AN INVESTIGATION OF MUNICIPAL SOLID WASTE MANAGEMENT DURING THE ARBA'EEN PILGRIMAGE IN KERBALA, IRAQ

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Declaration

The research reported in this thesis was conducted at Liverpool John Moores University, Faculty of Engineering and Technology, Department of Civil Engineering between August 2015 and January 2019. I hereby declare this thesis is the result of my own work and any quotation from, or description of the work of others is acknowledged herein by reference to the sources. This thesis has not been submitted for any degree at another university.

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Dedication

To my creator, Allah for bounties and blessing…

To my religious guides, the Prophet Muhammad and his sons for their grace and love…

To my father, the source of inspiration throughout my life …

To my kind-hearted mother for her unlimited love, inspiration, sacrifices and prayers for me during my life;

To my brothers and sisters for their help, support and encouragement …

To my sweetheart and beloved wife for her endless love, great patience, encouragement and personal support …

To my beloved children, Maryam, Jaafar and Malaak for their smiles and love that give me the energy to work …

I dedicate this work hoping that I made all of them proud …

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List of Publications

List of peer-reviewed published journal papers:

1. Muhammad Abdulredha, Patryk Kot, Rafid Al-Khaddar, David Jordan & Ali Abdulridha (2018) ***Investigating municipal solid waste management system performance during the Arba'een event in the city of Kerbala, Iraq.*** Environment, Development and Sustainability, 1-24. https://doi.org/10.1007/s10668-018-0256-2
2. Muhammad Abdulredha, Rafid Al-Khaddar, David Jordan, Patryk Kot, Ali Abdulridha & Khalid Hashim (2018) ***Estimating solid waste generation by hospitality industry during major festivals: A quantification model based on multiple regression.*** Waste Management, 77, 388-400. https://doi.org/10.1016/j.wasman.2018.04.025.
3. Muhammad Abdulredha, Rafid Al-Khaddar, David Jordan and Ali Alattabi (2017) ***Facing up to waste: How can hotel managers in Kerbala, Iraq, help the city deal with its waste problem?*** Procedia Engineering, 196, 771-778. https://doi.org/10.1016/j.proeng.2017.08.006.
4. Muhammad Abdulredha, Rafid Al-Khaddar, David Jordan & Khalid Hashim (2017) ***The development of a waste management system in Kerbala during major pilgrimage events: Determination of solid waste composition.*** Procedia Engineering, 196, 779-784. https://doi.org/10.1016/j.proeng.2017.08.007.

List of peer-reviewed published conference papers:

1. Muhammad Abdulredha, Rafid Al-Khaddar, Patryk Kot, David Jordan, & Ali Abdulridha (2018) ***Benchmarking of the current solid waste management system in Karbala, Iraq using wasteaware benchmark indicators.*** World Environmental and Water Resources Congress 2018, 40-48. https://ascelibrary.org/doi/10.1061/9780784481417.004.
2. Muhammad Abdulredha, Rafid AL khaddar, David Jordan, Ali Alattabi & Ali Alzeyadi (2017) ***Public participation in solid waste management during mega festivals: A pilot study.*** The 12th International Conference for Internet Technology and Secured Transactions (ICITST-2017), 38-41. https://www.orpems.org/Proceedings/ICITST-WorldCIS-WCICSS-WCST-2017.pdf.
3. Muhammad Abdulredha, Rafid Al-Khaddar & David Jordan (2017) ***Hoteliers' attitude towards solid waste source separation through mega festivals: A pilot***

study in Karbala. 3rd BUiD Annual Doctoral Research Conference 2017, Dubai, 13 May of Conference. http://www.buid.ac.ae/BDRC-2017.

List of oral and poster presentations at national and international conferences

1. Muhammad Abdulredha, Patryk Kot, Rafid Al-Khaddar & David Jordan (2018) ***Pilgrims' intention to participate in future solid waste recycling scheme in Kerbala city during AL-Arba'een.*** Liverpool John Moores University, Faculty Research Week, May 2018. Elevator Pitch Presentation.
2. Muhammad Abdulredha, Rafid Al-Khaddar, Patryk Kot, David Jordan & Ali Abdulridha (2018) ***Visitors' participation in solid waste recycling in Kerbala city during Ashura festival.*** Second International Conference for Science and Arts, University of Babylon, Iraq, March 2018, Oral Presentation.
3. Muhammad Abdulredha, Rafid Al-Khaddar, David Jordan, Brett Lempereur & Khalid Hashim (2017) ***Solid Waste Generation in Hotels of Kerbala City during Major Religious Events***. Edge Hill University, UK, April 2017, oral presentation.
4. Muhammad Abdulredha, Rafid Al-Khaddar & David Jordan (2017) ***Public involvement in solid waste management during mass gatherings: A pilot study in Kerbala.*** Liverpool John Moores University, Faculty Research Week, May 2017, Poster Presentation.
5. Muhammad Abdulredha, Rafid Al-Khaddar & David Jordan (2017) ***Solid waste generation from camps during major events: A pilot study in Kerbala***. Preserving the Architectural and Urban heritage of post-war Iraq, Nottingham Trent University, February 2017, oral presentation.
6. Muhammad Abdulredha, Rafid Al-Khaddar, David Jordan & Brett Lempereur (2016) ***Solid Waste Management in Kerbala City during Major Events.*** Liverpool John Moores University, Faculty Research Week, May 2016, Poster Presentation.

Abstract

Every year, religious events (REs) attended by millions of pilgrims, take place in different holy cities around the world. However, research on municipal solid waste management (MSWM) is limited despite the reputation of REs to generate large amounts of municipal solid waste (MSW), which negatively influences the environment and human health when poorly managed. The Arba'een is one of the largest REs in Iraq and worldwide that attracts more than 11 million pilgrims annually. A large quantity of MSW is produced during this event, which is poorly managed and disposed of in a dumpsite without any treatment, due to the lack of research and data about MSW generated during such events. Thus, this research aims to address part of this gap and contribute to new knowledge on MSWM at REs by studying the MSWM system applied at the Arba'een, a subject that has never been considered before. This study adopts mixed methods research approach, employing composition analysis for MSW, questionnaire surveys and interviews with the stakeholders (hoteliers, camp owners, pilgrims and MSWM authorities) and on-site observations as key methods for generation of data. The MSWM system was assessed based on the opinion of the key stakeholders and the Wasteaware benchmark indicators formwork. Numerical models were built to estimate the quantities of MSW produced by pilgrims' accommodation (hotels and camps) based on the characteristics of the accommodation (capacity, area etc.). MSWM services users' (hoteliers, camp owners and pilgrims) intention to participate in a recycling scheme and the variables influence this intention were studied with a view of investigating the possibility of introducing a recycling scheme at REs. The results showed that REs account for 14% of the city's MSW and its main components were organic (57.9%), paper (14.9%) and plastic (14.6%). The MSWM system suffers from operational and governance weaknesses; the key weaknesses are lack of controlled disposal facility, absence of a formal recycling scheme, deficit of key waste-related data, poor public involvement, inadequate planning, and funding limitations. Statistical analyses showed that average municipal solid waste generation (MSWG) from hotels and camps were 112 and 413kg.day^{-1}, respectively. Hotels' MSWG is influenced by their capacity, staff size and expenditure while camps' capacity, expenditure and food services affect its MSWG. MSWG from hotels and camps can be modelled with a coefficient of determination of about 0.80. In addition, more than 65% of MSWM system users are willing to participate in MSW recycling during REs and it is expected that about one third would perform recycling; this indicates that introducing MSW recycling during REs could be successful.

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List of Abbreviations

ANN	Artificial Neural Networks
CAG	Camp owner's Age Group
CC	Camp's Capacity
CE	Camp's Expenditures
CEL	Camp owner's Education Level
CFA	Camp's Floor Area
CFS	Camp's Food Services
CL	Camp's Location
CPRI	Compulsory Pilgrim's Recycling Intention
CRI	Camp owner's Recycling Intention
CRK	Camp owner's Recycling Knowledge
CSL	Camp owner's Satisfaction Level
CSOI	Central Statistical Organization in Iraq
CSS	Camp's Staff Size
CWCF	Camp's Waste Collection Frequency
DEFRA	Department of Environment food and Rural Affairs
DV	Dependent Variable
EPIA	Environmental Protection and Improvement Act
FMENCNS	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
GDP	Gross Domestic Product
GNI	Gross National Income
HAG	Hotelier's Age Group
HC	Hotel's Capacity
HE	Hotel's Expenditures
HEL	Hotelier's Education Level
HFA	Hotel's Floor Area
HL	Hotel's Location
HR	Hotel's Rating
HRI	Hotelier's Recycling Intention
HRK	Hotelier's Recycling Knowledge
HSA	Holy Shrines Authorities
HSL	Hotelier's Satisfaction Level
HSS	Hotel's Staff Size
HWCF	Hotel's Waste Collection Frequency
ID	Iraqi Dinar
IRS	Informal Recycling Sector

ISO	International Organisation for Standardisation
ISWM	Integrated Solid Waste Management
IVs	Independent Variables
KM	Kerbala Municipality (centre based institution)
KMs	Kerbala Municipalities (outskirt based institutions)
LR	Logistic Regression
MCHPM	Ministry of Construction and Housing and Public Municipalities
ME	Margin of Error
MLR	Multiple Linear Regression
MSW	Municipal Solid Waste
MSWG	Municipal Solid Waste Generation
MSWM	Municipal Solid Waste Management
NIC	National Investment Commission
NMPP	Number of Meals Per Pilgrim
NWBPP	Number of Water Bottles Per Pilgrim
OPRI	Optional Pilgrim's Recycling Intention
PAG	Pilgrim's Age Group
PDH	Pilgrim's Drinking Habits
PEH	Pilgrim's Eating Habits
PEL	Pilgrim's Education Level
PG	Pilgrim's Gender
PRK	Pilgrim's Recycling Knowledge
PSD	Pilgrim's Staying Duration
PSL	Pilgrim's Satisfaction Level
PWDB	Pilgrim's Waste Disposal Behaviour
REs	Religious Events
RI	Recycling Intention
SD	Standard Deviation
SE	Standard Error
SVM	Support Vector Machines
TTSs	Temporary Transfer Stations
UNEP	United Nations Environment Programme
USEPA	United States Environmental Protection Agency
VIF	Variance Inflation Factor
WRAP	Waste and Resources Action Programme

Nomenclature

A	The Population Size
B_i	Regression Coefficients
C	Sample True Proportion
D	The on-site density of the waste sample from each accommodation
ε	The Random Residual Error Coefficient.
kg	Kilogramme
km/h	Kilometre per hour
kt	Kilo Tonne
M	The Mass of solid waste produced at each accommodation
m^2	Squared metre
m^3	Cubic metre
N	Sample Size
n	Number of Independent variables
p	Statistical Significance
p^2	Pseudo Coefficient of Determination
$\hat{p}_i$	The Estimated Probability of the Response Variable
R^2	Coefficient of Determination
t^*	Student t Statistics Corresponding to the Desired Level of Confidence.
U	The Explanatory Variable
V	The total volume of solid waste produced at each accommodation
wt.%	Weight Percent
X	Actual Variable Score
X'	Transferred Variable Score
$\bar{X}$	Estimated Mean
Y	Sum of the Total Squared Difference Between the Mean and Observed Scores
Y'	Sum of the Total Squared Difference between the Mean and Predicted Scores
$\hat{Y}$	Predicted Value of the Response Variable
Z	The Abscissa of the Normal Curve that Cuts off an Area at the Tails

Chapter 1

Introduction

1.1 Research Background

Municipal solid waste management (MSWM) is becoming a challenging task for governments and has changed considerably over the past decades (Ghiani et al, 2014). It is no longer merely the process of collecting and disposing of municipal solid waste (MSW) in landfills, it also includes all activities that seek to reduce health and environmental impacts of MSW (Suthar and Singh, 2015). Scholars (Wilson et al, 2012) reported that MSWM is developing continuously, where MSW disposal in landfills is noticeably minimised and resources recovery increased. The adoption of developed MSWM technologies can reduce environmental damage, the quantity of MSW, resources depletion and management costs, as well as producing products from waste benefiting both the environment and the economy (Salhofer et al, 2007; Zheng et al, 2016). All of these can lead to an integrated solid waste management (ISWM) strategy which is followed in many developed countries (Koroneos and Nanaki, 2012). However, this is not the case in many developing countries, where MSW is collected and disposed of in landfills or open dumps without treatment or resource recovery (Alsebaei, 2014).

Many developing countries such as Egypt struggle to develop ISWM, citing deficit of funds, lack of accurate information about municipal solid waste generation (MSWG) and low public participation as their primary reasons (Challcharoenwattana and Pharino, 2016). An ISWM programme requires precise estimation of MSWG and active public involvement in implementing those policies (Farrelly and Tucker, 2014). Unfortunately, there is a lack of comprehensive data on MSWG in many developing countries due to insufficient funds and inadequate management (Azadi and Karimi-Jashni, 2016).

Iraq is considered as a developing country particularly in environmental terms (Narayan and Narayan, 2010). Iraq is faced with a growing issue of MSWM (Al-Anbari et al, 2014), where almost all cities in Iraq used landfilling as the main method of MSW treatment and disposal. There are 163 sites without environmental approvals (dump sites) and 73 sites with environmental approvals in the country (Central Statistical Organization Iraq, 2016a). Similarly, MSW generated in the city of Kerbala, where the majority of religious events (REs) occur, is collected and disposed of in the city landfill by MSWM authorities without treatment (Al-Anbari et al, 2014).

Kerbala city is one of the main holy cities in Iraq and the region because it contains the shrine of Imam Hussain and so it is a destination for millions of Muslims around the world (Mujtaba Husein, 2018). Each year, more than 11 million of the world's Muslims make the Arba'een pilgrimage to this holy shrine in Kerbala, making the Arba'een the world's largest annual gathering. Thus, this event management is more challenging than other REs (Alkafeel Global Network, 2016c).

MSW generated during the Arba'een is managed by Kerbala MSWM authorities. This has made MSWM in the Arba'een to be as poor as MSWM in Kerbala where all MSW produced is collected and disposed of in Kerbala's landfill without treatment. This means that, to date, an effective MSWM has not been considered during the Arba'een. Thus, this research focuses on assessing the current MSWM during the Arba'een, the possibility of estimating MSWG and the need to introduce recycling as an improvement alternative.

1.2 Kerbala City

Iraq covers an area of 438,310 km^2 (Al-Ansari and Knutsson, 2011). It is located in the south-western resign of Asia; surrounded by Iran from the east, Turkey to the north, Syria and Jordan to the west, Saudi Arabia and Kuwait to the south and the Gulf to the southeast. It was populated by 17.47 million in 1990; this had increased to 37.20 million in 2016 with an annual growth rate of 3.0% (The World Bank, 2018). It has 18 cities with an average population density of 85.7 people per square kilometre (The World Bank, 2018).

The city of Kerbala is located in the middle of Iraq, about 60 miles from the Iraqi capital, Baghdad (Figure 1.1). It covers an area of 5034 km^2, representing nearly 1.2% of the total area of Iraq. According to the Central Statistical Organization in Iraq, it has a population of 1,151,152, constituting about 3.2% of the total population of the country with a population density of 223 people per square kilometre (Central Statistical Organization Iraq, 2015a). The central area of Kerbala is called the old city of Kerbala, where the holy shrine is located (Al-Anbari et al, 2014).

Kerbala has smooth topographical features with a general elevation ranging between 30m-95m above sea level (Khalaf and Hassan, 2013). It experiences hot weather conditions in summers and cool in winter, with an average annual rainfall of approximately 85 mm (Central Statistical Organization Iraq, 2015a). The city contains several freshwater streams, one lake (Razzaza Lake) (Figure 1.1) and several groundwater reservoirs.

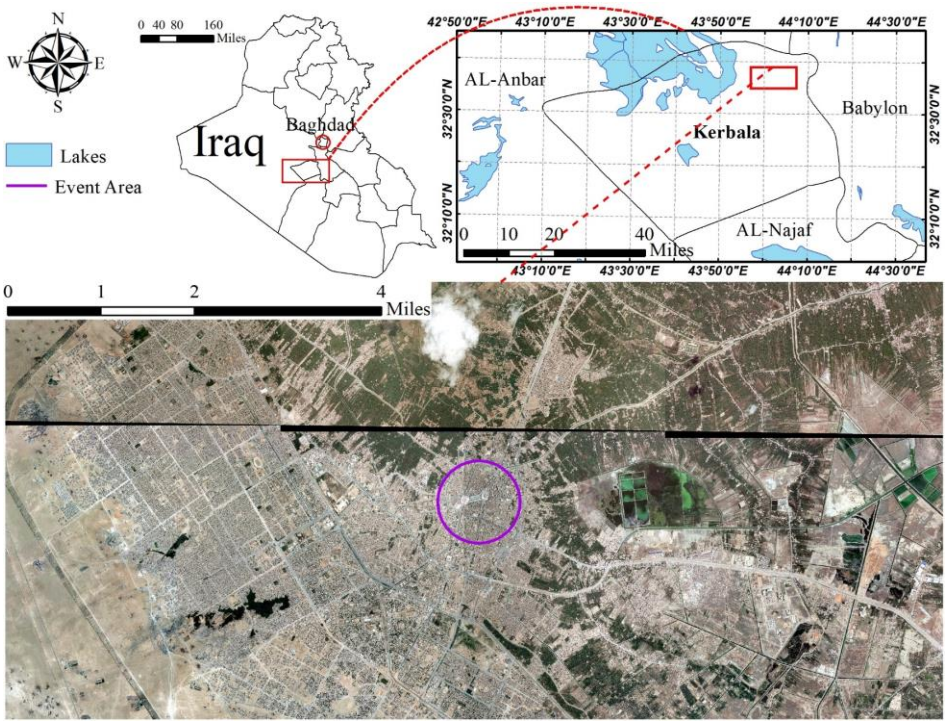

Figure 1.1: The geographical location of the city of Kerbala and the event area (Kerbala municipality, Iraq)

1.3 Large Religious Events

In Islam, millions of Muslims believe that after the demise of the Prophet Muhammad, a chain of twelve devout descendants was meant to succeed him, starting with his cousin Ali, known as Imams (Aghaie, 2005). Imams have been considered infallible religious guides for humanity, although not Prophets, (Mujtaba Husein, 2018). Many Muslims believe that devotion to Imams brings them closer to God. This belief in the distinct holiness of the Imams has generated the practice of visiting (pilgrimage) the places where the Imams are buried (Aghaie, 2005). The main pilgrimage destinations are Saudi Arabia (Medina), Iraq (Kerbala, Najaf, Baghdad and Salah Ad-Din) and Iran (Mashhad), as these cities house the shrines of the Imams (Mujtaba Husein, 2018).

Kerbala hosts the shrine of Imam Hussain bin Ali, the grandson of the Prophet Muhammad, who has exceptional virtues due to his sacrifices in the battle of Kerbala (680 CE), which is one of the most important and symbolic events in the Islamic history (Aghaie, 2005). Every year, millions of Muslims commemorate the 10th of Muharram (the first month of the Arabic calendar), known as 'Ashura', where Imam Hussain and his male companions were martyred (Mujtaba Husein, 2018). Forty days from then on, the 20 of Safar (the second Arabic month), Arba'een is observed. In remembrance of the battle of Kerbala, Muslims commemorate Ashura and Arba'een via various ritual practices in their places of residence.

Pilgrims visit Kerbala year round, where an almost constant number of 11 thousand pilgrims are visiting Kerbala each day (National Investment Commission Iraq, 2014). However, the special Arabic calendar dates that correspond to the most important time to visit Kerbala remain the Ashura and the Arba'een (Davidson and Gitlitz, 2002). There are no official statistics for the numbers of pilgrims attending large REs in Kerbala before 2016 (Alkafeel Global Network, 2016c). The Al-Abbas's Holy Shrine issued for the first time a report showing the numbers of pilgrims attending the Arba'een in 2016 (Alkafeel Global Network, 2016c). The Al-Abbas's Holy Shrine used to control cameras technology to count the pedestrians pilgrims entering Kerbala from three axes (Baghdad-Kerbala, Najaf-Kerbala and Babylon-Kerbala) over 13 days. Noting that the pilgrims entering Kerbala during the night, using all kinds of vehicles, entering from other two axes (Al-Hussayniya-Kerbala and Aid Tamr- Kerbala) and entering before running the counting system were excluded (Alkafeel Global Network, 2016c). The counting system showed that 11,210,367 pilgrims attended the Arba'een event over 13 days in 2016, making it the world's largest annual gathering in one place (Alkafeel Global Network, 2016c). Ashura, the second RE in Kerbala, lasts up to 8 days attracting up to 3.5 million pilgrims (Alkafeel Global Network, 2016b).

Pilgrims travel to reach Kerbala, adopting various modes of transportation even including walking on foot (Mujtaba Husein, 2018). Al-Modarresi (2014) reported that pilgrims who walk hundreds of miles from other Iraqi cities or cross the border from other countries, do not need to carry anything except their clothes. The sea of millions of pilgrims (Figure 1.2) walk beside thousands of camps (temporary tents and some built houses set up by local Iraqis and some charities) lining the pilgrims' paths and in Kerbala city which provide accommodation, fresh food and refreshment and all the needs of pilgrims, free of charge (Mujtaba Husein, 2018). There are more than 8,460 camps (Alkafeel Global Network, 2016a) and 667 hotels (Central Statistical Organization Iraq, 2016b) located within the administrative boundaries of Kerbala to meet the needs of arriving pilgrims. The large number of pilgrims attending REs generates enormous amounts of MSW, which severely impacts the local MSWM systems (Abdulredha, 2012).

Figure 1.2: Pilgrims walking to Kerbala passing through camps are generating MSW

1.4 **Problem Statement**

MSWM in Iraq, like many developing countries, comprises three phases that are generation and storage; collection and transportation; and disposal (Alnakeeb, 2007). Usually, citizens throw their daily waste into containers that are distributed either in the street (common system) or at each door (Elagroudy et al, 2011). The storage containers are emptied daily or twice a week by fleets of medium to large size collection trucks that are owned by municipalities, with a crew consisting of a driver that never leaves the truck and two workers who unload the containers (Elagroudy et al, 2011; Husham AbdMunaf, 2015). According to Elagroudy et al (2011), there is a significant deficiency in the number of bins distributed throughout the urban areas which has resulted in waste filling the bins and accumulating around on streets. Most of the collected MSW is transported and disposed of in unregulated landfills, with little concern about both the environment and human health (Alnajjar, 2016).

It is reported that more than 11 million tonnes of waste were collected by Iraqi municipalities in 2015 (Central Statistical Organization Iraq, 2016a). The same report shows

that about 32 thousand tonnes of waste were collected every day with an average generation rate of 1.5 kg per capita per day. All of this is directly transported and disposed of in uncontrolled landfills or open dumpsites. Fire outbreaks, surface water pollution, groundwater contamination and substantial greenhouse gas emissions have been the hallmarks of Iraqi landfills (Elagroudy et al, 2011). The MSWM problem is already severe in Iraq as MSWM infrastructures have not been able to keep pace with the amounts of MSW produced. It is common to find large piles of waste lying in a disorganised manner in large Iraqi cities (Elagroudy et al, 2011).

Last decade, Kerbala witnessed a significant increase in MSWG. According to Ali (2009), around 100 thousand tonnes of MSW were collected in Kerbala city in 2008. In comparison, the annually collected MSW was about 300 thousand tonnes in 2012 (Abdulredha, 2012). Then, Central Statistical Organization Iraq (2015a) reported an even higher increase in MSWG in 2014 reaching 560 thousand tonnes. These numbers show considerable growth of MSWG. In addition, information about the quantity of MSW, which is not collected, is not available. Accordingly, it can be said that the total amount of MSW produced in Kerbala is unknown.

Kerbala like other Iraqi cities faces similar problems of poor MSWM. MSWM activities in Kerbala consist of collection, transportation and disposal (Al-Anbari et al, 2014). This system can be considered as very basic where most of its cost is directed toward collection and transportation, as it requires a substantial number of workers and significant operation time. Three institutions, namely Kerbala Municipality (KM), Kerbala Municipalities (KMs) and the Holy Shrines Authority (HSA) are responsible for delivering MSWM services in the city. KM delivers MSWM services in the central district of Kerbala while HSA is responsible for providing MSWM services in the old city areas only. KMs are several municipalities providing MSWM services in districts on the outskirts of Kerbala such as AL-Hurr and AL-Hindiyah. Their activities include collecting and dumping MSW into the nearby landfill (Figure 1.3) with no treatment or resources recovery such as recycling.

During REs, these institutions concentrate their efforts on REs areas. KM and HSA manage the MSW generated in events' areas while KMs collect MSW produced at the main routes to REs areas. Besides, other cities' municipalities such as Babylon and Baghdad provide additional support in terms of machinery and personnel with the aim of collecting the waste generated during REs. However, all these efforts were not able to cover the entire area of the REs where the sight of waste piles and bins overflowing is common (Figure 1.4).

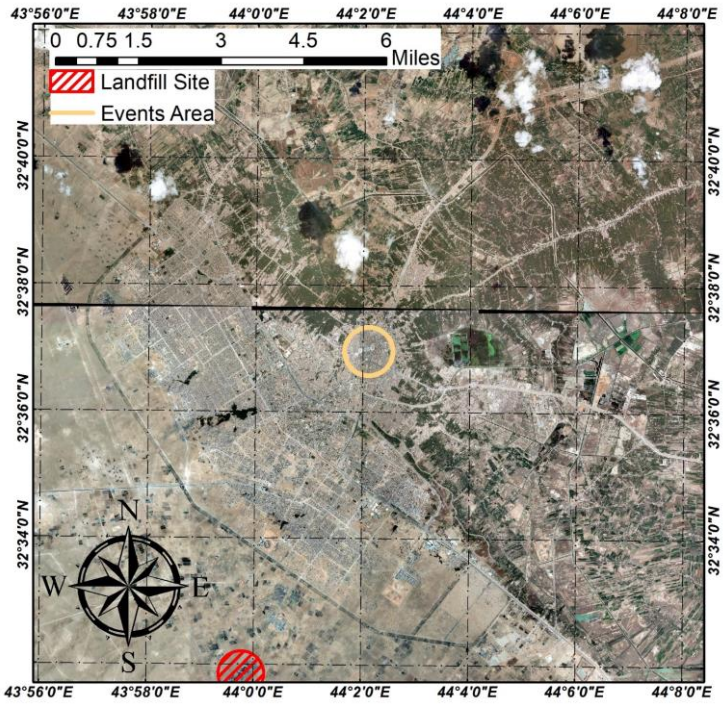

Figure 1.3: The location of the official landfill site in Kerbala (Kerbala municipality, Iraq)

Figure 1.4: MSW piles and bins overflowing during the Arba'een

The government always tries to hide the problem of MSW in Kerbala during REs by making it less visible because the problem is not considered very important for the government. Almost no research has been undertaken, especially regarding MSWM in Kerbala during events. Therefore, accurate data about the REs' MSW such as generation rates, composition

and sources do not exist, leading to weak planning and service delivery (Abdulredha et al, 2018). This situation has led to an improper MSWM infrastructure and illegal dumping (Abdulredha et al, 2017c). The MSWM situation in Kerbala has reached a state of crisis (Al-Anbari et al, 2014), making it imperative that a critical evaluative study needs to be applied to address the challenges facing Kerbala and enable management institutions to prioritise their actions to make improvements.

1.5 Aim and Objectives

The aim of this study is to investigate the current activities of MSWM in the city of Kerbala during REs to identify its strengths, weaknesses, quantify MSWG and recognise public readiness to practise MSW recycling.

To achieve this aim, the following objectives are required:

Objective 1. Investigate MSWM in developed and developing countries, particularly during REs. This helps to identify the barriers and success factors affecting the achievement of ISWM as well as the aspects that affect MSWG and public involvement in MSWM.

Objective 2. Design a mixed methods research approach to gather information about REs' MSWM. This includes designing questionnaires, interviews, field observations and on-site MSW audit to collect essential data such as MSWG, MSWM system users' variables and stakeholders' readiness to recycle.

Objective 3. Conduct fieldwork during the Arba'een to gather the required data. This consists of conducting interviews with MSWM authorities, surveys with the system's users (hoteliers, camp owners and pilgrims), on-site MSW audit at hospitality accommodation (hotels and camps) and on-site observations.

Objective 4. Assess the performance of the Arba'een MSWM system. The Wasteaware indicators framework was implemented to identify strengths, weaknesses and prioritise actions to develop the Arba'een MSWM system, based on interviews, field observations and official documents.

Objective 5. Quantify MSWG from hotels and camps based on the surveys and on-site audit. This comprises estimating MSWG, exploring accommodation's characteristics (capacity, staff number etc.), ascertaining influential characteristics on MSWG and developing MSWG prediction models that utilise influential characteristics.

Objective 6. Ascertain the intention of stakeholders (hoteliers, camp owners and pilgrims) to practise MSW recycling during REs. This consists of exploring their variables (age, gender etc.), their readiness to practise MSW recycling and recognising the variables that influence stakeholders' positive intention towards recycling during REs.

1.6 Contribution to the knowledge

The contribution of this study lies in the fact that there is little information about MSWM in developing countries such as generation rate, composition, public involvement and environmental impacts, particularly during REs compared to developed countries. The lack of essential data such as MSWG and public involvement has significantly weakened MSWM performance in developing countries, which needs to be addressed to reduce the negative consequences. Large REs have a reputation for creating substantial amounts of MSW over a short period; however, research has largely neglected MSWM during REs, particularly in developing nations. The international statistical institute (ISI, 2015) classified countries with Gross National Income (GNI) per capita per year of 11,905 US$ or less as developing countries, where Iraq is one of those countries. There is no prior research on MSWM during REs in Kerbala, Iraq, which makes it necessary to study the state of the REs' MSWM to develop the performance of MSWM in cities hosting large REs in developing countries.

1.7 Thesis Structure

This thesis is organised in six chapters, which are outlined below.

Chapter 1 is an introduction to the entire thesis and presents the context of the research. It provides a general background of Kerbala and large REs. The problem statement, the aim, the objectives, and the contribution of the research to the knowledge are also briefly outlined.

Chapter 2 is devoted to presenting a review about MSWM in developed and developing countries, focusing on MSWM during large events. The aspects affecting MSWG in addition to the techniques used to provide reliable predictions for MSWG were explored. Also, the intention to participate in MSW recycling, the factors affecting this intention and forecasting techniques are highlighted. Frameworks applied to develop a comprehensive evaluation for MSWM were also explored. Moreover, social research approaches to collecting comprehensive data are presented in this chapter.

Chapter 3 covers the methodology adopted for undertaking this research. The targeted population, the specific research methods and the construction of the research instruments and the data collection processes are detailed. The data analysis techniques and process are presented as well as the reasons behind applying these methods.

Chapter 4 presents detailed information about the current situation of MSWM in Kerbala at the Arba'een. This includes information about MSWM processes which include generation rate, composition, collection, transportation and disposal. Besides, the aspects that influence the current MSWM operation are also presented. It also shows the results of the Wasteaware benchmark indicators framework for the MSWM system used during the Arba'een, which helped to identify the strengths and the weaknesses of the applied system.

Chapter 5 discusses the results of the questionnaire surveys. The generation rate of MSW from the hospitality accommodation is examined in addition to the accommodation's characteristics that affect waste generation rate. Besides, the users' intention to sort their MSW at the event and the factors that might affect such an intention, particularly demographic factors are also inspected. The stakeholders' assessment of MSWM in Kerbala is discussed.

Chapter 6 presents the summary of the findings in line with the aim and objectives that guided the study and offers suitable recommendations to enhance and improve MSWM in Kerbala during REs, which is the aim of this study.

Chapter 2
Literature Review

2.1 Introduction

The purpose of this chapter is to provide context for this research. An introduction to the types, classifications and composition of municipal solid waste (MSW) is presented. In addition, the global trend of municipal solid waste generation (MSWG), the aspects affecting MSWG and MSWG modelling techniques are outlined. Municipal solid waste management (MSWM) operations that are handling at source, collection, transportation, treatment and disposal are highlighted. The importance of MSW recycling as a treatment method and the aspects affecting MSW recycling are discussed. The types of tourism events and the management approaches of MSW during large events are displayed. Finally, MSWM assessment frameworks and data collection approaches adopted in social research are reviewed.

2.2 Municipal Solid Waste

2.2.1 MSW Definition and Classification

Waste is defined as any substance or object that is no longer needed and discarded or intended to be discarded (European Union Commission, 2008). Waste is classified according to physical conditions (solid, liquid and gas), physical properties (compostable, recyclable and combustible), safety (hazardous and non-hazardous), sources (Domestic, institutional, commercial etc.) and materials (organic, metal etc.) (McDougall et al, 2008; Christensen, 2011).

MSW is defined as the waste collected from domestic or other sources by management authorities or their agents, including waste from households, parks, commercial entities, offices and street litter (Ezeah, 2010; Alsebaei, 2014). Other researchers (Baabereyir, 2009; Peter, 2016) suggest that MSW also includes all sewage wastes (solid, liquid and gases) collected by the public and private authorities from domestic and commercial sources. It is also classified according to safety, composition and sources (Garcia, 2015).

2.2.2 MSW Composition

MSW materials are generally classified into organic and inorganic (Peter, 2016). Organic includes several wastes such as food scraps, yard waste and wood. Inorganic contains several wastes such as plastic (bags, packaging, containers, etc.), metal (cans, foil, tins,

bicycles, etc.), glass (bottles, light bulbs, etc.), paper (cardboard, magazines, bags, boxes, wrapping paper, etc.), and other materials (textiles, leather, rubber, electronic, ash etc.) (Hoornweg and Bhada-Tata, 2012).

The compositions of MSW is influenced by many factors including cultural norms, economic activities, geographical location, climate etc. (Garcia, 2015). In wealthier countries such as the United Kingdom, the consumption of inorganic material (plastic, papers etc.) normally increases, leading to an increase in the inorganic fraction of MSW with a relative decrease in the organic fraction (Hoornweg and Bhada-Tata, 2012). Conversely, low- and middle-income countries such as Ghana and Mexico tend to generate higher proportions of organic waste compared to high-income countries (Hoornweg and Bhada-Tata, 2012). Figure 2.1 shows different values of the MSW composition by income level.

