and involve and integrate other fields that affect the planning and implementation of ISMSWM systems. For the regional level, this research provides a unique and valuable example for countries that have similar circumstances. At the same time, the GCC countries are all in the stage of transitioning from their current implementation of conventional MSW management toward planning of ISMSWM systems; therefore, it is still too early to find an example country from among the GCC countries to be a model that can be adopted and implemented in Kuwait, yet each country has useful lessons that can be learned. The GCC countries can share their experiences and best practices. Thus, further research is recommended among the member states to improve best practices and build upon the good achievement available within other GCC states, to support and share knowledge to help promote and achieve SDGs.

An important note that should be remembered while applying this study to other local studies in the GCC countries is that the case study of Kuwait considers the Municipality of Kuwait as the central municipality of the country. Therefore, it is easier to apply the findings to other similar-sized countries (e.g. Bahrain, Qatar). For large countries with federal (e.g. UAE) or provincial (e.g. KSA) governmental units, it is recommended that this research be applied to each unit separately and analysed separately. Later, the results for each unit can be integrated and analysed on a national level.

5.15 Conceptual contribution to body of broader knowledge

ISWM is based on a holistic approach to SWM. The ISWM framework was defined and developed as a systematic approach that takes a holistic approach to dealing with the waste management system and uses various types of waste processes, from prevention to final disposal. The ISWM framework incorporates waste prevention, minimization, separation, collection, transportation and treatment options. Various treatment options include recycling, composting, incineration, biogasification and sanitary landfill. In order to choose the best management options, ISWM also considers the recovery of materials and energy. In addition, it promotes the integration of stakeholders within the policy-making process, and encourages active local participation of stakeholders. This type of integrated approach must consider waste management from different perspectives, including existing waste management practices, planning, societal and stakeholder involvement, as well as economic and environmental concerns. In order to tackle the previously described SWM issues, the ISWM model is recommended to be adopted and implemented within city waste management plans (Ikhlayel 2017).

The literature review focuses on the necessity of implementing an integrated approach to SWM and MSW management. Interactions between socioeconomic and technical systems must also be taken into account that affect, and are affected by, the achievement of sustainable MSW management. The term “integration” for SWM and MSW management is not well defined, so it is unclear how to operationalize the integration tangibly on the ground to incorporate social, economic, and technical systems while planning, implementing and achieving sustainable MSW management that can even contribute to SDGs.

To clarify the term “integration”, and determine how to operationalize the integration in managing MSW, the ISMSWM framework is developed in this research as a suitable framework to understand and address the obstacles and opportunities of planning and implementing integrated and sustainable MSW management. The ISMSWM framework has been designed to identify the interconnected fields that should be considered when transitioning from conventional MSW management toward planning and implementing an ISMSWM system in oil-exporting high-income (GCC) countries. The ISMSWM framework includes the interconnected fields: IEM, SDD, MSW components and ESA tools.

For a long time, SWM and MSW management were excluded (ignored) from the IEM approaches, while recently, various research (e.g.: El Asmar 2012, Hettiarachchi 2016, p.93, Ikhlayel 2017, Massoud 2019) has recommended the involvement of SWM and MSW management within the IEM approaches, since waste is considered to be a resource, even though it is a human-made resource (Elagroudy 2016, p.10, Hettiarachchi 2016, p.93, Ikhlayel 2017). Understanding the conceptual and operational IEM approaches would help in planning and implementing ISMSWM. A good grasp of the conceptual approaches of IEM would help in understanding the different practices within specific local situations, as well as the advantages and disadvantages and the various practices to be modified and adopted. This will provide fresh thinking and a better understanding of the characteristics of MSW management in a specific situation. When planning for ISMSWM, this open-minded perspective can help in understanding the existing institutional framework and in generating detailed information about the policy, strategy, laws and regulations relevant to different governmental levels. This perspective helps in recognizing the responsible authorities, their responsibilities, the funding system and the existing regulatory and economic enforcement tools, in addition to the current MSW management practices, the level of public participation and the social considerations and attitudes.

All these details about the current situation of a specific case will help in identifying the adopted and implemented management approaches related to top-down vs. bottom-up processes and the level of action required for planning, decision-making and implementation of MSW management and the wide range of relevant stakeholders. Understanding the complex interactions within all these fields will help to identify the weak and strong points within the local situation, the priorities, the specific objectives, the required outputs and the desired outcomes for planning an ISMSWM system.

The operational approaches of IEM can support stakeholder participation and collaboration, ensuring the participation and cooperation of key stakeholders, which will move the procedure forward towards proper planning, decision-making and implementation. Bringing the stakeholders from different sectors together and facilitating coordination and communication among them will provide many details that will better clarify the obstacles and opportunities of ISMSWM planning.

The key issues and processes related to planning and implementing an integrated and sustainable approach to municipal solid waste management are explored within the context of a case study analysis of the potential opportunities and challenges in Kuwait's municipal waste management system as it attempts to transition to an ISMSWM model. The research framework was designed in light of the developed ISMSWM framework (figure 2.5). Data for the case study in Kuwait was collected and analyzed using a combination of qualitative and quantitative research methods. The results of the research provide an overview of how to integrate the multiple subsystems and sustainability dimensions of an MSW management system, with particular emphasis on considerations for planning and implementation of ISMSWM in the oil-exporting high-income (GCC) countries. Kuwait represents an excellent example of a country that has a high-income level and available economic and technical resources, yet they face challenges in sustainable development.

Building the research framework based on the structure and details of the ISMSWM framework, leads to the identification of many details that affect the planning and implementation of the ISMSWM system in Kuwait as presented in the discussion of the results in this chapter. As an example of the findings of the research, although institutional, legal and economic instruments are available in the country, the lack of monitoring and evaluation systems, and limited provisions for capacity development and collaboration, present obstacles to planning for an ISMSWM system. Accordingly, this study importantly provides a holistic understanding of the MSW management system in order to highlight the key areas that government and private sector waste managers must be aware of while planning an ISWMSWM framework. Moreover, the empirical research points to weaknesses in Kuwait's current waste system and institutional context, with the intention of avoiding these obstacles in the future and promoting better opportunities for collaborative and participatory planning and management.

As a consequence of the research results and discussion, the ISMSWM conceptual framework - part 1 (figure 2.5) was modified to be suitable to the case under study and to account for critical factors that would affect the operationalization of the ISMSWM framework. ISMSWM - part 2 (figure 5.1) includes: the required outputs and the expected outcomes to present the local situation of the case under study. The arrows represent the monitoring and evaluation methods that should accompany all planning and implementation processes. Moreover, from the results it was found that research is not involved as a part of the whole process; therefore, it is included in the ISMSWM conceptual framework - part 2, in order not to be neglected and to be incorporated within the planning process. As a departure from the status quo situation, with its inherent weaknesses and strained resources, the research findings provide a pathway for comprehensive thinking and integrative planning, decision-making, and implementation of ISMSWM for the oilexporting high-income countries (GCC) and other relevant global contexts.

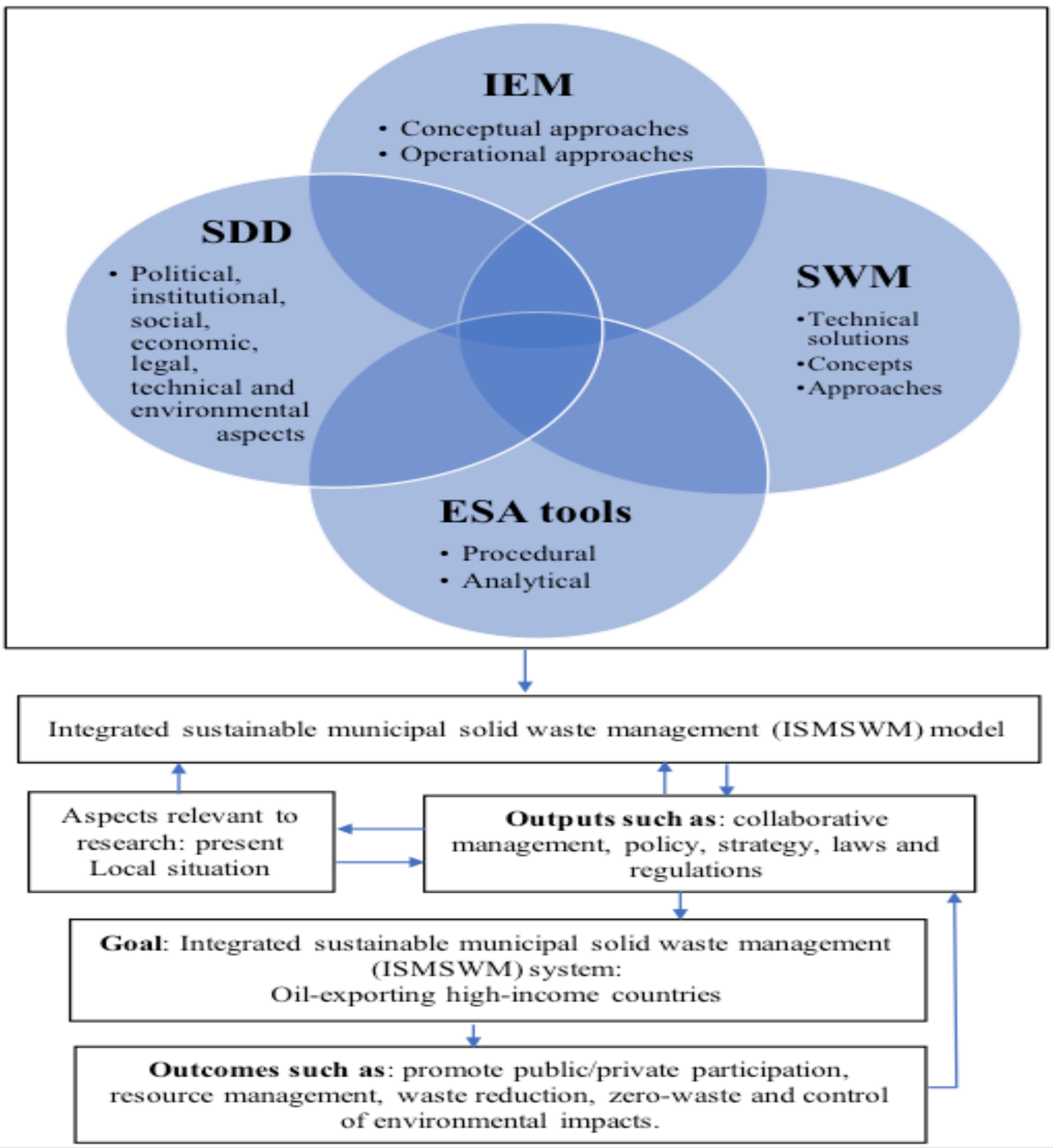

Figure 5.1: Conceptual framework for ISMSWM: GCC countries (Developed by AlManssor 2019).

5.16 Directions for future research

Based on the findings of the case study, several directions for future research are identified:

1. What are the tools and mechanisms to establish more qualified MSW data?
2. What is the role of civil societies in ISMSWM planning?
3. What is the role of the private sector in ISMSWM planning?
4. Extended producer responsibility (EPR) is an approach that is increasingly being adopted by high-income and middle-income countries (e.g. Brazil, China, South Africa); accordingly, it is important in the role of EPR in planning of ISMSWM systems.
5. Implement stratified random sampling for householders' questionnaire to better ensure a sample that can present the population and to promote the generalization of the results to the population. In addition, it necessary to stratify the population according to the six provinces in Kuwait. This point should be considered carefully to investigate if there is a different pattern of behavior or reaction toward MSW management that could vary by different regions
6. Further research is recommended to understand the contradictory nature of involving EFW and a zero-waste approach.
7. What are the implications of implementing SEA by the World Bank in managing MSW in Kuwait and in planning ISMSWM system in Kuwait?
8. To get results of LCA model that are better present the local situation, it is recommended to develop a model that is designed based on local conditions.
9. Is it practically useful and affordable to integrate the capacity development approach in the collaboration practices and the implementation of ISMSWM? What are the characteristics of capacity development that are needed?
10. Research findings promote the adoption of adaptive management since monitoring and evaluation, education, social learning and collaborative research are promoted. How can an adaptive management approach to MSW management be adopted and what are the implications for ISMSWM planning?

11. How can education and social learning be engaged in the collaborative approach for planning for sustainable integrated environmental management?
12. Find a country example that can be useful for the case study of Kuwait to understand how to avoid the obstacles and get the advantages of the opportunities to plan and implement ISMSWM system in Kuwait.
13. What are the obstacles and opportunities of implementing an IEM approach in other environmental fields in Kuwait (i.e. water management, coastal management and wastewater management)?.
14. How can the conceptual framework for ISMSWM be adapted to the GCC particular contexts?.

5.17 Conclusions

In summary, the following conclusions of this research study were developed to address the challenges of achieving ISMSWM in the oil-exporting high-income (GCC) countries, and Kuwait was a case study as an example of these countries. To allow for successful data collection and analysis, a post-positivism was adopted to perform the research framework and allow for the fusion of qualitative and quantitative methods within an in-depth case study. The research questions are as follows:

The *first question* in this part is related to identifying the current situation and practices of MSW management in Kuwait. These practices include the daily collection and transportation of mixed waste and dumping of waste in landfill locations – unsanitary landfills. Limited activities of recycling by the private sector promote the practice of scavenging. Many studies were established to shift the current situation toward a sustainable MSW management system but these studies faced obstacles and were discontinued. In 2016, Kuwait's public-private partnership (PPP) announced a project that plans to treat up to half of the MSW in Kuwait. The project is a energyfrom-waste (EFW) scheme that will be developed under a design-build-finance-operate-transfer system.

The *second question* in this part is to identify, with the support of the research framework, the obstacles and opportunities in ISMSWM planning from the perspective of the SWM elements, the stakeholders, and the sustainable development dimensions (legal and regulatory, institutional arrangement, technological/operational, social, economic and environmental factors). The ISMSWM framework was very important in guiding the research framework to integrate relevant sustainable development topics, SWM elements, and stakeholders into the research framework. Table 5.2 lists the obstacles according to the research findings. Although there are technical limitations, the main obstacles are regulatory, political, institutional, and social obstacles. Relevant to the stakeholder's perspectives and contribution in planning and implementing sustainable solid waste management, the local waste actors admit that they are encouraging the move toward ISMSWM planning and implementation; they promote participation in the process and they understand the need to improve their level of participation to be part of the decision-making process. For their participation to be efficient and effective, they need to develop their capacity to understand the political elements, regulatory structures, and social aspects in addition to the technical characteristics that are suitable for the local situation. Capacity development can be achieved by practicing collaborative approaches, building trust with government and among all other stakeholders, monitoring and evaluation processes, education and social learning. Although there was a lack of random sampling in the householders' questionnaire, and it was recommended to be repeated in the proper season, the householders' sample characteristics and the statistical analysis could present a good indicator of their tendency to change their practices toward better participation in the ISMSWM system. Education, social learning and involvement of media and social media can promote better practices and a higher level of participation. It is essential to not ignore any stakeholders (e.g. private sector, civil societies).

The *third question* is related to whether or not the environmental systems analysis ESA tools promote planning for the ISMSWM system. ESA tools, if unable to support decision-making in a direct way, can build bridges of communication and knowledge transfer among the users and stakeholders, decision-makers, waste actors, planners, waste-managers, environmental managers and other participants in the planning process. Moreover, procedural ESA tools (e.g. SEA tool) can help to organize the work.