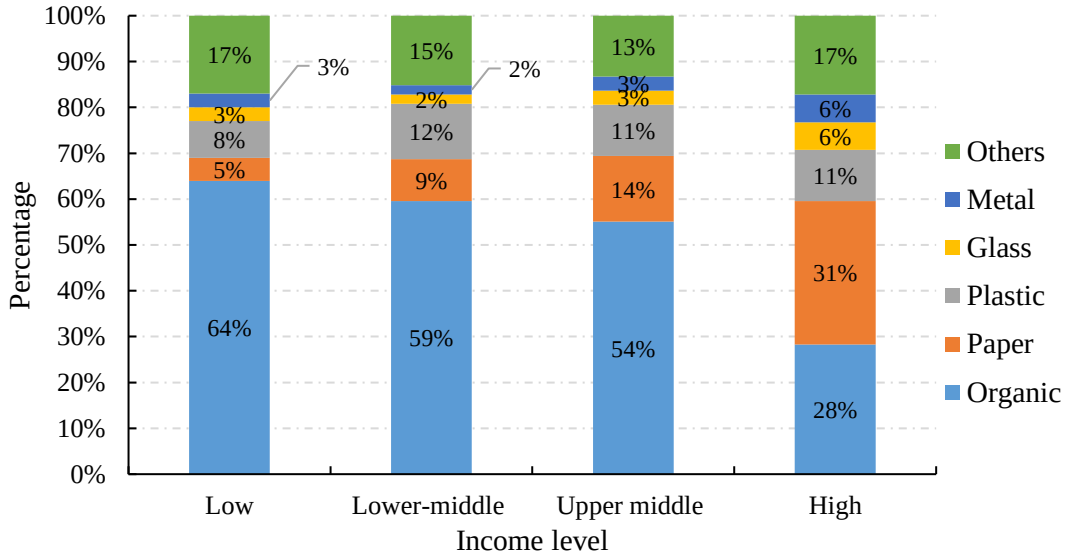

Figure 2.1: MSW compositions by income level (created with Hoornweg and Bhada-Tata (2012) data)

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Figure 2.1 was build according to the information from the Hoornweg and Bhada-Tata (2012) report, which includes data from 105 countries classified by income from 2006 to 2012. It can be seen that organic waste increases with the decrease in income level, where low-income countries have a higher organic fraction of 64% compared to 28% in high-income countries. In contrast, recyclable fractions increase with the increase in income level, where higher average fractions of paper, glass and metal were recorded compared to other income levels. Scholars (Thanh et al, 2010; Garcia, 2015; Intharathirat et al, 2015)

reported that identification of the MSWG and composition is vital for integrated solid waste management (ISWM) planning.

2.2.3 Municipal Solid Waste Generation

All human activities produce MSW (Azadi and Karimi-Jashni, 2016). Hoornweg and Bhada-Tata (2012) reported that the global average MSWG was 1.2 kg per capita per day in 2012 and expected to increase to 1.42 kg per person per day in 2025. This rate varies considerably by region, country, city and even within the city. Many aspects, including economic development, degree of industrialisation and local climate influence MSWG rates. The increase in the income level and urbanisation lead to an increase in the consumption of goods which correspondingly increases the amount of MSW generated, where urban residents produce about twice as much MSW as their rural counterparts (Hoornweg and Bhada-Tata, 2012). Table 2.1 shows waste generation rates (kg/capita/day) for various income levels. High-income countries produce more waste (2.1 kg/capita/day) than low-income countries of 0.6 kg per capita per day. There is a significant variation in the waste generation rate within the same income level. For instance, some high-income countries produce 0.7 kg of waste per capita per day while other countries produce up to 14 kg per person per day.

Table 2.1: Waste generation per capita according to income level (created with Hoornweg and Bhada-Tata (2012) data)

Income level	**Waste generation per capita (kg/capita/day)**		
	Lower Boundary	**Upper Boundary**	**Average**
High	0.70	14.0	2.1
Upper-middle	0.11	5.5	1.2
Lower-middle	0.16	5.3	0.79
Low	0.09	4.3	0.60

MSWG represents the basic data required for the planning and the operating of an ISWM system (Kolekar et al, 2016), which entails a demand for reliable data on MSWG. This is challenging to achieve, as MSWG cannot be measured directly like other centralised infrastructures such as electricity supply (where the consumption of every single end-user can be measured). This happened only in rare situations e.g. in areas where a Pay-As-You-Throw system was adopted (Beigl et al, 2008). Thus, modelling of MSWG is of particular importance (Beigl et al, 2008; Thanh et al, 2010; Garcia, 2015; Intharathirat et al, 2015).

Various modelling techniques of differing complexity have been developed that focus on the estimation, explanation or prediction of the whole, or parts of the MSW stream (Edjabou et al, 2015; Fu et al, 2015; Intharathirat et al, 2015; Azadi and Karimi-Jashni, 2016; Grazhdani, 2016). MSWG modelling approaches can be categorised according to modelling scale, explanatory factors and modelling techniques (Beigl et al, 2008).

2.2.3.1 Modelling Scale

The modelling scale refers to the size of the identifiable sample unit observed in each study. The definition of each scale is based on existing administrative units, the sources used of waste data and the explanatory variables to hypothesise relationships. Based on Kolekar et al (2016), the modelling scale has been categorised into three levels.

First, household or dwelling represents the lowest level and explores the relationship between MSWG in each household and the individual features of the household itself or the household's representative. MSWG prediction was based on income level (Ojeda-Benítez et al, 2008; Thanh et al, 2010), socio-economic groups and family size (Suthar and Singh, 2015), where sample sizes ranged from 50 to 144 units (dwelling) using a random sampling approach to select representative sample size. Waste data and household characteristics are mainly collected using personal interviews or questionnaire survey, due to the data protection issues and the lack of census based on an individual level (Kolekar et al, 2016).

Second, the competence and the availability of data explain the fact that the majority of the MSWG prediction models selected districts as the smallest modelling unit. MSWG modelling in terms of districts includes municipality (Lozano-Olvera et al, 2008; Abbasi et al, 2014), part of a city (Oumarou et al, 2012), city (Kollikkathara et al, 2010; Azadi and Karimi-Jashni, 2016; Ghinea et al, 2016) and federal states (Purcell and Magette, 2009; Dai et al, 2011). Many studies have documented the use of time series on an annual, monthly or daily basis (Lozano-Olvera et al, 2008; Purcell and Magette, 2009; Kollikkathara et al, 2010; Dai et al, 2011; Abbasi et al, 2014) while others adopted input-output analysis (Ali Abdoli et al, 2012; Abbasi et al, 2013). The data used for modelling of the independent variables could be MSW quantity statistics, management-related data, census and socio-economic variables (Purcell and Magette, 2009; Ghinea et al, 2016).

Finally, countries represent the highest aggregation level in modelling MSWG, which mainly employs input-output (Intharathirat et al, 2015), cross-sectional (Antanasijević et al, 2012) and time series analyses (Rimaityte et al, 2012). The first type aims at estimating

MSW streams in a single country (Intharathirat et al, 2015; Younes et al, 2015). The other two methods focus on comparisons between countries and/or in time by means of aggregated variables, such as social, economic and demographic indicators (Beigl et al, 2004; Antanasijević et al, 2012). The typical data sources include national MSW measures on an annual basis and census-related and economic information from statistical offices (Beigl et al, 2008).

2.2.3.2 Explanatory Variables

Wide varieties of independent or explanatory variables (IVs) have been hypothesised and tested in MSWG prediction models. Intharathirat et al (2015) and Beigl et al (2008) reviewed more than 90 models developed to predicted the quantity of MSWG at different levels, household, city and country. Based on these studies, Intharathirat et al (2015) grouped the most important factors affecting MSWG in two categories that are socio-economic and demographic factors as presented in Figure 2.2.

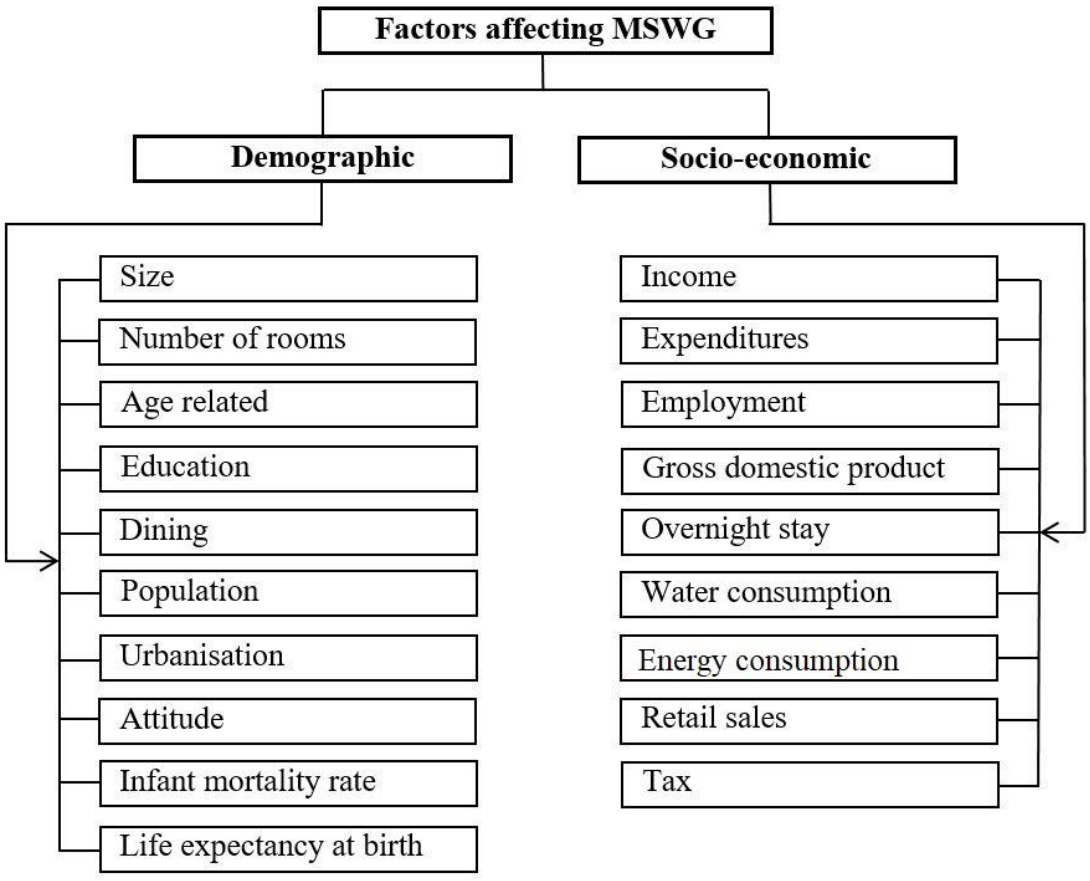

Figure 2.2: List of the most important factors affecting MSWG

Among demographic factors (Figure 2.2), population-related factors such as population, population density and number of households are widely adopted in estimating MSWG.

Studies (Ball and Abou Taleb, 2010; Thanh et al, 2010; Sukholthaman and Chanvarasuth, 2013) have shown a significant positive relationship between population and MSWG. This means that a higher population produced more MSW (Chung, 2010; Khajuria et al, 2010). Intharathirat et al (2015) reported that population-related factors could be considered the best for explaining the variation in MSWG. Further to the well documented impacts of population-related aspects (Intharathirat et al, 2015), other variables related to dwelling type (Emery et al, 2003), occupancy rate (Ball and Abou Taleb, 2010), number of rooms (Sankoh et al, 2012) and education (Ojeda-Benítez et al, 2008) proved to have positive correlation with MSWG.

Other significant influential aspects are represented by age and life expectancy at birth (Beigl et al, 2004), percentage of children (Johnstone and Labonne, 2004) and urbanisation (Khajuria et al, 2010; Rimaityte et al, 2012). For instance, many studies reported age as an influencing aspect, where elderly households produce lower quantities of MSW than households with infants and children due to their activities (Beigl et al, 2008). However, most such research considered age as an insignificant factor (Intharathirat et al, 2015). Apart from the aforementioned factors, individual characteristics of households such as household size (Lebersorger and Beigl, 2011), the structure age (Beigl et al, 2004) and consumption habits (Sankoh et al, 2012) proved to be significant. Education-related factors were employed to explain the changes in MSWG at household level but were not considered significant for MSW modelling at municipality level (Lebersorger and Beigl, 2011).

Socio-economic factors (Figure 2.2) have become widely hypothesised factors in MSWG forecasting, where income could be considered the most influential factor followed by gross domestic product (GDP), expenditures and employment (Intharathirat et al, 2015). Questionnaires survey has been effectively employed to investigate the relationships between MSWG at household level and the socio-economic variables (Beigl et al, 2008). Variables related to income (Thanh et al, 2010; Sankoh et al, 2012), expenditure (Yuan et al, 2012) and GDP (Chung, 2010; Khajuria et al, 2010) have been widely utilised to forecast MSWG at household and city levels. Many researchers such as Kolekar et al (2016) confirmed that higher income is accompanied by higher consumption potential and more MSW produced. However, other researchers (Skovgaard et al, 2005; Liu and Yu, 2007) found that income has an insignificant influence or is the least factor affecting MSWG. Liu and Yu (2007) reported that the growth of income might change the consumption patterns of citizens to invest more in durable goods such as housing and automobiles.

At city and country levels, GDP has been widely employed in MSWG forecasting because it is measured consistently, frequently, and is widely available (Beigl et al, 2008; Khajuria et al, 2010; Rimaityte et al, 2012). GDP represents the situation of a country's economy and the power of pay per person, where the increase in GDP leads to increased consumer activities and business, which in turn increases MSWG (Purcell and Magette, 2009). However, Liu and Wu (2011) did not find a clear cut relationship between the quantity of MSWG and GDP. Sokka et al (2007) believed that improved MSWM measures contributed to the minimisation of MSWG and decoupling of MSWG and GDP.

Consumption expenditure and employment are observed to be important factors affecting MSWG (Beigl et al, 2008; Intharathirat et al, 2015). Many researchers (Liu and Yu, 2007; Liu and Wu, 2011) found that consumption expenditure is closely related to MSWG. Other scholars (Rimaityte et al, 2012) found that the higher the proportion of employees to total population in a city, the more MSW is produced due to economic prosperity. Other factors such as waste collection frequency (Azadi and Karimi-Jashni, 2016), area of paved road (Sankoh et al, 2012), taxes (Lebersorger and Beigl, 2011), temperature (Ali Abdoli et al, 2012), road lighting (Yu et al, 2014) were used as proxy indicators to model MSWG using various modelling techniques.

2.2.3.3 Modelling Techniques

To date, a wide range of modelling techniques of different levels of complexity have been employed to estimate the quantity of MSW. Mainstream techniques include grey and fuzzy models, simulation models, statistical models, and non-probabilistic statistical learning models (Jiang and Liu, 2016).

The grey models can solve problems with uncertainty, and have been successfully implemented to forecast MSWG using small and poor datasets (Liu and Yu, 2007; Intharathirat et al, 2015). Karavezyris et al (2002) applied fuzzy logic to improve the confidence in the validity of linguistic variables of system dynamic models. Intharathirat et al (2015) developed a multivariate grey model to forecast MSW collected in Thailand with prediction intervals in the long term using population, urbanisation, employment and household size as IVs. These models are able to explore the uncertainty of systems and handle small sample datasets (Jiang and Liu, 2016); but, the conventional grey forecast model is sensitive to initial values (Guo et al, 2014).

Simulation models processing helps to simulate and analyse the structure, interactions and behaviour of complex systems, which are difficult to express via mathematical formulae (Jiang and Liu, 2016). One form of simulation models is system dynamic which has been widely adopted for forecasting MSWG (Karavezyris et al, 2002; Kollikkathara et al, 2010; Ahmad, 2012). These models are able to provide robust and reliable outcomes using a multivariate method (Kollikkathara et al, 2010). However, such models are far more complex due to the diverse interactions between the selected IVs (Beigl et al, 2008). Thus, it is hard to validate such models (Jiang and Liu, 2016).

Non-probabilistic statistical learning models such as artificial neural networks (ANN) and support vector machines (SVM) have been widely applied for MSWG forecasting (Jiang and Liu, 2016). These models have a powerful ability to deal with nonlinear forecasting models (Azadi and Karimi-Jashni, 2016). Abbasi et al (2014) proposed SVM models to predict weekly MSWG in two Iranian cities (Mashhad and Tehran). Jahandideh et al (2009) employed ANN analysis to predict the medical waste generation rate of 50 hospitals in Fars Province, Iran and Batinić et al (2011) used the same technique to estimate the quantity and composition of MSW in Serbia and indicated that the ANN model was efficient in forecasting MSWG. Researchers such as Jiang and Liu (2016) stated that non-probabilistic statistical learning models are promising in forecasting MSWG. However, they have some weaknesses such as over-fitting training, difficulty in the determination of network architecture, poor generalising performance, limiting the application and requiring large datasets (Abbasi et al, 2014; Intharathirat et al, 2015).

Various statistical learning models such as autoregressive moving average, autoregressive integrated moving average and linear regression models aim to discover linear relationships between one or more IVs and a dependent or response variable (DV) (Jiang and Liu, 2016). Among those, multiple linear regression (MLR) is used to model the association between two or more IVs and DV, by fitting a linear equation to the observed data (Azadi and Karimi-Jashni, 2016). MLR is one of the most common methods for forecasting in many fields such as biology, medicine, economics and environment (Pires et al, 2008).

MSWM is an environmental research field where MLR has been widely adopted (Pires et al, 2008). Parisi Kern et al (2015), for example, suggested an equation using MLR to determine the mass of waste generated in the construction phase of high-rise structures by examining the influence of building design and production systems, concluding that the suggested equation was useful for prediction purposes. Jahandideh et al (2009) also used

MLR to forecast the generation rate of medical MSW from 50 hospitals in Fars Province, Iran, their results also suggesting that MLR can be used to forecast the generation rate of medical waste from medical establishments. Thanh et al (2010) developed MLR models to estimate the quantity of MSW produced by 100 households in the city of Mekong Delta in southern Vietnam using the size and income of the households as IVs. Lebersorger and Beigl (2011) used tax revenues, household size and the percentage of buildings with solid fuel heating to estimate MSWG from 542 municipalities in Styria, Austria. The developed MLR models were able to explain the variation in the quantity of MSW at household and municipality levels. Besides, Beigl et al (2008) reported that the validation of MLR can be achieved when each IV meets the stringent requirements (i.e., independence of variables and normality of errors) and does not violate the fundamental regression assumptions. Such validation measures have not been applied for other multivariate methods (Beigl et al, 2008). Thus, MLR techniques can provide reliable estimates to the quantity of MSW produced at household and municipality levels, which are essential for planning and operating of an ISWM system.

2.3 Municipal Solid Waste Management

MSWM is the planning and delivery of processes and technologies that aim to safeguard public health, to protect the environment and to conserve resources and energy (von, 2011). The activities associated with MSWM include handling at source, collection, transportation, treatment and final disposal as well as the supervision of such operations and the after-care of disposal sites (European Union Commission, 2008). These elements are connected, but they are not necessarily presented in every MSWM system. MSWM activities are limited to handling at source, collection, transportation and disposal at landfills, in the best case in most low- and middle-income countries (Wilson et al, 2015). On the other hand, most high-income countries have an ISWM system where functional elements are found within it (von, 2011).

2.3.1 Handling at Source

Handling at source includes all activities associated with the management of MSW from the sources until it is stored in storage points for collection and transportation (Tchobanoglous et al, 1993). This is one of the most important steps in MSWM because it significantly influences the remaining MSWM elements that are collection, transportation, treatment end even disposal (von, 2011). For instance, separation at source reduces the cost and the energy of the production process and increases the efficiency and the quality of the recycling

process by reducing the contamination potential of recyclable materials (Alsebaei, 2014). It also includes backyard or home composting, which significantly minimises the adverse environmental impacts generated from the storage and the transport of organic refuse to treatment sites as well as extending the lifetime of disposal sites (Tchobanoglous et al, 1993).

Container system refers to temporary waste receptacles at sources, which is an important aspect of MSW handling at source due to its aesthetic and health impacts (von, 2011). The variety of containers is vast, which are classified mainly by type (bags, bins, barrels, wheeled containers, roll-off containers etc.), material (Plastic and metal) and volume (small, medium and large) (Rodrigues et al, 2016). Improper planning for the capacity and distribution of temporary waste receptacles could lead to negative aesthetic and health impacts (Wilson et al, 2015). Depending on storage time and weather temperature, the degradation of the organic fraction produces odours and rodents and insects that spread disease (von, 2011). Thus, it is essential to distribute adequate containers and receptacles for on-site storage based on the characteristics (quantities and materials) of the MSW, the collection system arrangements, and available space for placement of containers (Tchobanoglous et al, 1993).

Practices of proper MSW handling at source require efficient MSWM infrastructure, adequate incentives and educational programmes of waste generators in order to achieve active public involvement (Miliute-Plepiene et al, 2016). High-income countries often employ a combination of civic commitment, environmental awareness, public education, law enforcement to support proper MSW handling at source (von, 2011). However, such activities in low- and middle-income countries are usually weak, where most of the management effort is directed towards collection and transportation (Alsebaei, 2014).

2.3.2 Collection and Transportation

MSW collection and transportation is defined as the actions of gathering the MSW from temporary receptacles using a specific route in a specific area and transporting it to emptying points that include separation plants, treatment or energy recovery facilities, transfer stations, or landfill sites (Tchobanoglous et al, 1993). The frequency of MSW collection is determined according to the rate of MSWG and the collection methods. For instance, Alsebaei (2014) reported that mixed MSW is collected once a week in the United Kingdom whereas it is collected every day in Saudi Arabia. This shows the significant differences between developed and developing countries where the collection costs reached up to 90%

of the total cost of MSWM in developing countries compared to 70% in developed countries. The high cost of MSW collection in developing countries happens because of the need for large numbers of labourers and a large amount of equipment (Alsebaei, 2014).

Collection and transportation of MSW are visible signs that the MSWM is able to achieve its objectives (Wilson et al, 2015). Inappropriate and insufficient planning and delivery of MSW collection services cause littering, uncontrolled dumping and poor public sanitation (von, 2011). High-income countries use various modes of MSW collection such as door-to-door, kerbside, drop-off site and green points (Rodrigues et al, 2016). The mixed or pre-sorted MSW is delivered by the producers to these locations and then it is collected by MSWM authorities (municipality or private sector) (Gallardo et al, 2015). These methods of MSW collection are well established in the majority of high-income countries (Wilson et al, 2012). However, in low- and middle-income countries, the MSW collection system is suffering from the irregular collection, poor collection route planning, and unhygienic public collection points (von, 2011). The current collection operations in low- and middle-income countries could lead to negative consequences and need to be addressed (Peter, 2016).

2.3.3 Treatment and Disposal

There are many methods for treating and disposing of MSW, where some are a considerable source of pollution and do not offer financial returns while others cause less pollution and have financial benefits (Alsebaei, 2014). MSW treatment methods include thermal treatment, Biological treatment, materials recovery or recycling and landfilling (von, 2011).

2.3.3.1 Thermal Treatment

Thermal treatment is the process of reducing the volume of the waste in a specially designed combustion chamber, where the energy content of the waste can be recovered using the heat released in the thermal process (Alsebaei, 2014). Thermal treatment technologies are categorised into incineration and advanced thermal treatment technologies, such as gasification and pyrolysis (Turner, 2016). Energy can be formed by a heat exchange system because incineration generates hot emissions including water vapour, carbon dioxide and nitrogen (von, 2011).

Thermal treatment technologies have the advantage of the complete destruction of the organic portion of waste, control of air emissions, a significant reduction in waste volume up to 90% and the process residues often contain a high proportion of metals, which can be

recovered (Tchobanoglous et al, 1993). Therefore, many developed countries used thermal treatment technologies to treat their waste. In the UK, 22% of the waste was incinerated in 2012 (Alsebaei, 2014). Besides this, a number of advanced thermal treatment technologies are operational or under construction in the UK, which expected to play an important role in waste treatment (Turner, 2016). On the other hand, besides their high operation and maintenance cost, these technologies are considered a waste of resources and harmful to the environment. They do not destroy all the hazardous materials, which could be dumped in landfills with the ash and a large fraction of resources (recyclable and organic) are incinerated, which could be recycled or composted (Alsebaei, 2014).

2.3.3.2 Biological Treatment

Biological treatment employs bacteria to decompose the organic fraction of waste to water, carbon dioxide, methane and acids. The main biological waste treatments include composting and anaerobic processes (von, 2011). Composting refers to the natural process of the degradation of the organic components of waste in the presence of air (oxygen) while the degradation of the same components in the absence of air to produce biogas and a liquid and/or solid effluent is known as anaerobic digestion (Turner, 2016). These technologies can be considered as forms of recycling where their products can be used to generate electricity (from biogas) and soil fertilisers (from compost) (von, 2011).

Many developed countries such as the UK employ biological treatment as an alternative to MSW landfilling, (Turner, 2016). However, despite organic fraction is more than 40% in many developing countries, which is theoretically ideal for biological treatment, these technologies have not been significantly successful or widespread in practice (von, 2011). There are many challenges facing the development of the biological technologies including absence of stable and reliable markets, inadequate equipment maintenance and inappropriate technology (von, 2011; Alsebaei, 2014). Besides, these processes can produce contaminated products when food waste materials are contaminated with heavy metals (von, 2011). Therefore, it is essential to improve the environmental awareness among the public regarding waste separation and handling at the source.

2.3.3.3 Materials Recovery and Recycling Technologies

The main goal of these technologies is to minimise MSW, which includes prevention and treatment (Singh et al, 2014). Waste prevention emphases the importance of minimising the quantity of MSW produced, such as, reducing packaging materials, which would decrease the total quantity of waste (Zaman and Lehmann, 2013). Such a project requires significant

co-operation among goods producers, government and users with the aim of controlling MSWG. According to the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (FMENCNS, 2013), a waste prevention programme was initiated in Germany in 2012 for preventing substances, materials, or products from becoming waste. Also, the United States Environmental Protection Agency (USEPA, 2018) reported that waste reuse as a prevention method also concentrates on making products more reusable than disposable such as buying used products, renting or borrowing products, which prevents usable goods from going to disposal sites. Such activities reduce the quantity of MSWG at various levels.

On the other hand, recycling is the process of capturing and recovering material resources from the waste stream, where recovered materials are processed to be used for manufacturing new products (USEPA, 2018). Waste recycling can be done with organic waste, which will produce compost, and with inorganic waste (metal, glass and plastic), which will produce raw materials. Waste can be segregated at source by producers or can be collected commingled and sent to material recovery facilities to be sorted and reclaimed (Turner, 2016). The main benefit of waste recycling is protecting the environment by decreasing the energy consumption for materials manufacturing, reducing the usage of raw material and the need for mining, and controlling the emissions (Alsebaei, 2014). In addition, the recycling industry can potentially create new job opportunities e.g. about 200,000 employees are working in 3,000 companies in the field of recycling and recovering resources from waste in Germany (FMENCNS, 2013).

Separation at the point of MSWG is much more efficient than separation in the sorting facility because its cost is low and recovered materials are significantly less contaminated by other materials compared to materials recovered at a recovery facility (Christensen, 2011). The success of source separation and recycling programme largely depends on active public participation, which is affected by the availability of well-designed infrastructure (Zhuang et al, 2008) and high public intention to sort waste as a part of their environmental awareness and responsibility (Christensen, 2011).

2.3.3.4 Sanitary Landfills and Open Dumps

Landfilling has been the primary disposal method for waste throughout the world (Wilson et al, 2012). In the past, landfill sites, or ‘dumps’, were generally left uncapped and unlined leading to serious impacts such as exacerbating the problem of climate change, polluting the surrounding environment (contaminating air, groundwater and land) and destroying

valuable resources (Turner, 2016). Many low- and middle-income countries still rely on landfilling. Wilson et al (2012) reported that about 72% and 40% of the low- and middle-income counties, respectively currently use simple controlled disposal sites or dumpsites. Controlled disposal indicates a disposal site with a minimum degree of management, consisting of gate control, fencing and waste placement with no leachate and emission control whereas dumpsites are sites where MSW is disposed of in a disorderly fashion without regard for the environment (Wilson et al, 2013a). Even after the closure of landfill sites, waste continues to decompose, increasing levels of leachate and landfill gas, leading to serious destruction to the environment for several decades.

As recognition of this pollution risk, landfill site design has developed over past decades towards fully engineered and state-of-art facilities that act to protect the surrounding environment and public health (Wilson et al, 2015). State-of-art landfills are well-engineered facilities that are located, designed, operated and monitored to ensure environmental and human protection (Wilson et al, 2013b). They consist of many cells, which should be designed at specific slopes, a liner of different materials, a leachate collection system, and a gas collection system. In addition, many developed countries are trying to avoid using landfills e.g. according to the department of environment food and rural affairs (DEFRA, 2017), the UK local authorities disposed of about 15.7% of generated MSW in landfills in 2016/17.

2.3.4 Waste Hierarchy

The revised Waste Framework Directive, which applied through European Union member countries (European Union Commission, 2008), sets the basic concepts and definitions for waste management, such as the definitions of waste, recycling, reuse, and recovery, and the establishment of end of waste criteria. In the waste management hierarchy, the previous waste treatment technologies were ranked based on their environmental consequences (Figure 2.3), where prevention was the most preferable option and disposal was the least. The principles of Waste Directive include firstly the obligation to handle waste without posing a negative impact on the environment or human health and secondly the hierarchy of the best overall environmental options in waste management, from prevention to disposal (Christensen, 2011). It also emphases the importance of adopting environmentally friendly techniques such as recycling.

European Union members are free to address their local distinctiveness by creating the laws, regulations and administrative provisions to achieve the goals of Waste Framework

Directive (Costa et al, 2010). Therefore, the members approach the implementation of the Waste Directives differently to suit their background distinctiveness. For example, the UK developed two main documents set the legislative framework for waste management that are the Environmental Protection Act (*Environmental protection act (chapter 43)*, 1990) and Environmental Act (*Environment act (chapter 25)*, 1995). Environmental Protection Act (1990) introduces the definition of waste and the responsibility of care on creators/operators for the collection, treatment and disposal of waste. Environmental Act (1995) which outlines the need for improved legal and institutional setting for waste management, the need for a national waste management strategy, and defines the generators' responsibility in relation to resources recover of MSW. Central and devolved administrations are responsible for MSWM policy development and enforcement. However, since devolution in the UK is asymmetric, the powers among devolved administrations differ to some degree (Costa et al, 2010). UK's MSWM policy is reflected in the Waste Strategy for England 2007 (DEFRA, 2007). The strategy proposes instruments and targets for reducing the impact of waste generation and management and encourages MSW resources recovery to achieve the objective of the Waste Framework Directive.

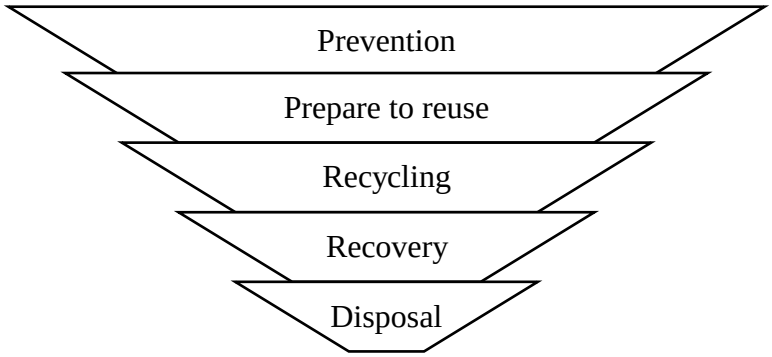

Figure 2.3: Waste hierarchy where the disposal is the least favourable option (adapted from Papargyropoulou et al (2014))

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2.4 MSW Recycling

The growing environmental awareness and the knowledge about limitations in the availability of primary raw materials highlighted the importance of MSW recycling in recent decades (von, 2011). Recyclable materials can be captured and recovered at source or at a recycling facility, where separation at source is more efficient than separation at a recycling facility (section 2.3.3.3). Christensen (2011) reported that the cost of separation at source is very low and the recyclable material is normally uncontaminated by the rest of the waste,

whereas the sorting recycling facility is expensive and some of the recovered material (such as paper and cardboard) are contaminated, which make it unsuitable for recycling. At the source, recycling can be done formally or informally, with one main difference being the recyclable waste collection method. According to Wilson et al (2015), formal recycling is done through local government or its representatives whereas the informal recycling activities are performed by the informal recycling sector (IRS) that is, individuals or enterprises who are not authorised by a local authority such as scavengers.

IRS is becoming an increasingly important player in MSWM particularly in developing countries; indeed, the IRS handles large quantities of MSW (about 20-30% of the total generated) which would otherwise have to be collected and disposed of (Scheinberg et al, 2010). To give working examples, over 120 enterprises in Bamako, Mali, collect about 300 thousand tonnes of waste annually, while informally recycled waste in Lusaka, Zambia, reaches up to 30% of the city total waste. IRS is clearly any city's key ally as it lowers the cost of waste collection and disposal (Wilson et al, 2015). However, many informal recyclers work in very poor conditions leading to the generation of many problems such as occupational and public health and safety, child labour, uncontrolled pollution, untaxed activities, crime and political collusion (Wilson et al, 2013c).

In contrast, formal recycling seems to be the main method of waste recovery in developed countries (Wilson et al, 2013c). For instance, about 10.2 million tonnes (44.9%) of the total MSW generated in the UK was recycled by the formal sector (DEFRA, 2017). Generally, MSW is sorted at source by generators before being collected using several collection methods such as door-to-door, kerbside, drop-off sites and green points (Gallardo et al, 2015). Recyclable materials can be collected as mixed together (single stream) or separate from each other e.g. waste is divided into five groups or more in Germany (FMENCNS, 2006). The most basic method is to separate MSW into two groups that are recyclables (plastic, paper, metal and glass) and the remaining materials (includes organic waste) (Alsebaei, 2014). The separation method affects the process of recycling and the equipment needed for it, and to increase the rate of sorting, the households should be motivated to sort their waste effectively (Christensen, 2011).

2.4.1 Factors Affecting MSW Recycling

Attitudes and behaviours are very important aspects that drive the recycling performance of MSW generators (Zain et al, 2012). The existence of a positive environmental attitude leads to better sorting behaviour which in turn increases the rate of participation in MSW

recycling (Perrin, 2002). Although many individuals are in favour of recycling, this does not necessarily translate into action due to the impact of several situational and attitudinal barriers (De Feo and De Gisi, 2010a). Aspects related to the design of the recycling scheme and the individual's characteristics significantly influence public participation rates as well as the success of a recycling programme (Alsebaei, 2014). There is a strong connection between these aspects, for example, inconvenient recycling infrastructure results in a significant decrease in public participation, which in turn, reduces the rate of MSW recycling. Besides, individual characteristics are very important aspects that drive citizens' intention and behaviour to be involved in MSWM practice (Purcell and Magette, 2010). For instance, the lack of understanding of a recycling programme on the part of the generators can negatively affect their recycling participation rate, as well as the quality of recycled MSW presented. Thus, it is critical to understand the factors that mainly affect individuals' willingness to sort their waste at source. For example, citizens are more likely to sort their easy waste, such as magazines, than mixed waste such as food containers (Perrin, 2002).