The *fourth, fifth and sixth questions* are related to the obstacles and opportunities in planning for ISMSWM from the perspective of IEM: how might the current implemented approach of MSW management be improved toward planning and implementing an ISMSWM system?, what are the characteristics/components of the conceptual framework for the planning and implementation of an ISMSWM system?, and based on the research findings, how might the ISMSWM conceptual framework be utilized to improve the waste management situation in the oil-exporting high-income GCC countries?. The current policy-making, planning and decisionmaking with regard to MSW systems relies on a top-down approach in Kuwait. International organizations contribute on a national level to modify the political, regulatory and institutional arrangement to promote the transition from a conventional MSW management approach toward sustainable MSW management. The outcomes of this contribution, although it has made some radical changes at the regulatory and policy-making levels, it has failed to deliver tangible changes on the operational level. Lack of public participation, limited private-sector participation, lack of community engagement, limited horizontal cooperation (between stakeholders) and lack of integration in the vertical level (policies, strategies, plans and relevant institutions in the national level) demonstrated that the gap between policy and action is a major problem. The decisionmaking authority, the responsibility and the location of MSW facilities are formed within a central framework. It is beyond the scope of this research to decide whether a decentralization approach is a good choice for sustainable MSW management in Kuwait. Further research is recommended on the proper governance and administrative framework to understand the proper level of topdown versus bottom-up or combined approaches to planning, decision-making and operationalization of the ISMSWM system.

The research findings in terms of literature review, waste actors and decision-making perspectives and the amended regulatory system show that IEM and collaborative planning are critical elements in ISMSWM planning. This implies the need for an intensive willingness to change and build a structure of collaborative planning, decision-making and management that will transfer the tendency of operations toward change, and understand the needed type of outputs, its targets and the implementation strategies as well as the desired outcomes. The motivation for IEM adoption and implementation needs to be supported by various approaches, mechanisms and tools (i.e. building trust, monitoring and evaluation, capacity building, education and social learning, and ESA tools). For example, collaborative practices, continuous monitoring and evaluation of the process, CD, communication, education, social learning, collaborative research and addressing the sustainable development dimensions can support the identification of the content of the collaborative structure, the target of participation, who should participate, the level of participation and capacity of participation, and how to develop the capacity of participation. These examples are not the final answer as to what is required to support the operationalization of IEM approaches.

It depends on the local situation and on the results of continuous monitoring and the evaluation process to identify the actual obstacles and determine how to overcome these obstacles by developing and practicing collaborative approaches.

In this research, an ISMSWM framework was designed to account for IEM approaches along with the sustainable development dimensions, SWM elements, stakeholders' involvement and ESA tools to address the obstacles and opportunities during planning, decision-making and operationalization of ISMSWM. The ISMSWM framework includes the research part, the review of the outputs and the required outcomes of the planning process to account for the specific situation of local circumstances. This allows for the review, monitoring and evaluation of MSW as a resource, and is treated under the perspective of IEM approaches.

In summation, to ensure sufficient and effective MSW management practices in Kuwait, an IEM approach along with a comprehensive perspective are highly recommended for planning and implementing an ISMSWM system that will develop local practices to promote the movement toward sustainable development targets. At the same time, change in itself is not a panacea. It is essential to consider MSW as a resource rather than a problem in order to generate economic and environmental benefits including: savings in energy and natural resources, production of energy from waste, GHG emissions reduction, job creation and business opportunities. The shift from the conventional approach toward the adoption and implementation of an IEM approach requires intensive willingness to change, as well as building a structure of collaboration that increases awareness of the process. This will transfer the tendency of operations toward effective change and allow actors to understand and adopt the support approaches and tools as discussed in this chapter. Continued research is needed to understand both the obstacles and the progress associated with the stages of successful planning and implementation of ISMSWM in Kuwait.

It is a hope that the current study will promote awareness about identifying the obstacles and opportunities of implementing ISMSWM system within the oil-exporting high-income (GCC) countries that still possess challenges in sustainable development. Financial resources and technical options are priorities, but they cannot achieve a sustainable IEM system on their own. In Kuwait, as an example of an oil-exporting high income (GCC) country, based on the research findings, it is clarified that ISMSWM planning is subject to regulatory, social, political and institutional obstacles. As explained, IEM and collaborative approaches for planning and management are the critical keys to successful planning and implementation. The participation of the decision-makers, stakeholders, private sector, civil societies, and the public, while never ignoring any interested party, is fundamental. Without participation, the mutual understanding of the problems, the operationalization of IEM approaches, the production of effective and efficient outputs, the monitoring and evaluation of the process and the achievement of the outcome will all be difficult. It is essential for the participants in adoption of collaborative approaches to understand the target of participation, level of participation and the capacity for participation. Moreover, it is useful to understand how to promote participation.

Regarding the environmental problems in Kuwait, economic and technical factors are priorities, but are not the main obstacles in the planning of IEM. Extra research is required in this context, but as a general overview, the obstacles in the environmental management fields (e.g. water management, wastewater management, coastal management) are socio-political related factors that differ in the details. The adoption of collaborative approaches is critical in planning for integrated sustainable environmental management systems. This result is based on the fact that the same institutions, the same regulatory system, and in some cases, the same people, were subjects of interest throughout the environmental management system in Kuwait. It is a hope that this study will be a gateway and may contribute to a paradigm shift in changing the current planning and management perspectives toward a better understanding and implementation of IEM approaches. The obstacles and opportunities related to the planning and implementation of IEM systems should be subject to research, and collaborative research is recommended.

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Appendix A

Employing the IWM-Model to Assess the Environmental Impacts of Alternative MSW Management Options

The aim of this paper is to present a series of scenarios for managing Municipal Solid Waste (MSW) including sending no wastes to landfill, energy–from–waste (EFW), AD, resource recovery and waste reduction. The scenarios offer a change from the current situation of MSW management toward an integrated and sustainable management system.

1. Introduction

In this paper the IWM-Model – an example of a Life Cycle Assessment (LCA) is used to analyze and compare different scenarios for MSW management in The State of Kuwait. Life Cycle Assessment is an analytical method that aims to assess environmental impacts based on a product's life cycle, beginning with raw material production through to use and disposal. Conducting an LCA helps researchers, managers, stakeholders and decision makers select the operations or processes that result in the least impact on the environment by analyzing the transfer of environmental impacts from one medium to another. In the context of solid waste management, the interrelations between integrated sustainable MSW management system components (i.e. stakeholders, technologies and operation and sustainable development dimensions) require the adoption of a holistic approach. This promotes the understanding of the life cycle of products, operations and services. Life Cycle Assessment of waste aims to assess the performance of a number of interconnected waste management technologies (e.g. recycling, composting, anaerobic digestion), operations (e.g. collection, transport, material recovery facility MRF) and approaches (e.g. energy from waste, waste minimization, zero-waste approach) based on the composition, production and final disposal of waste.

In order to evaluate alternative municipal solid waste (MSW) management strategies, models are required to calculate environmental emissions in terms of waste composition and quantity (Harrison 2000). For this research study, an environmental life cycle model has been chosen. As a critical part of the Life Cycle Assessment approach, Life Cycle Inventory Assessment (LCIA) is defined as "a technique for assessing the environmental aspects and potential impacts associated with a product, by compiling an inventory of relevant inputs and outputs considering the entire life cycle of a product system—from cradle to grave (from raw material acquisition through production, use, and disposal); evaluating the potential environmental impacts associated with those inputs and outputs; and interpreting the results of the inventory analysis and impact assessment phases in relation to the objectives of the study (ISO 1997)" (Thanh 2012).

The LCI analysis tool is essentially an accounting framework for tracking air, water and other emissions from different life cycle stages of a product or process. For example, environmental burdens occurring over the life of a product or process being analyzed include energy requirements, raw material requirements, air emissions, water effluent, and solid waste. In the life cycle of a product, an important stage is waste disposal, and this is linked to environmental burdens just as occurs with other life-cycle stages (Thanh 2012). To assess the burdens of MSW management strategies on the environment, models are needed so that environmental emissions and energy consumption can be calculated for each process in the solid waste system with respect to scenarios composed of combined units and processes including processes related to collecting, separating, recycling, treating, and landfilling of waste. In order to compare environmental emissions and energy consumption/production against various alternative MSW management strategies, these unit process models can be incorporated into a larger model (Harrison 2000). The Life Cycle Inventory model for waste management is useful to compare environmental burdens within various MSW management scenarios (Wilson E.J. 2002). The Life Cycle Inventory Assessment method can be used for multiple assessments based on different factors, such as greenhouse gas emissions, energy production or consumption, economic cost/revenues, land use burden and investment/operating costs (Thanh 2012).

For the Kuwait case study, the life cycle inventory analysis software tool (Integrated Waste Management Model: IWM-Model) designed by EPIC/CSR for MSW was used. The IWM-Model is a spreadsheet tool with a Visual Basic interface and has been developed in Canada by the Environment and Plastics Industry Council (EPIC) and the Centre for Social Responsibility (CSR). Model developers and the target user group aim to (EPIC, 2004):

> give municipalities a broad indication of the environmental effects of waste management decisions, and point to strategies that potentially can improve the environmental performance of the waste management system…p.1

The IWM-Model has gone through several iterations since it was first released in 1998. The version used in this research is Version 2.0.6 (2004) and is available from the University of Waterloo web site (www.iwm-model.uwaterloo.ca).

Figure A.1 shows the system boundary to be analyzed. The environmental burdens that were tracked for this study include: energy, air emissions, water and land, and the life cycle (i.e. from when the material enters the waste stream until it is either finally disposed of or recycled into useful material or energy). Solid waste management elements covered in the model include waste collection, sorting facilities (MRFs), composting, anaerobic digestion, energy recovery and landfilling. The environmental parameters quantified in the model are listed in table A.1.

The IWM-Model receives input through a series of formatted spreadsheets for which the user is required to supply various types of information including: the quantity and composition of waste being managed; the quantities of each flow by waste type; the distances that waste is transported by various modes; the presence or absence of MRF; and the conditions at the landfill. Once the input screens have been successfully populated with data, the model produces an output file with four spreadsheet tabs, summaries of input data and a detailed profile of the outputs (EPIC, 2004).

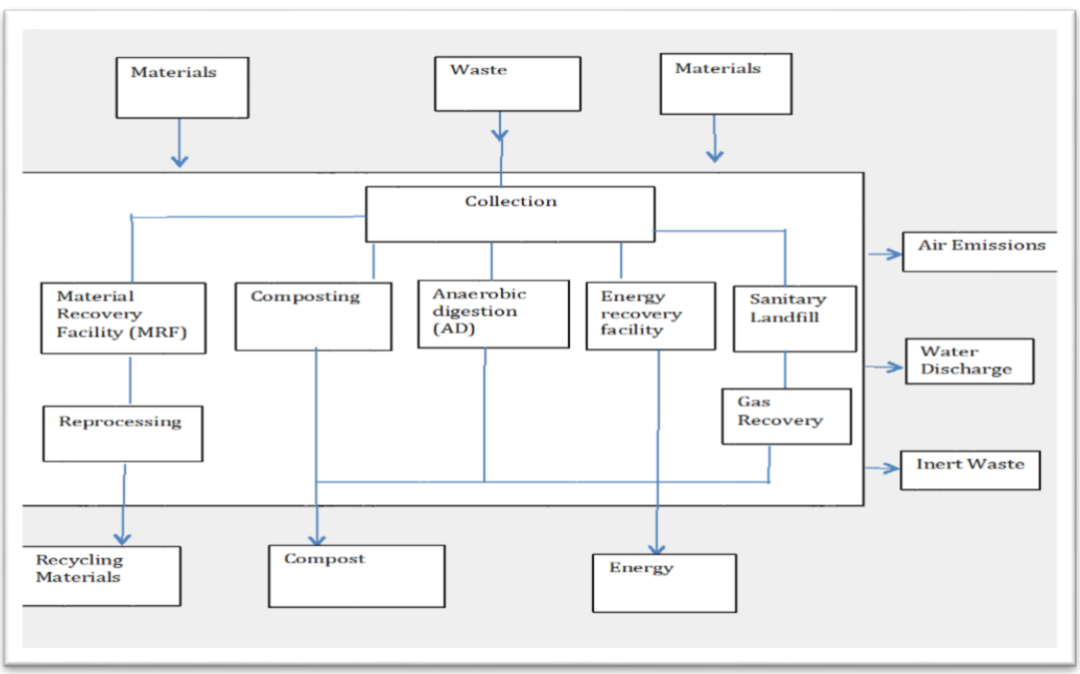

Figure A.1: System boundary for the environmental analysis model (IWM-Model)
Source: Integrated solid waste management tools: Measuring the Environmental Impact of Waste Management System (n.d.) (www. Iwm-model.uwaterloo.ca)

Table A.1: Environmental parameters evaluated in IWM-Model

Indicator Parameter	**Indicator of**	**Indicator Parameter**	**Indicator of**
Emissions to air		*Emissions to water*	
1. Greenhouse Gases: • Carbon dioxide (CO_2) Methane (CH_4)	Climate change	1. Heavy Metals Lead (Pb) Cadmium (Cd) Mercury (Hg)	Health risk, environmental degradation
2. Acid Gases: • Nitrogen oxides (NOx) • Sulphur dioxide (SO_2) • Hydrogen Chloride (HCl)	Acidification, health risk	2. Trace Organics Dioxins & Furans (TEQ)	Health risk, environmental degradation
3. Smog Precursors: • Non-methane Volatile Organic Compounds (VOCs) • Nitrogen oxides (NOx) • Particulate Matter (<10 microns) (PM-10)	Smog formation, health risk	3. Biochemical Oxygen Demand (BOD)	Water quality, environmental degradation
4. Heavy Metals: • Lead (Pb) • Cadmium (Cd) • Mercury (Hg)	Health risk		
5. Trace Organics: • Dioxins & Furans (TEQ)	Health risk		
Emissions to land		Energy	
Residual solid waste	Land use disruption	Total energy consumed	Resource depletion

Source: Epic, 2004; Haight, 2004

In this study, the inputs to the IWM-Model to establish different scenarios for MSW management in Kuwait include various municipal solid waste (MSW) streams, either as whole input streams (food waste, yard waste, plastics and metals) or other fractions of combustible, recyclable or compostable materials. The waste management scenarios include: incineration with energy recovery; landfilling with gas recovery and leachate collection; recycling; anaerobic digestion; and food composting. The incineration generates energy that is then used for electricity production. Emission results were calculated for the entire system as well as individual waste streams and combined waste streams. This facilitates the comparison of various proposed scenarios with respect to the combination of waste treatment methods.

Table A.2 shows the treatment of the waste fractions collected in Kuwait over the period of one year (2014). The data for the year 2014 was implemented in the IWM-Model since it is the year for the latest updated data for the MSW categories and composition. The composition of waste fractions is outlined in tables A.3 and A.4. The data used in this study were obtained from the Kuwait Municipality, World Bank documents and other previously published work on the status of MSW in Kuwait (AlAwadi, 2002; Alhumoud, 2006; Al-Yaqout, 2002; Aljarrallah, 2014). Data that were collected during key informant interviews with staff from the Municipality of Kuwait and waste collection companies include electrical energy, diesel fuel and distance to landfill site. Regarding the unavailable data, either the default data in the model were used, or assumptions were made based on relevant research in the literature.

Table A.2: Quantity of MSW for Kuwait

Waste amount	**Weight (tonnes)**
Municipal solid waste consists of:	
• Households and institutions	1,490,235
• Agricultural	265,725
• Commercial waste	341,812
Quantity of municipal solid waste (2014)	2,097,772

Source: Kuwait Annual Statistical Abstract, 2014, p.49 and Kuwait Annual Abstract, 2017, p.51.

Table A.3: Waste categories and examples of the composition of such categories

Category	Description
Sanitary	Diapers, sanitary napkins, and tissues
Paper	Office paper, newspaper, magazines and paper bags.
Corrugated fibres	Milk, juice, fruit and vegetable containers, cardboard, and paper cups and plates.
PET bottles	Containers (e.g., soft drink, milk, water containers)
Film	Packing plastic (e.g., bags, sacks, wraps)
Organic waste	Food waste, yard waste and tree leaves
Wood	Wooden furniture, and fruit and vegetables boxes.
Metals	Durable goods, such appliances and furniture, in addition to containers and packaging such as soda cans, food cans, pots, and clothes hangers.
Glass	Containers (soft drink bottles, jars for food, cosmetics, and other products)

Adapted from Al-Jarallah (2014)

Table A.4: Estimations of MSW classified categories and composition as provided by various sources for the years 2002, 2011 and 2014

Waste	% Composition*	% Composition**	% Composition***
Sanitary	6.23		
Paper	6.67	21	14.5
Corrugated fibers	8.40	5	
PET bottles	6.89	13	16 (mixed plastics)
Film	11.3		
Organic	45.8	50	45.6
Metals	3.95	3	9.9
Glass	6.09	3	4.7
Wood	3.82		
Other waste		5	9.3

* Adapted from Koushki (2002), Alhumoud (2006).
**Adapted from The World Bank (2011)
***Adapted from Al-Jarallah (2014)

The first step in LCA system analysis is to define the system operations and boundaries. To define the LCA system boundaries for MSW management, we first must define both the current situation and then develop the proposed scenarios according to the current policies adopted by the Municipality of Kuwait for MSW management. The actual practices of MSW management, including scavenging activities that are practiced in many areas to collect recyclable materials to be sold to private sector companies, are presented in figure A.2.

The relevant boundary system that was applied in the IWM-Model is presented in figure A.2 The MSW management alternatives are relevant to the first part of the IWM-Model data analysis, whereas the proposed MSW management scenarios are relevant to the second part of the IWM-Model data analysis. The analysis of MSW management alternatives in the IWM-Model are the analysis of single units of MSW management such as recycling, composting and AD. The boundary system includes the informal sector (scavenging activities) which operates in many areas. Although the relevant data on collected recyclable material by the scavengers is unavailable, the maximum collected recyclable rate of the waste is assumed to be 30% in order to evaluate the current situation of MSW in Kuwait. Scavenging recyclable aluminum scraps was included in the boundary system since this activity is practiced in different areas all over Kuwait.

The current situation and the proposed scenarios had to be defined according to the current adopted policies for MSW management. The specified landfill areas that are managed by the Municipality of Kuwait can actually be characterized as dumping sites since they are not designed as engineered sanitary landfills. Dumping practices for MSW are used for a baseline study scenario for the different proposed alternatives and scenarios of MSW management using the IWM-Model. The selected baseline case (dumping) is the current practice in Kuwait. The proposed scenarios for the IWM-Model are suggested based on the current adopted policies (e.g. zero-waste-to landfill, EFW, AD, resource recovery, waste reduction, and reduced land use) by the Municipality of Kuwait for ISMSWM planning. Moreover, these scenarios were developed with available data and key informant interviews.

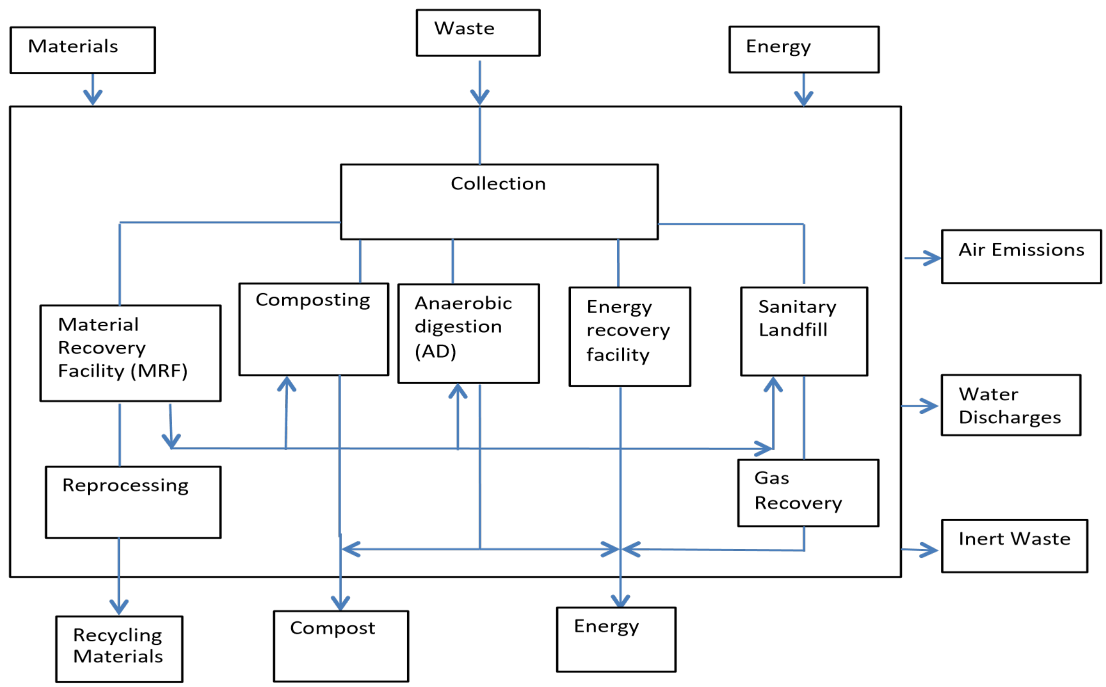

Figure A.2: The system boundary for the proposed Municipal Solid Waste management practices in the State of Kuwait to transfer from the current situation toward ISMSWM

Table A.5: Notes and assumptions related to running models within IWM-Model

Categories:	**Assumptions:**
Power supply grid	Oil
Fuel of trucks	Diesel
Assumptions:	
Distance from collection area to	50 Km
Distance from MRF to facilities	25 Km
Distance from inside the location	10 m

For the first part, table A.6 presents alternative MSW management approaches and the next sections, a-g, present the analysis resulted from IWM-Model for each of the listed alternatives in the table. The aim is to compare the actual practices of MSW management with different alternatives and to identify how effective each alternative is in reducing the environmental impacts compared to current dumping practises.

Table A.6: Different alternatives applied in the IWM-Model for municipal SWM in Kuwait

	MSW management practice	**Type of waste**	**Notes**
Baseline	Dumping	Total waste	Baseline case
Scenarios			
1	Landfill*	Total waste	
2	Scavenging activities	30% Plastics and 30% aluminum	
3	Recycling	40% of all recyclable waste	
4	EFW**	60 % of total waste	Energy recovery efficiency = 70%
5	Compost in vessel	Food waste	45.8% of total waste
6	Compost in windrow	Food waste	45.8% of total waste
7	Anaerobic digestion (AD)	Food waste and all paper	Energy recovery efficiency = 70%

*Landfill refers to engineering designed lined landfills with leachate collection systems. **Energy from waste

a. Greenhouse gases

CO_2 equivalents, as shown in figure A.3. account for greenhouse gas emissions. A carbon dioxide equivalent (CO_2 equivalent) is a "metric measure used to compare the emissions from various GHGs emissions on the basis of their global-warming potential (GWP), by converting amounts of other gases to the equivalent amount of carbon dioxide with the same global warming potential" (EEA 2018). Recycling, composting and EFW - with 70% energy recovery efficiency - and AD have a tendency to reduce the production of greenhouse gas emissions by at least of 40% in comparison to the baseline case (dumping). Anaerobic digestion (AD) results in a significant reduction in CO_2 equivalents compared with dumping practices and all other MSW management alternatives. The results of the IWM-Model show that alternative 7 in table A.7 (AD option) produces -1,200,000 tonnes of the CO_2 equivalents. Negative numbers for the relevant to the CO_2 equivalents relevant to the impact equivalents of net life cycle inventory in terms of reduction of emissions from relevant hundred cars for one year (CSR/ERIC 2004).

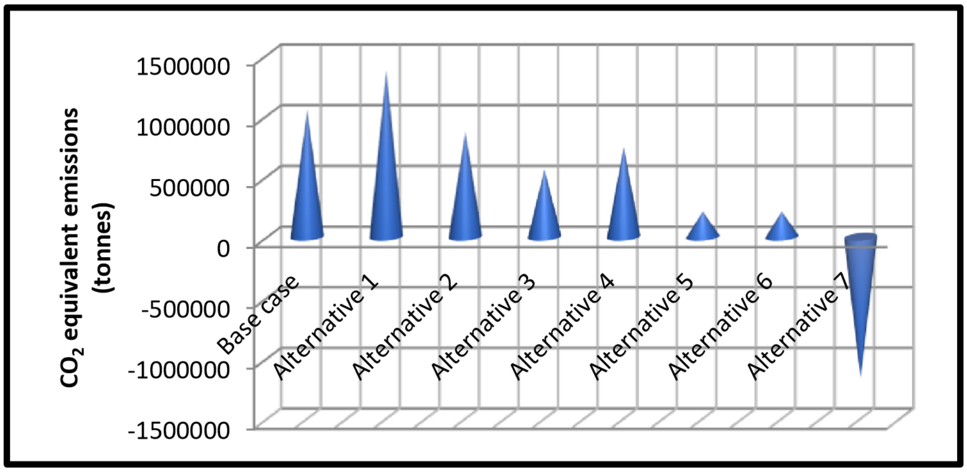

Figure A.3: Comparison of different MSW management alternatives in GHGs emissions – CO_2 equivalents (tonnes)

b. Acid gases

Figure A.4 presents a comparison between different MSW management alternatives in relation to acid gas emissions. Engineered landfill practice results in a small increase in nitrogen oxides (NOx) and a small decrease in sulphur oxides (SOx) emissions in comparison with current dumping practices. The other MSW management alternatives show a decrease in SOx and NOx emissions except (EFW) practice with 70% energy recovery efficiency results in the highest readings for NOx emissions, 350 tonnes. Alternatives 5 and 6 (composting in either vessel or window) results in the highest readings for SOx emissions, 50 tonnes.

The alternative engineered landfill, scavenging activities, recycling, EFW and AD result in SOx emissions: -100 tonnes, -1200 tonnes, -1700 tonnes, -150 tonnes and -2700 tonnes, respectively. Negative numbers for the SOx emissions relevant to the impact equivalents of net life cycle inventory in terms of reduction of power to supply relevant hundred homes for one year (CSR/ERIC 2004, Haight 2004, p.90).

The alternatives scavenging activities, recycling, EFW and AD result in NOx emissions: 800 tonnes, -1350 tonnes and -1700 tonnes, respectively. Negative numbers for the NOx emissions relevant to the impact equivalents of net life cycle inventory in terms of reduction of emissions from relevant hundred cars for one year (CSR/ERIC 2004, Haight 2004, p.90).

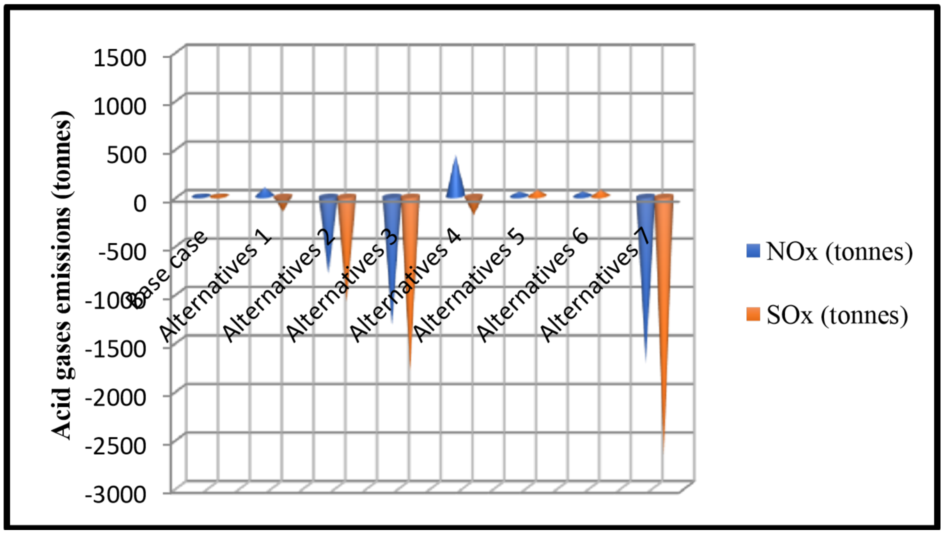

Figure A.4: Comparison of different MSW management alternatives in acid gases e.g., NO_X and SO_X

c. Smog precursors

Figure A.5 presents a comparison between different MSW management alternatives and the release of smog precursors. Emissions of NOx were described previously. For particulate matter (PM) emissions, all MSW management alternatives result in reductions in PM emissions, as compared to current dumping practices, except composting. Anaerobic digestion (AD) is the alternative with the lowest comparable PM emissions, -1000 tonnes. Negative numbers for the PM emissions relevant to the impact equivalents of net life cycle inventory in terms of reduction of power to supply relevant hundred homes for one year (CSR/ERIC 2004, Haight 2004, p.90).

Dumping practices, engineered landfill, EFW - with 70% energy recovery efficiency - and composting have the same rates of volatile organic compound (VOCs) emissions. Alternative 7 (AD) produces 100 tonnes of VOCs emissions, which is less by 50% compared to the base line case (dumping). The alternatives, scavenging and recycling, present VOCs emissions in figure A.: -700 tonnes and -1100 tonnes, respectively. Negative numbers for the VOCs emissions relevant to the impact equivalents of net life cycle inventory in terms of reduction of emissions from relevant hundred cars for one year (CSR/ERIC 2004, Haight 2004, p.90).