2.4.1.1 System-Related Attributes

An easy to handle MSW recycling scheme significantly increases source separation and recycling rates (Sheau-Ting et al, 2016). Alsebaei (2014) reported that recycling studies focused on the effects of different management system designs, such as the type and frequency of collection, access to collection points such as kerbsides, the number of waste fractions collected, economic incentives and information campaigns.

The design of storage containers system is of great importance, as it provides clear instructions on how to separate MSW correctly (Sheau-Ting et al, 2016). A study conducted by Guerrero et al (2013) showed that the individuals who received information on how to sort the waste are more likely to participate in a recycling programme. Therefore, recycling containers should be designed in a way that facilitates and controls the MSW separation process. A small barrier could be placed according to certain specifications to make the disposal of the sorted MSW easy while it could minimise the disposal of other waste in the sorting bins (DEFRA, 2008). For instance, cans recycling bins have a circular shaped opening to prevent contamination with other materials. DEFRA (2008) reported a contamination level between 5-20% is considered acceptable. In addition, the recycling bins should have an icon that explains what kind of waste should be placed in them. It is reported that iconography significantly raises the confidence and willingness among consumers as well as providing proper instructions and information to users (DEFRA, 2008).

Another important aspect is the location of the recycling containers which greatly encourages individuals' participation in recycling and separation of MSW (Malakahmad et al, 2010). A closer distance between generation points and recycling bins areas can increase recycling programme participation; recycling bins should be easily accessed at the place where there is a higher generation of waste (Sheau-Ting et al, 2016). Also, they should be located in busy public areas, but avoid blocking the entrances and causing problems in crowded places (DEFRA, 2008). For instance, recycling bins should be close to places that sell refreshments such as juices at large events (DEFRA, 2008). The willingness for MSW recycling increases when the recycling bins can be reached within walking distance (Babaei et al, 2015). Moreover, DEFRA (2008) recommended that recycling containers need to be distributed next to the general waste containers to avoid contamination of the recyclable MSW.

The type of MSW generated and which item can be sorted in an area should be carefully considered. Indeed, the recycling system should consider the main MSW components in the targeted area with a special focus on easily separated waste such as aluminium cans (DEFRA, 2008). Besides, Zain et al (2012) reported that less need for separation activities increase the participation rate in recycling programmes, for example, the transition from several separate bins to one large bin for all recyclable materials. In busy areas, DEFRA (2008) recommended that fewer materials should be collected and the people should be asked to sort the main items in their waste. Focusing on the main items of MSW could enhance the performance of the recycling system.

The effectiveness of incentives and public education in motivating desired environmental behaviour such as recycling has been confirmed in previous research. A study conducted by Kaplowitz et al (2009) showed that the lack of information concerning what, how, and where to recycle MSW at a public university in the US affected the student participation rate. Not knowing the measures for MSW sorting has been recognised as one of the factors that prohibit MSW sorting among households in Surabaya, Indonesia (Dhokhikah et al, 2015). Citizens who received appropriate information on how to separate MSW have a higher likelihood to practise recycling (Sheau-Ting et al, 2016). In addition, incentives encourage people to participate in MSW recycling. Gneezy et al (2011) stated that incentives provide an initial motivation to the public for environmental activity. Once such activity becomes a habit, they have a higher likelihood to continue this habit even without

external motivation. Therefore, people need to be motivated to participate in recycling schemes through very well designed publicity campaigns and incentives (Ekere et al, 2009).

2.4.1.2 Individuals-Related Attributes

A recycling programme is based on several rules that the public has to follow. The lack of correct structural information makes active public participation impossible in a specific programme (De Feo and De Gisi, 2010b). However, having accurate information about MSW recycling programmes does not necessarily mean that citizens translate this information into action. Researchers suggested that there is a wide range of personal factors such as convenience, income and education level which affect sorting intention and behaviour variance in each community (De Feo and De Gisi, 2010b).

Convenience in terms of time required and sufficient storage space have a significant influence on public participation in MSW recycling. Alexander et al (2009) reported limited space to store recyclables in a high-rise building as one of the barriers that minimise public participation in MSW recycling. Timlett and Williams (2009) reported that people who live in flats or have no external space to store waste are less likely to recycle waste compared with other groups. However, even if storage space is available, people do not have an interest in recycling due to the time barriers. Alexander et al (2009) reported that individuals were not willing to practise recycling due to time constraints. The study of Grodzińska-Jurczak (2003) in Poland also showed that the lack of time is the reason why people do not participate in improving MSWM in their place of residence.

Socio-demographic factors have been the most extensively studied of all factors. Typically, education level, income, age and gender are the most frequently investigated variables (Miafodzyeva et al, 2013), but there is not much consensus over the importance of the individual factors. For example, while some researchers (Saphores et al, 2006; Ekere et al, 2009) have found evidence that gender influences the involvement and engagement in MSW-related activities, the majority of research presented the gender as an insignificant variable (Hornik et al, 1995; Hage and Soderholm, 2008).

Age is another frequently investigated variable. Some scholars have found a correlation between age and recycling behaviour (De Feo and De Gisi, 2010b), but others reported an insignificant association (Schultz et al, 1995; Hage and Soderholm, 2008). Saphores et al (2006) found that middle-aged adults (between 36 and 65 years old) seem to be more willing to participate in MSW recycling. Nixon and Saphores (2009) confirmed the presence of a

significant relationship between participation in MSW recycling and age. However, Videras et al (2012) have not found clear evidence of a relationship.

Income is one of the most commonly investigated variables in literature. The majority of researchers have found associations between income and MSW recycling behaviour (Kurz et al, 2007; López-Mosquera et al, 2015; Miliute-Plepiene et al, 2016) while a minority of scholars have reported no connections (Hornik et al, 1995; Hage and Soderholm, 2008). The relation between income and recycling is not constant, for example, Kurz et al (2007) reported that participation in recycling in high-income areas is higher than participation in medium-income areas. However, Hage and Soderholm (2008) stated that higher income householders are not necessarily more willing to recycle than lower income.

The level of education is included in many studies that investigated socio-demographic variables. Similar to income, the influence of education level on recycling is not consistent. A large number of scholars have found connections between education level and recycling (Gonzalez-Torre and Adenso-Diaz, 2005; Saphores et al, 2006), however, a comparable number of scholars have reported an insignificant relationship (Hornik et al, 1995; Berglund, 2006). Scholars reported a significant association suggesting that a high education level increases the willingness to participate in recycling and lowers the frequency of difficulties encountered with such activities (De Feo and De Gisi, 2010b). In line with this, Saphores et al (2006) found that the willingness to recycle increases with the increase in college education. In contrast, Schultz et al (1995) report that householders with a higher education level have lower willingness to participate in recycling than householders with a lower education level.

In general, many studies have been conducted to explore the factors that affect public recycling intention. A review of literature conducted by Miafodzyeva and Brandt (2012) summarized the findings of studies between 1990 and 2010 on the subject of household recycling behaviour. According to Miafodzyeva and Brandt (2012), the convenience of the sorting system is an important factor controlling individuals' intention and behaviour; publicity campaigns can significantly promote the public's environmental concern which, in turn, enhances their role in MSWM and socio-demographic factors have a poor influence on MSW recycling intention and behaviour.

2.4.2 Relationship Analysis

To identify the most important factor that affects individuals' recycling intention or behaviour, there are several statistical analysis techniques such as binary logistic regression (Dhokhikah et al, 2015), multinomial logistic regression (Alsebaei, 2014), cross tabulation (Babaei et al, 2015), Pearson Chi-squared tests of independence (Byrne and O'Regan, 2014) and factor analysis (Karousakis and Birol, 2008).

One of the most employed analysis techniques is logistic regression (LR) (Alsebaei, 2014). LR allows the prediction of DV (e.g. intention to recycle MSW) from a set of IVs (continuous, discrete, dichotomous, or a mix) (Tabachnick and Fidell, 2013). This technique is especially useful when the distribution of DV (recycling intention) is expected to be nonlinear with one or more of the IVs (age, gender, education level, income etc.) (Pallant, 2011). LR has been widely adopted to explore the associations between individuals' recycling intention and their socio-economic or demographic variables. For example, Dhokhikah et al (2015) employed LR to test the relationship between the socio-economic characteristics of the householders and their recycling activities while Keramitsoglou and Tsagarakis (2013) investigated the agreement with the recycling programme according to several IVs including collection agent, financial incentives and socio-economic factors. Similarly, Purcell and Magette (2010) used LR to determine the strength of relationships between factors (age, education level, satisfaction with MSW services and accommodation type) and predict the respondent's MSWM behaviour in the Dublin region. Such models can provide useful information to develop a successful MSWM strategy.

2.5 Solid Waste Management in Developing Countries

Unplanned urbanisation with accelerated growth in population, the rapid growth of the economy, and improved living standards in many developing countries are leading to the generation of more MSW (Alsebaei, 2014). Peter (2016) reported that the rate of MSWG per capita in developed nations increased approximately three times over the last two decades while it increased by nearly five times in developing countries. Many developed countries are currently following ISWM strategy that employs various management approaches (prevention, recycling and recovery) aimed to reduce the quantity of MSW and its negative consequences (Koroneos and Nanaki, 2012). However, MSWM authorities in many developing countries are still concerned about collection and transportation of MSW and not interested in recycling and resources management (Guerrero et al, 2013).

Wilson et al (2012) reported that many high-income developing countries were able to achieve 99-100% collection coverage, but the vast majority of lower-income countries still were not able to achieve 70% collection coverage. The majority of MSWM authorities in developing courtiers are still using open dumping to dispose of their MSW (Alsebaei, 2014). This disposal method does not take account of the collection and treatment of the emissions and leachate. Disposal sites are normally located as far as possible from the city to hide the impact on the surrounding environment, which in turn significantly increases the total cost of MSWM (Guerrero et al, 2013).

Recycling and resource recovery are usually done through the informal sector, where it is reported that IRS is recovering about 20-30% of the total MSW generated in the developing countries (Alsebaei, 2014). Waste pickers (scavengers) sift through waste storage or disposal locations (public bins, transfer stations and disposal sites) and collect recyclable materials (Scheinberg et al, 2010). Many scholars consider this recycling method as a helpful way of reducing the use of landfills and of gaining some profit from the waste (Wilson et al, 2013a). In contrast, others suggested that this process has many disadvantages such as health and safety risks to the pickers and the communities, the uses of children to sort MSW and the increase in the rate crime and pollution (Alsebaei, 2014).

While information about the MSWM sector in developing countries is generally poor or non-existent (Wilson et al, 2015), existing research on the topic suggests that MSWM is generally characterised by inefficient collection coverage, incompetent resources recovery and poor final treatment and disposal (Ezeah, 2010; von, 2011; Alsebaei, 2014; Peter, 2016). Major urban settlements in many developing countries are characterised by MSW accumulations and poor environmental sanitation (Baabereyir, 2009). A review of literature conducted by Peter (2016) identified several aspects that militate against MSWM efforts in developing countries which are:

- Substantial growth in MSWG and limited available information.
- Low public awareness and limited active involvement in MSWM programme.
- Lack of legislation and insufficient enforcement.
- Lack of financial support and poor financial sustainability.
- Insufficient resources (human and machinery) and a dearth of proper training.
- Unsuitable MSW treatment and disposal technologies.
- Limited land areas for MSWM facility siting.

These aspects have discouraged the efforts of MSWM authorities in developing countries and made it challenging to keep the environment of their cities safe for inhabitants. Besides, a comparative study conducted by Wilson et al (2012) in 20 cities around the world also attributed the weak performance of the MSWM sector to resource constraints including the shortage of financial, physical, human and technical resources for the organisation of MSWM operations. Also, the insufficient efforts to include the non-governmental organisations and the public has made MSWM complicated (Wilson et al, 2015). In a study of the MSWM problem confronting two Ghanaian cities (Accra and Sekondi-Takoradi), Baabereyir (2009) identified several causes of the MSWM problem including lack of capacity in terms of financial, logistical and human resources to cope with the situation and the poor performance in terms of collection service delivery, and the siting of MSW disposal facilities. Many other scholars (Ezeah, 2010; von, 2011) have elaborated on how the factors cited above (plus others) imposed constraints on the MSWM sector in developing countries.

2.6 **Tourism Events**

Recently, there has been a surge in research in tourism-related events (Getz, 2010). Although all planned events have the potential to be of interest to tourists, the literature focuses on four broad categories: business, entertainment, sport and festivals or other cultural celebrations (Getz and Page, 2016).

Business events such as exhibitions and conventions have received quite a lot of attention, as the majority of major cities hold a substantial number of these events (Boo et al, 2008). Topics such as constraints which influence exhibition attendance (Lee and Palakurthi, 2013), loyalty and satisfaction (Tanford et al, 2012), economic impact (Dwyer, 2002) and the impact on public sectors (Andersson and Samuelson, 2000) have already been examined. However, Mair (2012) has acknowledged the need for research focusing on the environmental impacts of business events.

Entertainment events including recorded music, film, museums and theme parks, have also been studied by various researchers around the world (Getz and Page, 2016). Easto and Truzzi (1973) surveyed the nature of various carnivals in the US, estimating that they attract 85 million visitors every year. The motivation for music tourism in South Africa (Kruger and Saayman, 2012) and the environmental consequences of several music festivals in Germany (Cierjacks et al, 2012) have also been investigated.

A growing amount of research on sport events now exists in the literature (Getz and Page, 2016). Researchers have explored many sports tourism related topics such as motivation, satisfaction and behaviour (Prayag and Grivel, 2014), the relationship with urban development (Rozin, 2000) and their economic impact (Lee and Krohn, 2013). For instance, Kennelly and Toohey (2014) studied how the co-operation between sports tour operators and sports events organisers could enhance the financial outcomes of sports tourism while Wicker and Hallmann (2013) investigated willingness to pay to travel to or participate in marathon events.

Festivals or cultural events have occupied an important place in tourism-related studies (Getz and Page, 2016). A comprehensive review, conducted by Getz (2010), identified several forms of cultural events including pilgrimages, celebrations and carnivals. Matheson et al (2014) investigated the impact of spiritual attitudes on visitor attendance to the Beltane Fire Festival in Edinburgh, UK. Buzinde et al (2014) studied the experiences, activities and motivations of pilgrims on the Kumbh Mela pilgrimage, Allahabad, India. Giovanardi et al (2014) investigated encounters between residents and visitors of the 'Pink Night' festival in Italy while Panfiluk (2015) analysed the effects of tourist events in Poland on levels of employment and the income of the population.

However, the above research aside, Getz and Page (2016) state that academic research has largely neglected the environmental impacts of tourism events. For example, Arbulú et al (2017) looked at the impact of variations in tourism on the performance of waste-to-energy facilities. Zeng et al (2014) investigated greenhouse gas emissions from solid waste generated at the Shanghai Expo, 2010. Barber et al (2014) measured the recycling behaviour, attitudes and intentions of visitors to festivals in the US, while Alsebaei (2014) developed an econometric model to predict future recycling behaviour of the Hajj pilgrims in Saudi Arabia, based on their stated intentions. Collins et al (2012) have examined two methods of evaluating the environmental sustainability of mega sporting events in the UK and Ahmed et al (2008) studied the environmental impact of beach sports events in South Africa. Other topics such as litter management at festivals (Cierjacks et al, 2012) and the carbon footprint of mega-events (El Hanandeh, 2013) have also been investigated.

2.6.1 Large Event Management

A large event is defined as a sporting or cultural event (e.g. Olympics, music festivals, religious gatherings etc.) that attracts thousands or even millions of people in a specific place just for several days (Alsebaei, 2014). Huge efforts are made by many organisations

to minimise the environmental impact of large events and make them environmentally friendly (green). According to the United Nations Environment Programme (UNEP, 2007), green events are defined as those events that do not have negative consequences on the ecosystem and the environment. Besides, the international organisation for standardisation (ISO, 2012) developed a practical tool, known as ISO 20121, for sustainable event management. According to this tool, the event organisers are required to consider the economic, social and environmental aspects of the event in order for it to be classified as green (ISO, 2012). Therefore, it is very important to event managers to consider and utilise the experiences of other event managers to achieve environmental and economic sustainability where this should occur in the planning phase of any event (Ponsford, 2011).

2.6.2 Solid Waste Management at Events

One of the most important impacts of large events is MSWG. Many scholars stated that large events produce large quantities of MSW due to the activities of the people involved in the event (Alsebaei, 2014). Cierjacks et al (2012) stated that the cost of the waste collection during events is very high and many event managers try very hard to control MSWG. It is vital for these amounts of waste to be well managed by aiming towards sustainability by resource recovery and the production of zero waste. The concept of zero waste means that all the waste produced is managed through resources recovery and none of it is sent to landfill (Zaman, 2014b). This concept was first applied during the Olympics of 2012 in London, where it was planned to recover 70% of waste generated through recycling and reuse and dispose of the remaining 30% through incineration (Sullivan, 2012). The Sydney Olympics is considered as the benchmark template for the design and construction of green sustainable Olympics (Cox, 2012). Since 1994, any city has been required to have a comprehensive environmental programme to host the Olympics (Alsebaei, 2014).

The issue of MSWM is a very important part of the planning of a green event. According to Cierjacks et al (2012), MSWG at events depends on three aspects that are population density, public behaviour and the location or event characteristics. Thus, to plan a successful MSWM, factors such as the event type and background, the identification of key-waste related data (type, producers, location of production and infrastructure), educational campaigns related to MSWM, recycling possibilities and MSW handling arrangements need to be taken into account (Alsebaei, 2014; Abdulredha et al, 2018).

One example of well developed MSWM during large events is the MSWM programme at the Beijing Olympics 2008. In this event, the committee responsible for MSWM aimed to

achieve 100% sorted MSW and 50% recycled (UNEP, 2007). To reach this goal, a public recycling system was established throughout the entire city to make the public sort their waste, at source, into three groups, that is, recyclable, compostable, and the rest of MSW, with a target of 50% sorted and 30% recycled (UNEP, 2009). The management committee also spent about 11 million US Dollars to distribute a variety of publicity materials (posters and printed brochures) in order to increase the awareness of the importance of MSW sorting at source among the public (UNEP, 2009). As a result, about 3 million of the city inhabitants committed to sorting their MSW at source and more than 88% of the MSW generated during the 11th World Softball Championships was successfully recycled (UNEP, 2007)

Music festivals are another example of green events. The majority of MSW generated at such events is usually bottles, cans, and cups. Therefore, controlling the sale of drinks such as water and soft drinks could lead to successful MSWM planning. This concept was successfully applied in the UK by taking a deposit on these items; this deposit is refundable if the consumer returns the item (cup or bottle) for recycling (Jones, 2009). This strategy was successfully applied at the Rothbury Festival where 70% of generated MSW was recycled and 23% was composted (Jones, 2009).

However, MSWM during large events in many developing is still characterised as weak and incompetent (Alsebaei, 2014). While the vast majority of developed countries try to recover or recycle the entire quantity of MSW generated at events, MSW collection and disposal is still the main concern of many developing countries such as Saudi Arabia (Alsebaei, 2014). According to the Alsebaei (2014) study, more than 17 thousand tonnes of MSW was generated by more than 3 million pilgrims during the Hajj event in 2010. Despite the high fraction (66%) of recyclables (paper, plastic, metal and glass) during the Hajj event, all the MSW generated is directly disposed of into a landfill without resources recovery or recycling (Alsebaei, 2014). A similar practice was adopted during the Kumbh Mela pilgrimage in India where more than 300 tonnes of MSW are directly deposed of into the landfill with no treatment or resources recovery (Gangwar and Joshi, 2008). As well as these examples, a high incidence of littering, MSW accumulation around collection points and illegal dumping of MSW were reported during many large events such as three open-air festivals in Germany (Cierjacks et al, 2012), Hajj pilgrimage (Alsebaei, 2014), and Kumbh Mela pilgrimage (Gangwar and Joshi, 2008). Therefore, it is very important to comprehensively evaluate the MSWM system applied during any large event to identify the weaknesses and barriers that have led to this poor MSWM situation.

2.7 MSWM Evaluation Frameworks

Using properly developed indicators allows a city to review its own performance, in terms of service delivery, thus helping decision-makers to prioritise their actions for improvement (Wilson et al, 2015). Many researchers have developed indicators to measure the performance of particular aspects of MSWM systems. These have included MSW collection, collection of recyclables (Caio and Fernando, 2013), resource management (reduce, reuse, recycle) (Hotta, 2014), MSW prevention (Wilts, 2012) and zero waste management (Zaman, 2014a). Other indicators have been developed to examine other aspects including measuring the compliance with European Union requirements (Cifrian et al, 2012), comparing MSWM technologies (Menikpura et al, 2012), and evaluating MSWM programmes in US cities (Greene and Tonjes, 2014).

Among these, 'Wasteaware' benchmark indicators framework for ISWM systems (Wilson et al, 2015) comprehensively covers all aspects of a MSWM service (Figure 2.4). The aim of this framework is to provide an overview of a city's MSWM performance (to reveal clearly the weaknesses and strengths of MSWM aspects) and not to carry out a primary survey. It contains 12 quantitative and qualitative indicators used to evaluate any MSWM system according to its physical components (collection, disposal and recycling) and governance features (stakeholders' inclusivity, financial sustainability and sound institutions) (Wilson et al, 2015). Each of the qualitative indicators is derived from certain criteria to evaluate each aspect of the MSWM system. This framework has been developed over five years (Wilson et al, 2015) and has been tested in more than 50 cities around the world (Wilson, 2007; Scheinberg et al, 2010; Wilson et al, 2013a; Wilson et al, 2013b; Wilson et al, 2015). Thus, it can be considered as a well-developed framework, broadly covering all the features of the MSWM system, applied across a range of income levels and widely tested across a number of countries (Wilson et al, 2015).

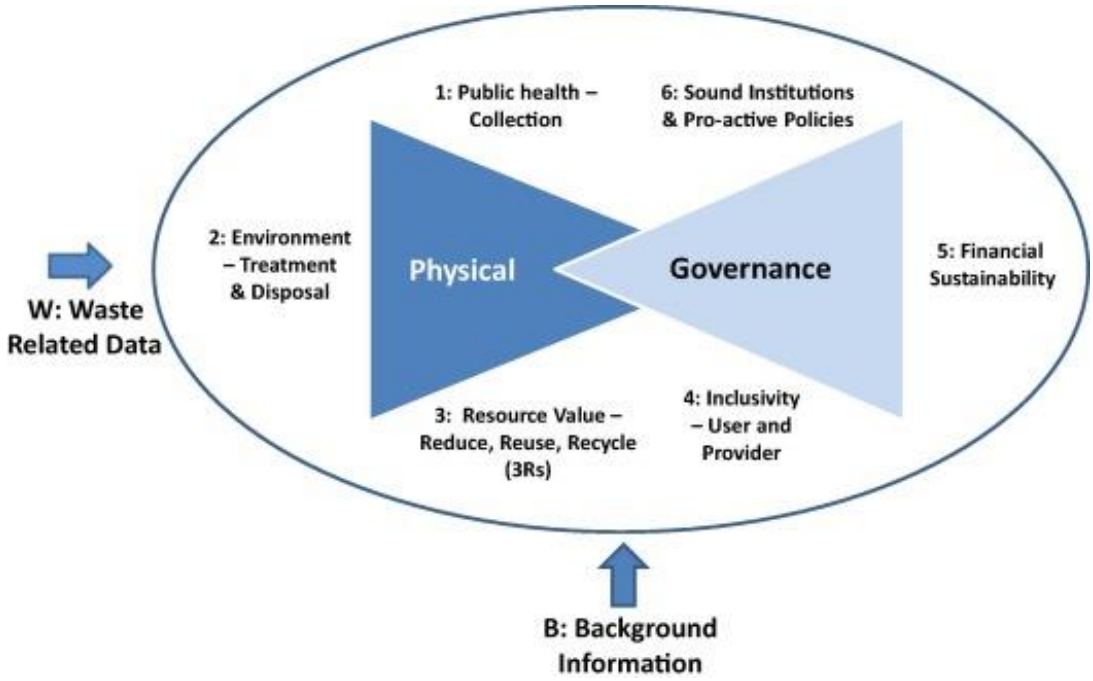

Figure 2.4: Wasteaware benchmark indicators for ISWM system (adapted from Wilson et al (2015))

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The framework also requires a summary of background features and MSW-related data to facilitate interpretation of the indicators and provide an appropriate comparison between cities (Wilson et al, 2015). The background data consists of income category, total MSWG and the total population while MSW-related data are yearly MSWG per capita and the four common components of the MSW; organics, plastics, paper and metals (Wilson et al, 2015). Therefore, a well-designed methodological approach is essential to collect comprehensive information about a city's MSWM system for accurate evaluation.

2.8 Theoretical Background on Data Collection Approaches

The methodological approach of a research study such as methods of data collection and the sources of the data is extremely important and connected to the ontological and epistemological assumptions of social reality (Grix, 2010). Two ontological viewpoints have inspired social research; these are objectivism and constructionism (Grix, 2010; Bryman, 2012). Objectivism implies that social phenomena exist independently and beyond social actors' influence (Bryman, 2012). The objectivism ontology shows that 'objective knowledge' is possible; because there is an unchanging reality which can be accurately accessed and utilised (Grix, 2010). Contrary to the objectivist view, constructionism suggests that social actors are continually constructing social phenomena and their

meanings (Bryman, 2012). Thus, the social phenomena and their meaning are not only produced through social interaction but also in a continuous state of change.

Epistemology seeks to answer the question of what constitutes an acceptable knowledge (Bryman, 2012; Gilbert and Stoneman, 2015). Similar to ontology perspectives, social research is divided into two viewpoints that are positivism and interpretivism (Bryman, 2012; Gilbert and Stoneman, 2015). The doctrine of positivism is that the social phenomena were made known through social actors' sense experience, people simply accept the sensory motivations and recount the reaction and thus contribute very little to knowledge (Miller and Brewer, 2003). Therefore, the endorsement or rejection of theory (knowledge) can only be revealed from data gathered through the way the phenomena are observed and experienced by the senses (Miller and Brewer, 2003). Thus, the data for the positivist paradigm of research is called 'hard data' indicating that this data is undamaged by the explanatory processes of the researcher (Creswell, 2009) and such data is numerical, seeking to measure and describe social phenomena by the attribution of numbers (Miller and Brewer, 2003). Techniques such as questionnaires, social surveys and experiments generate numerical data and supposedly extract phenomena that are untouched by people's interpretative and reality-constructing capacities (Miller and Brewer, 2003).

Interpretivism is the second paradigm of epistemology and how social phenomena can be known (Bryman, 2012). Contrary to positivism, interpretivism considers reality is a complex social construction of meanings, values, and experience that can be better understood through people's interpretive capacities rather than through sensory observation and experience (Grix, 2010; Bryman, 2012). Consequently, data for interpretivist study is acquired by the interpretations people give to their circumstances and experiences of reality. Denoted to as 'soft data', the interpretivist study data is typically verbal, pursuing to reveal and characterise social phenomena by the use of words (Grix, 2010; Bryman, 2012). Interpretive research data gathering techniques, therefore, involve observations, interviews, and documents that produce data mostly in the form of words (Grix, 2010).

2.8.1 Qualitative Versus Quantitative Research Approaches

Some researchers (Denscombe, 2002) believe that the variances between objectivism and constructionism are important since using one of these ontological theories will lead a researcher to adopt a different epistemological approach that can lead to different observations of the same phenomenon. The dichotomy between positivism and interpretivism has therefore created methodological distinctions between quantitative and

qualitative research views. In social science research, quantitative study is usually based on the assumptions of positivism while qualitative research relies on interpretivism (Denscombe, 2002; Bryman, 2012).

As the quantitative research is a numerically based approach (Bryman, 2004; Grix, 2004; Grix, 2010; Bryman, 2012), researchers who adopt this approach usually employ a highly structured approach in which competing justifications are constructed according to the relationships between variables (Grix, 2010). Consequently, quantitative research is usually condensed into as small a set of variables as possible which can explain as much as possible of a phenomenon (Miller and Brewer, 2003). The broader philosophical thinking of this approach is that general sets of relationships must be established which are robust across as many cases as possible (Miller and Brewer, 2003). The generalisation is, therefore, the main goal of establishing relationships and proving that these are general features of social life (Miller and Brewer, 2003; Bryman, 2012). This kind of approach is suitable for testing theories, identifying general patterns and making predictions (Miller and Brewer, 2003; Bryman, 2012).

In contrast, qualitative research tends to be based on the interpretivism assumption of social research, using data collection techniques that are flexible and sensitive to the social context (Grix, 2010). Techniques such as interviewing, observation, archival or other documentary analysis that do not rely on, but can include numerical measurements are usually used for in-depth investigation of a phenomenon (Ragin, 1994; Ragin and Amoroso, 2010). Qualitative investigators generally seek to amass data from their research on event, institution or location, with a goal of defining trends, patterns and relationships (Grix, 2004; Grix, 2010). The qualitative research, therefore, tends to revolve around case studies and social contexts instead of variables and hypotheses as in quantitative research.

In social science, some researchers take extreme positions on the relative merits of quantitative and qualitative methodologies (Preece, 1994). Some researchers argue that qualitative research is usually limited and non-representative (Bryman, 2012). This argument implies that the generated results for qualitative study cannot be generalised beyond the cases studied (Bryman, 2004; Bryman, 2012). The failure to generalise from limited samples or cases is seen to undermine the credibility of results obtained through qualitative study (Grix, 2010; Bryman, 2012). Another criticism of the qualitative study is the immersion of researchers in the social context they investigate which leads to a lack of objectivity and a tendency to use personal views instead of evidence to corroborate

arguments (Preece, 1994). As a result, a qualitative study is often accused of being unrepresentative, open to bias, whether this is conscious or unconscious, and even unscientific (Bryman, 2004; Grix, 2004; Grix, 2010; Bryman, 2012).

Similarly, quantitative research has been criticised for several reasons. Critics argue that researchers adopting quantitative research are often unwilling to move from correlation statements to causal statements and this can affect the understanding of the social phenomenon being studied (Silverman, 2000; Silverman, 2013). The quantitative research can be criticised as overdependence and excessive reliance on quantitative methods can lead to a neglect of the social context in which the measured variable functions are based (Grix, 2004; Grix, 2010). Reductionist is another criticism; using assumed or half-understood concepts are open to bias in many ways (Preece, 1994). Furthermore, numerical measurement is assumed to be difficult when it comes to some aspects of human activities such as human behaviour (Bryman, 2004; Grix, 2004; Grix, 2010; Bryman, 2012).

2.8.2 Mixed Methods Approach

Following on from the above debate, the question is whether the two approaches can be successfully combined in one study. Some scholars argue that method combination or triangulation is difficult because of the opposing ontological and epistemological assumptions of the two research methodologies (Lincoln and Guba, 1985; Blaikie, 2009). As the quantitative and qualitative studies are based on two opposing epistemological principles, combining two methodologies is unsuitable and denotes failure to recognise the difference between a paradigm and a method (Lincoln and Guba, 1985).

Contrary to the above viewpoint, other scholars suggest a triangulation process using both methodologies is useful regardless of their epistemological assumptions (Olsen, 2004; Grix, 2010; Bryman, 2012). Bryman (2012) has argued that methods themselves should be looked upon as mere tools for gathering data and should not be viewed as being rooted in epistemological commitments. Other methodologists such as Olsen (2004), Creswell (2009) and Grix (2010) identified that there is a considerable gain from the combination of the methods in a single research. Triangulation might be using different methods, sources and theories to address a social research question (Denzin, 1989; Bryman, 2012).

In the view of these researchers, quantitative and qualitative research approaches should not be considered as mutually exclusive but as complementary (Bryman, 2004). Employing more than one research technique will reduce or eliminate the weaknesses of each separate

method and will reap the benefits of each (Bryman, 2004; Grix, 2004; Grix, 2010; Bryman, 2012). Grix (2004) has recommended that it is generally good to adopt more than one method of investigation to enhance the chances of getting better and more reliable data in addition to minimising the odds of biased conclusions. These arguments provide a solid basis for integrating quantitative and qualitative approaches into social science studies.

Many scholars employed a mixed method approach to investigate the management system of MSW. For example, Peter (2016) adopted this approach to collect data from government officials, industry stakeholders and residential neighbourhoods in order to investigate MSWM issue in Greater Jos, Nigeria. This approach has also been employed to study the system of MSWM during the Hajj event in Mina, Saudi Arabia (Alsebaei, 2014). Using a mixed methods approach enabled Alsebaei (2014) to identify the weaknesses and strengths of the targeted system and propose future developments. Other researchers such as Ezeah (2010) and Baabereyir (2009) used the mixed method data collection approach to study the MSWM system.

2.9 Summary

This chapter reviews solid waste management practices in developed and developing countries. While service levels, environmental effects and management costs vary considerably, MSWM is arguably the most essential service that every city government provides for its residents.

A basic element of an ISWM system is having accurate and reliable information about the rate of MSWG as well as a precise prediction of it. Many modelling techniques were applied to estimate the rate of MSWG on several scales (individuals, municipality, city and country) using a range of explanatory variables (income, GDP, publication, age, gender etc.). Understanding of the key factors affecting MSWG is also progressively improving. Some of the aspects affecting MSWG and modelling techniques have been explored in this chapter. This helps to understand the effect of daily activities on the rate of MSWG.

The quantity of MSW generated per year is expected to be doubled or even tripled within a few years' time. Therefore, considerable efforts are being made to prevent, reuse and recover the waste. Some guidance and specifications related to MSWM have been introduced and applied. All these contribute to the improvement of MSWM and resources recovery. Many developed countries have already succeeded in recovering a high fraction of their waste by applying various modes of treatment. However, the vast majority of

developing countries, particularly low- and middle-income countries, are still suffering from poor MSWM. They are still focusing on MSW collection while struggling in using resource recovery techniques such as recycling.

It has been always emphasised that recycling is a very effective alternative to MSW disposal. It allows resources recovery and minimises the negative consequences of waste. However, the application of an MSW recycling programme is challenging due to the effect of a variety of aspects such as system design and recycled materials and public reaction and involvement. Scholars are increasingly exploring the factors that might affect the recycling intention and actual behaviour among the public to improve the recycling system. Many researchers suggested that a connection between recycling intention and variety of variables (age, gender, environmental awareness etc.) exists, however other scholars found no connection. These relationships need further investigation, particularly in developing countries, to improve the current MSWM practices.