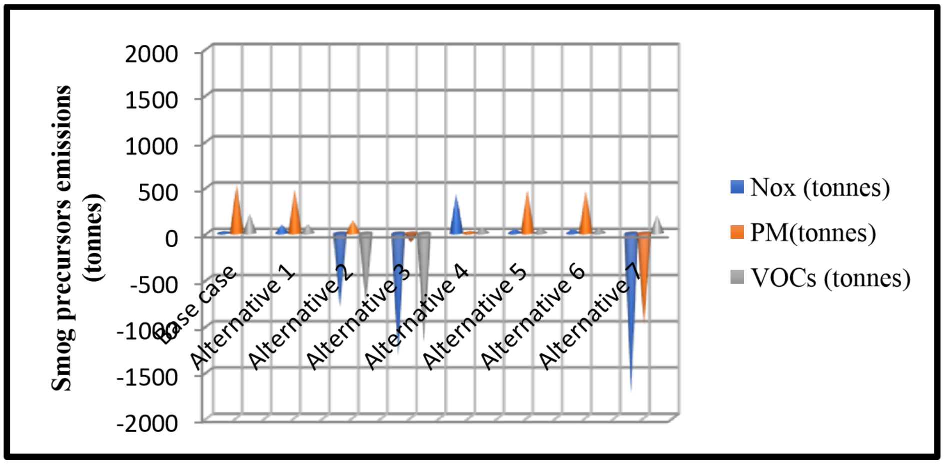

Figure A.5: Comparison of different MSW management alternatives in smog precursors

d. Heavy metals and organics (air)

Figure A.6 shows that EFW releases the greatest amount of heavy metals into the air: 780 tonnes of Pb emissions, 250 tonnes of Hg emissions and 50 tonnes of Cd emissions. Figure A.7 shows that both engineered landfills and EFW are the greatest producers of airborne Dioxin emissions: 0.15 tonnes and 0.75 tonnes.

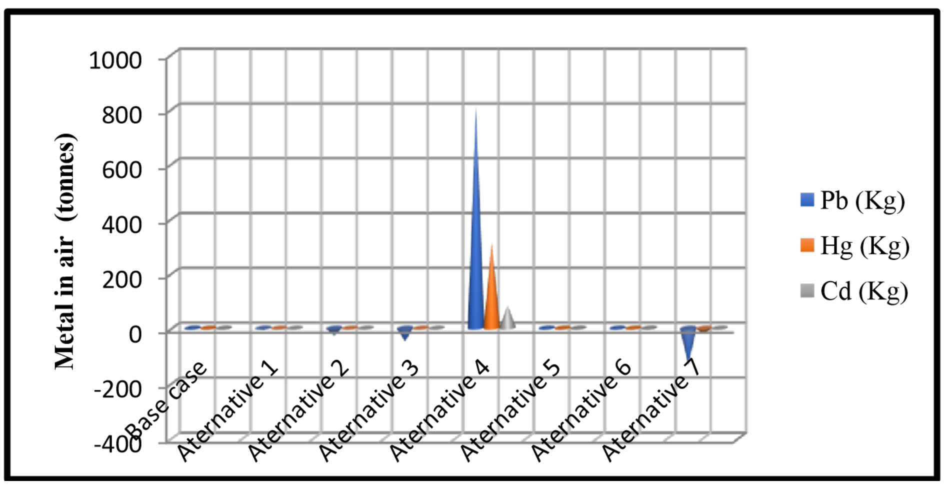

Figure A.6: Comparison of different MSW management alternatives in heavy metals (in air) (tonnes).

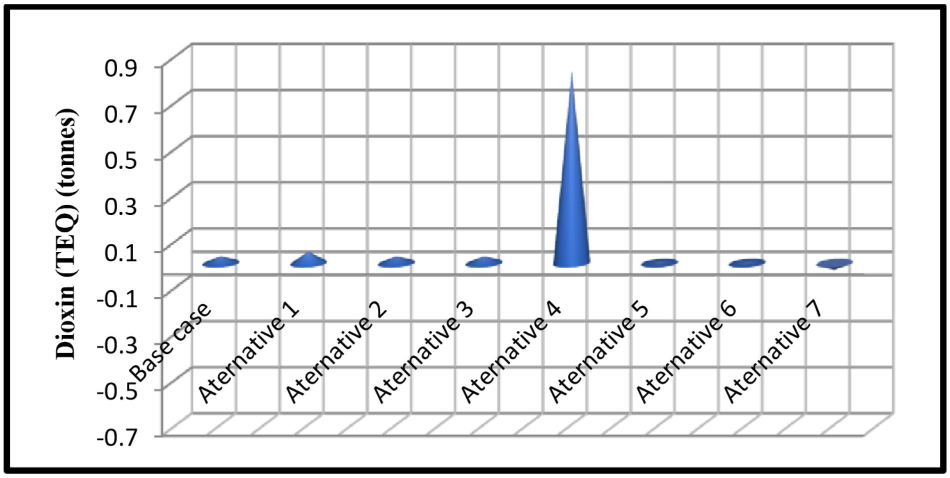

Figure A.7: Comparison of different MSW management alternatives in heavy metals and organics (in air) – Dioxin (TEQ)

e. Heavy metals and organics (water)

Figures A.8, A.9 and A.10 present a comparison between different MSW management alternatives in relation to heavy metals in water for Pb, Hg and Cd, respectively. Engineered landfills assist in reducing the heavy metals in water through the use of leachate (collection systems.

Figure A.8 shows that composting practices produce the highest levels of Pb in water, 100 tonnes. The alternatives, engineered landfill, EFW and AD present Pb levels in water of: -100 tonnes, -550 tonnes and -2900 tonnes, respectively. Negative numbers for the Pb (tonnes) traces in water relevant to the impact equivalents of net life cycle inventory in terms of reduction of power to supply relevant hundred homes for one year (CSR/ERIC 2004, Haight 2004, p.90).

Figure A.9 shows that scavenging practices, recycling and composting produce the highest traces of Hg (tonnes) in water: 0.25 tonnes, 0.45 tonnes and 0.1 tonnes, respectively. Figure A.10 shows that scavenging activities and composting produce the highest levels of Cd (tonnes) in water: 2.5 tonnes and 1.5 tonnes, respectively.

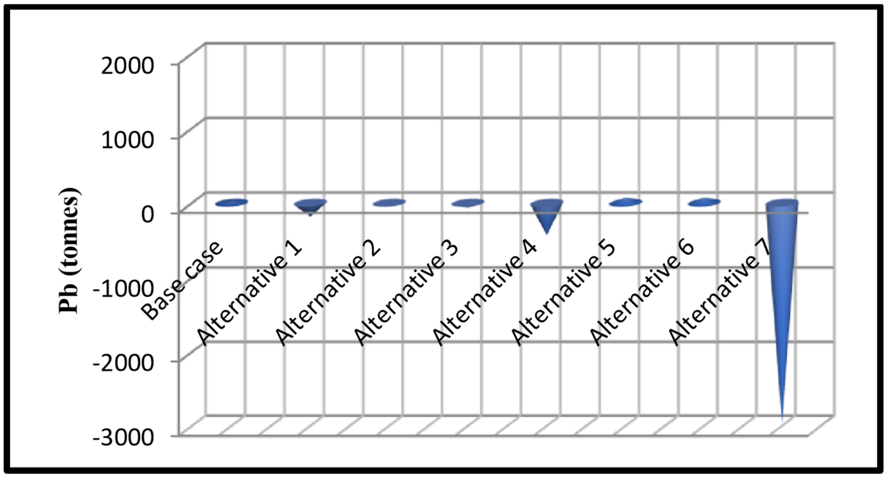

Figure A.8: Comparison of different MSW management alternatives in heavy metals (in water) – Pb (tonnes)

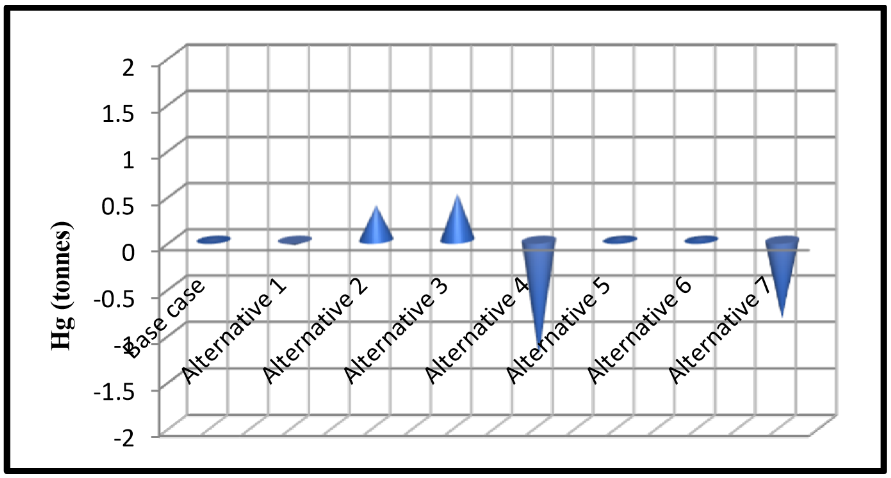

Figure A.9: Comparison of different MSW management alternatives in heavy metals (in water) – Hg (tonnes)

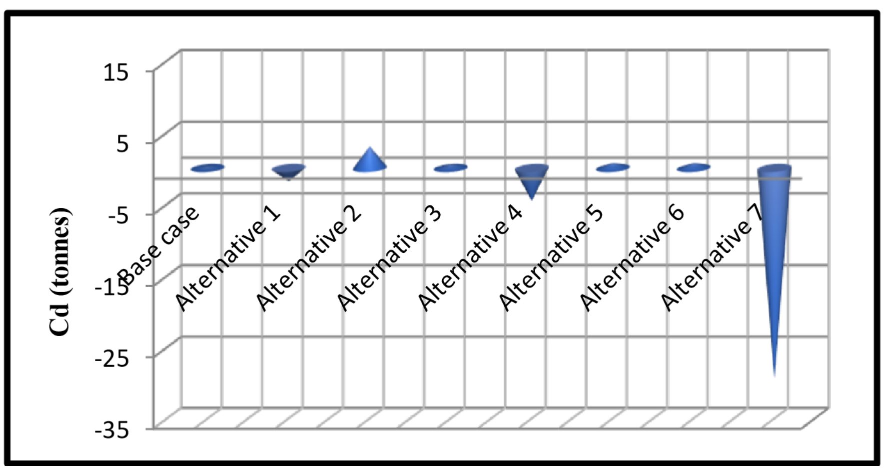

Figure A.10: Comparison of different MSW management alternatives in heavy metals (in water) – Cd (tonnes)

f. Residual waste sent to landfill

Figure A.11 shows that scavenging activities, with the assumed minimum and maximum collected amounts of plastics and aluminum, can reduce the levels of residual waste sent to landfills by 91-98% Recycling 40% of recyclable materials reduces the residual waste sent to landfills to 82%. Composting, EFW and AD of food waste could reduce the residual waste in landfills by 52-55%. In contrast, AD of food waste and paper could reduce the residual waste in landfills to 40%

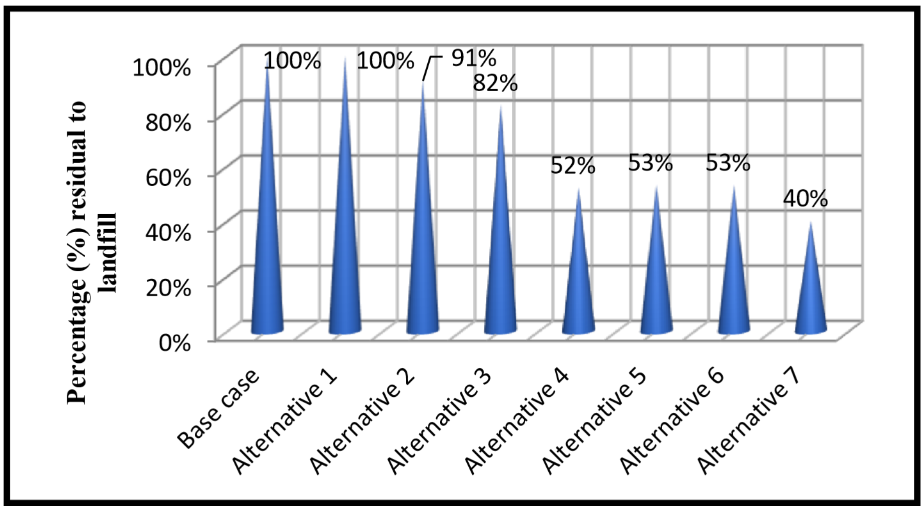

Figure A.11: Comparison of different MSW management alternatives in percentage (%) of residual waste to landfill

g. Energy

In figure A.12, scavenging activities, recycling, EFW, AD and landfills save energy rather than consume energy. Composting is the MSW management alternative with the highest rate of energy consumption. Recycling, EFW - with 70% energy recovery efficiency - and AD have the highest rates of saving energy compared with the base line case. Recycling, EFW with 70% energy recovery efficiency and AD have high rates of producing energy as follows: -12,000,000 tonnes, 13,000,000 tonnes and -15,000,000 tonnes, respectively. “Negative numbers for the energy are relevant to the energy production in terms of electricity of homes for one year” (EPIC/CSR 2004).

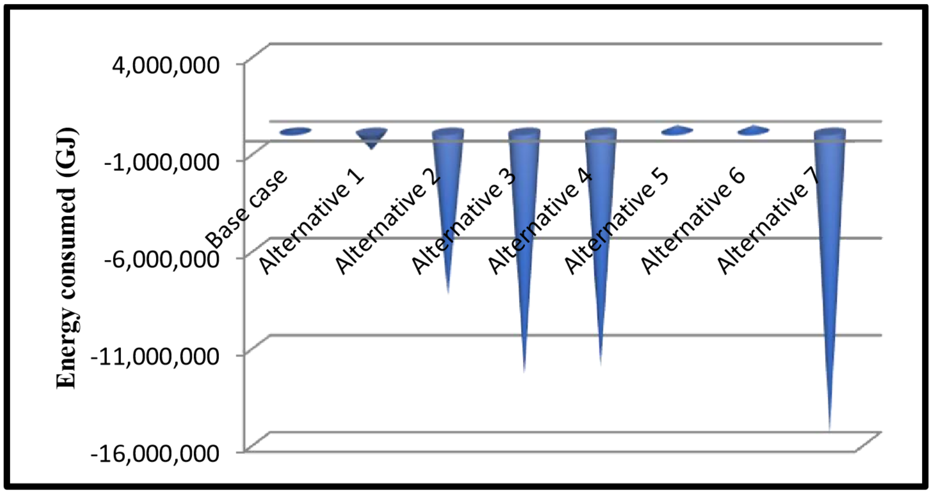

Figure A.12: Comparison of different MSW management alternatives in Energy consumed (GJ)

The second part consists of scenario comparisons based on an expanded boundary system derived from current adopted policies including: eliminating waste to landfill, EFW, AD, resource recovery, waste reduction, reduced land use (figure A.2). These alternatives were identified by stakeholders to transition from the current situation of MSW management in the State of Kuwait toward an efficient, integrated and sustainable MSW management system. Table A.5 presents the assumptions that were applied to run the IWM-Model. Comparisons between the categories of alternatives: in terms of greenhouse gases, acid gases, smog precursors, heavy metals and organics (in air), heavy metals and organics (in water), residual waste to landfill and consumed energy (EPIC/CS 2004).

Table A.7: Waste management scenarios evaluated in the IWM-Model

NO.	Scenarios and type of waste
Baseline	Dumping: Total waste
Scenarios	
1	Landfill*: Total waste
2	Composting – Landfill: Food waste (45.8%) and paper (8.4%) of total waste
3	EFW 100% - zero-waste approach: Total waste
4	AD food-waste – Landfill: Food waste (45.8% of total waste)
5	AD food-waste and all paper – Landfill: Food waste (45.8%) and paper (15%) of total waste
6	AD -Recycling – Landfill: AD: Food waste (45.8%) and paper (15%) of total waste Recycling:70% (18% of total waste)
7	AD -Recycling – Landfill: AD: Food waste (45.8%) Recycling:70% (plastics:18% of total waste) and 70% (paper: 15% of total waste)
8	AD -Recycling – Landfill: AD: Food waste (45.8%) Recycling:70% (plastics:18% of total waste) ,70% (paper: 15% of total waste) and 70% (10 of total waste)
9	AD -Recycling – Landfill: AD: Food waste (45.8%) and paper (15%) of total waste Recycling:70% (plastics:18% of the total waste) and 70% (10 of total waste)

* Landfill means engineering designed lined landfills with leachate collection systems.

Table A.7 presents various scenarios that can be analyzed using the environmental analysis model. Each scenario is designed to present applicable solutions. Current dumping practices are considered a baseline case. The next sections, a-g, present the results from the IWM-Model for each of the listed scenarios in table A.7.

a. ***Greenhouse gases***

The IWM-Model presents CO_2 equivalents as a measure of both CO_2 and CH_4. For CO_2 equivalents (figure A.13). Scenario 3, consisting of EFW - for the total waste – produces 450,000 tonnes of CO_2 equivalents, and has a tendency to reduce the production of greenhouse gas emissions by about 50% in comparison to the baseline case (dumping). Scenarios 4-9 that include either AD and landfill or AD, recycling and landfill with different portions of the type of waste for each unit in the different scenarios result in a significant reduction in CO_2 equivalents compared with base line case (dumping) practices. As an example, the results of the IWM-Model show that scenario 8 in table A.7 produces -2,500,000 tonnes of CO_2 equivalents. As mentioned before, "negative numbers for the relevant to the CO_2 equivalents relevant to the impact equivalents of net life cycle inventory in terms of reduction of emissions from relevant hundred cars for one year" (EPIC/CSR 2004).

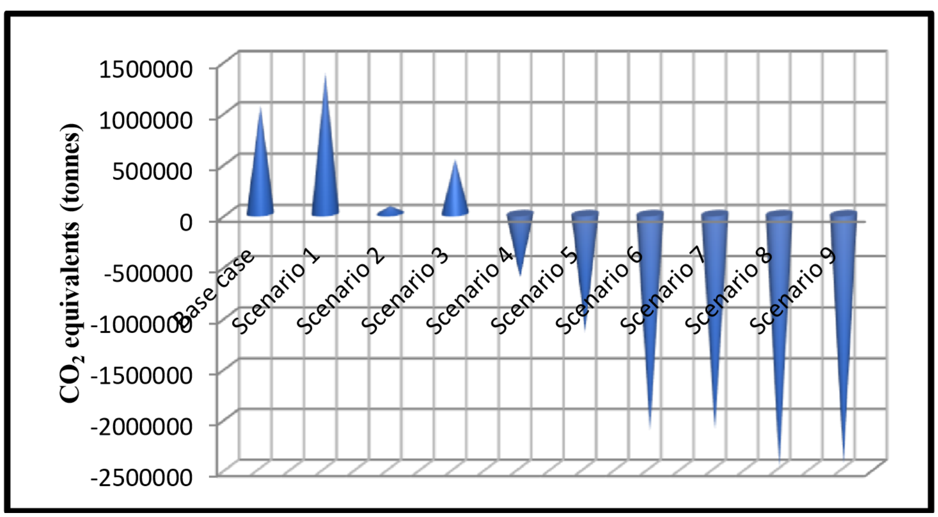

Figure A.13: Comparison between different MSW management scenarios in GHGs emissions – CO_2 equivalents (tonnes)

b. Acid gases

In figure A.14, it can be observed that the only contribution to acid gas emissions is presented in scenario 3 (EFW for the total waste) versus the baseline case and all other MSW management scenarios. Scenario 3 produces 500 tonnes of NOx emissions, the highest NOx emissions compared to the baseline case and all other scenarios. For the NOx emissions, scenarios 4-9 produce negative values. For example, scenario 9 produces -3700 tonnes of NOx emissions.

For the SOx emissions, scenario 1 and scenarios 3-9 produces negative values. For example, scenario 9 produces -5500 tonnes of SOx emissions.

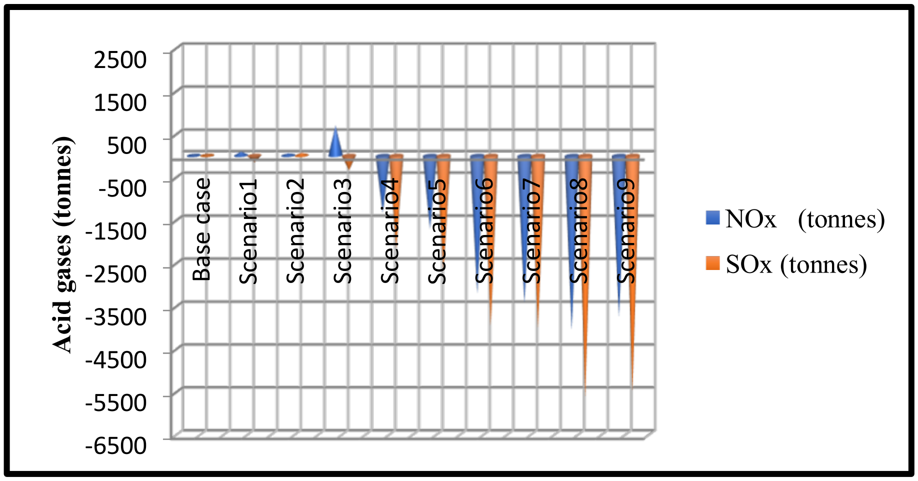

Figure A.14: Comparison between different MSW management scenarios in acid gases: NOx and SOx

c. *Smog precursors*

Figure A.15 shows a comparison between the MSW management scenarios that are presented in table A.7 in relation to smog precursors (NO_X, PM). Scenario 4 (AD (food waste) - landfill) presents the highest contribution to smog precursor emissions since it shows high levels of PM emissions, 11,000 tonnes, among the base line case and all other proposed scenarios. Scenarios 4-9 present values of PM emissions in the range of (-500 to -2000) tonnes.

For NO_X emissions, scenario 3 (EFW for the total waste) produces the highest values, 400 tonnes of NO_X emissions, among the base line case and all other scenarios. Scenarios 4-9 present values of NO_X emissions in the range of (-2000 to -5500) tonnes.

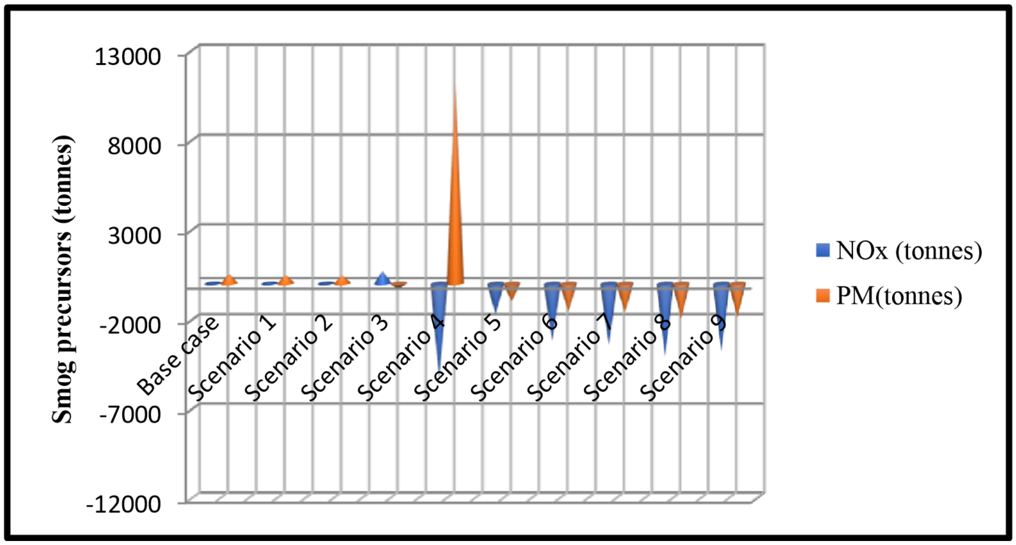

Figure A.15: Comparison between different MSW management scenarios in smog precursors: NO_X and PM

d. ***Heavy metals and organics in (air)***

Figures A.16 and A.17 present the comparison between different scenarios and emissions of heavy metals and organics entering the air. In figure A.16, scenario 3 (EFW (total waste) – Landfill) shows the highest contribution of heavy metals and airborne organics among the base case and all other scenarios: 1250 tonnes of Pb emissions, 450 tonnes of Hg emissions, 150 tonnes of Cd emissions and 1.2 tonnes of Dioxin (TEQ) being released into the air. Scenario 7 (AD (foodwaste) - recycling 70% plastics and 70% paper- landfill) shows the second highest value of Pb emissions, 100 tonnes being released into the air. Scenarios 4-6, 8 and 9 have negative values. For example, result of scenario 9 is -220 tonnes of Pb emissions.

In figure 17, Scenarios 4 - 9 present similar amounts of Dioxin (TEQ), 0.20 tonnes, being released into the air, which is slightly higher than the base case, 0.10 tonnes, and scenario 1, 0.15 tonnes.

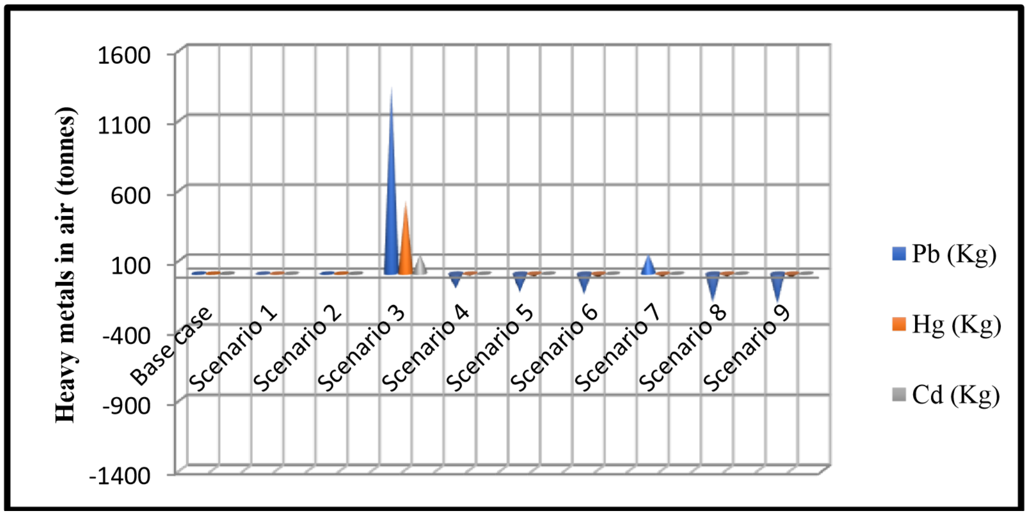

Figure A.16: Comparison between different MSW management scenarios in heavy metals (in air)

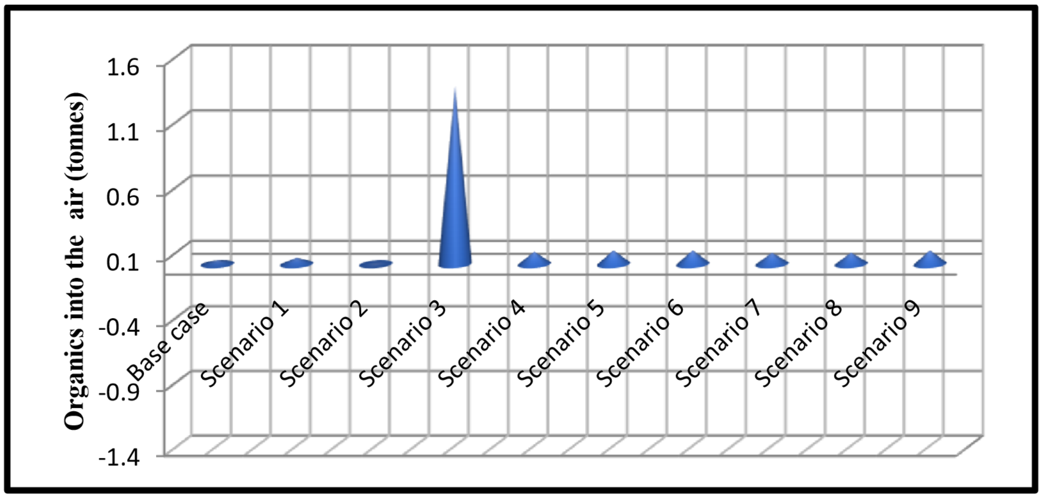

Figure A.17: Comparison between different MSW management scenarios in organics released into the air – Dioxin (TEQ)

e. Heavy metals and organics (water)

Figures A.18, A.19 and A.20 show the concentration of heavy metals, Hg, Pb and Cd, in water, respectively. In figure A.18, Scenario 2 (composting - landfill) is the only scenario that presents a contribution to Pb emissions, 100 tonnes in water. The results for scenarios 3-9 present negative values. For example, scenario 9 produces -3100 tonnes Pb traces in water.

In figure 19, Scenarios 2, 7 and 8 are the only scenarios that contribute to Hg levels in water, 0.1, 0.2 and 0.2 tonnes, respectively. and they are all in the same range. Results for scenarios 3, 4 and 5 show negative values. For example, scenario 3 produces -2.1 tonnes of Hg in water.

In figure 20, none of the scenarios indicate any significant contribution to Cd (tonnes) levels in water. The engineered landfill, the leachate collection system and the reduction of residual waste to be sent to landfills are all good reasons to explain the reduction of the concentration of heavy metals in water (specifically underground water).