On top of that, many large events take place in many countries around the world. Those events have the effect of generating very large quantities of MSW over several days. As well as the economic benefits of large events, many developed countries are trying to recycle and recover all the generated waste and minimise its negative impacts. On the other hand, there is a lack of data about events' MSWM in developing nations. The available information suggested that events' MSWM in developing countries is also poor, where heaps of MSW and bins overflowing can be easily seen. Besides, these wastes are transported and disposed of into dumpsites or landfills with poor environmental considerations. Therefore, the management system of MSW needs to be studied during events in order to provide a better understanding of problems and propose solutions to improve the current state.

Chapter 3
Research Methodology

3.1 Introduction

In this chapter, the general approaches and specific techniques adopted to address the goals of this study are concisely presented. Firstly, the research population and the methods employed in the selection of representative samples are highlighted. Then, the design stages of data collection instruments (questionnaires and interview guide) alongside data collection stages are outlined. Following that, data analysis techniques and the justification for adopting these techniques are stated. Additionally, the approach adopted to evaluate the municipal solid waste management (MSWM) system is summarised. Finally, techniques employed to model the relationships between municipal solid waste generation (MSWG) and participants' variables are displayed alongside techniques to investigate the relationships between individuals' variables and their recycling intention (RI).

3.2 Research Motivations

This study was conducted to provide an understanding of problems affecting MSWM during large (multi-million) religious events (REs) due to the limited available data to understand the nature of MSWM during REs. The Arba'een is one of the largest annual gatherings in the world and takes place in Kerbala, Iraq and it was selected for evaluation of the performance of the MSWM system, as there is no prior research on that system during this event. The 'Wasteaware' ISWM benchmark indicators framework, an important and widely used tool for assessing MSWM systems, was used to assess the performance of the MSWM adopted in Kerbala during the Arba'een. This framework was adopted among several evaluation tools (Scheinberg et al, 2010; Laurent et al, 2014; Zaman, 2014b; Zaman, 2014a; Wilson et al, 2015) to ensure that Kerbala's MSWM system applied during REs is comprehensively evaluated.

To develop and implement effective MSWM programmes, it is globally recognised that having an accurate and reliable estimation of the quantity of generated and collected MSW is necessary (Mentaschi et al, 2013; Intharathirat et al, 2015; Parisi Kern et al, 2015; Azadi and Karimi-Jashni, 2016). The lack of historical data on MSWG in developing countries, particularly during REs has made the study of MSWG a priority (Azadi and Karimi-Jashni, 2016; Ghinea et al, 2016). Accordingly, the generation rate of MSW from two of the main MSW generators during REs (hotels and camps) has been investigated in this study.

Questionnaire surveys and on-site MSW audits were conducted with the managers of the hotels and the camps to estimate the mass of MSW produced from those generators and to define the variables (hotels' and camps' characteristics) that might have a significant influence on MSWG. Based on the surveys, validated numerical models were developed to predict MSWG from hotels/ camps according to their features.

In addition, many environmental organisations emphasised the importance of adopting recycling and resources recovery as the main options to manage MSW and reducing the negative environmental impact of events (Alsebaei, 2014; Barber et al, 2014). However, very limited research has been conducted to investigate the environmental impacts of events (Getz, 2010; Collins et al, 2012; Getz and Page, 2016) and to study pilgrims' intention toward participation in MSW recycling during REs (Barber et al, 2014). Although recycling has not been yet considered as an option for MSWM in Kerbala, particularly at large REs, a questionnaire survey with the pilgrims was conducted to investigate the relationship between the pilgrims' demographic and their intention toward participation in a future recycling system during events. The RI of accommodation managers (hoteliers and camp owners) were also investigated. Using questionnaire surveys, the demographic of accommodation managers and the features of their establishments were implemented to study their future RI. As a result, logistic models were developed in this study to ascertain the participants' (hoteliers and camp owners and pilgrims) willingness to practice MSW recycling according to their variables.

The outcome of this study will facilitate the critical decisions undertaken by the MSWM authorities during large REs, particularly in Kerbala by identifying the key issues to be addressed from a waste and resource management perspective. Predicting the rate of MSWG and the identification of the factors affecting this rate could be a valuable aspect for designing and planning MSWM services including storage, collection, treatment and disposal. This study will also be useful for the design and planning of future recycling schemes during the Arba'een and other similar REs in other cities. To achieve these outcomes, rigorous and robust research methodology is imperative to understand the relevant complex issues.

3.3 Research Approach

As this study aims to evaluate the present activities of MSWM in Kerbala during REs, particularly the Arba'een event, the varied nature and sources of the information required

and the limited time available to conduct the fieldwork in such crowded events made the mixed method approach appropriate among several data collection approaches discussed in section 2.8. The choice of the mixed method approach was justified on several grounds. First, the combination of methods was adopted to achieve logic triangulation since no single method could fully capture all related aspects of the study (Denzin, 1989). Besides, this approach enabled the researcher to crosscheck the data collected by various techniques, thereby, enhancing the validity and reliability of the results (Bryman, 2012). Furthermore, it made exploring the research questions from different viewpoints possible, which led to a wider understanding of the issues connected with MSWM during events. This methodology provides a good opportunity to obtain detailed information from the different categories of participants including MSWM services providers, users of the services and communities affected by waste management facilities during REs.

In line with this approach, tools such as on-site observation, field audit, interviews, questionnaires, and documentary analysis were combined to collect the required data. According to the framework of this study shown in Figure 3.1, the study has four main stages: identifying the goals of the study and developing data collection instruments; data gathering using several research methods; evaluation of the present MSWM adopted during REs using Wasteaware benchmark indicators; predicting MSWG using numerical models alongside investigating users' RI using logistic techniques. More details about the relationship between the research objectives and methods as well as the supportive references for the chosen research methods are given when each method is described in detail.

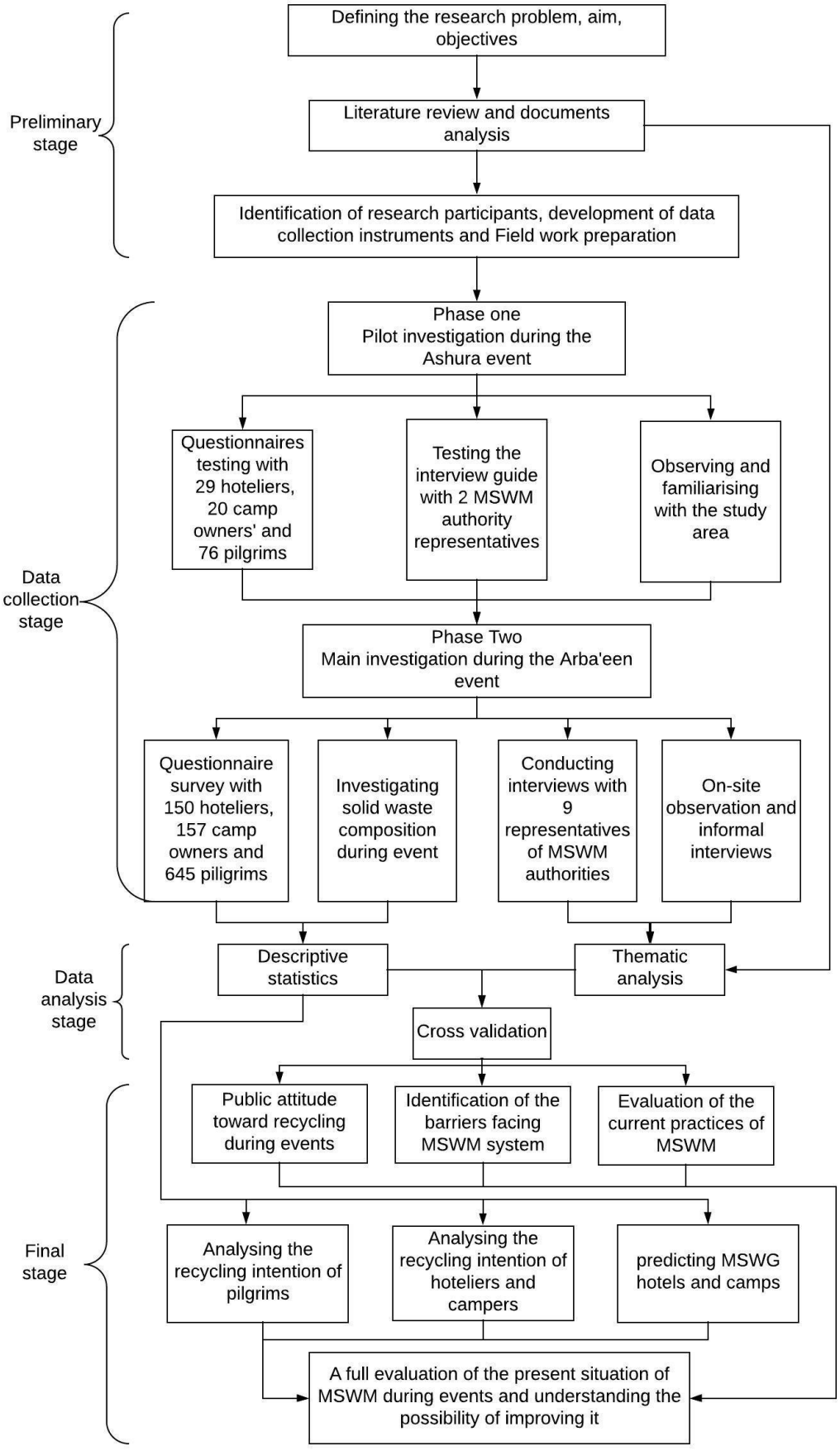

Figure 3.1: Study framework

3.4 Study Population

Since Kerbala hosts several large religious commemorative events that attract millions of pilgrims on an annual basis (Mujtaba Husein, 2018), all pilgrims are involved in some aspect of MSWM (produce waste or require MSWM services) and are regarded as the population of this study. The institutions (section 1.4) that are responsible for delivering MSWM services during REs were also considered in this study, as MSWM authorities can have comprehensive and rich information about MSWM services and the barriers facing them. Thus, senior officers who have access to detailed data about the MSWM system, particularly during REs, with long experience in Kerbala's MSWM institutions were targeted. Besides that, the accommodation establishments that host the pilgrims were also included in this study. Many scholars (Ball and Abou Taleb, 2010) regarded hospitality accommodation as one of main MSW sources in tourist destinations. Accordingly, the managers of the pilgrims' accommodation (hoteliers and camp owners) were targeted in this research, as they can provide detailed information about the characteristics of their accommodation (e.g. area, capacity etc.) and MSWG and composition. Table 3.1 presents the main stakeholders that were targeted for the current study.

Table 3.1: Key Participants in this study

Stakeholders	Participants
MSWM services providers	Kerbala Municipality (KM) (senior officers)
	Kerbala Municipalities (KMs) (senior officers)
	Holy Shrine authorities (HSA) (senior officers)
MSWM services users	Hoteliers (the mangers of the hotels or their representatives)
	Camp owners (the managers of the camps or their representatives)
	Pilgrims (individual pilgrims participating in the event)

3.5 Data Collection

Methods and procedures used in data collection and analysis are of great importance in research. The nature and size of data collected define what method and procedures are used for data collection as well as analysis. Figure 3.1 illustrates the process and key phases followed in the data collection stages.

Prior to data collection, research ethical approval was required and granted by the Research Ethics Committee, Liverpool John Moores University (Approval number 16/CIV/002 shown in Appendix I). Then, the author contacted the HSA (several institutions that are responsible for organising REs in the city of Kerbala in co-operation with other governmental institutions such as Kerbala governance) represented by Kerbala Centre for

Studies and Research, for permission to carry out the study. The authorities supplied several research assistants (A group of employees with bachelors of sciences degrees and trained to conduct surveys professionally) to conduct the field survey as well as contacting all related institutions to facilitate the task of the researcher.

Subsequently, a pilot investigation was carried out over 10 days during the Ashura event in 2016 as the first phase (Figure 3.1). This phase enabled the researcher to be familiarised with the study environment, identify key stakeholders, closely observe the current practice of MSWM, and pre-test data collection instruments (questionnaires and interview schedule). In the second phase, the main investigation was performed over 15 days during the Arba'een event in the same year. Figure 3.2 depicts the relationships between the adopted data collection activities and the research aims and objectives.

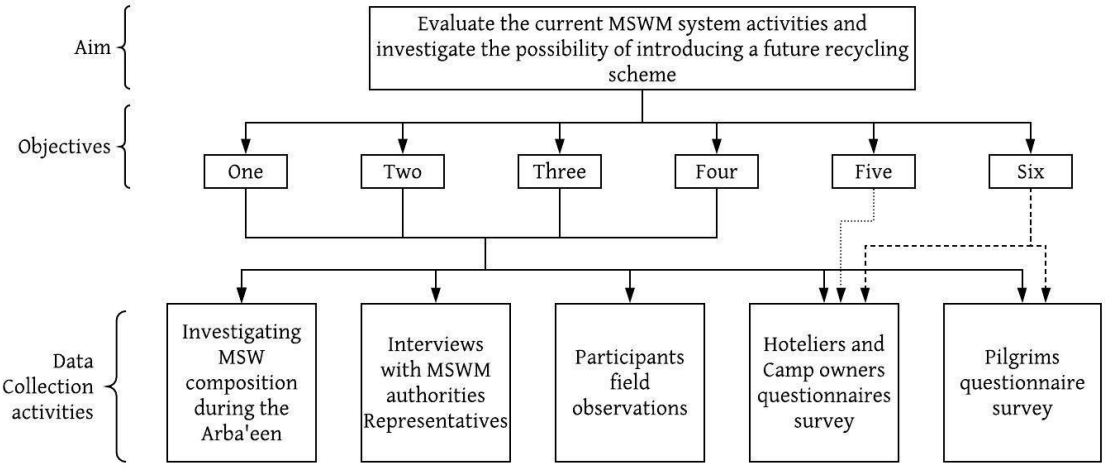

Figure 3.2: Data collection activities and their relation with research aim and objectives

3.5.1 Interviews with MSWM Authorities

The main goal of selecting MSWM authorities was to develop a comprehensive understanding of the current practices of MSWM in the city during REs, to obtain undocumented data about management services and key waste-related information (quantity and composition) and to delineate problems facing the current system in the view of the management authorities. KM (city centre based), KMs (outskirt districts based) and HSA (old city based) were identified as directly responsible for the provision of waste management services in the city and during events. Figure 3.3 illustrates the jurisdiction area of each institution during events.

Interviewing is a powerful technique for gathering qualitative data as it allows respondents to report on their views, beliefs, concerns, experiences and interactions (Bryman, 2012; Bryman, 2015). It also creates the opportunity for an interviewee to ask for clarification when he/she does not comprehend a question just as the interviewer can request an expansion on a response given by participants. Furthermore, it guarantees a high response rate since all questions are replied to or, at least, attempted by the interviewee. Therefore, this technique was employed to obtain data from a number of MSWM authorities' representatives.

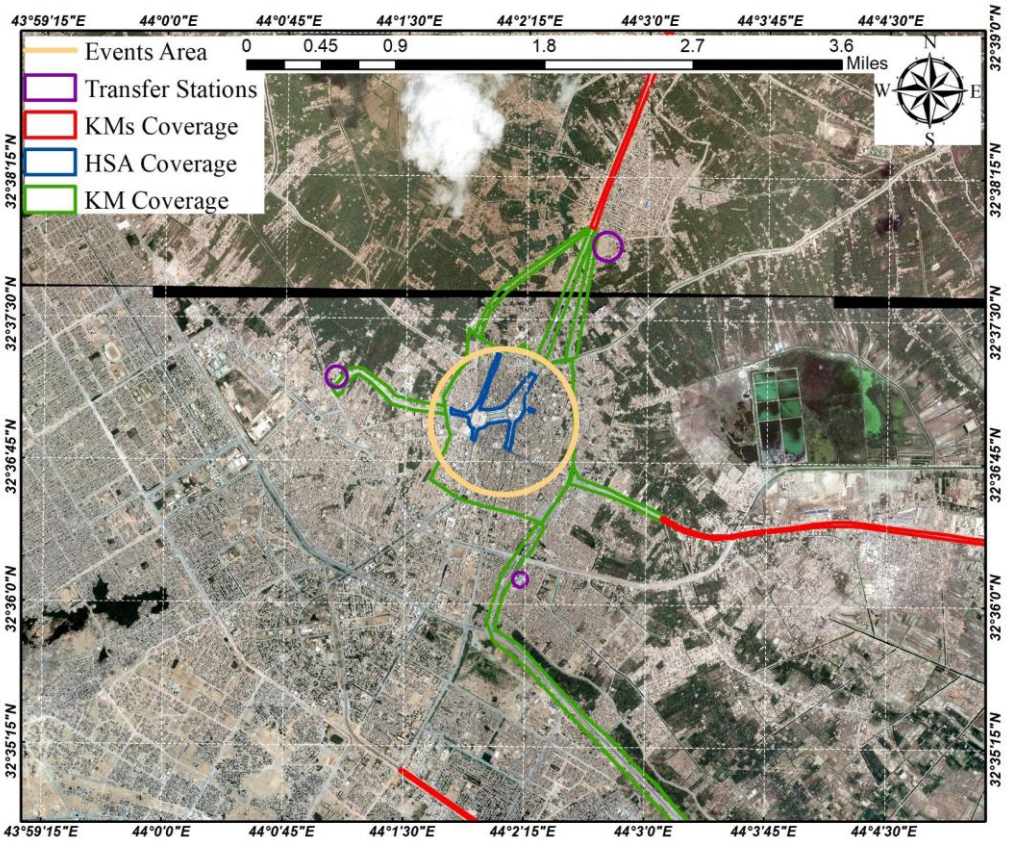

Figure 3.3: Jurisdiction areas of MSWM authorities during events (Kerbala municipality, Iraq)

3.5.1.1 Developing the Interview Guide

Guided by the aims of this study of investigating MSWM during the Arba'een, a semi-structured interview schedule (encompasses open-ended, close-ended and follow-up questions) was designed following the advice of Bryman (2012) on the use of the interview as a data collection instrument (Appendix A). The items in the interview schedule were formulated after carrying out a comprehensive literature review about MSWM (MacDonald, 1996; Scheinberg et al, 2010; Cifrian et al, 2012; Wilts, 2012; Greene and Tonjes, 2014;

Jones et al, 2014; Zaman, 2014b; Wilson and Velis, 2015). The schedule was divided into nine sections covering various issues in MSWM such as Key waste-related data, stakeholders involvement in MSWM and current MSW collection and treatment services. The schedule also covered issues relating to financial and logistics constraints to MSWM operations as well as public education and involvement.

3.5.1.2 Ensuring Validity and Reliability

To ensure the schedule is valid and reliable as well as avoid any positive bias, first, it was developed according to the objectives stated in this study. Then, it was sent to a panel of waste management and survey professionals (two senior researchers from Liverpool John Mores University, an expert in MSWM from the University of Technology, Iraq and an expert in data collection and survey methods from Kerbala Centre for Studies and Research, Iraq) asking them to review the content and establish construct validity. Additional changes were made in light of the experts' suggestions. In order to check potential areas of ambiguity and comprehensiveness, two key staff (senior managers) from Kerbala MSWM authorities were asked to review the schedule and comment on its clarity. Based on staff recommendations, the schedule was amended and used in the main survey during the Arba'een.

3.5.1.3 Conducting the Interviews

Bryman (2012) outlines several sampling approaches to select participants to interview, such as purposive and random sampling. In this study, purposive sampling was employed to recruit municipalities' participants. This technique has been selected as it enables the researcher to select specific participants that have rich and detailed information about the current MSWM system adopted in Kerbala such as key waste-related data, MSWM operations, and barriers (operational and governance) against developing MSWM. The participants were senior officers in the afore-mentioned institutions (Section 3.5.1), who can provide comprehensive and rich information about specific areas of interest. During the Arba'een in November 2016, the researcher approached 15 individuals out of 24 senior officers working in Kerbala's MSWM authorities, to describe the objectives of the study and subsequently arrange an interview appointment. Of these, 9 agreed to participate in the study. The interviews were anonymous and carried out both before and throughout the event during working hours. All interviews lasted between one and two hours, responses recorded through the use of notes as this study is not interested in the way the participants responded, but what the participants had to say about the subject (Bryman, 2012). As the official

language in Iraq is Arabic, the interviews were conducted in Arabic; the responses were translated into English by the author for analysis.

3.5.2 Hoteliers', Camp owners' and Pilgrims' Questionnaire Survey

To develop an ISWM system, a precise prediction of the quantity of MSW generated and an understanding of the preferences of the system users are essential (Chung and Lo, 2004; Amasuomo et al, 2015; Intharathirat et al, 2015; Azadi and Karimi-Jashni, 2016). According to the latest survey on hotels and tourist accommodation published by Central Statistical Organization Iraq (Central Statistical Organization Iraq, 2016b), Kerbala has 667 hotels encompassing almost half of the country's hotels (Figure 3.4 shows hotels rating), the majority of these are small hospitality businesses (financed by one individual or small group, directly managed by their owners in a personalised manner and not through the medium of a formalised management structure). These hotels are fully occupied and providing services as well as the basic needs of their guests during the events. To meet the needs of the huge number of pilgrims, the city also contains about 8,400 camps which are also managed by their owners located within the administrative boundaries of Kerbala (Alkafeel Global Network, 2016a). According to a private interview with the head of the department of Rituals and Hussayni processions, HSA, the majority of hotels and around 600 camps are located within the centre of the events area (Figure 3.5). Thus, due to the huge number of camps and hotels as well as the short time of the event period, the camps located in the centre of the events and all the hotels were considered as the total population of the surveys in this study.

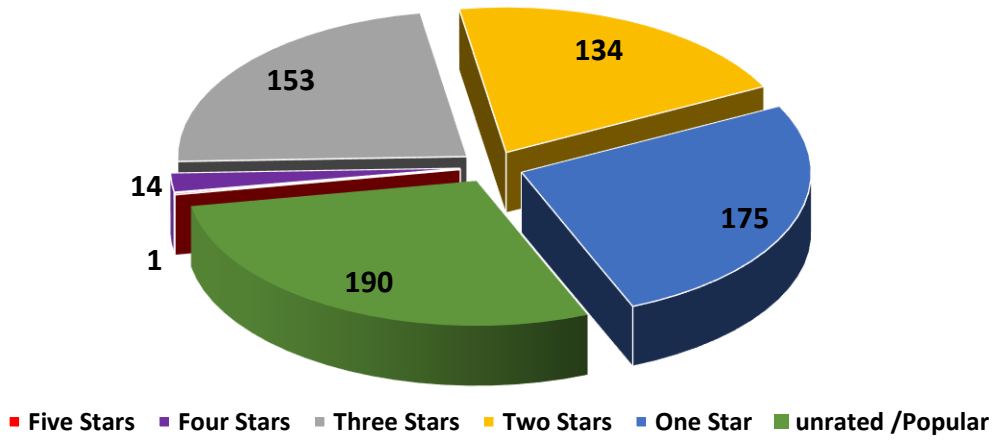

Figure 3.4: Hotels rating in Kerbala city (Central Statistical Organization Iraq, 2016b)

To extract representative samples from such large populations (hotels, camps and pilgrims), the questionnaire is adopted, as it is one of the most widely used tools for data collection

(O'leary, 2004; Bryman, 2012; Bryman, 2015). It facilitates collecting standardised data in respect of the same variables for every participant in terms of cheap and quick administration (Bryman, 2012).

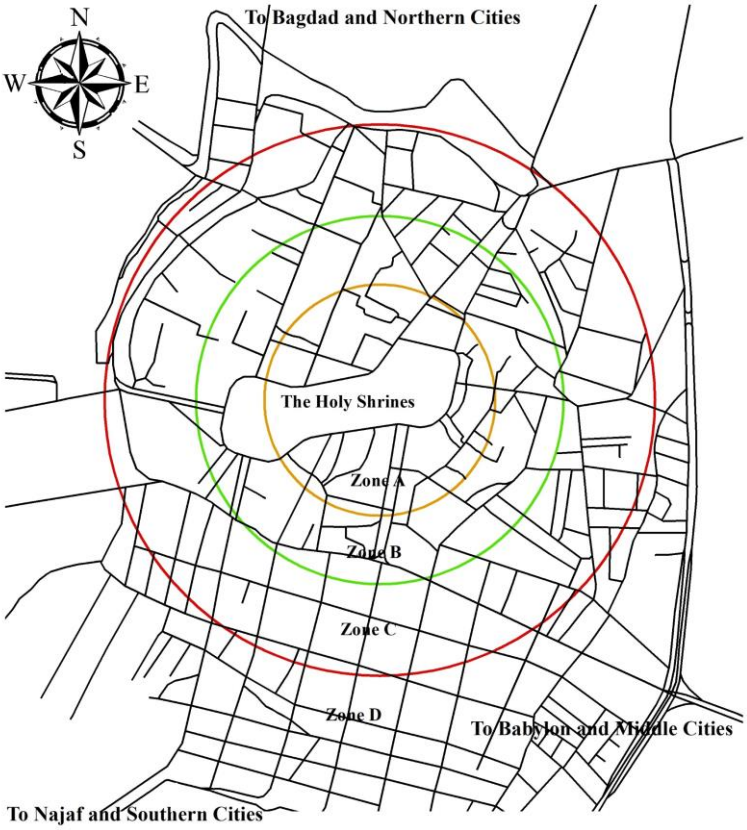

Figure 3.5: The Central area of the events (Kerbala old city) and data collection zones

3.5.2.1 Development of the Questionnaires

To meet the objectives of the current study, three questionnaires were developed (Appendix B, C and D). Two structured questionnaires (encompasses open-ended and close-ended questions) targeting hoteliers and camp owners were divided into four parts. Part one collects data about the demographics of the participants and the characteristics of the accommodations (size, area, location and expenditure). Part two gathers information on the quantity of MSW and recyclable materials produced in each participated accommodation. The other two parts focus on the intention of accommodation managers about participating in MSW recycling scheme during events, and their assessment of the present MSWM operations.

Based on the literature review, MSWM authorities should adopt a waste source separation strategy and force users by law to comply with it by making it compulsory (Alsebaei, 2014). Thus, a third structured questionnaire targeting pilgrims was designed in one section to

identity pilgrims' intention to sort their waste at source (optional and mandatory), their education level and environmental knowledge and other information while they are in Kerbala.

3.5.2.2 Reliability and Validity

To achieve reliability and validity, all questionnaires were designed over several stages with great care, matching the questions with the objectives of the study. Firstly, the questionnaires' items were formulated after carrying out an extensive literature review (Beigl et al, 2008; De Feo and De Gisi, 2010b; De Feo et al, 2013; Edjabou et al, 2015; Azadi and Karimi-Jashni, 2016; Grazhdani, 2016; Pirani and Arafat, 2016). In the second stage, questionnaires were reviewed by a panel of MSW management and survey research experts to check their construct validity. They were then revised and corrected, according to the suggestions and feedback from the experts in order to be tested in a pilot study.

3.5.2.3 Pilot Testing of the Questionnaires

Bryman (2012) stated that it is desirable to conduct a pilot test before administrating the self-completion questionnaire in order to ensure that the developed questionnaire functions well. Despite that the developed questionnaires are not self-compilation ones, pilot studies were conducted during one RE (Ashura) to check the content validity of questionnaires, possible areas of ambiguity and comprehensiveness. Accordingly, 29 hoteliers, 20 camp owners and 76 pilgrims, were asked to complete the questionnaires and comment on their clarity or areas of ambiguity. Based on the results of the pilot study, questions that seem not to be understood or make the respondents uncomfortable have been revised and amended to be used in the main survey during the Arba'een.

3.5.2.4 Administering the Questionnaires

To reflect a population accurately, literature presents a variety of sampling approaches such as non-probability sampling (theoretical and snowball) and probability sampling (random, systematic and stratified). Each sampling approach employs a specific method and aims for a specific outcome from selected participants. For example, the goal of non-probability sampling is to sample cases in such a way, that those sampled are relevant to the research questions that are being posted. However, such an approach does not allow the researcher to generalise the finding to a population (Bryman, 2012). Alternatively, probability sampling provides an equal chance of inclusion to each unit in the selected sample, which allows the researcher to generalise the finding from a sample to the population (Rea and Parker, 2014).

Based on the variety of sampling approaches presented in the literature (Bryman, 2012; Rea and Parker, 2014), and guided by the objectives of this study, simple random sampling was selected in this study (Bryman, 2012). This technique enables the researcher to randomly select participants (hoteliers, camp owners and pilgrims) and generalise the findings to the total population. Rea and Parker's (2014) method was used to determine the sample size (Appendix F), as it is widely adopted among researchers to calculate the representative sample size. 123 hotels and 121 camps were required to achieve a 95% confidence level with confidence intervals of 8% in the study area, this from a total population of 667 hotels and 600 camps. Of 12 million pilgrims, 385 pilgrims were also required to achieve a 95% confidence level with confidence intervals of 5%.

Based on this approach, the event area was divided into four zones (Figure 3.5). The survey took place over a period of 15 days during the Arba'een event in November 2016. The research team visited three to five hotels, three to five camps and contacted about 20 pilgrims, in person, in each zone, on each survey day. All visited accommodation establishments in all zones were given an information sheet describing the research objectives, the interview outline and details about confidentiality. In total, the research team approached 180 hotels, 160 camps and about 700 pilgrims, in person, to obtain their permission to participate in the study. Of these, 150 hoteliers, 157 camp owners and 645 pilgrims consented to participate in the survey. Following this, the questionnaire items were read to each participant and his/her responses were recorded accurately. The research team ensured that all of the questionnaire items were properly addressed. Using this method, every hotel, camp and pilgrim in the city centre, has an equal chance of being included as part of the sample. In this way, a representative sample is more likely to be targeted, the findings from the sample then generalised to the total population from which it was selected.

After completing the questionnaires, an on-site audit was conducted at targeted hotels and camps with the aim of estimating the quantity and the composition of MSW generated from each. Following the methodology used by the Waste and Resources Action Programme (WRAP, 2011), the on-site MSW audit includes defining the number of waste bins in the accommodation, the size of these, how many times per day bins are emptied and the average fill level for each bin over the event duration. This process aimed to identify the volume of the MSW generated by each hotel or camp. To convert the volume to mass, the on-site density of the MSW was calculated. This process included randomly selecting two full bins to record their weight and volume. MSW density was estimated by calculating the average

waste weight divided by the average volume of the two bins. This density was then used to calculate the total mass of MSW generated from the targeted hotel or camp over a one day period according to the following equation:

$$M = D * V \quad (3.1)$$

Where:
M is the mass of the MSW produced in each accommodation.
D is the on-site density of the MSW.
V is the estimated volume of MSW produced over a specific period.

To validate this estimation, the actual amount of MSW generated from 10 randomly selected hotels from the total sample was recorded and compared with the estimated amounts.

3.5.3 Investigating MSW Composition at the Event

To evaluate the present MSWM system during events, identification of the material composition of the MSW generated during the event was required (Zaman, 2014a; Wilson et al, 2015). This was done based on international standards ASTM D5231-92 (2003) and adjusted to the local environment.

3.5.3.1 Sampling and Sorting Procedure

The number of sorting samples used in the current research was calculated according to Equation 2 that is identified in Appendix F . Several parameters, namely level of confidence, standard deviation, level of precision and the mean are used to estimate the number of samples. The governing component of the MSW was selected as corrugated because of the MSW generated during the Arba'een was mixed. The estimated mean and standard deviation were 0.14 and 0.06, respectively, a precision of 10% and a confidence level 90% required. Consequently, 52 samples were required to be sorted during the Arba'een.

The MSW sorting method was based on the waste samples collected over a period of ten days (November 5th to November 15th, 2016) during the Arba'een. A ten-day period was chosen to ensure that fluctuations in the composition of the waste stream during the event were considered. 60 samples were collected from three Temporary Transfer Stations (TTSs) around the event area, 2 samples per day from two randomly selected trucks. The locations of these TTSs are shown in Figure 3.6. On selection of the collection vehicle, the driver was directed to discharge the truckload in a secured area. From each MSW vehicle load, a sample weighing approximately 100 kg was prepared, according to the standards test, this sample then was manually sorted on a secure sorting platform into the waste groups shown in Table 3.2.

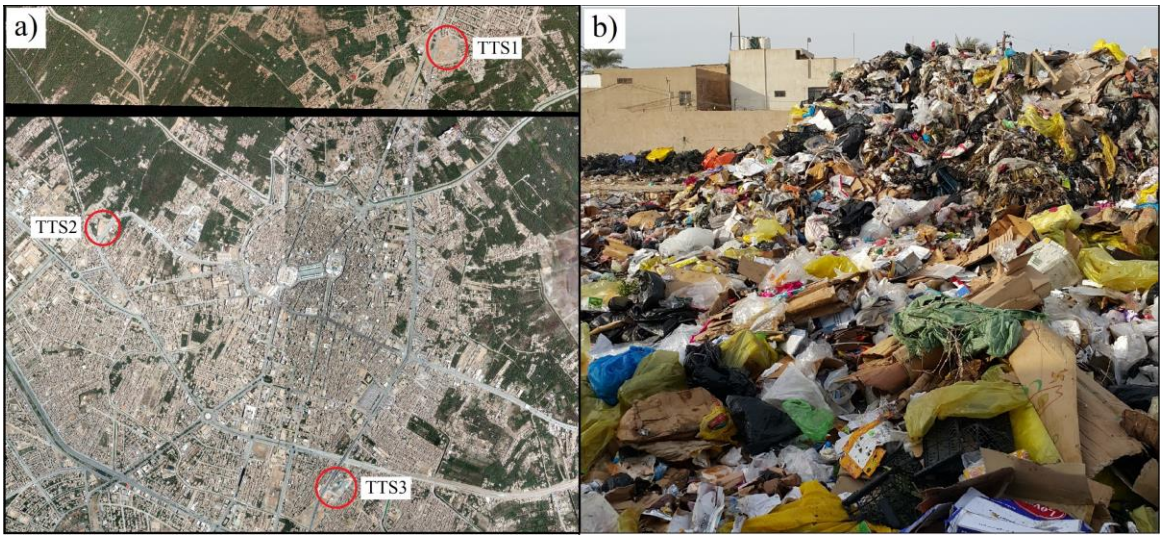

Figure 3.6: (a) Aerial image of TTSs sites, (b) Site image for transfer station one (Kerbala municipality, Iraq)

3.5.3.2 Statistical Analysis

After data collection, basic descriptive statistics were conducted to find the mean of each MSW component and the lower and upper level of confidence intervals at a 95% level of confidence. The level of confidence is defined as the boundaries where it is assumed the actual mean falls (Field, 2013).