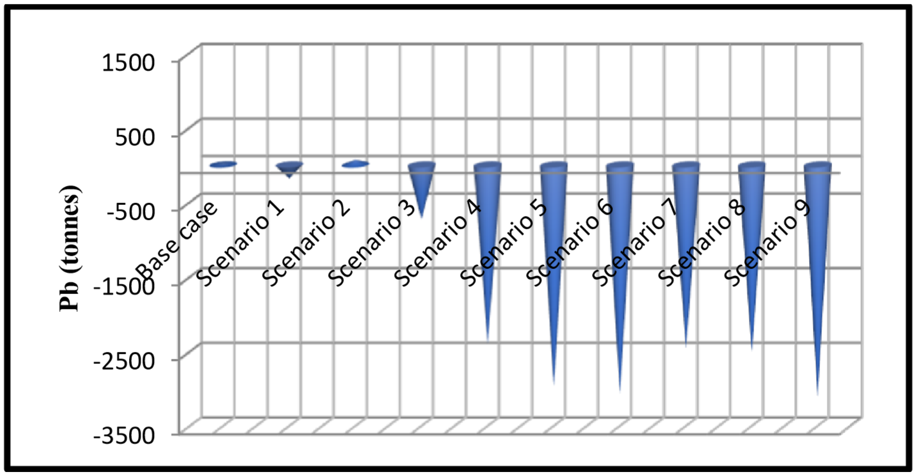

Figure A.18: Comparison between different MSW management scenarios in the field of heavy metal (in water) – Pb

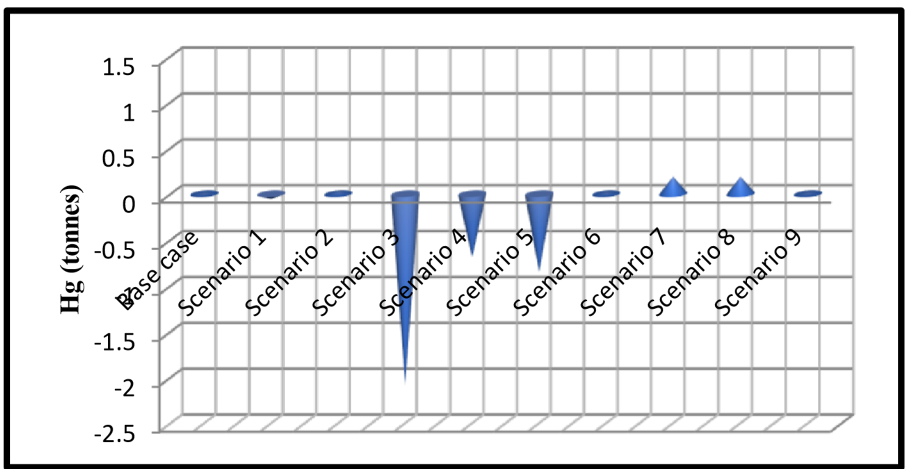

Figure A.19: Comparison between different MSW management scenarios in the field of heavy metals (in water) – Hg

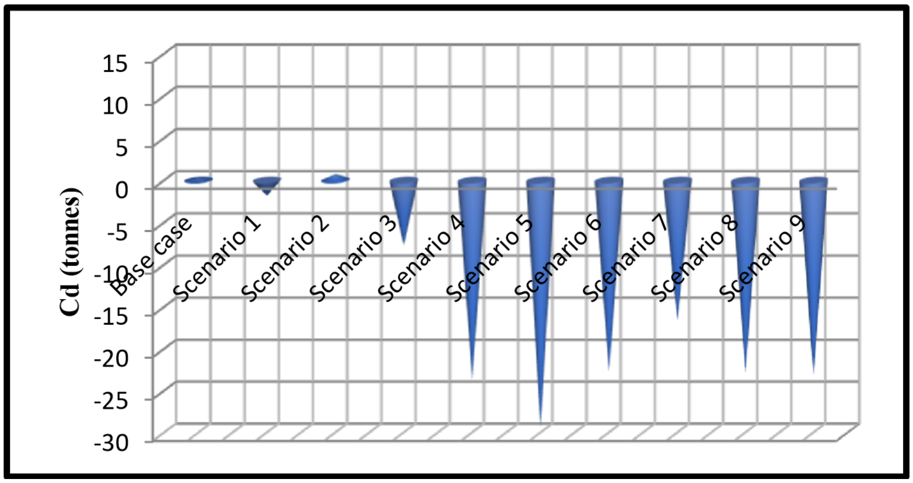

Figure A.20: Comparison between different MSW management scenarios in the field of heavy metals (in water) – Cd

f. ***Residual of waste sent to landfills***

Figure A.21 shows the comparison between different scenarios and residual waste to be sent to landfills. Scenarios 2-9 show the reduction in the residual waste sent to landfills in the range of 17 – 54%. Scenarios 3, 8 and 9 show the highest reduction in residual waste sent to landfills, in the range of 21%, 18% and 21%, respectively. Table A.8 presents the scenarios of MSW management and the relevant percentage of waste sent to landfills.

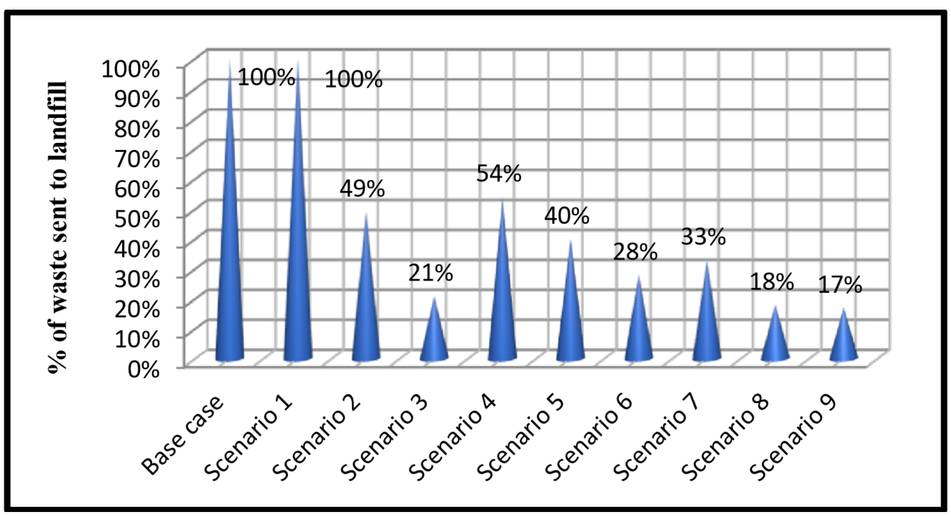

Figure A.21: Comparison between different MSW management scenarios in percentage (%) residual waste (tonnes) to landfill

Table A.8: The percentage (%) of waste sent to landfill for each proposed scenario

NO.	Scenarios	Percentage (%) of waste sent to landfill
baseline case	Dumping	100
1	Landfill	100
2	Composting – Landfill	49
3	EFW 100% - zero-waste approach	21
4	AD food-waste – Landfill	54
6	AD food-waste and all paper – Landfill	40
8	AD food-waste and all paper -Recycling 70% Plastics – Landfill	28
9	AD food-waste -Recycling 70% Plastics and 70% paper- Landfill	33
10	AD food-waste -Recycling 70% Plastics and 70% paper and 70% metals- Landfill	18
11	AD (food-waste and paper) - Recycling 70 % (Plastics and metals)	17

g. Energy

Figure A.22 presents the comparison between the different MSW management scenarios and energy usage. The transfer from dumping to landfill with lined landfills, leachate collection and energy recovery causes energy production rather than energy consumption. Scenarios 3-9 all show that after all processes and operations go through the routes of the scenarios, the net energy in the system is negative. "Negative numbers for the energy are relevant to the energy production in terms of electricity of homes for one year" (EPIC/CSR 2004). This means that they are saving energy rather than consuming energy. For example, scenario 10 produces 36,000,000 GJ. Scenario 2 (composting - landfill) is the only scenario that indicates energy consumption, 2,000,000 GJ. Scenarios that include EFW or AD with energy recovery are not consuming energy. This means that they are saving energy and producing net energy rather than consuming energy.

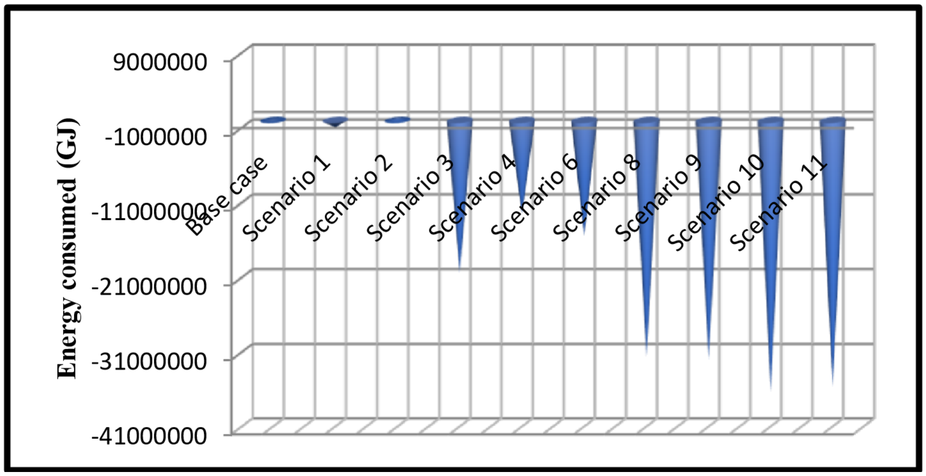

Figure A.22: Comparison between different MSW management scenarios in the field of energy consumption (GJ)

The environmental impacts of various MSW management options in comparison to dumping can be summarized as follows: engineered landfills, EFW with energy recovery efficiency of 70%, composting, recycling and AD can help to reduce greenhouse gases, smog precursors, heavy metals in water, energy consumed and residual waste entering landfills. Scavenging activities show positive environmental impacts in terms of saving energy rather than consuming energy and reduction of residual waste sent to landfill. Results show that composting in either vessels or windrows has the same environmental impacts.

In spite of the lack of some data entry in the model, using the LCA analysis and the IWM-Model offers a good opportunity to examine different scenarios for MSW management in The State of Kuwait. Moreover, it is an opportunity to compare these scenarios in different environmental impact categories. The comparison between these different scenarios can provide an overview of different options for MSW management. Small changes could offer significant differences that can help in reaching targets and can promote and hasten decision-making. These scenarios were suggested based on the available data, key informant interviews about the current situation, and current adopted national policy to shift from conventional MSW management toward integrated MSW management approaches (for example zero-waste and EFW). The results of the different comparisons show that the change from current dumping methods to different MSW management scenarios leads to an observable reduction in greenhouse gas emissions, acid gases, smog precursors, heavy metals in air and water, and reduction in energy consumption. In addition, these different scenarios could help to reduce the residual waste efficiently, which means less demand for more land area for landfills and dumping sites.

One of the key limitations of the LCI method is that while it supports a comparison of the environmental emissions and other burdens imposed by different options, it does not assess the environmental impact of the options (either as absolute or comparative values). However, an environmental impact assessment used alongside the LCI can provide additional information that can provide for a better understanding of the environmental significance (ISO, 2006a).

For the IWM-Model, the default values and the assumptions in the model are based on Canadian standards (EPIC/CSR 2004, p.24, Haight 2004, p.71). For the case of Kuwait, the available data for the MSW management situation in Kuwait during the research period were used in the model. For the unavailable values, assumptions were made based on the information gained from key informant interviews and the updated literature review up to 2014. If proper assumptions that are closer to the actual situation such as the gas recovery efficiency for engineered landfill and the energy recovery efficiency and the generated ash for EFW were not available, then the default values of the model were used.

The IWM-Model results presented in this paper are compared to the baseline case of dumping. The model allows users to use impact equivalents in order to evaluate the LCI of the existing waste management system as well as incremental impacts (EPIC/CSR 2004, p.27). "Impact equivalents are conversion factors that allow users to convert the inventory results into every day equivalents" (EPIC/CSR 2004, p.27). Impact equivalents are used for most environmental parameters that are analyzed by the model. When applicable, the impact equivalent for each pollutant is selected so that: a1. It refers to common every day activities and 2. It is a significant pollution source (EPIC/CSR 2004, p.27).

For example, the energy consumed by different waste management processes is compared to the average Canadian home electricity use for a year, with energy consumption based on the number of homes consuming an equal amount of energy as electricity yearly. Another example involves NOx and VOCs emissions, which are expressed in terms of the average number of Canadian cars emitting an equivalent amount of pollution per year. SOx and PM air emissions are expressed in terms of the amount of electricity consumed by homes per year producing an equivalent amount of pollution.

The previous explanation about the used data and the applied impact equivalents in the IWM-Model, demonstrate that the results of the model are not absolute. The missing data, the available assumptions and the conversion factors that are relevant to Canadian standards lead us to understand that if relevant local data for the situation in Kuwait is available, then the results are expected to be different in terms of values. Rather than previous limitations, the available advantage of the model to compare between different options and scenarios in terms of decrease and increase of various emissions, energy consumption and residual waste sent to landfill provide a good opportunity to understand the current situation and the expected changes in the environmental impacts when different alternatives or scenarios were applied for the available data.

In spite of these results, it is recommended to develop a local LCA model that can avoid the data gaps and develop local conversion factors that can be used in the model to compile with the local situations.

Appendix B

Waste actors' Questionnaire

Note: This questionnaire is only intended for academic purposes. The responses you give will be protected and be kept confidential. At the end of the research program the questionnaire will be destroyed.

NOTE: The context of this questionnaire is about the municipal solid waste (MSW) management in the State of Kuwait. Municipal solid waste is the non-hazardous and non-medical discarded materials including food wastes, yard wastes, packaging products and containers, and other miscellaneous wastes from households, commercial, institutional, and industrial establishments.

Please provide the following details:

Name of your organization: ....
Designated position: .... Number of years in office: ....

1. Are you working in the waste management field?
    a. Yes
    b. No

2. If your answer for question (1) is <u>no,</u> have you participated in projects or studies related to solid waste management?
    a. Yes
    b. No

3. Who do you consider as appropriate stakeholders for the planning and managing of collection, transportation and segregation of MSW in Kuwait?
    a. Municipality of Kuwait – Department of Environmental Affairs
    b. Municipality of Kuwait – Department of Public Cleansing
    c. Environmental Public Authority (EPA)
    d. Ministry of Public Work
    e. Ministry of Electricity and Water
    f. Others, please specify….

4. Who do you consider as appropriate stakeholders for the planning and managing of treatment and disposal of MSW in Kuwait?
    a. Municipality of Kuwait – Department of Environmental Affairs
    b. Municipality of Kuwait – Department of Public Cleansing
    c. Environmental Public Authority (EPA)
    d. Ministry of Public Works
    e. Ministry of Electricity and Water
    f. Others, please specify…

5. What are the current municipal solid waste management practices in Kuwait? (Circle all that apply)
    a. Dumping
    b. Landfill
    c. Composting
    d. Recycling
    e. Incineration
    f. Others, please specify………….

6. Please, comment on the importance of the contributions of the current waste management practices in the State of Kuwait.

		Important	Not important	No opinion
A	Promote resource recovery*			
B	Reduce GHGs** emissions (e.g. CO_2, CH_4) that are produced from landfills			
C	Prevent leachate penetration into soil and groundwater			
D	Promote recycling			
E	Promote waste minimization/reduction			

* Resource recovery is the selective separation of disposed materials for an alternative and specific next use, such as reuse, recycling, composting or energy generation.

**GHGs: Greenhouse gases

7. Please comment on the importance of the current contribution of the responsible institutions (e.g.: Municipality of Kuwait) to offer the following facilities:

		Important	Not important	No opinion
A	Municipal waste collection and transportation			
B	Source separation of waste (e.g. separate waste from household, schools, offices …)			
C	Methods to collect data for sources of waste generation			
D	Methods to collect data for quantities of waste being generated			
E	Methods to collect data for composition of waste being generated			

8. Are there any waste management-related issues that you consider to be an important problems or obstacles? Choose according to the following criteria.

		Important	Not important	No opinion
A	Illegal dumping			
B	Limited knowledge on the advanced technological solutions			
C	Limited economic resources			
D	Limited facilities including technologies (e.g. recycling facilities, lack of landfill area)			
E	Lack of coordination among relevant authorities: national authorities, local authorities and other sectors in terms of the formulation of the policy measures			
F	Lack of coordination between responsible authorities for solid waste management			
G	Lack of national policy			
H	Ineffective national policy			
I	Lack of regulations			
J	Ineffective regulation			
K	Lack of laws			
L	Ineffective laws			
M	Lack of strategy strategy/Unclear strategy			
N	Ineffective strategy			
O	Ineffective administration			
P	Ineffective monitoring program			
Q	Lack of statistical data			
R	Indicate role for private sector			
S	Un-supportive public participation			
T	Lack of appropriate curriculum in the schools			
U	Others, please specify…….			