Table 3.2: Descriptions of the sorting groups

Groups	Items
Organic waste	Food waste (cooked and uncooked) including bones, garden waste, yard waste and other plant parts.
Paper and cardboard waste	All paper such as office paper, newspaper, brown paper, high-grade paper, packing board, carton boxes and corrugated paper.
Plastic waste	All plastics, for example, bags, packaging, pens, bottles and toys.
Glass waste	All glass, for instance, glass pieces and glass bottles (without metal or plastic lids).
Metal and aluminium waste	All kinds including tin cans, aluminium cans, bi-metal cans, lids and aluminium foil.
Other waste	Textile, wood, rubber, shoes and batteries (anything that does not fit into the categories above).

3.5.4 Field Observation and Informal Interviews

Observation is an important technique used to address the goals of a study together with other data collection techniques (O'leary, 2004). It generates a wider range of data and enables the researcher to obtain information which would have been unavailable in other formats (Bryman, 2012; Bryman, 2015). Mackellar (2013) also reported that the

participants' observation technique could reveal a new view, which enables the investigator to study an event in great depth. Thus, to obtain a comprehensive background to the current MSWM in Kerbala during the Arba'een and to reinforce the results of the interview, an unstructured observation was employed in this study (Bryman, 2012), as it enables the observer to note things that are unexpected. The observation focused on several aspects of the MSWM system in the city including storage, collection services, transportation and treatment. It enabled the researcher to discern some of the MSWM challenges during REs and investigate pilgrims' behaviour while they are in Kerbala. The observation took place in streets, camps, hotels and TTSs. In addition, photographs were captured with the observations so that observations made at the time could be checked against the photographic evidence. These photographs were taken after permission from Kerbala authorities had been granted.

3.6 **Data Analysis**

Quantitative and qualitative data were collected in this study. Prior to analysis, all questionnaires were examined for errors in the filling and missing data. Then, the numerical data were fed to the Statistical Package for the Social Sciences (SPSS), which is one of the most widely used computer software packages for the analysis of quantitative data, particularly in survey organisations (Bryman, 2012). The latest version namely IBM-SPSS-23, which was developed by International Business Machines Corporation, is used to perform the statistical analysis and modelling. Descriptive analyses were performed to generate a picture of the data collected on such MSWG, composition, and barriers facing the MSWM system in the view of the respondent and their satisfaction with MSWM services. For scale data, mean and standard deviation were employed to express the quantitative variables. For categorical data, mode and range were used to point out the variables (Aday and Cornelius, 2006; Long and Freese, 2006).

For qualitative data, interviews and field observation were translated into English, transcribed and then fed into QSR's NVivo version 11 software, a popular software designed to organise and analyse qualitative or unstructured data (textual data) such as interview responses (Bryman, 2012). This software enables the researcher to label, separate, compile, and organise textual components that seem to be important to the study to be analysed (Bryman, 2012). Thematic analysis, one of the prominent means of analysis, is used in this study (Thomas and Harden, 2008; Bryman, 2012). Ryan and Bernard (2003) recommend looking for repetitions, indigenous typologies, metaphors, transitions and linguistic

connectors to identify themes. This process was carried out over two overlapping stages: line-by-line coding and the organisation of codes into related areas to construct themes. In the first stage, 307 codes were generated covering the entire spectrum of MSWM issues including stakeholders, finance and legislations. Secondly, similarities and differences between codes were examined in order to group codes into a hierarchical structure. This procedure led to the generation of a tree-like structure comprising several layers, which allowed the organisation of 78 themes (Appendix F). Figure 3.7 depicts an example of the tree relationship between themes relating to collection services and other management issues such as public awareness. Finally, the results of the analysis were used to evaluate the present MSWM system in relation to the Wasteaware benchmark indicators (Scheinberg et al, 2010; Wilson et al, 2015).

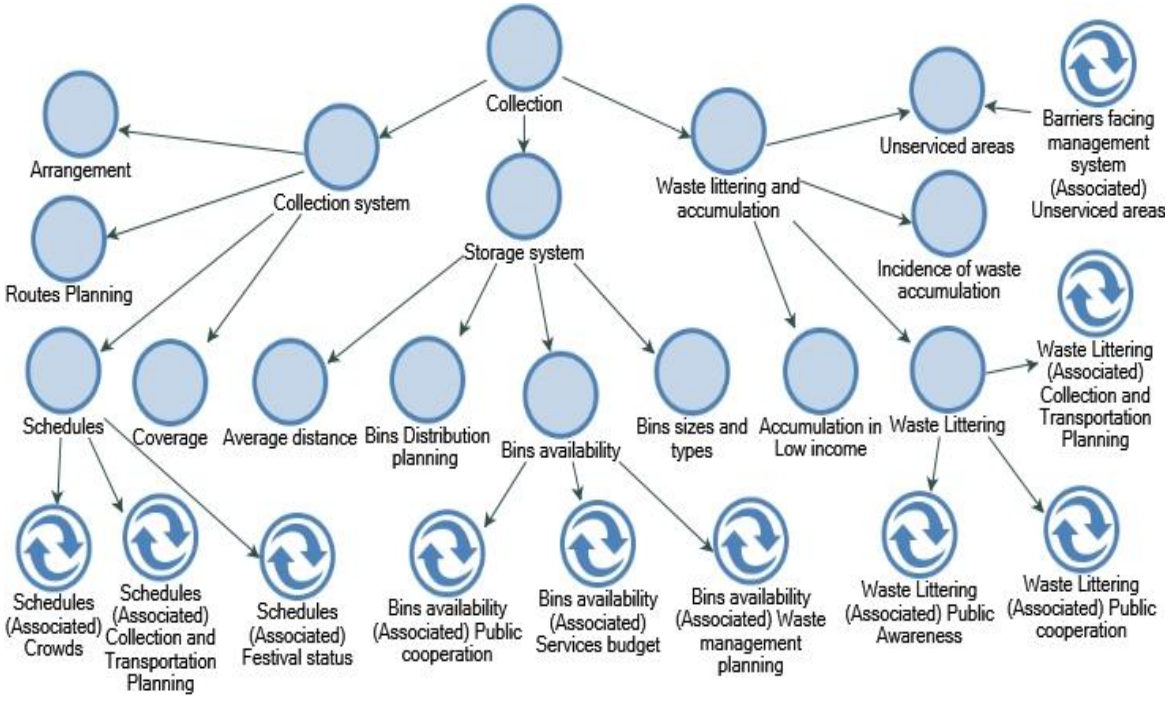

Figure 3.7: Tree relationship between collection services themes

3.7 Evaluating the Performance of MSWM

Wasteaware indicators (Wilson et al, 2013b; Wilson et al, 2015) aim to raise stakeholder awareness regarding MSWM performance, to identify the direction for future improvements and to allow comparison between cities. Used as the evaluation framework in this study, it evaluates the MSWM system over two dimensions: physical/technical components and governance aspects. A summary of background information and waste-related data was also included to facilitate the interpretation of indicators and provide an appropriate comparison between cities (Wilson et al, 2015).

Background information consists of income category and total MSWG and the total population (Scheinberg et al, 2010). Waste-related data varies widely between cities and is vital for MSW treatment technology choices (Wilson et al, 2012). This includes yearly MSWG per capita and the four common elements that comprise MSW; organics, plastics, paper and metals (Scheinberg et al, 2010; Wilson et al, 2015).

According to Wilson et al (2015), the physical and technical components consist of three key categories: MSW collection services; MSW treatment and disposal and resource management. Each category includes a quantitative indicator and a composite indicator for the quality of service provision. Collection services have three indicators; collection coverage, MSW captured by the management system and the quality of collection services. The MSW treatment and disposal indicator evaluates levels of environmental protection during MSW treatment. It includes two indicators; control over MSW treatment or disposal and the degree of environmental protection during treatment and disposal. Similarly, resources management evaluates resource recovery according to two indicators; recycling rate and the quality of recycling services (Scheinberg et al, 2010; Wilson et al, 2015).

The governance aspects of an MSWM system are assessed according to three main categories; inclusivity (users and providers), financial sustainability and soundness of institution (national policies and local institutional coherence). Wilson et al (2015) developed composite indicators to evaluate each of these aspects. Inclusivity has two indicators which cover the degree of involvement of key stakeholders; user and provider inclusivity. Two composite indicators are also used to assess the national MSWM framework and the degree of institutional coherence. Financial sustainability has one composite indicator, which encompasses six criteria covering the full spectrum of financial aspects of an MSWM system.

Based on interviews with MSWM authorities, on-site observations, MSW investigation, questionnaire survey and the judgment of the researcher, scores were assigned to each criterion according to the User Manual (Wilson et al, 2015). This manual offers comprehensive guidance on the definitions of the indicators, descriptions, interpretations, assessment and scoring against each criterion for composite indicators (Appendix H).

3.8 Statistical Modelling

Regression is a set of statistical techniques that assess the association between one response variable (DV) and several independent variables (IVs) (Pallant, 2011; Field, 2013;

Tabachnick and Fidell, 2013). Based on the type of DV (continuous or categorical), the assumptions of regression analyses (Tabachnick and Fidell, 2013) and study objectives, two regression techniques were implemented in this study. Multiple Linear Regression (MLR) was used to predict a continuous DV (MSWG) based on multiple IVs (hotels' and camps' features) (Pallant, 2007; Tabachnick and Fidell, 2013). This technique has been selected over other analysis techniques such as artificial neural networks (ANN) and support vector machines (SVM) (section 2.2.3.3) due to its simple algorithm and theory (Intharathirat et al, 2015), wide and successful application in modelling MSWG (Thanh et al, 2010), achievable validation and relatively low overfitting problems (Azadi and Karimi-Jashni, 2016). While, Logistic Regression (LR) attempts to predict the probability that an observation falls into one of two or more categories of a categorical DV (sorting intention) based on one or more IVs (factors expected to have an influence on RI) that can be either continuous or categorical (Pallant, 2011; Field, 2013; Tabachnick and Fidell, 2013). This technique has been adopted in this study, as it explores the relationships between several IVs and binominal or multinomial DV (Tabachnick and Fidell, 2013). Modelling was performed using the IBM SPSS-23.

3.8.1 Predicting MSWG Rate from Hotels and Camps

Due to its simple algorithms and theory, MLR is commonly applied to predict MSWG (Jahandideh et al, 2009; Parisi Kern et al, 2015). In these techniques, the interrelationship among several IVs and a DV are modelled by fitting a linear equation to the training dataset as shown in Equation (3.2) (Tabachnick and Fidell, 2013; Azadi and Karimi-Jashni, 2016):

$$\hat{Y} = B_0 + \sum_{i=1}^{n} B_i \, x_i + \varepsilon \qquad (3.2)$$

Where:
$\hat{Y}$ is the predicted value of the response DV.
B_i (1, 2, …, n) are the regression coefficients.
x_i (1, 2, …, n) are the IVs.
ε is the random residual error coefficient.

MSWG is a function of several parameters including geographical location, season, collection frequency, characteristics of the service area, economic conditions, management laws, local culture and beliefs, population, expenditure, income etc. (Tchobanoglous et al, 1993; Beigl et al, 2008; Purcell and Magette, 2009; Li et al, 2011; Pirani and Arafat, 2014; Intharathirat et al, 2015), which can be expressed as follows:

$$MSWG = f(population, income, laws, charachteristics, \dots etc) \quad (3.3)$$

In the current study, the objective is to estimate MSWG from hotels and camps and to define accommodation's features that influence MSWG during events. Thus, parameters namely hotel's capacity (measured by the number of beds) (HC), staff size (number of staff)(HSS), expenditure (HE), floor area (HFA), location (HL), rating or ranking (HR) and waste collection frequency (HWCF) were selected to estimate MSWG rate from hotels. Therefore, hotel MSWG is expressed by the following equation:

$$Hotel\ MSWG = f(HC, \mathrm{HE}, \mathrm{HWCF}, HFA, \mathrm{HSS}, \mathrm{HR}, \mathrm{HL}) \quad (3.4)$$

Similarly the influence of camp's capacity (measured by the number of beds) (CC), staff size (number of staff)(CSS), expenditure (CE), Floor area (CFA), location (CL), food services (measured by the number of food servings provided) (CFS) and waste collection frequency (CWCF) were implemented to estimate the amount of MSW generated from each camp. Equation (3.5) states MSWG from camps.

$$Camp\ MSWG = f(CC, \mathrm{CE}, \mathrm{CWCF}, CFA, \mathrm{CSS}, \mathrm{CFS}, \mathrm{CL}) \quad (3.5)$$

Based on the assumptions stated above, to develop MLR models, it is essential to define the regression coefficients in such a way that is statistically significant (Azadi and Karimi-Jashni, 2016). Several methods including standard, hierarchical and stepwise can be used to determine the regression coefficients. In the current study, a stepwise MLR technique was adopted due to its ability to exclude the IVs which have weaker correlations with the DV (Pires et al, 2008; Tabachnick and Fidell, 2013).To develop a stepwise MLR, two stages must be followed (Pallant, 2007; Pallant, 2011). The first is to check the assumptions of the technique and data treatment, the second to evaluate the performance of the developed model and the contribution of IVs.

3.8.1.1 Assumption of MLR and Data Treatment

- *Types of Variables (IVs and DV)*

The type of variable is one of the important elements that are related to the study design. There are different types of variables that are measured at different levels such as continuous and categorical (Wooldridge, 2012; Tabachnick and Fidell, 2013). The scale variable is measured at the continuous level such as weight (measured in kg) (Laerd Statistics, 2015). The categorical is a variable that can take on one of a limited number of possible values.

There are two types of categorical variables: nominal is a variable that has two or more categories without having any kind of natural order e.g. gender, while ordinal is a variable for which the possible values are ordered e.g. education level. In MLR, the DV should be one scale variable (continuous) and the IVs should be two or more that are measured at continuous or nominal level (Pallant, 2007). In addition, the ordinal variable can still be entered in an MLR, but it must be treated as either a nominal or a continuous level (Laerd Statistics, 2015).

- *Sample Size*

The generalizability of the model built by MLR is influenced by the size of the dataset, as the results cannot be generalized if a small dataset is used (Pallant, 2007). The minimum required sample size to develop a generalizable model, taking into account the number of IVs, can be calculated by the following equation (Tabachnick and Fidell, 2013):

$$N \geq 50 + 8 * n \tag{3.6}$$

Where:
N is the sample size.
n is the number of explanatory IVs used in the MLR.

- *Normality of IVs and DV*

Variable screening for normality is an important primary stage in MLR. Although normality of IVs is not always required for data analysis, the result is more robust if all the IVs are normally distributed (Pallant, 2011; Tabachnick and Fidell, 2013). Expected normal probability plots, Q-Q plots, are effective graphical tools for assessing normality (Parisi Kern et al, 2015). In these plots, expected normal values are compared with actual normal values for each case. The closer the actual values are to the expected values, the closer they are to a normal distribution (Tabachnick and Fidell, 2013). The literature provides many data transformation methods depending on the direction of the skewness and the extent from a normal distribution, such as logarithmic transformations, to enhance the distribution of variables (Tabachnick and Fidell, 2013).

- *Linearity of IVs*

This term refers to the relationship between the DV and the IVs. This assumption needs to be tested individually and collectively (Pallant, 2007; Tabachnick and Fidell, 2013). Individually, this assumption assumes that a linear relationship exists between the DV and each IV, which can be examined using partial regression plots between the DV and each IV

or multivariate scatter plots for all variables (Laerd Statistics, 2015). However, categorical variables such as education level can be ignored at this stage, as it is not necessary to test the linearity at this stage (Laerd Statistics, 2015). Collectively, this assumes that a linear relationship exists between DV and IVs collectively. This assumption can be checked by plotting a scatterplot of the standardised residuals against the (unstandardised) predicted values (Laerd Statistics, 2015). To meet this assumption, the standardised residuals need to form roughly a rectangular distribution, where most of the observations are concentrated in the centre of the plot (Laerd Statistics, 2015).

- *The Homoscedasticity of the Residuals*

The homoscedasticity assumes that the residuals are equal for all values of the predicted DV (Pallant, 2007; Tabachnick and Fidell, 2013; Laerd Statistics, 2015). This means that the values of the residuals are not influenced by the value of the DV (remain constant irrespective of the value of DV). The same plot of the standardised residuals against the (unstandardised) predicted values is also useful to check this assumption. This assumption can be met when the variances of the residuals form a roughly rectangular distribution and there no clear systematic pattern to the residuals e.g. curvilinear, or higher on one side than the other (Pallant, 2011; Tabachnick and Fidell, 2013).

- *Independence of Observations*

In MLR, it is expected that the errors for any adjacent two cases are uncorrelated (Laerd Statistics, 2015). This assumption is violated when the residual terms are correlated (not independent) (Field, 2009). This assumption can be checked using the Durbin-Watson test for serial correlation of the residual (Tabachnick and Fidell, 2013). The Durbin-Watson test ranges on a scale between 0 and 4, the closest value to 2 suggesting that the residuals are uncorrelated (Field, 2009).

- *Absence of Outliers*

An outlier is a case with an extreme value or one which is incompatible with other cases in the same variable (Tabachnick and Fidell, 2013). Outliers affect negatively on the conclusions drawn from MLR, as they skew results and make the regression outcome invalid, therefore IVs and DVs must be analysed to remove such extreme values in the initial screening runs (Laerd Statistics, 2015). Cases with standardised residuals of greater than ±3 might be representative of an outlier or not. Statistically, the presence of outliers within the

variables can be checked using the Mahalanobis distances (Pallant, 2011). The latter values must be less than the critical values shown in Table 3.3 (Tabachnick and Fidell, 2013).

Table 3.3: Mahalanobis distances critical values

No. of IVs	critical value	No. of IVs	critical value	No. of IVs	critical value
2	13.82	4	18.47	6	22.46
3	16.27	5	20.52	7	24.32

- *Multicollinearity*

A correlation among the IVs within the data set is the phenomenon of multicollinearity, which negatively influences the outcome of the MLR (Pallant, 2011). Multicollinearity must be addressed by excluding one of the correlating IVs, or by producing a new IV representing the correlated IVs (Laerd Statistics, 2015). The presence of multicollinearity can be detected by calculating the Variance Inflation Factor (VIF) values (Equation (3.7)) by which each IV, represented by U, becomes the response DV, while the other IVs are preserved as independent variables. Accordingly, the VIF is determined for each IV (VIF_U) as in Tabachnick and Fidell (2013). The current literature provides a wide range of threshold values for VIFs, a value of more than 10 is a common cut-off-point in the literature, used to confirm the existence of multicollinearity in this dataset.

$$VIF_U = \frac{1}{1 - R^2} \tag{3.7}$$

Where:
VIF is the Variance Inflation Factor values.
R^2 is the regression coefficient of determination for the U explanatory variable.

3.8.1.2 IVs Contribution and Model Performance.

- *The Contribution of IVs.*

The contribution of IVs to the results of the built model varies from tangible to negligible according to their statistical significance (p) (Tabachnick and Fidell, 2013). An IV with a p-value of less than 0.05, significantly impacts on results of the proposed model; stepwise MLR excludes any IV with a $p \geq 0.05$ owing to its low contribution to the model (Pallant, 2011).

- *Model Performance*

Prediction accuracy, an essential performance measure of the MLR model, refers to its ability to explain variations in the DV (Laerd Statistics, 2015). The coefficient of

determination (R^2) is a tool used to evaluate the performance of the applied model, as it measures the differences between observed DV scores and predicted DV scores via the regression model. It ranges on a scale between 0 and 1, a coefficient of 1, or close to 1, suggesting that the model can produce a reliable outcome. R^2 can be calculated by the following equation (Tabachnick and Fidell, 2013; Azadi and Karimi-Jashni, 2016):

$$R^2 = \frac{Y'}{Y} \tag{3.8}$$

Where:
Y' is the sum of the total squared difference between the mean and predicted scores.
Y is the sum of the total squared difference between the mean and observed scores.

When a small data set is used, the R^2 value tends to be a rather optimistic estimation of the model performance (Tabachnick and Fidell, 2013). The Adjusted R^2 statistic provides a better evaluation of the performance of the prediction model by taking into consideration the size of the data set and the number of the predictive variables (Laerd Statistics, 2015). Adjusted R^2 can be determined by the following equation (Tabachnick and Fidell, 2013):

$$\text{Adjusted } R^2 = 1 - (1 - R^2)\left(\frac{1 - N}{1 - n - N}\right) \tag{3.9}$$

Where:
R^2 is the coefficient of determination.
N is the data set size.
n is the number of independent variables (IVs).

3.8.2 RI for Hoteliers, Camp Owners and Pilgrims

To predict the participants' (hoteliers, camp owners and pilgrims) future positive RI, logistic models were formulated. LR is similar to MLR, with the exception of the measurement type of the DV (i.e., MLR uses a continuous DV rather than a nominal one). Depending on the number of categories in the DV, there are two types of LR, which are: binomial LR and multinomial LR (Porter and Gujarati, 2008; Pallant, 2011; Wooldridge, 2012; Tabachnick and Fidell, 2013). Unlike MLR, both LR types are not attempting to determine the predicted value of the DV, but the probability of being in a particular category of the DV given the IVs (Pallant, 2011; Tabachnick and Fidell, 2013). Since the model produced by LR is nonlinear (Porter and Gujarati, 2008; Wooldridge, 2012), equations used to describe results are slightly more complex than those for MLR. The outcome ($\widehat{p_i}$) is the probability of having one outcome or another based on a nonlinear function of the best linear combination of IVs; with two or more categories (Porter and Gujarati, 2008; Tabachnick and Fidell, 2013):

$$\widehat{p_i} = \frac{e^{\hat{Y}}}{1 + e^{\hat{Y}}} \quad (3.10)$$

Where:
$\widehat{p_i}$ is the estimated probability that the ith case (i = 1, . . . , n) is in one of the categories.
$\hat{Y}$ is the typical MLR equation (Equation (3.2)).

Researchers suggest that RI is influenced by individual attributes such as education level (Kok and Siero, 1985), income (Pieters and Verhallen, 1986), accepting responsibility (Miafodzyeva et al, 2010), age (Nixon and Saphores, 2009) and gender (Ekere et al, 2009), which can be expressed as follows:

$$RI = f(age, income, gender, education\ level, \dots etc) \quad (3.11)$$

In this study, a binary LR model was developed to investigate the possibility of predicting hoteliers' future RI during events according to several attributes including age group (HAG), education level (HEL), MSW recycling knowledge (HRK), satisfaction of the current management services (HSL), HR, HL, HSS, HE, HWCF and MSWG. Hoteliers' recycling intention (HRI) is expressed by the following equation:

$$HRI = f(HAG, \text{HEL HRK, HSL, HR, HL}, HFA, \text{HSS, HWCF}) \quad (3.12)$$

Similarly, another binary LR model was developed to investigate the possibility of predicting camp owners' future intention to sort their MSW at source via implementing camp owners' age (CAG), education level (CEL), recycling knowledge (CRK), satisfaction with the current management services (CSL), CFS, CSS, CE, CFA, CL, CWCF and MSWG. Camp owners' recycling intention (CRI) is indicated by the following equation:

$$CRI = f(CAG, \text{CEL, CRK, CSL, CL}, CFA, \text{CSS, CWCF}) \quad (3.13)$$

In addition, two multinomial LR models were developed to predict the pilgrims' future RI. All items in the pilgrims' questionnaire were divided into DVs and IVs. The DVs were item 11 (optional sorting) and item 12 (compulsory sorting) (Appendix D) whereas the IVs were the other items in the questionnaire, which represent the factors expected to have an impact on RI. These factors were level of education (PEL), age (PAG), gender (PG), and recycling knowledge (PRK), in addition to other activities such as pilgrim's staying duration in Kerbala (PSD), eating habits (PEH), number of meals consumed each day (NMPP), drinking habits (PDH), number of water bottles consumed per day (NWBPP), waste disposal behaviour (PWDB) and satisfaction level about the current MSWM activities (PSL). These factors were selected based on information derived from the literature review

(section 2.4.1.2), time and place factors and limitations. Optional (OPRI) and compulsory (CPRI) recycling intentions of the pilgrims are expressed by the following equations:

$$OPRI = f(\text{PEL}, PAG, \text{PG}, \text{PRK}, \text{PSD}, \text{PEH}, \text{NMPP}, PDH, \text{NWBPP}, \text{PWDB}, \text{PSL}) \quad (3.14)$$

$$CPRI = f(\text{PEL}, PAG, \text{PG}, , \text{PRK}, \text{PSD}, \text{PEH}, \text{NMPP}, PDH, \text{NWBPP}, \text{PWDB}, \text{PSL}) \quad (3.15)$$

Similar to MLR, to develop LR models, it is vital to define statistically significant regression coefficients (Porter and Gujarati, 2008; Tabachnick and Fidell, 2013). Thus, stepwise LR (binary and multinomial) were used to develop prediction models that predict the RI of the participants (Pallant, 2011; Tabachnick and Fidell, 2013). This technique allows assessment of the influence made by each IV over and above that of the other IVs (Tabachnick and Fidell, 2013; Laerd Statistics, 2015). This was done by checking the assumptions of the LR techniques and data treatment as well as evaluating the performance of the developed models and the contribution of the IVs (Porter and Gujarati, 2008; Pallant, 2011; Wooldridge, 2012; Tabachnick and Fidell, 2013).

3.8.2.1 Assumption of the LR and Data Treatment

- *Types of Variables (IVs and DV)*

The design assumption of LR requires the DV to be a categorical variable of two or more outcomes, while the IVs can be measured at a continuous or nominal scale (Laerd Statistics, 2015). For example, multinomial LR involves a DV of a nominal scale (a nominal variable with more than two outcomes), while binary LR necessitates the use of a dichotomous DV (a nominal variable with two outcomes only) (Tabachnick and Fidell, 2013). Thus, to adopt such techniques to investigate a relationship between several IVs and a DV, the design assumption needs to be satisfied. This means that the DV has to be measured at a nominal scale with two or more outcomes, while IVs can be measured at various scales such as categorical or continuous (Laerd Statistics, 2015).

- *The ratio of Cases to IVs*

Problems may occur when there are few cases relative to the number of IVs (Tabachnick and Fidell, 2013; Laerd Statistics, 2015). To avoid such problems, bearing in mind the number of IVs, the minimum required sample can be calculated by the following equation (Laerd Statistics, 2015):

$$N \geq 15 * n \quad (3.16)$$

Where:
N is the sample size
n is the number of IVs.

- *Linearity in the Logistic Regression*

LR assumes a linear relationship between continuous IVs and the logit transformation of the DV. To test this assumption, the Box-Tidwell approach (Hosmer and Lemeshow, 2000) is the simplest among several statistical and graphical methods (Tabachnick and Fidell, 2013; Laerd Statistics, 2015). In this approach, terms that represent interactions between each continuous IV and its natural logarithm are added to the LR model (Equation (3.17)). The assumption is violated if one of the added terms is statistically significant. Literature provides several data transformation methods of the offending IV such as logarithmic transformations (Tabachnick and Fidell, 2013).

$$Term = IV * Ln\ IV \quad (3.17)$$

- *Multicollinearity*

Like other multiple regression techniques, LR is sensitive to correlation among the IVs (Pallant, 2011; Tabachnick and Fidell, 2013). Multicollinearity can be signalled by a high VIF value (Equation (3.7)) of more than 10 (Pallant, 2011; Tabachnick and Fidell, 2013). To find a source of multicollinearity among all IVs, each categorical predictor should be replaced with dichotomous dummy variables (one less than the number of categories in the categorical IV) and then calculating the VIF for each IV (Tabachnick and Fidell, 2013; Laerd Statistics, 2015).

- *Outliers*

LR is also sensitive to cases that are poorly predicted by the model (Pallant, 2007; Laerd Statistics, 2015); a case that actually is in one category of the result may show a high likelihood for being in a different category. Outlying observations are found by examination of standardised residuals (Tabachnick and Fidell, 2013). Most of the software packages such as SPSS generate a table that highlight cases with high standardised residuals (Tabachnick and Fidell, 2013; Laerd Statistics, 2015). Case with a standardised residual value of more than 2.5 should be carefully examined and excluded from the analysis if this is believed necessary (Pallant, 2011; Laerd Statistics, 2015).

3.8.2.2 IVs Contribution and Model Performance.

- *The Contribution of IVs.*

There are various tests such as Wald test and Lagrange multiplier test available in the literature to evaluate the contribution of the IVs to a model (Porter and Gujarati, 2008; Pallant, 2011; Tabachnick and Fidell, 2013). The evaluation of the effect of omitting an IV is considered superior to other tests (Tabachnick and Fidell, 2013). An IV is evaluated by comparing models with and without the IV (sometimes called a likelihood-ratio test) (Pallant, 2011; Tabachnick and Fidell, 2013). An IV with a *p*-value of less than 0.05 significantly influences the results of the proposed model.

- *Assessing Developed Models*

There are a number of models in LR such as a constant only model (no predictors), an incomplete model (with some predictors), a full model (with all predictors) and a perfect model (would provide an exact fit) (Tabachnick and Fidell, 2013). Consequently, the comparison between these models can provide an indication of the performance of a developed model with a set of predictors. The comparison of the constant-only model with the model that includes the constant plus all IVs is broadly adopted (Porter and Gujarati, 2008; Tabachnick and Fidell, 2013). The log-likelihood technique is used to evaluate the improvement of the applied model (Tabachnick and Fidell, 2013). Improvement in the model prediction is found when the log-likelihood for the full model is statistically different ($p \geq 0.05$) from the log-likelihood for the constant-only model. Another way of assessing the adequacy of the model is to analyse how poor the model is at predicting the categorical outcomes. This is tested using the Hosmer and Lemeshow goodness of fit test that is automatically generated during the binary LR run. A p value of more than 0.05 indicates that the developed model (with the set of IVs used as predictors) is better that SPSS's original guess.

Additionally, a number of measures have been suggested in LR to mimic the R^2 in MLR (Hu et al, 2006; Tabachnick and Fidell, 2013; Laerd Statistics, 2015). Cox & Snell, Nagelkerke and McFadden pseudo p^2 are a transformation of the likelihood-ratio statistic representing the proportion of variance that can be explained by the model (Hu et al, 2006). Pseudo p^2 values offer an indication of the amount of variation in the DV explained by the model (from 0 to 1) (Pallant, 2011; Tabachnick and Fidell, 2013). Research suggests that

pseudo p^2 of 1, or close to 1, indicates that the model can produce a reliable outcome (Field, 2013).

3.8.2.3 Predict Future Sorting Behaviour Based on Stated RI

Scholars believe that the relationship between RI and actual behaviour is debatable as stated RI is, sometimes, a poor predictor of future behaviour (Manski, 1990). Few studies have addressed this issue of comparing intention, behaviour, and habit. Fujii and Gärling (2003) is the only research found that provides actual percentages for expected actual behaviour based on stated RI. Fujii and Gärling (2003) showed that to predict behaviour from stated RI, individuals with the habit should be distinguished from individuals without the habit. This is because individuals without the habit are requested to change their existing behaviour and acquire a new one. In order to predict future behaviour, the stated RI were divided into three groups; the first group are individuals with strong stated RI; the second group are individuals with weak stated RI; and the third group are individuals with no stated RI (Fujii and Gärling, 2003). Accordingly, when people have a habit, it can be estimated that an average of 65% of the first group could transfer their stated RI to actual behaviour whereas about 35% and 5% of the second group and third group, respectively are expected to perform a behaviour (Fujii and Gärling, 2003). Besides, Fujii and Gärling (2003) concluded if the public does not have the habit, the expected figures to perform the behaviour decrease by an average of 25%.

To predict the actual future sorting behaviour among the current study participants (hoteliers, camp owners and pilgrims), the answers to the sorting willingness questions were divided into three groups and the predicted future behaviour was estimated for each group. The first group contains participants with a strong RI (participants who said ‘Yes’ to sorting willingness question); the second group was weak RI group (participants who answered ‘Maybe’); the third group was the participants with no RI (participants whose responses were ‘No’). As the vast majority of the participants in this study were from Iraq, where they do not have the habit of MSW recycling, the future behaviour for the three intention groups was estimated based on the ‘no habit’ scenario. Accordingly, the expected future sorting behaviour was 49%, 26% and 3.8% of the stated strong, weak and no RI values, respectively for all participants.

3.9 Methodological limitations

Although this research has successfully collected data to evaluate the MSWM system during major events and to estimate MSWG and RI among participants, it is limited in several ways that can be summarised as follows:

- Limited time and financial support to gather data. The fieldwork had to be done only over 15 days in the Arba'een events. Access to a larger number of REs would have provided data from a wider range of venues.

- Interviews were also limited to key staff from institutions who participated in the study, such as KM. Broader staff participation, including lower level administrative staff, would provide richer data for the study.

- Surveys were limited to the population in the centre of the REs. Broader area coverage, including the main entrances and other surrounding areas, would provide comprehensive data for the study.

- The use of expressed recycling intention. Further studies should be conducted on practical recycling behaviour.

- Crowding and congestions complicated the data collection stage. The investigators had to walk between locations in crowded streets that consume more time and effort.

- It is not possible to work on the day of the RE or the four days preceding it. Thus, the data collection had to be stopped 4 days before the Arba'een. More days might result in a larger and more representative sample.

- Arabic is the official language in Iraq, so all the interviews and surveys were conducted in Arabic and translated to English. Although the author has good knowledge of the Arabic language, the translation might have resulted in a loss of meaning and thus affect the quality of the collected data.

3.10 Summary

The research approach and methodology adopted are presented in this chapter. The tools adopted in data collection that are questionnaires, interviews, field observations and on-site MSW audits were discussed in this chapter. These methods were employed to collect detailed information about the current MSWM operation, the barriers facing MSWM

development, the public involvement and readiness to practise MSW recycling and the rate of MSWG from hospitality accommodation (hotels and camps) during events. Data collection instruments were developed in stages that are a comprehensive literature review, design of initial drafts according to the aim and objectives, experts' evaluation to improve the initial drafts and pilot testing with targeted populations to generate final drafts that meet the objectives of the study of collecting reliable and valid information regarding MSWM during REs. Besides this, a comprehensive data collection stage was conducted with 645 pilgrims, 157 camp owners, and 150 hoteliers by a team of 10 members during the Arba'een in 2016. In addition, in-depth interviews with nine representatives of the MSWM authorities and on-site observation were conducted to evaluate the current system. Data analysis practices (descriptive, MLR, LR and thematic analyses), which are employed in this study to analyse the collected data, are explored in this chapter. This includes the assumptions of the techniques, the justification for their selection, and the relationship with the aim and objectives of this study. Moreover, the Wasteaware benchmark indicators framework is adopted in this study, which allows detailed evaluation of the MSWM system adopted in the city of Kerbala, particularly during REs.