Note: The "informal sector" in solid waste management refers to "individuals and private sector (micro-) enterprises working in waste management services and whose activities are neither organized, sponsored, financed, contracted, managed, nor reported upon by the formal solid waste authorities".

9. What role (if any) does the informal sector play in the field of reuse and recycling of municipal wastes?
    a. Waste collection
    b. Waste separation
    c. Reuse 40.6%
    d. Recycling
    e. Others, please specify……

10. Do you promote informal sector reuse and recycling activities? Why or why not? a. Yes
    b. No

11. In your opinion, what is the role of data collection and accuracy in planning for integrated sustainable solid waste management in Kuwait that you are aware of?

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12. Are there any current plans or programs to modify the waste segregation (such as blue bins for recyclable materials), collection and transportation for MSW management? a. Yes
    b. No
    c. Don't know

13. If yes is the answer to (q.12), what are the methods proposed to implement the new plans of waste segregation, collection and transportation? (circle all that apply)
    d. Communal containers for different types of waste (e.g. Metals, plastic, papers) 56.4%
    e. Blue bins for recyclable waste
    f. Green bins for organic waste
    g. New trucks prepared for different types of waste
    h. Material recovery facility (MRF)
    i. Other, please specify…

Note: (A) Integrated sustainable waste management (ISWM) recognizes three critical factors: (1) stakeholders, (2) elements of the waste system (3) sustainable development in the planning of integrated solutions for the handling and disposal of waste. Integrated sustainable solid waste management takes a holistic approach in examining waste material from beginning to end, including resource recovery, waste prevention or minimization, in addition to the various waste collection and treatment options finally ending with the environmentally responsible disposal of waste.

(B) Integrated sustainable solid waste management-related approaches aim to represent the solid waste management elements in a combination of several stages, being part of a solid waste management system that is integrated and supplements the existing system or new system plan according to local waste management priorities of resource recovery, waste prevention or minimization, reuse, recycling or any other form of resource recovery.

14. Has the Municipality of Kuwait latterly adopted any integrated sustainable solid waste management related approaches for MSW management? (If any, choose all that apply).
    a. Resource management
    b. Waste minimization/prevention
    c. Zero-waste[C]
    d. Energy-from-waste
    e. Material recovery facility (MRF)
    f. Other, specify
    g. Not applied
    h. Don't know

15. Do you promote implementing waste-to-energy or not (e.g. Anaerobic digestion or thermal treatment) as an option for MSW management in Kuwait? Please, specify reasons.

    ----

16. In your opinion, which technology do you think is suitable for Kuwait to move toward sustainable solid waste management? Why?
    a. Anaerobic digestion (AD)
    b. Thermal treatment
    c. MRF (material recovery facility) then AD
    d. MRF then thermal treatment
    e. Composting
    f. Other, please specify
    g. Don't know

17. For MSW management in Kuwait, do the responsible institutions (Municipality of Kuwait and EPA) follow any environmental national and/or local guidelines, regulations and policies? Please specify.
    a. National policy
    b. Strategy
    c. Laws
    d. Regulations
    e. Local guidelines

Note C: The zero-waste approach is considered a holistic approach that encompasses the entire life cycle of a product, from the raw material stage to the final disposal of the product (Zaman 2014).

18. If applied, what are the goals of the recent adopted policy for MSW management in Kuwait? (check all that apply)
    a. Promote resource recovery
    b. Promote recycling
    c. Zero-waste to landfill
    d. Reduce air emissions
    e. Promote renewable energy
    f. Implement economic instruments to enforce the environmental strategy
    g. Promote environmental education
    h. Promote public participation
    i. Other, please specify…….

19. Who is responsible for the establishment and implementation of the solid waste management strategy? (check all that apply)
    a. Municipality of Kuwait
    b. Environmental Public Authority (EPA)
    c. University of Kuwait
    d. KISR- Kuwait Institute for Scientific research
    e. Ministry of Public Work
    f. Ministry of Finance
    g. Industrial Bank of Kuwait
    h. Other, please specify…

20. Who typically assists the responsible institutions to formulate the strategy of MSW management in Kuwait? (choose all that apply)
    a. International commitments (e.g. Kyoto Protocol, Basel Convention)
    b. International institutions (e.g. US EPA, The World Bank)
    c. Local research institutions (e.g. KISR)
    d. Local educational institutions (e.g. Kuwait University)
    e. International research institutions
    f. Local industrial institutions
    g. Civil societies
    h. Consulting institutions
    i. Others, please specify…

21. In what ways does the environmental institution monitor the implementation of the strategy?
    f. Annual performance report
    g. Quarterly performance report
    h. Use of performance indicators
    i. Others, please specify………

22. Do the responsible institutions apply periodic monitoring, revision and remediation to the strategy being followed?
    a. Yes
    b. No
    c. Don't know
23. If the answer to (q.22) is yes, what time period does the strategy (long term planning) of MSW management in Kuwait cover?
    a. Annual
    b. Every two years
    c. Every five years
    d. Other, please specify…

24. Please comment on the relative importance of the current contribution of the following factors to support planning for integrated sustainable municipal solid waste management in the State of Kuwait:

		Exist: Yes/NO	important	Not important	No opinion
1	Existing laws and regulations to support the implementation of the national environmental policy				
2	Economic instruments such as taxes or fines when implementing the municipal solid waste management strategy				
3	Integration of the sustainable development dimensions for the planning of a sustainable MSW management system				
4	Implementing a strategic environmental assessment (SEA)[D] tool to monitor the consequences of policies, strategies, plans and programs				
5	Environmental court to support the implementation of the solid waste management policy, regulations and strategy				

25. If applied, in your opinion, which economic instruments are the most effective to promote the implementation of the current adopted solid waste management policy?
    a. Public taxation
    b. Industrial taxation
    c. Commercial taxation
    d. Economic charges/fines
    e. Extended Producer responsibility (EPR)[E]
    f. User fees
    g. Other, please specify……..

Note D: Strategic environmental assessment (ESA) is a procedural tool used for site-specific procedural analysis, and is used for plans, policies, programs and projects at the beginning of a decision-making process (Finnveden, 2007).

Note E: "Extended producer responsibility (EPR) is defined as an environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle (OECD, 2001). The key feature of EPR is a refocus on sustainable production of products with the shifting of responsibility for the treatment or disposal of post-consumer products from the government and consumers to the producer (economically and physically) and shifting towards environmentally friendly product designs" (Agamuthu 2011).

26. What types of funding are used to establish MSW facilities?
    a. Tax
    b. BOT (Build-operate-transfer) system
    c. Energy-from-waste revenues
    d. Governmental subsidies
    e. Governmental loans
    f. Other, please specify…….

27. Please comment on the importance of the following criteria which could serve to motivate the establishment of MSW management facilities in the State of Kuwait:

No.	criteria which could serve to motivate the establishment of MSW management facilities	Important	Not important	No opinion
1	Adapting the target of zero-waste (Little amount of refuse)			
2	Reducing and controlling the environmental impacts of unsanitary landfills			
3	Reducing GHGs (Greenhouse gases) emissions			
4	Looking for solutions for lack of landfills			
5	Promoting the national perspective of renewable energy resources			
6	Preventing informal waste separation and promote small enterprises			
7	Enhancing the role of Kuwait in the international commitments for reduction GHGs			
8	Promoting the sustainable development projects in Kuwait			
9	Selecting a project on the basis of lowest initial cost			
10	Selecting a project which provides best revenues			
11	Selecting a project which provides labor opportunities			
12	Promoting private sector involvement			
13	Increasing the public awareness of natural and resource management			

Note: Decentralized management involves decentralization of authority from national governments to local levels. Here, institutional accountability is higher, and attention can be specifically paid to local problems (USAID, 2006).

28. In your opinion, do you agree/disagree with the suggestion of decentralizing MSW management in Kuwait from one central governmental authority to local provincial levels? Why?
    - Agree
    - Disagree

29. In your opinion, do you agree/disagree with the suggestion of decentralizing MSW management facilities in Kuwait from one central governmental authority to local provincial levels? Why?
    - Agree
    - Disagree

30. Please, add comments to questions 27 and 28.

31. Please comment on the importance of the following criteria to support the planning for integrated sustainable MSW management (ISMSWM) in the State of Kuwait?

NO.	Criteria to support the planning for ISMSWM	Important	Not important	No opinion
1	Collaboration and integration of stakeholders			
2	Starting with local communities, civil societies, and employees to develop a plan or project that can be reviewed and assessed by higher levels of decision-makers			
3	Public participation in waste separation and collection			
4	Training programs for the public to participate in waste separation programs			
5	Public consultation			
6	Inclusion of environmental aspects and waste management specific topics in the education curriculum at different educational levels			
7	Advertisement and media			
8	Social communication media (e.g.: twitter, Facebook…)			

32. Which of the following do you consider as appropriate methods and tools for communicating between the different stakeholders? (choose all that apply)
    a. Establishment of collaborative committees
    b. The periodic meeting of collaborative committees
    c. Communication through official letters
    d. Cellphone
    e. Internet (web page, Facebook.tc.)
    f. Others, please specify…………...

Householders' Questionnaire

Note: This questionnaire is only intended for academic purposes. The responses you give will be protected and will be kept confidential. At the end of the research program, the questionnaire will be destroyed.

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1. Are you:
    a. Male
    b. Female

2. Are you between the ages of?
    a. 18-29
    b. 30-39
    c. 40-49
    d. 50 and over

3. Are you the property owner?
    a. Yes
    b. No

4. The building functions as:
    a. Home
    b. Business
    c. Both

5. How many people currently live in the house?
    a. 2-3
    b. 4-6
    c. 7-8
    d. 8-10
    e. 10 and over

6. What is your highest level of education?
    a. Primary elementary
    b. Secondary/technical vocation
    c. High school
    d. University
    e. Higher education

7. Knowing that the natural environment is everything around you (land, air, water…), are you concerned about the current state of the natural environment in Kuwait? a. Yes
   b. No
   c. Do not know

8. What do you personally think about the following issues currently affecting the natural environment in Kuwait?

	Factors affecting the natural environment in Kuwait	Important	Not important	No opinion
1	Air emissions from automobile exhaust			
	Air pollution emissions from Factories			
2	Air emission from petrochemical industry			
3	Household waste			
4	Hazardous solid wastes like chemicals, waste from industries, and medical waste from hospitals and medical centers/institutions			
5	Desertification			
6	Poor public behavior such as littering, graffiti			
7	Other, please specify			

9. Please specify how your household deal with the following types of waste to get rid of them from your house

Types of Garbage	Garbage Truck	Recycle	Reuse	Compost	Other *(Specify)*
Food waste					
Yard waste/trimmings					
Paper/cardboard					
Plastic					
Metals					
Glass					
Large items such as:					
• Used appliances					
• Used furniture					
Used clothes					
Other items, please specify					

10. Are residents or servants of this house responsible for taking out the waste?
    a. Residents
    b. Servants
    c. Both
11. If you sell waste, to whom would you sell it to?
    a. An individual who comes to my door to collect it
    b. A business that comes to my door to collect it
    c. Other, specify

12. How do you rate the current waste collection service?
    a. Excellent
    b. Good
    c. Regular
    d. Bad

13. If the answer is a, b or c, what do you like about the current waste collection system? a. Easy to use
    b. Streets are clean
    c. Municipal trucks are collecting waste daily
    d. Free of charge
    e. Other, please specify

14. If the answer for q12 is d, what do you dislike about the current waste collection system?
    a. Sometimes the container is full and/or overfilled
    b. The container capacity is too small to share with the neighbors
    c. The plastic bags look awful in the street
    d. Recyclable materials are not separated
    e. Bad odour, and/or flies near the container
    f. Cats pull waste out of the container and make a mess around them
    g. People make a mess around the containers, do not use the container correctly
    h. The container blocks the parking spot in my building
    i. I do not like the container in front of my house, it shows a bad view
    j. Other, please specify……

15. What do you think could be improved with the current waste collection system?
    a. Apply fees to waste collection and transportation
    b. provide fees to force people to separate wastes
    c. More containers in the area
    d. People should use the container correctly
    e. No need for containers, plastic bags are enough
    f. Increase the efforts to promote the public education about recycling
    g. Offer training courses for the public about separating wastes

h. Involve the media and advertisements in the announcement for the waste separation systems benefits/tools/process.
i. Provide better equipment (trucks) for waste separation
j. Other, please specify…

16. If you have a complaint or suggestions about waste containers, waste collection or the waste management system in general, whom would you discuss your concerns with?
    a. My local political representative
    b. The municipal waste collectors
    c. The municipality
    d. The environmental public authority (EPA)
    e. My neighbourhood board
    f. Other, please specify…….
    g. No one

17. To the following 6 questions, please inform me how concerned you are*:

	Concerned	Not concerned	No opinion	Comment
1. "How concerned are you about garbage-related health risks?" (Post 2007, p.149)				
2. How concerned are you about water pollution due to illegal dumps?				
3. "How concerned are you about the depletion of natural resources that are used to produce the various commercial products we consume?" (Post 2007, p.150)				
4. How concerned are you about litter?				
5. "How concerned are you about illegal dumping in landfills?" (Post 2007, p.150)				
6. How concerned are you about including the environmental aspects of solid waste management in the education curriculum?				

Note: The references presented in the householders' questionnaire was not included while distributing the questionnaire forms during the research period.

18. Please, to the following 15 questions, answer with either: yes, no, or don’t know and add comments as you required.

	Yes	No	Don’t know	Comment
1. Have you ever known about composting? (Post 2007, p.149)				
2. Have you ever known about recycling? (Post 2007, p149)				
3. “Would you be willing to participate in a program to separate various waste materials into specific separate bags for collection purposes?” (Thirumarpan 2016)				
4. Would you like to participate if every house were offered a bin for recyclable materials?				
5. If two or more containers were put in your neighborhood, one for only paper, and one for only glass, plastic and metal, would you separate out these wastes in your home and put the separated materials into these containers?				
6. “Would you prefer to participate in a program for composting food and yard waste?” (Post 2007, p. 149)				
7. If every house were offered a green bin for organic material and the remaining waste was to be placed into plastic bags, would you participate?				
8. “If you were paid for each plastic bottle that you returned to the grocery store, would you participate in a program to collect and return plastic bottles?” (Post 2007, p. 150)				
9. “Would you be willing to buy reusable (fewer throwaway) products to help reduce your amount of generated garbage - if an alternative product is available?” (Post 2007, p.149)				
10. Would you prefer to have more information about what and how you can reduce, reuse, recycle and compost your amount of generated garbage?				

11. Would you promote enforcing taxes to implement new solid waste management services (e.g. Anaerobic digestion, thermal treatment, composting) in order to protect land, soil, underground water, reduce air pollution emissions, support resource management and renewable energy?				
12. Would you promote enforcing fines for illegal practices of solid waste disposal in your community?				
13. Are you willing to report illegal practices of solid waste disposal in your community?				
14. Would you like to participate in a committee to discuss environmental problems in general and solid waste management in particular in your local community which would make it easier to communicate with the government to explain the related public perspectives?				
15. Do you think such committees will be useful to solve problems?				

Appendix C

Key informant interviews:
Questions

The key informant interview questions are part of the data collection methods in phase 1 of the research framework. The participants of the interviews will be employers who work in MSW management projects in the Municipality of Kuwait and the Environment Public Authority (EPA). These questions will follow general themes that will be modified and added to as information is revealed. The interviews will be semi-structured interviews. The aim of these interviews is to gain a general overview about the current situation and challenges being faced by MSW management in Kuwait.