Chapter 4

Municipal Solid Waste Management during the Arba'een

4.1 Introduction

In line with the objectives, a background about municipal solid waste management (MSWM) in Kerbala during large religious events (REs) is established in this chapter based on the interviews with MSWM authorities, field observations, and documents analysis. This includes identifying the capacity of MSWM institutions, key-waste related data, municipal solid waste (MSW) collection services, MSW treatment and disposal methods and resources, and planning and development of the MSWM system. The factors that might have a significant influence on the current MSWM adopted in the city of Kerbala, particularly during large REs were also identified. In addition, the results of the evaluation of the present MSWM in the city during large REs, based on 'Wasteaware' benchmark indicators, were also presented in this chapter.

4.2 Background and Affiliation of Respondents

Using purposive sampling (Bryman, 2015), nine senior officers, representing MSWM authorities in Kerbala, participated in the interviews conducted during the Arba'een. The interviews were conducted in October and November 2016. The participants' affiliations include Kerbala Municipality (KM), Kerbala Municipalities (KMs) and Holy Shines Authorities (HSA). Figure 4.1A shows that the majority of participants (45%) were from KM as it is considered the authority responsible for MSWM in the city with the largest fleet and staff. 33% were from HSA, responsible for the collection of MSW in the central area of the old city (Figure 3.3). Only two respondents were from KMs, in charge of MSW collection at the main entrances to the city during REs (Figure 3.3) (Abdulredha et al, 2017c). From Figure 4.1B, it can be seen that the respondents were experienced, over half of whom with more than 7 years of involvement in MSWM. Almost all participants had a Bachelor of Science degree, one with a Diploma qualification.

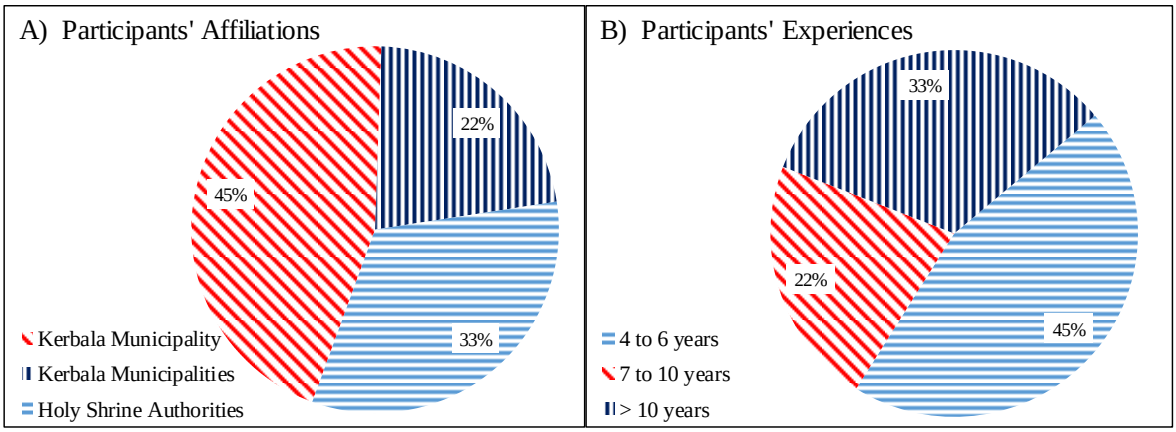

Figure 4.1: MSWM representatives' background information

4.3 MSWM Authorities during REs

MSWM is one of the most complex services a city management authority(s) delivers (Al-Khatib et al, 2010; Wilson et al, 2013a; Arbulu et al, 2015). The interviewees described how MSWM authorities (KM, KMs and HSA) are responsible for the planning and delivery of MSWM services in the city. KM is responsible for delivering MSWM services in central districts of Kerbala covering a total population of 633,392 inhabitants (Al-masoudi and Al-haidary, 2015). According to a senior official in KM, the municipality is in charge of planning MSWM operations, siting MSWM facilities and delivering MSWM services in Kerbala central districts. It also carries out surveillance on environmental conditions within Kerbala through enforcement of environmental standards and regulations clauses. A senior officer in KM claimed that the municipality has field staff that carry out environmental surveillance within Kerbala centre districts on a daily bases. The participant cited many cases that have been handled in Kerbala central districts related to the violation of environmental standards.

Similarly, KMs plays the same role of MSWM in the outskirt districts of Kerbala city. A senior engineer from KMs claimed that KMs have control over the implementation of MSWM plans and strategies in the outskirts districts such as AL-Hurr and AL-Hindiyah. KMs also carries out surveillance on the environment within the areas under their jurisdiction. While the HSA has different activities and jurisdiction in Kerbala other than KM and KMs. A director in charge of the MSW collection department outlined that their functions are only collection and transportation of MSW from public places in the centre of the old city (the centre of large REs that is shown in Figure 3.3) and establishments owned by the HSA. Besides, HSA is normally organising large REs, as they represent the highest religious authority in the city.

During large REs, more than 11 million pilgrims (Alkafeel Global Network, 2016c) are gathering in the centre of the old city. A large proportion of the pilgrims enter the city on foot, which leads to the overcrowding of the centre of the city as well as the main roads leading to that centre. Thus, as the organisational capacity of KM and HSA are not compatible with the amount of MSW produced from such a large population, other institutions including KMs and nearby cities' municipalities provide support in the form of collection vehicles and personnel that collect and transport MSW produced in the areas assigned to them by KM. The director in charge of the environmental department in KM stated that the capacities of KM and part of the fleets from other cities such as Baghdad and Basra are concentrated on the collection and transportation of the MSW generated from the areas of the REs only. Similarly, as the main roads leading to the centre of the REs are overcrowded too during REs, the efforts of KMs and the rest of the supporting fleets from other cities are focused on collecting and transporting the MSW generated in these roads (Figure 3.3). The director of KMs stated that KMs encompasses five municipalities working on the collection and transportation of MSW from the main road connecting Najaf, Babylon and Baghdad to the event area in Kerbala city. While HSA maintained its areas of jurisdiction in the centre of the old city by doubling or tripling working shifts during events.

4.4 MSWM Practices during Large REs

Excessive growth in the population can lead to the emergence of many problems, which impact on society and the environment (Garcia, 2015). The higher population and population density during REs lead to the higher demand for public services such as water, transportation and MSWM. Thus, such an increase when the demand for public services exceeds the services' capacity emphasises the importance of investigating such services to minimise their impact on society and the environment (Garcia, 2015). In order to understand the present MSWM issues in the study area, a review in line with one of the research objectives – to investigate the MSW problems in Kerbala during major REs has been undertaken. This includes defining key waste-related issues, investigating applied practices of MSW handling at source, inspecting operations of MSW collection and transportation as well as studying MSW treatment and disposal.

4.4.1 Key-Waste Related Data

To develop an ISWM system, the literature agrees that accurate information about the sources, the quantities and the composition of the generated MSW is required (J. S. Kumar et al, 2011; Intharathirat et al, 2015; Peeters et al, 2015; Azadi and Karimi-Jashni, 2016; Ghinea et al, 2016; Jiang and Liu, 2016). Inaccurate data may result in difficulties such as

negative impact on the environment, MSW treatment facilities, which do not have the required capacity and inappropriate policies (Beigl et al, 2008; Intharathirat et al, 2015).

4.4.1.1 Sources of MSW during REs

Besides its resident population, Kerbala is an important tourism centre in Iraq that attracts tourists from all parts of the country and beyond (Obaid et al, 2014). The generation and consumption activities of both residents and floating populations increasingly generate large amounts of MSW on a daily basis. The interviewees listed a number of factors that contribute to the growing quantities of MSW in Kerbala. The rapid urbanisation combined with the prosperity of the economic situation has led to an increase in the production and consumption of products. Besides, the displacement of citizens from other cities that suffer from an unstable security situation and in search of work has led to a sharp increase in the population of Kerbala and municipal solid waste generation (MSWG). The Aerial image in Figure 4.2 shows a high increase in the illegal settlement areas in the agricultural lands surrounding Kerbala city centre from 2007 until 2013.

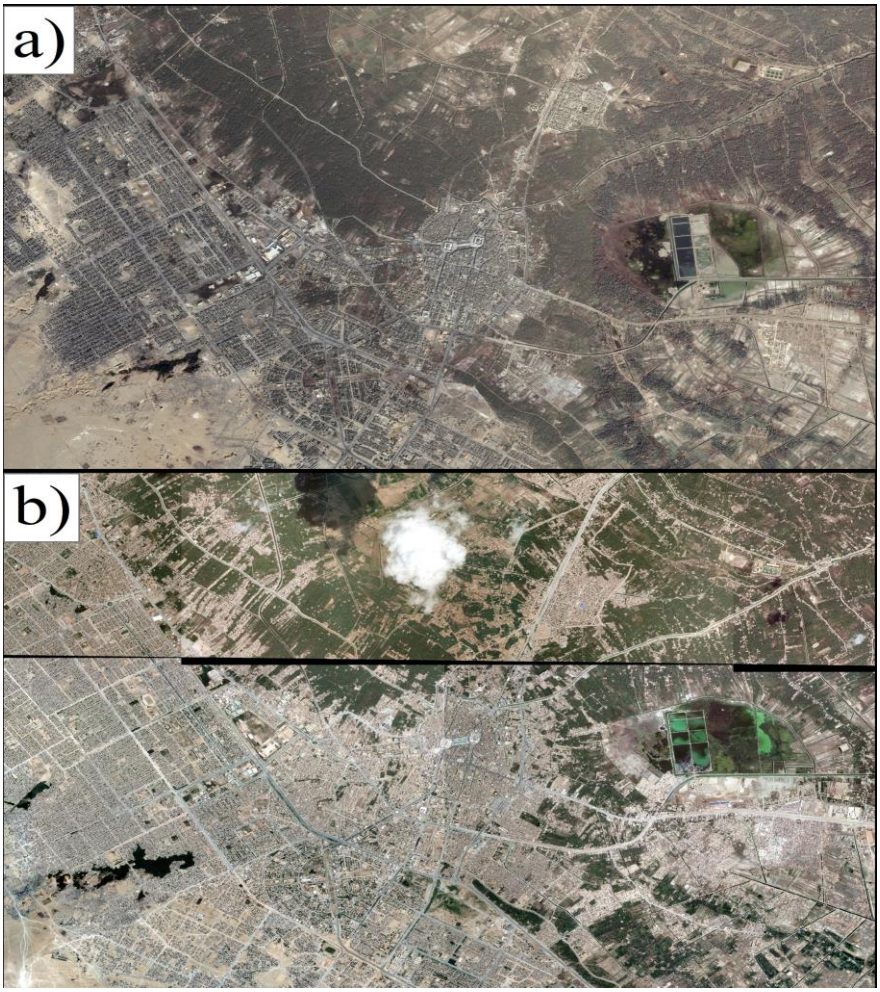

Figure 4.2: Arial images demonstrate the increase of illegal settlement in the agricultural lands surrounding Kerbala over six years: a) 2007, b) 2013 (Kerbala municipality, Iraq)

Additionally, the continuous increase in the number of pilgrims attending main REs in the city has been accompanied by a large increase in temporary and permanent accommodation (hotels and camps) that provide services to all pilgrims. These accommodation establishments were regarded to have a significant contribution to the growing volumes of MSW in Kerbala, particularly during large REs. In this regards, a director noted "in the centre of the old city, there are a large number of hotels and camps, … these provide a wide range of free meals and services to the pilgrims, …therefore, the majority of camps and hotels produce large volumes of MSW'.

4.4.1.2 Municipal Solid Waste Generation

Accurate and reliable information about MSWG is of great importance in MSWM (Thanh et al, 2010; Parisi Kern et al, 2015; Azadi and Karimi-Jashni, 2016). In 2013, the Central Statistical Organization Iraq (2014) reported that each person in Kerbala produced 1.5 kg of MSW in a day. Thus, about 397.6 kt of MSW were collected from 708,755 residents, about 94.3% of the residents occupying the urban areas of the city in 2013 (Central Statistical Organization Iraq, 2014). However, in 2014, the CSOI reported that MSWG suddenly increased to reach 2.1 kg per resident per day (Central Statistical Organization Iraq, 2015a). The MSW stream data suggested that the residents of the urban areas generated an average of 1.55 kt each day, and more than 560 kt in 2014 (Central Statistical Organization Iraq, 2015a). In addition, two directors in KM and KMs provided comprehensive data about the quantities of MSW collected within their jurisdictions in 2014 during the interviews. According to their data, KM collected over 340 kt of MSW from Kerbala central districts, with an average of 0.93 kt per day and KMs representative detailed that more than 168 kt of MSW were gathered from Kerbala outskirts districts. In total, in excess of 508 kt of MSW were collected by both institutions in 2014, which is relatively close to the figure provided by the CSOI.

Based on the above, Kerbala generates large amounts of MSW (over 500 kt per year). Wilson et al. (2012) stated that there is a positive relationship between Gross National Income (GNI) and per capita MSWG, whereby MSWG for upper-middle income countries ranges from 246 kg/capita/year to 529 kg/capita/year with an average of 373 kg/capita/day. As Iraq falls in the upper-middle income level with per capita GNI of $5,430 (The World Bank, 2018), the average MSWG in Kerbala is higher than average MSWG in middle-income countries, estimated at 766.5 kg/capita/year (Central Statistical Organization Iraq, 2015a). The Central Statistical Organization Iraq (2015a) explained that the surge in MSWG has happened because a large number of displaced people entered Kerbala in 2014. In this

regards, the national survey of the displaced people in Iraq (Central Statistical Organization Iraq, 2015b) reported that Kerbala hosted more than 56,000 displaced people from various cities suffering from the unstable security situation. In addition, it can be clearly seen from Figure 4.3 that Kerbala's inhabitants also produce more solid waste per day than the rest of the Iraqi cities' residents (Central Statistical Organization Iraq, 2014; Central Statistical Organization Iraq, 2015a). Several interviewees suggested this is because the city attracts thousands of tourists on a daily basis. According to the Iraqi National Investment Commission guide (National Investment Commission Iraq, 2014), almost a constant number of 11 thousand tourists are visiting Kerbala each day generating large quantities of MSW. Furthermore, the city hosts many large REs on an annual basis (Abdulredha et al, 2017b), attracting millions of tourists from many countries across the world (Mujtaba Husein, 2018) and generating large amounts of MSW. Estimating the amount of MSW produced by the events' participants will help improve the current MSWM system applied in the city.

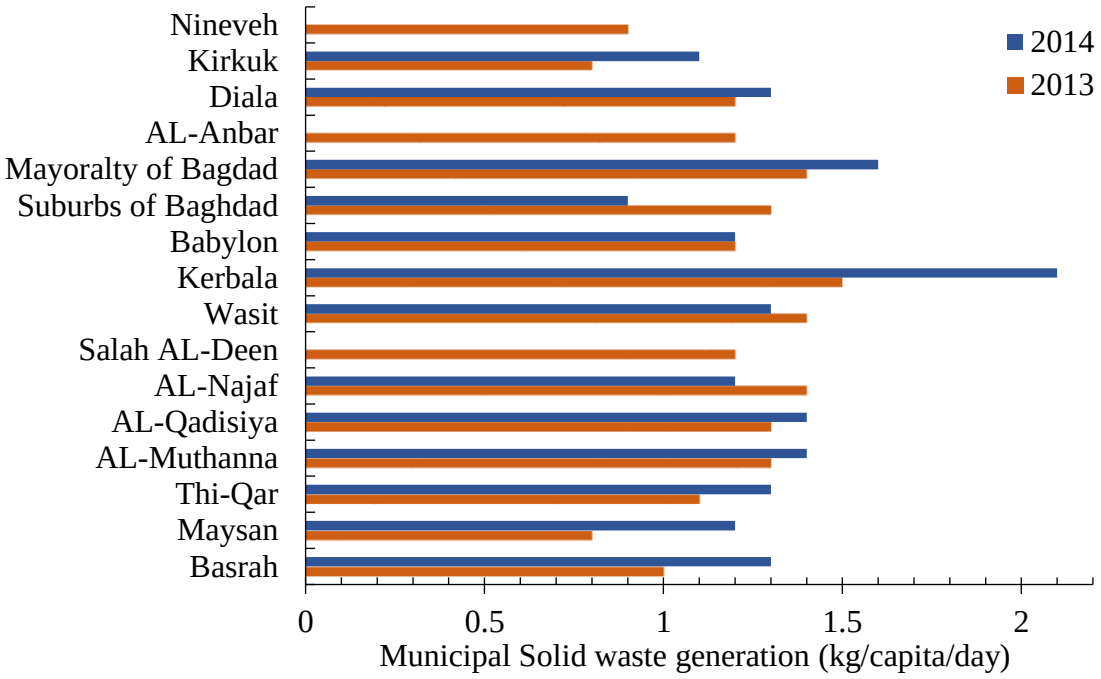

Figure 4.3: Solid waste generation per capita per day in Iraqi cities (Central Statistical Organization Iraq, 2014; Central Statistical Organization Iraq, 2015a)

In fact, it is vital to establish a proper estimation of the amounts and sources of MSW during large REs to develop an MSWM system. However, it should be noted here that exact and reliable figures about key waste-related data are not available and have had to be estimated by MSWM authorities. The interview with the MSWM authorities revealed that an estimated 48 kt of MSW was generated during the Arba'een in 2015 while up to 11 kt of MSW was generated during the Ashura in the same year. These quantities are completely

different from those generated from other REs around the world. For instance, MSWG during Ashura was greater than that generated from the World Youth Day (for Catholics) of 490 tonnes by 3.7 million pilgrims over 5 days (salt & light, 2013) and from Kumbh Mela (for Hindus) of 300 tonnes by 8 million over one day (Gangwar and Joshi, 2008). MSWG during the Arba'een is relatively comparable with the quantity produced during the Hajj (for Muslims) of 17 kt by 3.69 million pilgrims over 5 days.

The interviewees suggest that above 80 kt of MSW is generated from large REs which take place in Kerbala each year. These amounts account for around 14% of the total MSW generated in the city each year of 560 kt (Central Statistical Organization Iraq, 2015a). However, these estimates must be considered unreliable, as the city lacks any reliable MSW information system that accurately captures MSWG in the city let alone during large REs. Because of the absence of a weighbridge at the landfill site and limited available finance, management authorities' respondents indicated that they used an estimated density of 400 kg/m^3 for collection trucks to calculate the amount of MSW collected and delivered to landfill, this calculation according to the volume of the trucks and number of trips to the landfill. MSWM authorities do not have any information about MSWG from the city or REs which is not delivered to the designated landfill.

In summary, the MSWM system in Kerbala is inefficient and has not been managed for many years (Ali, 2009; Abdulredha, 2012; Abdulredha et al, 2017c). Comparing to other events and cities, Kerbala produces huge amounts of MSW. However, MSW data is not systematically collected/recorded, because of the absence of an appropriate information system that captures such data. The available data about MSWG is mostly based on the estimation and does not capture the quantity of MSW, which is not delivered to the landfill.

4.4.1.3 MSW Composition

The sudden increase of MSWG in Iraq cities, particularly Kerbala (Figure 4.3) made establishing accurate and reliable information about the composition of MSW crucial. MSWM authorities do not have information about the composition of the MSW generated from the city residents let alone that generated from pilgrims during REs. The interview respondents confirmed the absence of data on the MSW components due to the absence of a dedicated department within their institution or other institutions studying MSW in the city. However, a few scholars have investigated the composition of the MSW generated from the residents of the central districts (Ali, 2009; Abdulredha, 2012; Al-masoudi and Al-

haidary, 2015; AL-Yasari, 2015), but there is no research or records involving MSW composition during REs.

The large quantity of MSW generated during REs (14% of the total city's MSW) made investigating its constituents essential to assess the present MSWM operation. Therefore, this study was designed with the purpose of identifying the composition of MSW generated during REs, based on a site investigation conducted during the Arba'een in 2016. The approach tries to capture the fluctuations in the composition of the waste stream during the RE. The method included collecting representative samples of the MSW generated during the Arba'een and sorting samples for different waste materials.

- *The Sampling and Sorting Procedures Implementation*

The respondents from KM and HSA confirmed that all the MSW generated in events areas are normally moved using collection vehicles to three temporary transfer stations (TTSs) situated around the old city (Figure 3.6). In the TTSs, the MSW is transferred to larger trucks and then transported to the designated landfill in the south-west of the city (Figure 4.11). Thus, the sampling and sorting protocol of unprocessed MSW was conducted in the three TTSs while the event was ongoing. Two samples (vehicle loads) were selected in each TTS over a period of 10 successive days to ensure that fluctuations in the composition of the waste stream during the event were captured. In total, 60 samples were representing the composition of the MSW generated during the Arba'een in 2016.

According to the standard procedure for measuring the composition of unprocessed MSW (ASTM D5231-92, 2003), a portion of 91 to 136 kg is considered to represent the composition of a vehicle load of MSW. Thus, from each selected vehicle, a sample weighing approximately 100 kg was prepared, according to the standards test, this sample then manually sorted on a secure sorting platform into the waste groups shown in Table 3.2. Segregated constituents were weighed to determine their weights as a fraction of the total weight of the sample. Then, descriptive analysis was conducted to find the mean of each MSW constituent and the lower and upper level of confidence intervals at a 95% level of confidence.

- *The Composition of the Sampled MSW*

Table 4.1 shows the descriptive statistics of the six categories of MSW generated during the Arba'een including the mean, upper and lower level of confidence at 95% along with standard error, median, standard deviation (SD), standard error (SE), minimum values and maximum values (these values represents the weight percentage of the sorted categories as

it is received). From the mean and level of confidence intervals in Table 4.1, it can be clearly seen that the MSW composition analysis resulted in three main components of waste: organic, paper and plastic made up 86% of the total waste. Organic waste was the highest at 57.9±2.2%, while plastics and papers were 14.6±0.9% and 14.9±1.1%, respectively. Figure 4.4 shows the components of MSW. This analysis indicates that MSW generated during the Arba'een has an average compostable and recyclable content of 93%. This waste material contains organic, metal and plastic, which occur in diverse percentages in comparison to non-event days in Kerbala and in other neighbouring cities (Alnakeeb, 2007; Abdulredha, 2012; Al-masoudi and Al-haidary, 2015). There is, therefore, considerable potential for MSW recycling and recovery programmes (Al-Khatib et al, 2010).

Table 4.1: Descriptive statistics for waste composition at the Arba'een (wt. % as received)

Waste components (wt. % as received)	Mean	Conf. -95%	Conf. +95%	Median	SD	SE	Min. Value	Max. Value
Organic Waste	57.9	55.7	60.0	59.3	8.3	1.1	43.0	79.0
Paper Waste	14.9	14.0	15.9	14.6	3.6	0.4	2.0	23.0
Plastic Waste	14.6	13.5	15.7	14.3	4.4	0.5	1.0	24.0
Metal Waste	3.6	3.2	4.0	3.4	1.4	0.2	1.0	9.0
Glass Waste	2.4	2.1	2.8	2.1	1.4	0.2	1.0	7.0
Other Waste	6.5	5.6	7.3	6.3	3.3	0.4	2.0	15.0

Key: wt. % = weight percent; Conf. -95% = lower level of confidence; Conf. +95% = upper level of confidence; SD = standard deviation; SE = standard error; Min. Value = minimum value; and Max. Value = maximum value.

The primary component of the refuse generated during the Arba'een was organic, mainly food residual mixed with plastic and paper packaging. Pure organics such as food residual were also observed in the waste stream. The average organic refuse generated during the RE (57.9%) was found to be more than that generated in Kerbala over the year (56.6%) (Al-masoudi and Al-haidary, 2015). The percentage of organic waste generated during the Arba'een is greater than the organic fraction in other REs such as Kumbh Mela (51.8%) (Gangwar and Joshi, 2008) and Hajj (29.3%) (Alsebaei, 2014). It is worth noting here that 7,600 camps located within the administrative boundaries of Kerbala (AYN, 2016) provide free food and drinks for all pilgrims over the total period of the RE. Consequently, pilgrims have many free options to choose from. This practice is possibly responsible for the increase in organic waste generation during the RE. This happened despite the fact that the majority of camp owners practise controls over the quantity and the size (the portion) of serviced meals so that the pilgrim consumes all the food prepared.

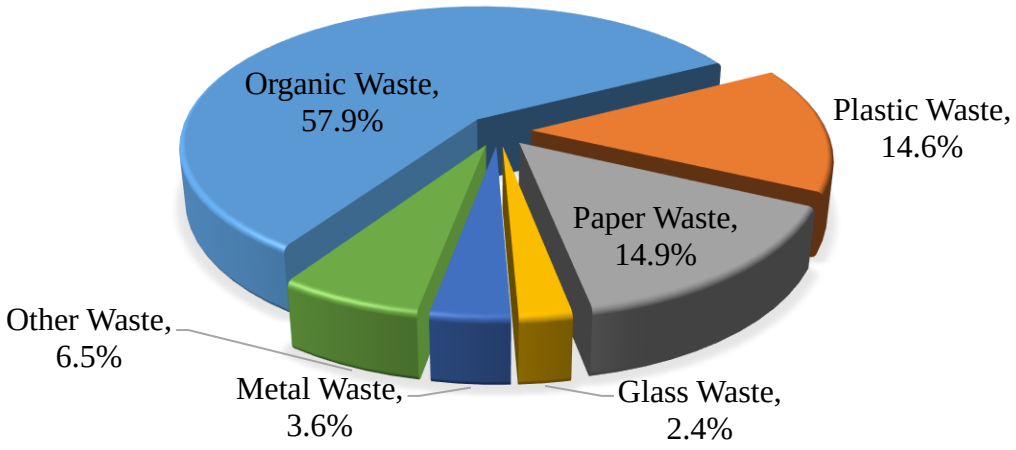

Figure 4.4: MSW composition for the representative chosen samples of MSW generated during the Arba'een

Two waste categories, paper and plastic, share 29.5% of the event refuse. Due to the extensive use of packaging materials by camps, paper (14.9±1.1%) and plastic waste (14.6±0.9%), it was expected that these would constitute a high percentage of event refuse. Almost all camps provide plastic or paper packaged takeaway meals for the pilgrims during the event period meaning that the paper and cardboard waste found during the sorting process were mostly cardboard, paper plates and mixed paper while plastic waste was mainly plates and plastic films. The average percentage of paper waste was greater than that generated during non-event days of 12.3%, while plastic waste was less than that produced during non-event days of 14.9% in Kerbala (Al-masoudi and Al-haidary, 2015). These materials (plastic and papers) represents 10.89% of the waste generated during Kumbh Mela (Gangwar and Joshi, 2008) and 52.6% of the waste generated during Hajj (Alsebaei, 2014).

Metal and glass waste made up 6% of the total refuse, which is a significantly lower fraction than that generated during Hajj (13.2%) (Alsebaei, 2014) and Kumbh Mela (10.73%) (Gangwar and Joshi, 2008). These low percentages of metal (3.6%) and glass (2.4%) can be attributed to minimal use of canned drinks and glass materials. The average percentage of both metal and glass in the event waste were less than that in non-event metal and glass waste of 3.7% in Kerbala (Al-masoudi and Al-haidary, 2015). Similarly, the percentage of other waste generated during the event of 6.5% was less than that generated in Kerbala and other Iraqi cities as well as during similar REs (Alnakeeb, 2007; Gangwar and Joshi, 2008; Ali, 2009; Alsebaei, 2014; Al-masoudi and Al-haidary, 2015).

- *Average Weight of Waste Components in the Arba'een*

To estimate the amount of each MSW constituent from the Arba'een, the total weight of MSW generated during the aforementioned RE needed to be known. However, although the

exact amount is unknown, it can be estimated. According to the Kerbala MSWM authorities, 48 kt of MSW were collected during the Arba'een in 2015 (section 4.4.1.2). This amount represents all the MSW collected from the city over the 15 days of the RE, as respondents stated that the management authorities were able to collect all the MSW generated. Based on this amount, weights of different MSW components were calculated as shown in Table 4.2. Considering the fact that the MSW generated during REs has very high organic content (57.9%), areas of the event needed a proper MSW storage system and more frequent collection services to prevent waste decomposition and contamination of the surroundings.

Table 4.2: Calculated weight of each MSW produced during the Arba'een, where the percentages were taken from the results of the 60 representative samples

Waste components	Mean (wt. % as received)	Estimated weight of waste components for overall Kerbala (tonne)
Organic Waste	57.9	27807.5
Paper Waste	14.9	7009.6
Plastic Waste	14.6	7174.8
Metal Waste	3.6	1153.1
Glass Waste	2.4	1736.3
Other Waste	6.5	3118.8

4.4.2 Waste Handling at Source

The storage of MSW prior to collection is an important aspect of MSW handling practices (Ghiani et al, 2012; Rodrigues et al, 2016), so this study sought from the MSWM authorities how the waste is stored before collection and disposal during REs. Table 4.3 shows types, sizes and numbers of MSW storage bins used during REs in Kerbala according to the MSWM authorities' responses.

Table 4.3: Types of storage containers used during REs

Type of container	Size	No.	Ratio (%)	Note
Small wheeled bins	240L	500	17.9	Maintained by HSA
Medium wheeled bins	660L	300	10.7	Maintained by KMs
Large wheeled bins	1100L	1993	71.4	100 owned by HSA and 1893 maintained by KM
Total		2793	100	

The respondents from KM agrees that the municipality has 1,893 large containers (1100L) distributed in the areas under their jurisdiction during REs (Figure 4.5). These are distributed in streets according to the vision of the supervisor of each zone. A director from KM described that "the supervisor organises the locations of containers according to the

presence of shops, camps, hotels and population density. Containers are normally placed in streets intersections, empty areas, and next to large camps (Figure 4.5), the distance between containers ranges from 20 to 50 meter in our areas". In addition, containers owned by households, hotels and camps of different sizes (240 to 1100 L) are also used to store waste during REs. This issue was reiterated by a senior official of KM when he said: "most houses, hotels and camps have their own containers, which are used to store their waste and placed in front of the premises for collection by the collecting KM…"

Figure 4.5: 1100 L Containers maintained by KM placed next to a camp

On the other hand, a different storage system is adopted in areas under HSA areas. The representatives of the HSA stated that they use smaller containers (240 L) and denser distribution in addition to some large bins. A director outlined that they have around 500 small containers and 100 large containers. These bins are placed along the streets in the centre of the event on both sides with an average distance of 15 metres (Figure 4.6), while the large bins are placed in the intersections of the vital streets.

KMs that are the Hurr, the Hindiyah, the Husayniyah, the Jadwal AL-Gharbi and the Khairat have 300 medium size containers (660L). According to a director in KMs, each municipality is supplied with 60 containers and is responsible for a segment of roads entering the city of 13 km length. The bins are placed along the segment with an average distance of 220 metres. In addition, all institutions (KM, HSA, and KMs) distribute large polythene bags to all camps, hotels and shops to store the excess waste until the collection vehicle reaches their location during congested times (Figure 4.7).

Figure 4.6: 240L Containers maintained by HSA placed along the Sidra Street

Figure 4.7: Polythene bags filled with a camp waste

Based on the above, sizes and distribution of the storage containers used during REs are varied according to the authority areas and the opinion of the zones' supervisors. During the field observation, Garmin GPSMAP 78s was used to mark the locations and record the sizes of the MSW containers in the REs area. From Figure 4.8, it can be clearly seen that 240L bins were mostly used in the areas of HSA activity while 1100L bins were used in the areas of KM activity, which confirms the statement of MSWM authorities' respondents. There are some 2200L bins and the one 3300L bin (Figure 4.8) due to placing more than one

container in one place (Figure 4.5). According to the MSWM authorities, the use of 240L bins is because of the crowded situation and it is difficult to transport the large containers to the collection vehicle in such circumstances.

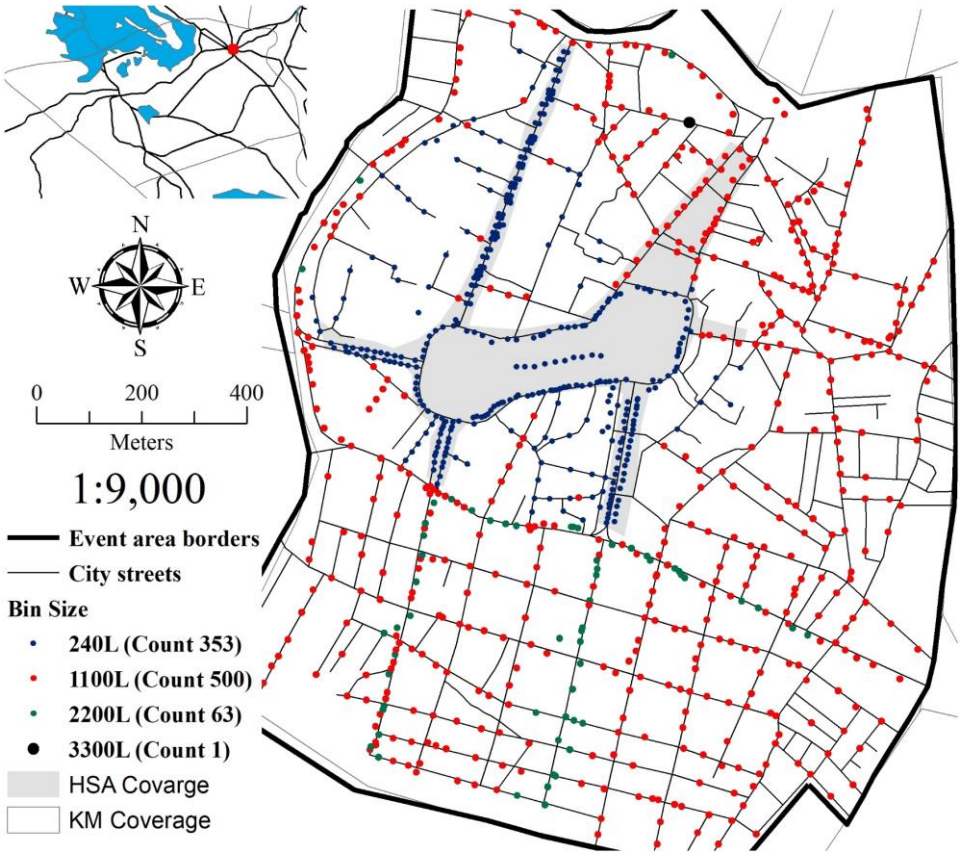

Figure 4.8: MSW storage bins distribution in the area of the REs

Overall, these results indicated that there has been no study to quantify the waste generated during REs in Kerbala and to match MSWG with the capacities of storage receptacles issued. The storage system adopted in Kerbala during REs relies on the traditional model of collecting waste with small waste receptacles of 240L to 1100L. This system is usually incompatible and therefore unsuitable to store the MSW generated during REs. A study to quantify the generated waste during REs and develop the storage system accordingly is critically required to overcome issues of inadequate capacities for waste storage and collection.

4.4.3 MSW Collection and Transportation

Waste collection and transportation are widely accepted across the world to account for the majority of expenditure on MSWM, up to 80% of the MSWM budget in middle-income countries (Das and Bhattacharyya, 2015). KM, HSA and KMs are responsible for the collection and transportation of MSW generated in Kerbala during REs with the support of

other municipalities. Table 4.4 provides a summary of MSWM machinery owned by these institutions during REs, while Table 4.5 shows the human resources according to the municipalities' records.

Table 4.4: Summary of MSW vehicle operating during REs

Equipment	Existing units in each institution				Total
	KM	KMs	HSA	Other	
Management vehicle	40	35	3	0	78
Waste compactor truck	140	70	12	80	302
Sweeping vehicles	18	7	3	18	46
Truck (lorry)	25	36	3	40	104
Transport trailer	6	0	0	0	6
Water tanker truck	20	16	2	0	38
Fuel tanker truck	4	0	1	0	5
Grader	8	14	0	0	22
Bucket loader	11	15	0	3	29
Compactor	1	0	0	0	1
Excavator	3	0	0	0	3
Bulldozer	2	0	0	0	2
Total	278	193	24	141	636

Table 4.5: Summary of MSW human resources during REs

Equipment	Existing human resources in each institution			Total
	KM	KMs	HSA	
Administration	40	25	20	85
Engineers	9	0	0	9
Supervisors	79	27	30	136
Drivers	178	174	24	376
Mechanics	7	10	5	22
Workers	1705	700	1000	3405
Others	101	0	0	101
Total	2119	936	1079	4134

MSW collection is performed in three stages during events. In the first stage, the MSW is collected from the generation units (hotels, camps and households) to the storage system in the event areas (containers). In this regard, the authorities' respondents stated that the premises' owners keep their waste near their premises in private waste receptacles or transport it to the nearest communal container (Figure 4.8) until the collection truck visits their location for waste collection. In addition, 3,405 workers shown in Table 4.5 are sweeping the streets and transporting generated public MSW to the communal waste receptacles, transporting containers placed in some narrow and inaccessible streets as well

as making sure that all waste is collected when the collection truck passes through their areas.

In the second stage, the generated MSW is loaded from receptacles onto medium-sized collection vehicles then transported to the nearest TTS (Table 4.6) or directly to the landfill. Using kerbside collection arrangements during REs, respondents stated that a supervisor (Table 4.5) is assigned to each zone that is supplied with a number of collection vehicles and cleaning workers working according to his direction. The supervisor is responsible for planning the collection truck routes, allocating a collection vehicle to a number of streets to collect the generated waste, making sure the collection vehicle does not leave the area until completely full and ensuring that all the generated waste is collected.

Table 4.6: Summary of TTSs functioning with administrative boundaries

No	Name of the TTS	Total area (m^2)	Year of operation	Distance from collection area (km)	Operating authority	Operation capacity (tonnes)	Existence of informal recyclers
1.	Baghdad-Kerbala Road TTSa	500	2014	Center of the area	KMs	150	No
2.	Baghdad-Kerbala Road TTSb	2500	2008	Center of the area	KMs	200	No
3.	Babylon-Kerbala Road TTS	1000	2008	Center of the area	KMs	100	No
4.	Najaf-Kerbala Road TTS	4000	2008	Center of the area	KMs	N/A	No
5.	AL-Abbas district TTS	3000	2010	1	KM	1000	Yes
6.	AL-Raudhatain Street TTS	1500	2010	2	KM	500	Yes
7.	Hamza AZaghair Street TTS	1000	2012	2	KM	1000	Yes
8.	Kerbala Ancient Cemetery TTS	1000	2012	4	KM	2000	Yes

The large amount of MSW generated during REs forced the MSWM authorities to direct the collection vehicle to pass through the same area more than once per day, particularly main streets. The respondents agreed that the collection frequency reaches up to 8 times per day while the event is ongoing to ensure the majority of the generated waste is collected. Therefore, the collections were made from more than 70% of the event area while the event was ongoing. The remaining 30%, which is generated in narrow or inaccessible streets, was left until the end of the event to be collected in a massive campaign due to high population

density and the low mobility of collection vehicles in such streets. In this regard, the majority of the authorities' participants indicated that the collection trucks speed varies according to the size of the vehicle, the type of street and crowding circumstances. The speed of the collection vehicle has a negative relationship with the size of the truck and the crowding density, the larger the truck size and the denser population the slower the collection truck speed. Despite the fact the there is no study to estimate this speed, interviewees estimated according to their experience that the speed varies between 3 and 5 km/h.

Figure 4.9: MSW accumulation around bins and illegal dumping during the Arba'een

The small sizes and improper distribution of MSW receptacles (section 4.4.2), the crowding situation in the event areas and the slow speed of the collection truck have led to a high incidence of MSW accumulation around the collection points, of littering and litter bins overflowing and of illegal dumping due to the size of the event. This statement is confirmed by the responses of interviewees during interviews and field observations. Figure 4.9 shows examples of waste receptacles overflowing and illegal dumping of MSW during the Arba'een. To minimise the impact of such situations during times of congestion, MSWM

institutions distribute a large number of polythene bags to MSW producers in which to store the waste in case of collection truck delays. A director from KM said, "The waste piles up when the collection truck is late by only two hours in some streets. Therefore, we ask the camp owners to store their waste in the polythene bags until the collection truck arrives, these bags facilitate the process of loading onto the vehicle as well as minimising the negative effects of waste accumulation". Therefore, all municipalities provide collection services 24 hours per day over three shifts during REs. In addition, as the day of the event approaches (the actual Arba'een day), and the number of pilgrims increases, the movement of the collection vehicles becomes more problematic. Therefore, in the last days of the celebration, a number of trucks are normally placed next to some of the more waste-generating camps until they are filled. When full, these trucks leave their spots to transport the waste to the nearest TTS and return to the same spot again.

In the third and final stage, the waste in TTSs is loaded onto larger transportation vehicles such as Trailers and Lorries (Table 4.4), covered with a thin layer of sand (Figure 4.10) and then transported towards the landfill. Waste transportation to landfill is normally performed using specialised closed vehicles. However, owing to the huge amount of MSW generated during REs, MSWM authorities are forced to operate many open vehicles (Figure 4.10) and several TTSs (Table 4.6) (Abdulredha et al, 2017c) which adversely affects the environmental conditions of MSW collection.

The TTSs are empty lands selected by MSWM authorities to store the waste prior to transportation to the landfill. According to the MSWM authorities in Kerbala, there are eight TTSs in the city during the Arba'een; Table 4.6 provides a summary of all the TTSs operating in Kerbala. Four of them are managed by KMs and located at the main entrances of the city. A director from KMs stated that the locations of the TTSs are selected without any environmental consideration. As each municipality covers 13 km of the main routes, it searches for an empty area in the middle distance of that segment to gather the waste generated in that segment to transport it to the landfill. Generally, the TTSs are positioned as close as possible to the collection area and the transportation route. Managed by KM, the remaining TTSs located around the centre of the event (Figure 3.6) have comparable siting process and environmental condition. According to the informal interview with a householder who lives next to one of the TTSs, these locations have negative effects on neighbouring houses and the MSW collection staff. Because of the unpleasant odour and the spread of insects, some residents leave their houses during the event period.

Figure 4.10: MSW transportation trucks during REs

Although the MSWM authorities collect all the mass of the MSW during or immediately after the REs ends, the collection and transportation system is suffering from several issues such as improper siting of the transfer stations, very high incidence of MSW accumulation around collection points, and the use of improper transportation vehicles. Despite the high frequency of waste collection per day, the unplanned distribution of waste collection mechanisms and waste storage systems during REs have led to many instances of waste accumulation around waste storage points and illegal dumping. Besides, the current practice of using open transportation vehicles and improperly sited TTSs have the potential to cause serious harm to human health and the environment in the city. Thus, a detailed study of the MSW collection and transportation system during REs is important to understand the system and to investigate the possibilities of development, particularly in terms of service quality.

4.4.4 MSW Treatment and Disposal

There are many methods for disposing of or treating MSW; some of them pollute the environment without offering financial returns such as landfilling while other causes less pollution and have financial benefits i.e. recycling (Suttibak and Nitivattananon, 2008;

Curran and Williams, 2012; Wilson et al, 2013c; Alsebaei, 2014; Garcia, 2015). Like many developing countries (Alnakeeb, 2007; Wilson et al, 2012; Wilson et al, 2015), Kerbala is still using landfilling as the method of waste disposal.

According to the municipalities' representatives, Kerbala has one official landfill site, which has been approved by the Directorate of Kerbala Environment (Central Statistical Organization Iraq, 2016a). It is an old quarry pit located about 10 km south of Kerbala city centre and about 2 km from the city urban areas (Figure 4.11); lying next to one of the groundwater aquifers in the area (Dammam confined aquifer) (Khalaf and Hassan, 2013). The landfill has been receiving waste from all Kerbala districts since 2009. A director from KM stated that the waste-receiving capacity of the landfill site is about to be reached, so a new location must be identified as soon as possible to minimise the negative environmental impacts. In this regard, Abdulredha (2012) implemented the integration of geographic information systems and multi-criteria decision analysis to suggest several sites that might be appropriate for MSW landfilling in Kerbala.

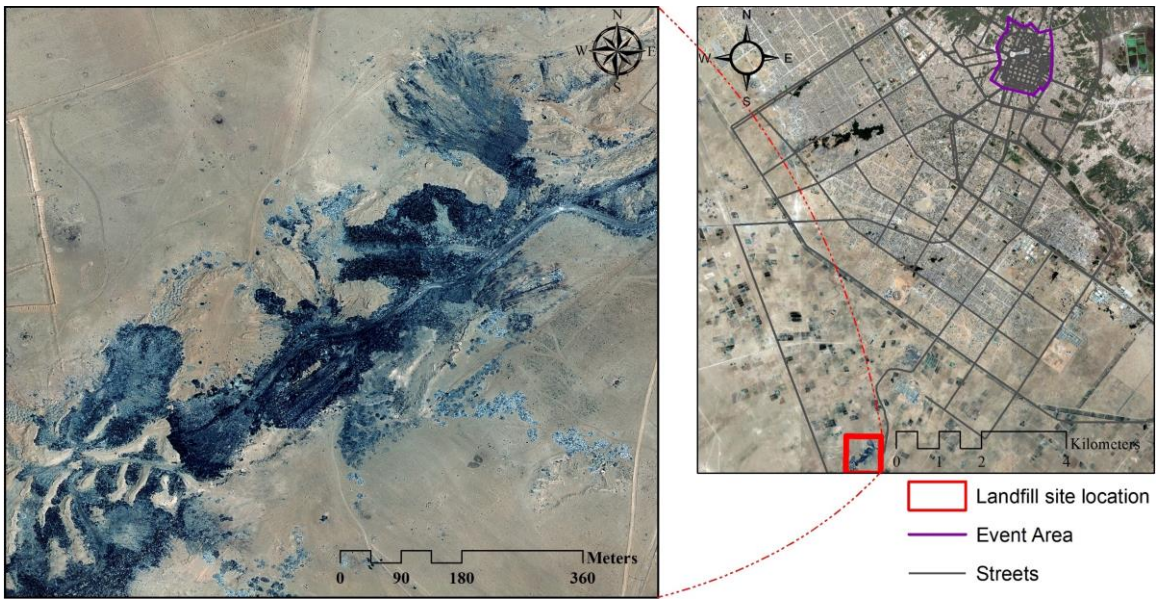

Figure 4.11: Aerial views showing the location of the landfill site relative to Kerbala (Kerbala municipality, Iraq)

According to the field observations and interviews, the present site is not engineered and is semi-controlled, operated with a compactor and two bulldozers maintained by KM (Table 4.4), the body responsible for managing and monitoring the site. This site is generally poorly maintained lacking fencing, access control, proper vehicular access, site security and waste scales (see Figure 4.12a and b). The MSW is crudely disposed into grooves of the quarry, compacted and occasionally covered with a thin layer of sand extracted from the same

quarry. In addition, KM does not practise appropriate environmental control schemes or carry out regular inspections of the site to ensure that it does not create a negative impact on the surrounding environment. Therefore, there are no provisions to extract the landfill gases and drain off leachate from the decomposing waste (Figure 4.12d). In consequence, the site experiences occasional outbreaks of fire (Figure 4.12c), wind-blown waste materials, uncontrolled emissions, uncontrolled leachate, and infestation by rodents, thus increasing the potential of water, soil and air pollution.

Figure 4.12: Field observation of the official landfill site in the city of Kerbala

To conclude, the present landfill site is about to reach its full capacity and identifying a new alternative is necessary. The absence of general site management issues such as fence and access control can lead to many negative impacts on the city, including waste blowing and intentional vandalism. In addition, the lack of control over the landfill gases and leachate might result in dramatic impacts on the surrounding environment, particularly with the presence of a large groundwater aquifer in the area of the landfill used for irrigation of the surrounding agricultural lands. Therefore, actions are required to improve the current

situation of MSW treatment and disposal in the city such as properly managing the current MSWM sites, developing a state-of-the-art alternative facility and investigating the possibility of introducing a less polluting treatment alternative such as recycling.

4.4.5 Resources Management

The large volume of MSW is causing problems for MSWM services and faster depletion of landfill's capacity (Mazzanti et al, 2010), which could lead to serious destruction to the environment (Mor et al, 2006) and impacts on public health (Al-Khatib et al, 2010). Recycling has been proved as one of the most economical approaches to reduce undesirable impacts of MSW (Babaei et al, 2015; Sheau-Ting et al, 2016). However, although Kerbala generates a large mass of MSW of more than 500 kt each year, the city authorities do not have a strategy that endorses MSW recycling.

The field observation and interviews confirmed that formal source separation and recycling schemes for MSW do not exist in Kerbala (Abdulredha et al., 2017a), particularly during REs. The participants attributed this to the absence of a plan to develop the system, to the lack of regulations and low public awareness. The Environmental Protection and Improvement Act (EPIA) number 27/2009 outlines MSWM legislation and implementation guidelines. Several participants suggested that the current regulations are weak and outdated, focusing only on public cleaning and ignoring MSWM system development. Thus, recycling activities throughout Kerbala are limited to informal contributors (Figure 4.13).

An IRS has grown substantially over the last decades, scavengers sifting through and recovering recyclable material from collection points, transfer stations and landfill sites (Figure 4.13). This sector is working on its own, as no organisation (neither government nor non-government) has made the effort to represent or include IRS within the formal system. Therefore, workers work in poor environmental conditions, having no appropriate clothing or equipment (e.g. gloves) nor an infrastructure for recycling purposes (Figure 4.13). Besides, there are no figures of the size of the active forces in IRS in the city, particularly during REs. MSWM authorities have no accurate estimates about the percentage of MSW that is recovered by the IRS. However, interviewees estimated that about 5% of the MSW generated during REs is recovered; about 25% of the materials recovered by IRS was clean and source separated.

Figure 4.13: Informal recycling activities: (a) at the landfill and (b) at the TTSs

This sector recovers several materials from the waste such as plastic, metal, paper and even leather. According to informal interviews with several scavengers, they are operating individually or in groups to extract specific materials from the waste stream mostly plastic, metals and papers (Figure 4.14). For instance, there is some separation of organic materials at source to reduce food waste contamination and using it for animal feed. One group active in the TTSs is interested in retrieving only leather from the waste stream, while another group operates solely at the landfill that recovers only paper and cardboard to sell it to a small-scale paper-recycling factory located near the landfill site. The majority of IRS participants concentrate on recovering plastic and aluminium cans.

Figure 4.14: Waste materials recovered by informal recycling activates

Kerbala, like many middle-income cities, still relies on informal recycling. A recycling rate of about 5% in Kerbala is lower than many cities around the world with comparable conditions (Wilson et al, 2013a; Wilson et al, 2013b; Wilson et al, 2015). This low rate of waste recovery is due to several factors including the failure to adopt a strategy to develop the MSWM system, the lack of awareness among the public, the non-inclusion of the private and IRS in the formal system and the lack of strict regulations by local authority and central government that empower laws and policies of MSWM.

4.5 **Factors Affecting MSWM.**

A rapid increase in the Kerbala population, particularly during REs has resulted in growing pressure on urban infrastructure and services. The previous section revealed that the MSWM authorities were unable to provide adequate collection and safe treatment and disposal of the MSW generated during REs. Thus, one of the objectives for carrying out this study was to identify the factors responsible for the current MSWM situation in Kerbala. While city population pressure can generally be regarded as a root cause of MSWM problems in Kerbala during REs, a number of aspects have emerged from the analysis as the factors

responsible for the improper MSWM situation in the city during REs. These factors are similar to those that affect MSWM efforts in other developing countries (section 2.5).

4.5.1 Governance Aspects

Scholars such as Wilson et al (2015) suggested that the effectiveness of a city's MSWM system could be used as a proxy indicator of good governance, and hence there are many governance aspects affecting the quality and performance of MSWM service delivery such as MSWM policy, stakeholders' involvement and financial aspects.

4.5.1.1 MSWM Policy

The presence of updated MSWM legislation and regulation to accommodate any changes in the national situation plays a vital role in the success of the MSWM performance (Wilson et al, 2015). The present legislative framework supporting MSWM in Iraq is inadequate. According to a director in KM, EPIA is the key piece of law that outlines MSWM legislation and implementation guidelines in the country.

According to EPIA, all MSW generated within the boundary of Kerbala is the property of the MSWM authority in the city, and they are mandated to remove and dispose of those materials without causing any nuisance to the public. According to the EPIA and confirmed by participants, the Ministry of Construction and Housing and Public Municipalities (MCHPM) is responsible for the management of MSW while the Ministry of Environment is in charge of enforcing environmental legislation and monitoring the performance of MSWM systems at a national level. The Ministry of Environment is also obliged to ensure that all activities, which includes industries as well as waste management sites, operate without an adverse environmental footprint. However, there are no prescribed standards or clear guidelines for the implementation of the MSWM policy. The current situation of the country also makes it difficult for management authorities to enforce standards, regulations and penalties on offenders to promote a positive environmental attitude among citizens. For instance, interviews conducted with MSWM authorities in Kerbala showed that there are national laws to prevent illegal disposal and littering of MSW and to minimise the impacts on the environment. However, due to unclear implementation guidance, weak cooperation with other bodies such as the police and the weak performance of the present MSWM authorities in the city makes the application of such laws difficult.

Additionally, EPIA emphasises the importance of minimising and recycling the waste produced from every project when possible. In addition, it further suggests the formulation of strategies to encourage MSWM through waste avoidance, reduction and recycling, and

thereafter final disposal in an environmentally friendly method. However, the MSWM authorities were not able to formulate such a robust long-term strategy for MSWM (normally 10 years) that adopts the hierarchy of MSWM. Local authority representatives who participated in the interview expressed their concern for the non-existence of a proper MSWM strategy that focuses beyond just collection and disposal and considers the possibility of introducing new MSW treatment activity. For instance, although large fractions of recyclable materials are generated each year from REs, authority officials expressed that their day-to-day operations are concerned with the collection and transportation of the generated waste to the landfill.

Briefly, the strategy for MSWM has its own shortcomings. It describes generic MSWM principles rather than a strategy that has a defined period to achieve specified targets. In addition, the current strategy does not differentiate between approaches for large and small cities, let alone cities that host REs. Thus, the improper application of the MSWM regulation and the ineffective MSWM strategy appear to be one of the reasons for the current challenges facing Kerbala city, particularly during REs.

4.5.1.2 Stakeholders' Involvement in MSWM

The government is legally responsible for MSWM in the city, particularly during REs, but the objectives of MSWM cannot be achieved without the active participation of all stakeholders (users and providers) who each have their distinct roles. The provision of transparent space for stockholders to contribute to the planning and delivery of MSWM services significantly enhances its performance (Wilson et al, 2012; Wilson et al, 2015).

- *User Involvement*

Any MSWM programme success depends on the assistance of its users (Sheau-Ting et al, 2016). For that, the active participation of MSW generators during REs is among the key elements of improving MSWM. In this regard, MSWM authority representatives indicate that public involvement in planning, application and evaluation of MSWM services during REs is poor and negatively impacts the performance of the MSWM system (Central Statistical Organization Iraq, 2016a). This occurred due to the lack of proper mechanisms for public participation and the lack of environmental awareness among users.

According to the interviewees, there is no well-developed mechanism that ensures actual public involvement in MSWM services planning and implementation process. The MSWM authorities have no legal obligation to consult with and involve people in decisions that directly affect them. In addition, the non-governmental organisation did not use any effort

to promote linkage between the MSWM authorities and citizens. Therefore, citizens are not actively participating in the design and planning stages of MSWM activities. A similar situation applies during REs where the public is not included in the procedure for siting MSWM facilities. However, a complaint system that uses telephone and internet communication is in place and functioning to allow citizens to transfer their complaints. Therefore, it is generally regarded that MSWM is the sole duty of the MSWM authorities and that the public is not expected to be involved. This practice has prevented the very important part of public involvement, and this problem can be addressed by improving public education and involvement.

The EPIA stated that the city's MSWM authorities are responsible for promoting environmental awareness among citizens using various means such as TV channels, radio stations and workshops. However, interviewees stated that MSWM authorities have a weak public education programme regarding MSWM, using printed posters and workshops. This is because there is insufficient funding for TV and radio programmes. A director from KM noted that the inadequate financial support has made authorities concentrate their effort on the collection of the waste. Therefore, the present educational programme has a negligible impact on public behaviour, leading to a poor environmental attitude among a large fraction of the populace. The situation of the weak public education on waste management and environmental sanitation greatly contributes to citizens ignorance about the harmful results of improper waste disposal. This view is supported by a director from KMs when he said "many people throw the waste anywhere such as the roadside and streams… because they do not know that these practices could have serious effects on the environmental situation of the city and even their health".

The indiscriminate waste disposal was clearly apparent during REs. People are discarding waste everywhere (Figure 4.15), a situation that greatly contributes to MSW accumulation in the streets of the events. The municipalities' participants stressed the need to raise public awareness during REs. Considering a large number of people gathered during REs, focusing efforts on raising public awareness could have a wider impact on society. MSWM authorities' respondents indicated that enormous opportunities exist to educate the people on environmental sanitation and waste handling during REs including the sermons and local electronic and printed media, which require less fund comparing to other media such as TV channels.

Figure 4.15: Indiscriminate waste disposal during REs

Like many developing countries (Ahmed and Ali, 2006; Vidanaarachchi et al, 2006; Alsebaei, 2014), the waste management authorities in Kerbala have failed to provide a policy that enhances the environmental awareness of the public and ensures their active involvement in MSWM aspects. The poor awareness and the lack of public contribution can, in turn, lead to a loss of many opportunities for the improvement of the present MSWM system that the citizens' involvement could offer. As scholars (Ahmed and Ali, 2006; Vidanaarachchi et al, 2006; Amasuomo et al, 2015) stress the importance of considering the people as partners for improving waste management services delivery, the authorities should make more efforts to enhance the environmental awareness and ensure the active contribution of the citizens.

- *Provider Involvement*

Provider inclusivity is the degree to which non-governmental bodies are involved in the planning and the active delivery of MSWM services in a city (Wilson et al, 2013a; Wilson et al, 2013b; Wilson et al, 2015). Researchers suggested that the private and community partnership with the governmental sector dramatically enhances the performance of the MSWM system (Ahmed and Ali, 2006; Masood et al, 2014). Therefore, this study

investigates the role of non-governmental bodies in planning and delivering MSWM services, particularly during large events.

Interviewees recognised that both the public and private sectors are allowed to provide stable MSWM services within the current legal framework. In addition, a clear and transparent bidding process for MSWM services delivery is open to all organisations that are able to deliver MSWM services. However, despite their contributions to the improvement of the system, the private sector does not participate in the provision of MSWM services let alone the planning of the services in Kerbala, particularly REs. There is a little acknowledgement of the role played by this sector regarding MSWM services delivery. According to the respondents' comments, MSWM authorities have not made sufficient efforts to attract investors and specialised companies to improve the current MSWM system. In addition, as illustrated in section 4.4.5, there is a lack of effort on behalf of city authorities to include the informal sector in the formal MSWM system.

In general, the informal and private sectors are not actively included in planning and delivering the MSWM services in Kerbala. As many cities such as Mina, Guadalajara and Castries (Wilson et al, 2013b; Alsebaei, 2014; Wilson et al, 2015) have improved the performance of the MSWM system by the inclusion of these sectors, the authorities in Kerbala should make more efforts to involve both the private and informal sector in MSWM service. This inclusion could significantly develop the system, enhance recycling, minimise MSWG, extend collection coverage and reduce management costs.

4.5.1.3 Financial Sustainability

It is accepted among researchers (Wilson et al, 2015; Grazhdani, 2016; Abdulredha et al, 2017c) that MSWM is one of the most expensive services that a city's authority delivers. For that, MSWM authorities should have a reliable and sustainable source of funds to deliver efficient MSWM services. The respondents identified that the MCHPM covers most of the capital costs required for MSWM in the city, which agree with AL-Yasari (2015) conclusion. Kerbala's government also provides an extra fund to cover the cost of MSWM during REs. These institutions have rigorous accounting procedures in place for MSWM operational costs (AL-Yasari, 2015). However, as these accounts are not open to public scrutiny, there is no transparency or accountability.

Apart from the financial support from the above-mentioned institutions, other revenues stream for management authorities that are licence fees, fines and service charges. The respondents outlined that there are fixed service charges for residential premises which are

collected as a part of the water and wastewater fees and sent to the municipality. The commercial activities also pay fees that vary according to the type and size of activity and are collected directly by MWM authorities. AL-Yasari (2015) reported that about 430 million Iraqi Dinar (ID) are collected by KM per year which represents about 2.23% of the MSWM cost in the central districts of the city over the year of more than 1.6 Billion ID. The majority of that supply is spent as vehicle fuel, maintenance and replacement as well as salaries to staff and labourers. The expenditure on system development, waste treatment and final disposal is very low (Central Statistical Organization Iraq, 2016a).

On the other hand, participants agreed that MSWM services are delivered free of charge during REs and the system lacks a user cost recovery system and the means to apply MSW disposal charges. Most of the respondents stated that MCHPM and Kerbala's government were able to provide more than 70% of the funds required regarding MSWM in the city during REs. As a result, participants identified that MSWM services during REs are constrained by a shortage of funds. A respondent from KM indicated that because of the low funds, MSWM authorities were unable to have adequate fleets (staff and equipment) to provide a proper service and keep the city clean during REs. This situation forced KM to request support from other municipalities to cover the gap between that capacity of the city management fleets and the quantity of waste produced during events. In addition, the shortage of funds also affects the acquisition of land to be used as sites for MSWM facilities such as landfills and transfer stations. A respondent from KM stated that "although the city is in desperate need for several transfer stations and new landfill, the municipality cannot secure suitable lands because of the low financial support to buy the required lands". It is, therefore, evident that the low financial support greatly affects the quality and coverage of the MSWM services.

The MSWM authorities stressed that some kind of fund injection is necessary to improve current services during REs. Even if the events capital expenditures are met by the fund from MCHPM and Kerbala's government, there is still a need for funding for recurrent expenditure and system development. A waste collection levy from the services users during REs was suggested as an option. Since all camps are providing various free services for all pilgrims, which generate large quantities of waste; these camps should, therefore, pay the fees of MSWM services, which achieve the camps' objectives, namely, to provide a suitable environment for pilgrims. The use of cost recovery programmes such as recycling was another option suggested by the management authorities. Respondents explained that the

MSW generated in the Kerbala area, particularly during the events, contains large quantities of recyclable materials, which can be used as revenue to improve the MSWM service.

The above analysis revealed that MCHPM and Kerbala's government provide more than 70% of funds required for proper MSWM services during events and the majority of the fund goes to payment of salaries and vehicle fuel. The inadequate funding and poor financial management are important factors that affect the current operation of the MSWM system in Kerbala, particularly during events. There appears to be a growing consensus among the authorities for a more practical approach to raise revenue for MSWM, which is in line with the conclusion generated by AL-Yasari (2015) for non-event days. A better financial situation will significantly improve the operation of the MSWM in the city and events.

4.5.2 Operational Factors

The availability of adequate technical expertise, sufficient fleet (equipment and personal), suitable lands for MSWM facilities siting and proper information about the generated waste are other important aspects of an ISWM (Vidanaarachchi et al, 2006; Scheinberg et al, 2010). These aspects are considered as common causes for poor MSWM services in the developing world (Vidanaarachchi et al, 2006; Suthar and Singh, 2015). Kerbala like many cities in the developing world appears to be greatly constrained by these aspects.

4.5.2.1 Reliable Data for System Planning and Operations

Accurate and reliable information about sources, quantity and composition of the MSW is crucial for the successful planning and organisation of the MSWM services and activities in any city (Jahandideh et al, 2009; Thanh et al, 2010; Parisi Kern et al, 2015). Interviews show that there is a lack of waste information due to the absence of information systems that continuously capture accurate information about the quantity and composition of the MSW. There is a lack of a comprehensive investigation of the composition of the waste generated from Kerbala, let alone the waste generated from REs (AL-Yasari, 2015; Central Statistical Organization Iraq, 2016a; Abdulredha et al, 2018). A director from KM stated that the municipality does not conduct studies on the waste generated from the city owing to the lack of funding and expertise. The absence of a weighbridge at the landfill site made the process of determining the quantity of MSW collected from the city and REs to be based on personal estimation. In addition, the MSWM authorities do not have an estimation of the quantity of waste, generated from the city or REs, which is not delivered to the designated landfill.

The lack of accurate and reliable data on the MSW situation, mainly from REs, can be regarded as a contributory factor to the current MSWM practices in the city. The failure to sponsor research on the waste situation in Kerbala can be considered as further evidence of the weak strategic planning of the city authorities. Accurate data regarding the rate of generation, sources and composition of the MSW is a priority. Developing an information system that captures updated MSW data enables the authorities to determine the fleet capacity and land required for the sustainable management of present and future MSW.

4.5.2.2 Land Space for MSWM Facilities

Researchers (De Feo and De Gisi, 2014) highlighted that the shortage of suitable land for MSWM facilities is a serious and growing potential problem in many countries. Data gathered during interviews showed that organisers of the MSWM activities in Kerbala have great difficulty in acquiring land for siting MSWM facilities such as a landfill. A director from KM outlined the process of acquiring land for waste facilities. The process includes several steps: identifying suitable areas for MSWM facilities, obtaining the environmental approvals, and acquiring the land if it is not owned by MCHPM. Suitable land for MSWM facilities is suffering from an acute shortage in and around Kerbala, which makes identification of new land a complicated task. In addition, a high proportion of these lands are not owned by MCHPM and very expensive. Consequently, purchasing these lands are considered as a challenge owing to the low financial allocation for MSWM development.

The majority of interviewees stressed that the city needs several transfer stations and a new landfill site (section 4.4.3). As the capacity of the landfill is about to be exceeded and a new one is required, a director from KM mentioned that there are no arrangements to find or prepare a new site to receive the MSW generated. Also, the landfill is located at a long distance from the centre of the generation area (Figure 4.11), making the use of collection vehicles for waste transportation more expensive. Thus, as the city does not have a permanent transfer station, MSWM authorities use several TTSs around the city, particularly during REs.

The shortage of suitable land for siting MSWM facilities appears to be one of the main challenges facing MSWM in Kerbala, particularly during REs. The failure of the MSWM authorities to acquire proper land for siting essential MSWM facilities could lead to severe impacts on the city environment, public health and large cost lose. Strategic planning, financial support and institutional cooperation hamper the acquisition of land required for siting MSWM facilities.

4.5.2.3 MSWM Equipment

The shortage and unsuitability of MSWM equipment are major obstacles that significantly influence the performance of the waste management system in the developing world (Jiang et al, 2009; Al-Khatib et al, 2010). In Kerbala, the situation is no different, as the shortage of specialised MSWM equipment is one of the important factors that are responsible for the improper MSWM in the city (Central Statistical Organization Iraq, 2016a), particularly during REs.

Information gathered during this study showed that MSWM authorities have a shortage of specialised machinery and equipment for MSWM. This shortage is very clear during REs where about 230 vehicles operate temporarily (Table 4.4). The respondents stated, although KM receives large support from other municipalities, the available management fleets were able to cover only 70% of the events area. In addition, MSWM authorities stressed the need for collection means that are able to access the narrow streets to collect the waste while the event is ongoing. As the majority of the generated waste is organic (section 4.4.1.3), the decomposition of the waste in the narrow streets could lead to a serious health issue during events. A director from KM noted that the municipality is under-resourced when it comes to equipment and blamed the low budget allocated to system development. Therefore, the city authorities use a large number of unspecialised vehicles to perform MSWM operations such as transportation.

From Table 4.4, More than 100 unspecialised trucks are used for waste transportation from the TTSs to the landfill, which accounts for around 16% of the total available machinery for MSWM operations during events. A respondent from KM pointed out that the municipality has only 6 specialised transportation trailers that are not able to transport MSW generated in the city during events. Thus, KM is forced to use open lorries for waste transportation. The use of uncovered vehicles (Figure 4.10) in MSW collection and transportation presents a serious challenge to the sustainable operations of MSWM in Kerbala, as vehicles are not manufactured for the purpose of waste transportation, lacking cover and compaction facilities. This practice often leads to waste spillage along routes to the disposal site, which, in turn, undermines the efficiency of the management operations.

The landfill is also affected by the shortage of machinery and equipment. According to a director from KM, only three machines operate at the landfill site (one compactor and two bulldozers) (Table 4.4). These machines are not competent to deal with the amount of MSW delivered to the landfill site leading to the poor maintenance of the waste disposal site. The

landfill machinery is used to level and compact the waste brought to the site as well as occasionally cover the waste with a layer of sand. A director from KM conceded that machinery at the site was inadequate and hampered operations, leading to unsatisfactory conditions at the landfill.

4.5.2.4 MSWM Personnel

There is no doubt that funds and equipment are essential for MSWM (Wilson et al, 2015; Rodrigues et al, 2016). However, human resource is also important for the successful organisation of MSWM services (Scheinberg et al, 2010; Wilson and Velis, 2015). The field observation and interviews show that the present MSWM operation is closely linked to the shortage of qualified personnel. The Central Statistical Organization Iraq (2016a) reports that the shortage of staff is one of the main issues affecting MSWM in all of the Iraqi cities. Table 4.5 shows the data on the staffing situation of MSWM authorities in Kerbala and during REs. The respondents pointed out that there are continuous reductions in the number of key personnel and operational staff.