1. What are the current practices of MSW management in Kuwait?
2. The current properties of landfills, are they sanitary landfills designed to prevent air emissions and collect leachate so as to prevent it from penetrating through soil and contaminating local groundwater?
3. What are the main challenges being faced by MSW management in Kuwait?
4. Are you aware of new national policy to mandate the current practices of MSW management in Kuwait to move toward integrated sustainable MSW management in Kuwait?

If the answer is yes,

5. What are the objectives of the adopted policy?
6. Are you following a strategy while implementing the current policy?
7. Are you following any guidelines, regulations or laws to support the implementation of the strategy?
8. How do you measure success?
9. Are there any enforcement mechanisms in place to ensure compliance with policy?
10. What are the main challenges being faced with planning for integrated sustainable MSW management?
11. Do you think there is a need for collaboration and integration of stakeholders' needs when planning and making decisions about MSW management?

12. Do you think there is a need to incorporate the public in the planning and decision-making regarding municipal solid waste management?
13. Finally, is there anything you would like to add?

Appendix D

Kuwait Environmental Requirements and Standards

Kuwait Al Youm, Appendix of Issue No. 533 – Year 47 Tuesday, 2/10/2001 15

Chapter IV
Management of Household, Hazardous, Healthcare and Sludge Wastes
First: Management of Household and Hazardous Wastes
Article (19)

The following expressions shall have the meanings as explained against respective terms:

Household wastes: Means any wastes resulting from the household use (Houses include hotels and entertainment utilities) as long no hazardous wastes are included therein.

Hazardous wastes: Means any wastes posing potential direct hazards to man or animal's health or the environment in general, resulting from industrial, commercial and agricultural activities and from the household wastes, which are identifiable by any of the discipliners stated in appendix (11-1) and classified in appendix (11-2) hereof and, thus, require carrying out the toxicity tests, analyzing the waste filtrate to check the permissible limits stated in appendix (11-3) hereof.

Treatment: Is any method or technique used to change the physical, chemical, biological properties of the wastes, handle the wastes, make use of the materials or energy therein, change the hazardous wastes to non or less hazardous wastes for safer transportation, storage or disposal thereof.

Disposal dump: Means or utility used to dispose of wastes in environment friendly methods such as storing, treatment, or the due disposal of hazardous wastes.

Generator: Means any such person who generates or becomes the main cause for the production thereof or who possesses the same.

Identification Number: It is the number specified by the Environment Public Authority for each product, transporter or storage, treatment or disposal utility of hazardous wastes.

Incinerator: Any such closed set used to incinerate by controlled flames in order to destroy wastes, provided the main aim of the incineration process is to not make use heat energy as boilers, or minimize or restore the resulting materials, such as the industrial furnaces.

Backfilling (Dumping): Means wastes disposal by use of an engineering method, digging the wastes in or over the ground, provided it is not ground storage dump or treatment utility. Kuwait Al Youm, Appendix of Issue No. 533 – Year 47 Tuesday, 2/10/2001 16

Transporter (Carrier): is the person licensed to transport wastes.

Article (20)

Selection of household wastes dump shall consider the following requirements:

(1) The dumpsite shall be at least five kilometers away from residential areas and be selected upon well-known scientific basics, which consider the geological and hydrological properties as well as the climatic factors and the various human activities.

(2) The dumping site shall be far from such areas of economic value; agriculture and mineral or unique material environments areas such as protectorates of unique animal or plant life, pastures, rain water catchments or course.

(3) The site shall be in a dry and hot weather places in which evaporation rates exceed rainfall rates. The common wind direction shall be away from residential blocks or streets.

(4) The space between filling up site and the nearest subterranean water borehole in the region shall be minimum 2 km. The location shall be in a direction opposite to that of the region subterranean water stream.

(5) The site shall be place and free of ups and downs. The soil shall be argillaceous and not sandy. Soil permeability must not exceed 10-^{7} cm/second. The area must be free of any earth cracks or any other various natural phenomena. In addition, the site must be close to water source and soil strata used in daily coverage.

Article (21)

Backfilling site design shall have the following conditions:

(1) The site must be specified and connected to specified and paved ways that are connected with the main road. Traffic and guidance signs that determine the entry and the way out of the area.

(2) The site shall be enclosed with an iron fence in minimum height of 2 meters. The same must be provided with a main gate for car entry, with a carload scales to weight every car entering into the location.

(3) The backfilling hole volume in the site regarding height, width and depth, shall be sufficient for minimum 15 years use. The hole walls shall be sloping to insure that it will not collapse. Some compressed materials that fix the walls shall be used. The height between the bottom of the hole and subterranean water shall be minimum 10 m.

(4) The site shall be designed in accordance with engineering and environmental requirements. Followed in preparing wastes backfilling locations. These include the following:

a) Site backfilling holes must be padded with unpenetrating covering or insulating layer of natural soil such as compressed soil strata. Thereof permeability must not exceed 107cm/sec.
b) The site shall be provided with accumulating and bypassing systems of gases resulting from bacterial dissolution.
c) The site shall be provided with a system for bypassing water accumulated in the bottom of backfilling holes.
d) The site shall be provided with surface drainage system to direct rain and floodwater away from the site.
e) The site shall be provided with a sewerage system. The same shall be consisted of a layer of pebbles directly under the surface layer. Therefore, thickness must be minimum 30 cm. and thereof. Permeability must be minimum 10-3cm/ sec. Thereof shall be a plastic pipe network, which contains holes and ends in catchments.

f) Monitoring points around the site, shall be installed to watch the leakage and spread of gases generated in wastes back filling sites. In addition, wastes must be dug in order to insure subtrainean water validity.
g) The site shall be provided with a station for washing car tires after discharging its load and before leaving the site.

Article (22)

On operating the site the following shall be observed:
(1) Separating materials apt to biotic dissolution from other wastes and not to bury then in the backfilling site.

(2) The site shall be operated in a way that forms no danger on the citizens' or workmen's health, besides following a method that depends on spreading the wastes in the form of layers and mashing them with heavy machines. They shall be separated with layers of isolating material such as sand or Gutch (low penetration materials).

(3) Materials shall be buried in cells separated by a layer of medium size stones which has a vertical pipe with side holes penetrating it to facilitate gas escape. The same shall be connected to the generated gas bypass system.

(4) Prohibiting any use of the site for house wastes burial to get rid of any kind of dangerous wastes, bury any kind of wastes, or to follow a random burning method in the site under any circumstances. Moreover, he must continually struggle the spread of insect, rodents and lost animals at the site in cooperation with the concerned authorities.

(5) The burial site shall be covered after daily burial with a soil layer, the thickness of which must not be less than 25 cm. and permeability of which must not be less than 10 cm/second). It shall be showered with water to fix it along with rolling it with equipment available at the site.

(6) The dumping site shall be covered after the end of the period determined for its use with a soil layer, the thickness of which shall not be less than 60 cm. and the penetration of which shall be not more than (10 cm/second). The cover final sliding degree shall be between (6-10 degrees) to bypass rainwater to sanitary drainage system in order to prohibit the wearing away of the site surface layer if not planted.

(7) The special information form shown in Appendix No. (11-4) of this regulation shall be kept.

Article (23)

All precautions and means necessary for the safety and health of site workers shall be provided in the dumping site in accordance with what is stipulated in laws and regulations in effect.

Article (24)

A license from competent authorities shall be obtained in order to collect and transfer wastes. This license shall be issued after confirming that all conditions of such wastes transfer safety are available in a way that does not affect public health, environment or natural sources.

Article (26)

The generator (source) of any of the dangerous wastes provided in the two Appendixes (11-1), (11-2) of this regulation shall obtain their identification number from Environment Public Authority.

The generator should comply with the following stipulations:

(1) These wastes production rate shall be reduced in quantity and quality by developing the used technology; following clean technology and choosing alternatives of the product or raw materials that are less dangerous on environment and public health.

(2) Wastes shall not be transferred outside the site unless after the approval of Environment Public Authority. Temporary storage in an environment friendly way shall be observed. Any authority that produces dangerous wastes due to its activity must not deal with any waste carriers or storage, treatment or elimination sites, which do not have identification number from Environment Public Authority and necessary licenses from concerned authorities.

(3) Wastes shall be transferred to special sites determined by concerned authorities in the state.

Article (27)

In selecting the dangerous wastes disposal site following stipulation must be observed:

(1) The site shall be remote from residential areas in a sufficient distance. It shall be managed in a way that creates not danger on citizens' or workmen's health. The site shall be provided with good streets and public services such as electricity and water. In addition, it shall be near the dangerous waste generation areas. Materials of daily filling up and covering, such as soil strata …etc. shall be available near to the site. The site expiry date shall be 20 years minimum.

(2) The distance between the dangerous waste disposal sites and the nearest subterranean water borehole shall not be less than 2 km. The area shall be free from any agricultural activities and shall not be of unique nature that makes it suitable for human usage, such as if it contains some rare or perishing animals and plants. The filling up site shall be flat and free of any ups and downs. The soil shall be argillaceous and not sandy.

Soil penetration must not exceed 10 cm/second. The area must be free of any earth cracks and remote from earthquakes, flowages and floods areas. The length between bottom of the hole and subterranean water must not be less than 10 meters.

(3) It is necessary to install some monitoring points around the site to watch gas leakage probability in a horizontal way. It is also necessary to install a watching system on the generated gases, as well as to dig some wastes and prepare monthly report of results to be submitted to the competent authorities.

Article (28)

In designing dangerous wastes disposal site the following points must be observed:

(1) A network of streets shall be provided to facilitate transportation and circulation of wastes inside and outside the site.

(2) The burial whole volume in the site, as for length, width and depth shall be sufficient to be used for 20 years maximum. The whole walls shall be side sloping from (1-3) and fixed to ensure it will not collapse.

(3) The hole walls and bottom shall be covered with a coating resistant to liquid leakage into subterranean water, bacteria, heat and sudden cracks. The coating material thickness and quality must be according to the nature of wastes that are filled with and subterranean water depth.

(4) The site shall be provided with a drainage system to divert rain and flood water away from the site. Subsystem shall consist of a layer of pebbles put directly under the surface layer and its thickness must not be less than 30 cm. and its penetration must not be less than (10 cm. / second). There shall be a plastic pipes network, which contains holes and ends in a corchment.

(5) The site shall be provided with a drainage system to bypass accumulated water in the bottom of backfilling hole. Therefore, the site ground must be sloping and provided with plastic pipes with side holes that transfers filtered liquids into a special hole where such liquids are bypassed and treated if the filtering materials concentration exceeded the limits allowed in Appendix (11-3). Then they are disposed after being treated in a secure way, in condition that the system shall contain one or two layers.

(6) The site shall be provided with an incinerator to get rid of wastes to be burnt and provide different planets special for treatment of semi solid wastes, such as oil, sludge and some chemicals before burning them, so as to remove water and oil from them.

Article (29)

The owner or user of the dangerous waste disposal site shall comply to the following:

(1) To obtain a license from concerned authorities after the consent of Environment Public Authority. This shall be before constructing and operating dangerous wastes disposal site and the site shall follow the ways of disposal provided in Appendix No. (11-5) of this regulation.

(2) To verify, on receiving hazardous wastes, that their identification number, certified transfer document and security data form of the freight are available. Each waste freight shall be checked before receiving it to ensure that it conforms to stipulations provided in transfer document attached. (3) The site shall be operated in a way that creates no danger on the residents and worker's health. The owner or the user shall not follow random burial method and to follow waste separation and he shall not use the site to bury house garbage or random burning in it under any circumstances. In addition, he shall check the spread of insects, rodents and lost animals in cooperation with concerned authorities.

(4) He shall take all necessary precautions in transportation and circulation of barrels at the site to avoid leakage of its contents. It important to treat dangerous wastes such acids and alkalis before burial and to separate liquid dangerous wastes from other liquids in burial, as well as to define special places to bury liquid wastes and others to bury solid wastes.

(5) Wastes transportation and burial data form provided in the appendix No. (11-6) of this stipulation shall be filled. The data of this form shall be written down in a record special for the site.

(6) It is necessary to provide suitable means and equipment to maintain security and health of site workers and to train them on suitable work methods as well as to put an emergency plan to face risks if its necessary.

(7) He shall maintain a special record that includes the following data:

a) A description of each dangerous waste group delivered and its quantity, quality as well as method and date of its storage, treatment or disposal, besides the place and quality of each dangerous waste at the site.
b) Search results and periodical supervision reports data of air quality, subterranean water and cases of emergency.
c) Copies of waste transportation documents and reports related to them as well as all wastes security data.

(8) An annual report introduces Environment Public Authority about wastes activities, which includes:

a) The name and address of the site and Environment Public Authority site identification number and the period that the report covers.
b) Identification numbers of the site from which wastes were received.
c) The description and quality of each amount of dangerous wastes received from each generator separately.
d) Method of storage, treatment or disposal of dangerous wastes.

Appendix E

In the field of waste management, section (3-5-3) of the Environmental Strategy of the State of Kuwait is related to the field of hazardous, medical and solid waste management. The main suggested measures are (EPA, 2002):

- Preparing and implementing plans for organized data collection concerning the source, type and production rates of these wastes.
- Preparing a national action plan that encourages campaigns to increase environmental awareness and encourage people to decrease product consumption, decrease waste production and start waste segregation at source.
- Encouraging the private sector to invest in the field of waste management.
- Preparing and issuing legislation and regulations for waste management and disposal that include all necessary measures for minimizing waste generation, packaging techniques and temporary storage and transporting to disposal sites.
-

The general causes of problems in the environmental health sector, and specifically in the field of hazardous, medical and solid waste management were discussed in the same issue of the Environmental Strategy of the State of Kuwait (EPA, 2002). These causes are summarized in the appendix (EPA, 2002):

1. The continuous increase in the production of large quantities of solid waste due to an increase in population and the implementation of ambitious development plans, especially with the continuing high per capita consumption patterns in Kuwait, which are considered of the highest in the world.
2. Absence in continuous awareness programmes through media, newspapers, radio, and TV, directed to all citizens and other groups to encourage minimizing the generation of solid waste and encouraging segregation of waste at source.
3. Kuwait Municipality, which is responsible for management of solid waste in Kuwait, does not provide the necessary tools and machineries at the various locations (i.e.

houses, industrial and commercial facilities), to allow for waste segregation for recycling and reuse.

4. The total dependence on landfills as an option for municipal and construction solid waste disposal and incinerators for the disposal of medical waste. Also, the absence of legislation and regulations among the authorities concerned with hazardous, medical and solid waste management, including the EPA, to monitor and properly dispose of such wastes in an environmentally suitable manner.
5. Insufficient manpower and financial capabilities present within authorities concerned with waste management and monitoring.
6. The continuing increase in technological and industrial development leads to an increase in the quantity and types of waste generated with the absence of certain data regarding the production rates and types of produced solid wastes.
7. The absence of using economic mechanisms, such as incentives, penalties, and taxes to preserve environmental health and to prevent violations.
8. Insufficient role of society and public participation.
9. Disorder of authority and absence of team work in activities performed by authorities to protect the environment, such as the EPA, Ministry of Electricity and Water, Ministry of Public Works, Kuwait Municipality, the PAAFR.