According to respondents, authorities are understaffed and require key personnel in engineering, finance and environmental health. The shortage of engineers (Table 4.5) affects many aspects of MSWM such as planning waste collection routes and siting and design of waste disposal facilities. Besides, from interviews, it emerged that MSWM departments in the municipalities lack researchers among their staff to investigate vital elements for successful MSWM operations such as the sources, quantity, composition and characteristics of waste generated. As a result, necessary data to facilitate the planning and organisation of MSWM is not available. Furthermore, respondents confirmed the shortage of qualified finance and accounting staff, leading to negative impacts on the financial sustainability of the MSWM system. Other professionals such as environmental health staff and legal and security staff that are helping with the enforcement of existing laws on MSWM are also in shortage. In addition, despite the fact that the majority of the MSWM staff are supplied with protective equipment such as distinctive clothing, gloves and safety shoes, the lack of environmental health staff has led to a lack of regular health checks for workers. This situation negatively affects the quality of the MSWM operation such as waste treatment and disposal (Wilson et al, 2013b).

Operational staff are also in short supply in departments of MSWM in the city of Kerbala. The data collected in this study showed that the operational personnel including drivers and labourers are lacking in spite of a large number of job seekers in the city. The respondents

outlined that MSWM authorities are unable to employ enough workers owing to the shortage of funds and low salaries. The majority of the unskilled workers are employed for a short term during REs to cover the large amount of MSW generated. A director from KM stated about 1,000 workers are hired to carry out MSWM operations during REs and immediately laid off after the end of the events. Most workers are not trained and lack experience, which leads to significant weaknesses in the quality of MSWM services.

Considering the significant role of the staff in MSWM operations, the shortage of staff (operational and professional) can be regarded as partly responsible for the inadequate MSWM operation in the city of Kerbala, particularly during large events. The dearth of professionals for MSWM is confronting the planning and organisation of MSWM operations. Thus, attracting a wide range of qualified professionals including engineers, sanitation officers, accounting staff and even investigators is more likely to improve the performance of MSWM operations. In addition, stable jobs with good training for unskilled workers might lead to an improvement in the overall situation of the MSWM system in Kerbala.

4.5.2.5 Other Physical Factors

The analysis so far has shown that MSWM in Kerbala is constrained by several aspects including the lack of funds, the inadequate equipment and the shortage of personnel. During REs, other factors include the overcrowding of the population, the closure of the streets due to the security situation and the indiscriminate distribution of camps are influences on the performance of the MSWM system.

The respondents stated that the crowding situation in the streets during REs is a major challenge facing the operations of MSWM. An officer from HSA specified that collection trucks' speed changes according to the population density, the more pilgrims the slower the speed. The participants estimated that a 5 km/h speed is hardly achieved during REs and this speed starts to decrease as the event day approaches. Several interviewees stated that most collection vehicles are forced to stop in certain places (normally next to a large camp) instead of roaming for waste collection owing to the difficulty of movement in the last two days of events. Besides, bins unload-time, which is the time required to collect the waste from the storage points to the collection truck, is longer than that on normal days. A director from KM estimated that an average of 5 minutes is required to unload each bin, which is longer than the average time reported by Faccio et al (2011) of 3 minutes.

The closure of many streets due to the security situation is also limiting the performance of MSWM. MSWM authorities' representatives reported that the majority of streets are normally closed due to the security situation during REs. Thus, the collection truck passes through several checkpoints to reach the collection area, where it takes a few minutes at every point. An officer from KM estimated that about 5 to 15 minutes are normally lost while the collection truck is crossing every checkpoint, leading to a significant delay in the total time required for MSW collection. Besides, the majority of camps are placed in empty areas and streets, which in turn lead to narrow streets and a decline in the movement of waste collection crews.

Data analysis shows that the overall situation during REs greatly affects the performance of the MSWM system. Population density, security checkpoints and service camps are aspects that negatively influence operations of the MSWM system. This problem stems from the poor planning and the weak cooperation between the waste management authorities and other institutions such as the Kerbala government.

4.6 Evaluating the MSWM System during REs

Wasteaware benchmark indicators framework (Wilson et al, 2015) (explained in section 3.6 and Appendix G) is used to comprehensively evaluate the present MSWM system applied in the city of Kerbala during REs in order to identify the strengths and the weaknesses of the present system and priority actions for development. As there are no previous studies investigating MSWM systems during REs, the data for this evaluation has been drawn from available official reports, detailed interviews with key members of staff representing Kerbala authorities, and field observations. The User Manual (Wilson et al, 2015) guidelines were followed to assign scores for each indicator and criterion of this framework. Table 4.7 to 4.13 provide a comprehensive evaluation of the present MSWM system adopted in the city of Kerbala during REs whereas Table 4.14 shows the summary of the evaluation results. Sources, explanations and reasons were added to the tables to justify the choices made.

In conjunction with the evaluation of the MSWM system in Kerbala, four other cities that are Mina, Saudi Arabia (Alsebaei, 2014), Guadalajara, Mexico (Wilson et al, 2015), Castries, Saint Lucia (Wilson et al, 2013b) and Qena, Egypt (Wilson et al, 2013a) were selected for comparison purposes. These cities were selected for comparison as they have comparable income level and their MSWM systems were evaluated using the same evaluation framework.

Table 4.7: Background information and key-waste related data about Kerbala city

No.	Item	Indicator or criterion		Results		Justification
B.1	Country Income Level	World Bank income category		Upper-middle income		The World Bank (2018) data of Iraq.
		GNI per capita		$ 5,420		
B.2	City Population	Floating Population	AL-Arba'een	12,000,000	In total 19,515,000 pilgrims	According to published research and reports (National Investment Commission Iraq, 2014; AYN, 2016; Abdulredha et al, 2017a; Abdulredha et al, 2018; Mujtaba Husein, 2018)
			Ashura	3,500,000		
			Daily Pilgrims	4,015,000		
		Local Population	Urban	773,506	In total 1,207,152 inhabitants	Ministry of Planning, Central Statistical Organisation Iraq data (Central Statistical Organization Iraq, 2015b; Central Statistical Organization Iraq, 2016a).
			Rural	377,646		
			Displaced	56,000		
B.3	MSW Generation	Total collected waste		565 kt/year		According to the report of Central Statistical Organization Iraq (2015a) and the municipalities records and estimations.
		Estimated event waste		80 kt/year		
W.1	MSW generation per Capita	Residents waste generation		766.5 kg/year		This is an approximation of data based on the report of the Central Statistical Organization Iraq (2015a) (Section 4.4.1.2)
		Pilgrims waste generation		4 kg/year (80 kt divided by 20 million pilgrims)		Estimation based on the total mass of MSW generated during events and the estimated pilgrims attending the events.
W.2.1	MSW composition in the city	MSW composition during events days	Organic %	57.9		AL-Arba'een event waste composition (Section 4.4.1.3)
			Paper %	14.9		
W.2.2			Plastic %	14.6		
			Metal %	3.6		
W.2.3		MSW composition during non-events days	Organic %	56.6		According to Al-masoudi and Al-haidary (2015) investigation.
			Paper %	12.3		
W.2.4			Plastic %	14.9		
			Metal %	3.7		

Table 4.8: The evaluation of the collection services of the MSWM system adopted during large events based on Wasteaware benchmark indicators for ISWM

No.	Indicator	Criterion	Results				Justification
			Score	NS	Code		
1.1	MSW collection coverage	% of users who can access a reliable collection	70	70	M		Collection were made from more than 70% of the event areas. About 30% that represents narrow or inaccessible streets was left until the end of the event to be collected in a massive effort (Sections 4.4.2 and 4.4.3).
1.2	MSW captured by MSWM system	% of the total MSW handled by the city's MSWM.	100%	100%	H		All MSW generated during large events is collected by the MSWM authorities during, or immediately after the event ends (Section 4.4.2 and 4.4.3).
1.3	Quality of the MSW collection service, Assessment based on the cumulative score of the six criteria	1.3.1. Presence of waste collection points.	5	45/120= 37.5%	L	M	Despite the high collection frequency (8 times/day) and dense distribution of waste bins during event, high incidence of containers over-flow has been observed (Figure 4.9).
		1.3.2. Efficiency of street cleaning.	5				Streets sweeping is not regular due to the crowding situation leading to high incidences of solid waste littering in the area of the event (Figure 4.15).
		1.3.3. Efficiency of MSW collection in low-income areas.	5				High incidence of illegal disposal (Section 4.4.3 and Figure 4.9).
		1.3.4. Efficiency of MSW transportation.	5				The use of open vehicles and operation several TTSs have reduced operational and environmental conditions (Section 4.4.3 and Figure 4.10).
		1.3.5. Collection service planning and monitoring.	15				A supervisor is planning and monitoring the operation of MSW collection during event (Section 4.4.3).
		1.3.6. Collection personal Health and safety.	10				Distinctive clothing, gloves and safety shoes were provided to each worker. However, there is a lack of regular health checks for collection staff (Section 4.5.2.4).

Key:NS- Normalized score, low performance (L)- red, low to medium performance (LM)- red-orange, medium performance (M)- orange, medium to high performance (MH)- orange-green, and high performance (H)- green.

Table 4.9: The evaluation of the treatment and disposal service of the MSWM system based on Wasteaware benchmark indicators for ISWM

No.	Indicator	Criterion	Results			Justification
			Score	NS	Code	
2.1	Controlled treatment or disposal of MSW	% of the total MSW destined for an engineered or controlled treatment or disposal facility	0%	0%	L	All collected waste is destined to uncontrolled landfill site (Section 4.4.3).
2.2	Environmental protection in MSW treatment and disposal; assessed based on the cumulative score of the six criteria	2.2.1. Control over MSW reception and general site management	0	20/120= 16.7%	L	No fencing, access control, proper vehicular access, site security and waste scales (Section 4.4.3).
		2.2.2. Control over MSW treatment and disposal	5			Waste is compacted and occasionally covered with a thin layer of sand. There is no control over waste leachate (Section 4.4.3).
		2.2.3. Monitoring and verification of environmental controls	5			Directorate of Kerbala Environment is approved the site. However, there is no regular site inspections (Section 4.5.1.1).
		2.2.4. Control of greenhouse emissions and/or energy recovery	0			No control over site gases and occasional fire outbreak (Section 4.4.3).
		2.2.5. Technical competence in the management and operation of treatment and disposal	0			Low service planning, manual for site operation, vehicle logs and disposal plans available, IT system for disposal fees and service provider management. Lack of implementation, maintenance and control (Section 4.4.3)
		2.2.6. Site personal health and safety	10			The frontline staff wear boots, distinctive overalls and hats but safe operating procedures and regular health-checks are not in place (Section 4.5.2.4).

Table 4.10: The evaluation of recycling service of the MSWM system based on Wasteaware benchmark indicators for ISWM

No.	Indicator	Criterion	Results			Justification
			Score	NS	Code	
3.1	Recycling rate	% of total MSW that is recycled by the formal and informal sector	5%	5%	L	No formal recycling scheme in Kerbala; However, there are growing activities of informal recycling; Authorities estimated that less than 5% is recycled by the informal sector (Section 4.4.5).
3.2	Quality of recycling service provision; Assesses the quality of MSW recycling service provision based on the cumulative score of the six criteria.	3.2.1. Source separation of dry recyclables materials	5	10/120= 8.0%	L	Interviewees estimated that less than 25% of the recycled MSW is cleaned and source separated (Section 4.4.5).
		3.2.2. Quality of recycled organic materials	5			There is some separation of organic materials at source to reduce food waste contamination meaning it can then be used for animal feed (Section 4.4.5).
		3.2.3. Top levels of MSW hierarchy	0			The city authorities do not have a strategy that endorses an MSWM hierarchy (e.g. reduction and recycling) (Section 4.5.1.1).
		3.2.4. Integration of informal sector	0			The informal sector is not included in the management system; No organization is representing the informal sector (Section 4.5.1.2).
		3.2.5. Environmental protection in recycling	0			No scheme to minimize the environmental impacts of recycling activities and Scavengers work in poor environmental conditions (Section 4.4.5).
		3.2.6. recycling personal health and safety	0			No appropriate clothing or equipment (e.g. safety shoes and gloves) nor an infrastructure for recycling purposes (Section 4.4.5).

Table 4.11: The evaluation of stakeholders' inclusivity in the planning and the organization of MSWM services based on Wasteaware benchmark indicators for ISWM

No.	Indicator	Criterion	Results				Justification
			Score	NS	Code		
4.1	User inclusivity; assessed based on the cumulative score of the six criteria.	4.1.1. Equity of service delivery	10	35/120= 29.16 %	L	M	The collection service is provided to all users. Yet, some areas were left until the end of the event (Section 4.4.3).
		4.1.2. The right to be heard	5				The users are not included in the in decisions that directly affect them (Section 4.5.1.2).
		4.1.3. Public participation	5				Poor public (visitors) involvement in planning, application and evaluation of MSWM services (Section 4.5.1.2).
		4.1.4. Public feedback	5				Weak public feedback mechanism using telephone and internet communication (Section 4.5.1.2).
		4.1.5. Public education programs	5				Authorities have a weak public education programme regarding MSWM, only using printed posters (Section 4.5.1.2).
		4.1.6. Effectiveness in achieving behaviour change	5				The educational programme has a negligible impact on public behaviour (Section 4.5.1.2).
4.2	Provider inclusivity; assessed based on a cumulative score of five criteria.	4.2.1. Legal framework	15	45/100= 45.0%	M		Private sectors are allowed to provide stable MSWM services within the current legal framework (Section 4.5.1.1).
		4.2.2. Representation of the private sector	5				Weak representation of the private sector in management planning (Section 4.5.1.2).
		4.2.3. Role of the informal and community sectors	5				The private sector is not actively participated within MSWM services planning and delivery (Section 4.4.5).
		4.2.4. The balance between sectors (public and private)	5				Weak balance between the public and private sector, majority of services are delivered by public sector (Section 4.5.1.2).
		4.2.5. Transparent bid processes	15				A clear and transparent bidding process for MSWM services delivery is open to all organisations (Section 4.5.1.2).

Table 4.12: The evaluation of the financial sustainability of the MSWM system adopted in Kerbala based on Wasteaware benchmark indicators for ISWM

No.	Indicator	Criterion	Results				Justification
			Score	NS	Code		
5.1	Financial sustainability; evaluated based on a cumulative score of the six criteria.	5.1. Cost accounting	15	30/100= 30.0%	L	M	Rigorous accounting procedures in place for MSWM operational costs. However, as these accounts are not open to public scrutiny, there is no transparency or accountability (Sections 4.5.1.1 and 4.5.1.3).
		5.2. Coverage of the existing budget	10				The city authorities covers most of the current MSWM operation (70%) (Section 4.5.1.3).
		5.3. Cost recovery from users	0				The management services are delivered free of charge during large events and the system lacks a user cost recovery system (Sections 4.4.3 and 4.5.1.3).
		5.4. Affordability of charges	N/A				As no charges are levied, this measure is marked as Not Applicable (N/A). Thus, the total score of the financial sustainability is 100.
		5.5. Waste disposal charging	0				No charge is applied for the treatment and disposal of the MSW in the city (Section 4.5.1.3).
		5.6. Availability of capital for investment	5				The capital fund allocated to cover cost of MSWM services delivery is insufficient to meet the management authority's needs (Section 4.5.1.3).

Table 4.13: The evaluation of management framework and institutional coherence of MSWM authorities in the city of Kerbala during events based on Wasteaware benchmark indicators for ISWM

No.	Indicator	Criterion	Results				Justification
			Score	NS	Code		
6.1	Waste management framework; evaluated according to the cumulative score of the six criteria.	6.1.1. Legislation and regulations	5	40/120= 33.3%	L	M	Generic and not specific legislative framework supporting MSWM in Iraq in place (Section 4.5.1.1).
		6.1.2. Strategy or Policy	5				Poor policy for development of the MSWM sector focusing on the collection and landfilling the produced waste (Section 4.5.1.1).
		6.1.3. Guidelines and implementation procedures	5				Guidelines to implemented MSWM legislations and strategies is weak (Section 4.5.1.1).
		6.1.4. National institution in charge of MSWM	15				MCHPM is responsible for the overall policy, planning and implementation of SWM in Iraq (Section 4.5.1.1).
		6.1.5. Monitoring control institution	10				Ministry of Environment are responsible for monitoring the execution of SWM activates (Section 4.5.1.1).
		6.1.6. Extended producer responsibility	0				No engagement or partnerships with companies responsible for producing materials that end up in the waste (Section 4.5.1.1).
6.2	Institutional coherence; evaluated according to the cumulative score of the six criteria.	6.2.1. Organisational structure	15	55/120 = 45.8%	M		KM is responsible for ensuring that MSWM services are planned delivered and partly funded (Sections 4.4.3 and 4.3).
		6.2.2. Institutional capacity	10				Key positions are partly filled with qualified personal; lower level staff are lacking for regular training (Section 4.5.2.4).
		6.2.3. City-wide MSWM strategy and plan	5				Poor MSWM strategy and poor implementation due to budgetary constraints (Section 4.5.1.1).
		6.2.4. Availability and quality of SWM data	5				The data available regarding MSW generation is estimated amounts of MSW disposed in the landfills (Section 4.4.1.2).
		6.2.5. Monitoring and supervision of service delivery	10				Supervisors ensure proper service delivery during large events (Section 4.4.3).
		6.2.6. Inter-municipal (or regional) cooperation	10				Cooperation between KM, KMs, HAS and nearby city municipalities to cover the event (Section 4.4.3).

Table 4.14: Summary results for Wasteaware benchmark indicators for Kerbala

No	Category	Indicator		Results		
	City			Kerbala		
	Country			Iraq		
Background information						
B.1	Income level	World Bank income category		Upper-middle income		
		GNI per capita		$ 5,420		
B.2	Population	Floating population		19,515,000		
		Local population		1,207,152		
B.3	MSW generation	Total City MSW (tonne/year)		565,000		
		Estimated events MSW (tonne /year)		80,000		
W.1	Per capita MSW	Residents MSW (kilogram/year)		667.5		
		Visitor MSW (kilogram/year)		4		
W.2	MSW composition	City	Organic %	57.9		
			Paper %	14.9		
			Plastic %	14.6		
			Metal %	3.6		
		RE	Organic %	56.6		
			Paper %	12.3		
			Plastic %	14.9		
			Metal %	3.7		
Physical and technical components						
1.	MSW collection and transportation	collection coverage		70%	M	
		MSW captured by MSWM system		100%	H	
		Quality of the MSW collection service		37.5%	L	M
2.	MSW treatment and disposal	Controlled treatment or disposal		0%	L	
		Quality of environmental protection		16.7%	L	
3.	Resources management	Recycling rate		5%	L	
		Quality of recycling service provision		8%	L	
Governance aspects						
4.	Inclusivity	User inclusivity		29.16%	L	M
		Provider inclusivity		45%	M	
5.	Financial sustainability	Financial sustainability		30%	L	M
6.	Management framework and institutional coherence	MSW management framework		33.3%	L	M
		Institutional coherence		45.8%	M	

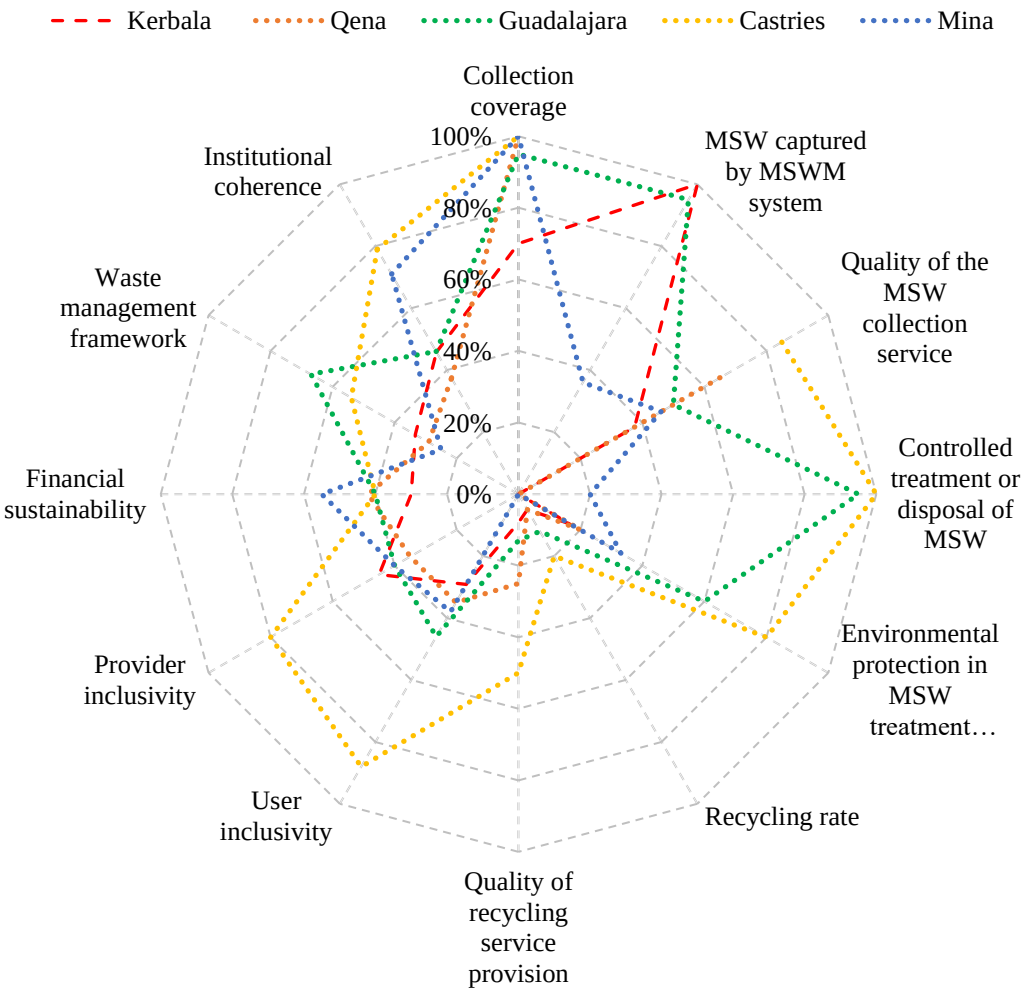

Figure 4.16: Radar Diagram summarising the 12 Wasteaware indicators for Kerbala and 4 comparative cities

The results of the evaluation of the MSWM system adopted in Kerbala during REs are shown in Table 4.14. Figure 4.16 shows the results of the application of Wasteaware benchmark indications framework on the MSWM systems in the city of Kerbala and the comparison cities. The red line (Figure 4.16) shows the performance of Kerbala MSWM during REs for the 12 Wasteaware benchmark indicators. It can be clearly seen from Figure 4.16 that the collection coverage and the quantity of MSW captured are considered the main strength of the present MSWM system. However, as Kerbala is a middle-income county (The World Bank, 2018), a collection coverage of 70% (indicator 1.1) is considered very poor comparing to other middle-income countries such as Guadalajara (Wilson et al, 2015), Castries (Wilson et al, 2013b) and Qena (Wilson et al, 2013a). In addition, the quality of the collection service in Kerbala of 37.5% is lower than other cities with comparable income level. For example, the quality of collection services in Mina city (Alsebaei, 2014) was 46% despite that Mina also hosts a large religious event (Hajj event) every year. Thus, MSWM

authorities in Kerbala need to focus on the improvement of the primary collection system by increasing MSW collection coverage, optimizing collection routes and the distribution the storage system and developing appropriate transfer stations during large REs.

Other aspects such as the user inclusivity (29.16%), the financial sustainability (30%) and the current MSWM framework (33.3%) have low to medium performance, which are low scores compared to middle-income countries' scores (Wilson et al, 2013a; Wilson et al, 2013b; Alsebaei, 2014; Wilson et al, 2015). These aspects seem to have significant impacts on the performance of the MSWM system adopted in Kerbala. Thus, clear national legislation and strategy for MSWM that provides financial solutions, and ensures public involvement in the planning and delivery of the MSWM services, might lead to better MSWM in the city, particularly during large events.

MSW disposal and recycling indicators had the lowest scores (Figure 4.16). The city lacks a formal recycling system and a controlled treatment facility. The lack of controlled disposal is a major failure compared to an average score of 95% for middle-income countries (Wilson et al, 2012). Despite the fact that similar scores were achieved by Qena (Wilson et al, 2013a), Wilson et al (2012) reported rapid positive developments in this area, for example, several cities around the world have started to attract international investment to assist the development of state-of-the-art facilities such as Kunming in China and Sousse in Tunisia (Wilson et al, 2012). This situation is likely to cause severe negative consequences to the environment and the great loss of valuable resources. Thus, as MSW recycling offers a valuable alternative to waste landfilling (Zheng et al, 2016), an appropriate and practical strategy to introduce MSW recycling which includes informal recycling, in Kerbala, particularly during events, is vital. Besides, the improvement of landfill sites in order to comply with environmental regulations is paramount; immediate action is needed by Kerbala's authorities to minimise the negative environmental impacts of the present landfill site.

4.7 **Summary**

The objectives of this chapter were to establish a background about MSWM in Kerbala during REs and to identify problems associated with this system. This helped to identify the priority actions to be taken by the MSWM authorities to improve the present situation in the city particularly during REs. The results showed that accurate and reliable information about the quantity of MSW is not available. However, MSWM authorities estimated that events' MSW accounts for 14% of the total MSW produced in the city each year. The main

components of this waste are organic (57.9%), paper (14.9%) and plastic (14.6%). To manage this waste, the city MSWM authorities receive large support from other cities. However, it was found that the MSWM system adopted in the city of Kerbala is generally weak. Aspects include poor MSW collection, improper treatment and disposal, lack of a formal recycling program, weak public involvement in the planning and delivery of MSWM services and weak financial sustainability are significantly influencing the performance of the MSWM system adopted in Kerbala during events. With this in mind, the importance of adopting an alternative MSW disposal method such as recycling that minimises a large amount of MSW destined to the landfill during events and increases revenue from waste management operations became apparent. To develop the MSWM system in Kerbala, having reliable information about the sources, quantity and composition of the MSW is essential to provide an appropriate infrastructure; gaining an understanding of peoples' preferences and willingness participate in MSWM system plays a vital role in the success of that system. As the hotels, camps and pilgrims were considered the main generators in the city during REs, the next stage of the study (Chapter 5) aims to quantify MSWG and to measure public intention to participate in MSW recycling during events.

Chapter 5

Waste Generation and Public Recycling Intention

5.1 Introduction

The analysis of the Arba'een municipal solid waste management (MSWM) system shows that, to date, the Kerbala authorities have focused their attention on improving municipal solid waste (MSW) collection and storage services. However, the authorities were able to reach only ~70% collection coverage with a high incidence of waste bins overflowing and illegal dumping. Besides, promoting actions higher in the waste hierarchy has not been considered such as recycling, and at present, the entire event MSW is disposed of into an uncontrolled landfill site. This practice is leading to substantial loss of valuable resources and a significant impact on the environment. Thus, the importance of applying an alternative to this system has emerged to gain benefit from waste and to minimise negative environmental impacts. Recycling is an effective method to gain benefit from waste where source separation is considered as a key prerequisite for its success. With this mind, accurate information regarding the quantity and composition of MSW at sources and users' readiness to participate in recycling is essential.

Guided by objectives of this study, the MSW produced from the pilgrims' accommodation (hotels and camps) has been estimated according to the results of questionnaire surveys and on-site audit in this chapter. This includes identifying the accommodation's characteristics e.g. the number of beds, the main MSW components according to managers' views and the estimated quantity of the daily MSW according to the on-site audit. Besides, regression models were developed to predict the quantity of MSW produced from these accommodation establishments according to their characteristics. The public environmental awareness and their willingness to participate in an MSW source separation to introduce recycling into REs were also investigated in this chapter. Logistic models were developed to explore the connections between users (Hoteliers, camp owners and pilgrims) recycling intention (RI) and their demographic e.g. education level and environmental awareness.

5.2 General Information of Surveyed Groups

5.2.1 Outline of Surveyed Groups

Table 5.1 outlines the number of hoteliers, camp owners and pilgrims who participated in questionnaire surveys during the Arba'een in 2016. In total, 952 were involved in this study. Of these, 150 respondents, equivalent to 15.8% were hoteliers, 157 respondents,

representing 16.5% were camp owners and 645 responses (67.7%) were collected from the pilgrims. Data collection was conducted in the central area of the event (Figure 3.5) owing to a large number of targeted groups (667 hotels, 600 service camps and about 20 million pilgrims). This area has been separated into four circular zones (Figure 3.5): zone A covers the centre of the event (250 meters in radius), zone B from 251 to 400 m, zone C from 401 to 600 m and zone D more than 600 m from the central area of the event.

Table 5.1: Outline of surveyed groups

Type of Respondent	Frequency	Valid Percent	Cumulative Percent
Hotels' Managers	150	15.8%	15.5%
Camps' Managers	157	16.5%	32.3%
Pilgrims	645	67.7%	100%
Total	952	100%	

Figure 5.1 shows the distribution of the participating accommodation (hotels and camps) according to zones from the holy shrines. The majority of the participated hotels (34.0%) are located within 250 metres of the Holy Shrines. This percentage decreases as zones move away from the centre to reach 19.3% in zone D. On the contrary, the majority of camps (46.5%) are located in zone D owing to the availability of empty spaces around the event area where camp owners place their tents. Data were collected from pilgrims in the above-mentioned zones without specifying the percentage of participants in each zone. This can provide a baseline about the main MSW producers at the Arba'een.

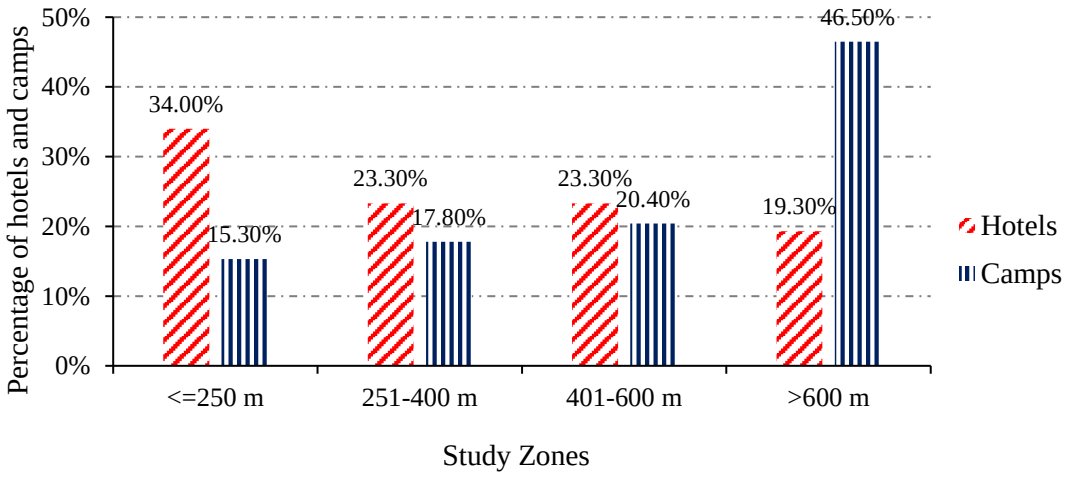

Figure 5.1: Zonal distribution of participating accommodation

5.2.2 Respondents' Demographic

Citizens' demographics such as gender, age and education level play an important role in their municipal solid waste generation (MSWG) activities as well as their attitudes toward MSWM operations (Azadi and Karimi-Jashni, 2016; Grazhdani, 2016). Therefore, three questions (questions 1, 2 and 3 in all questionnaires Appendix B to D) were designed to provide a description of respondents' demographics.

5.2.2.1 Gender

Figure 5.2 shows the gender profile of the respondents. From 952 participants, 730 respondents, representing 76.7% were males and 222 respondents, equivalent to 23.3% were females. Among 307 accommodation managers (hotels and camps), only one was a female and the remaining 306 managers were males. This was expected because of the cultural norms of Kerbala city. Opoku and Abdul-Muhmin (2010) stated that it is not easy to recruit females in a questionnaire survey because of the cultural issues, while Fotini Christia et al (2016) stated that there are rare occasions to access females outside their homes. However, 221 respondents, representing 34.3% of pilgrims who participated in the survey were female.

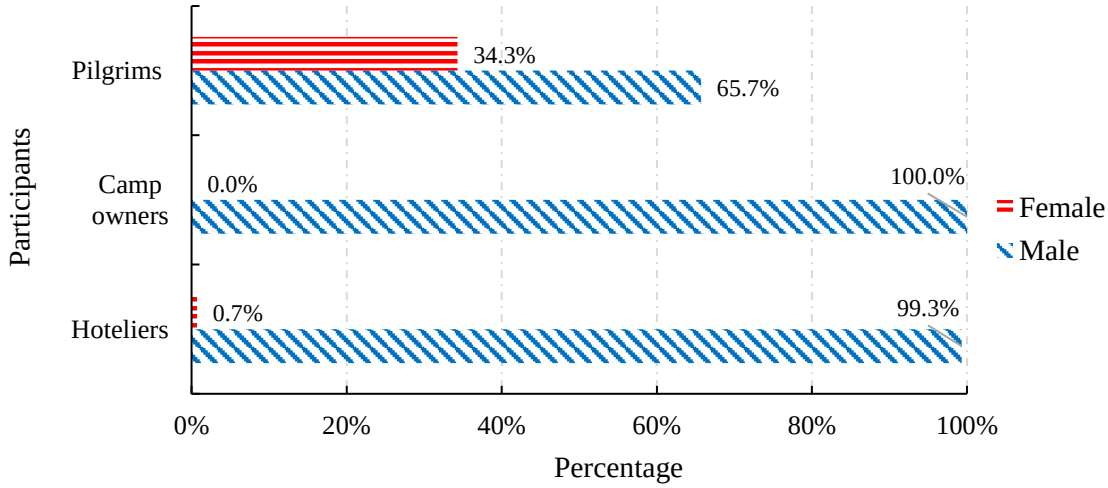

Figure 5.2: Gender profile of survey respondents

5.2.2.2 Age Group

Figure 5.3 presents the variety of ages among the three categories of participants. The majority of hoteliers were from young or middle age groups. 6.0% of hotel managers (9 people) from 18-25 age group, 39.3% (59 people) from 26-35 age group, 45.3% (68 people) from 36-45 age group and 9.3% (14 people) were from 46 and over age group, which is normal when it is compared against the dominant age group of the hotel managers in other countries. For instance, the Capita Business Services (CBS, 2011) reported that 49.4% of

the workforce in the hospitality sector in the UK falls within the 25-49 age group while Üngüren et al (2015) stated that the majority of hotel managers in Turkey (83.8%) falls within the 26-48 age group. Instead, camps' managers tend to be older, 4.5% (7 people) from 18-25 age group, 10.2% (16 people) from 26-35 age group, 36.9% (58 people) from 36-45 age group and 48.4% (76 people) were from 46 and over age group. This was expected due to the cultural norms in Iraq.

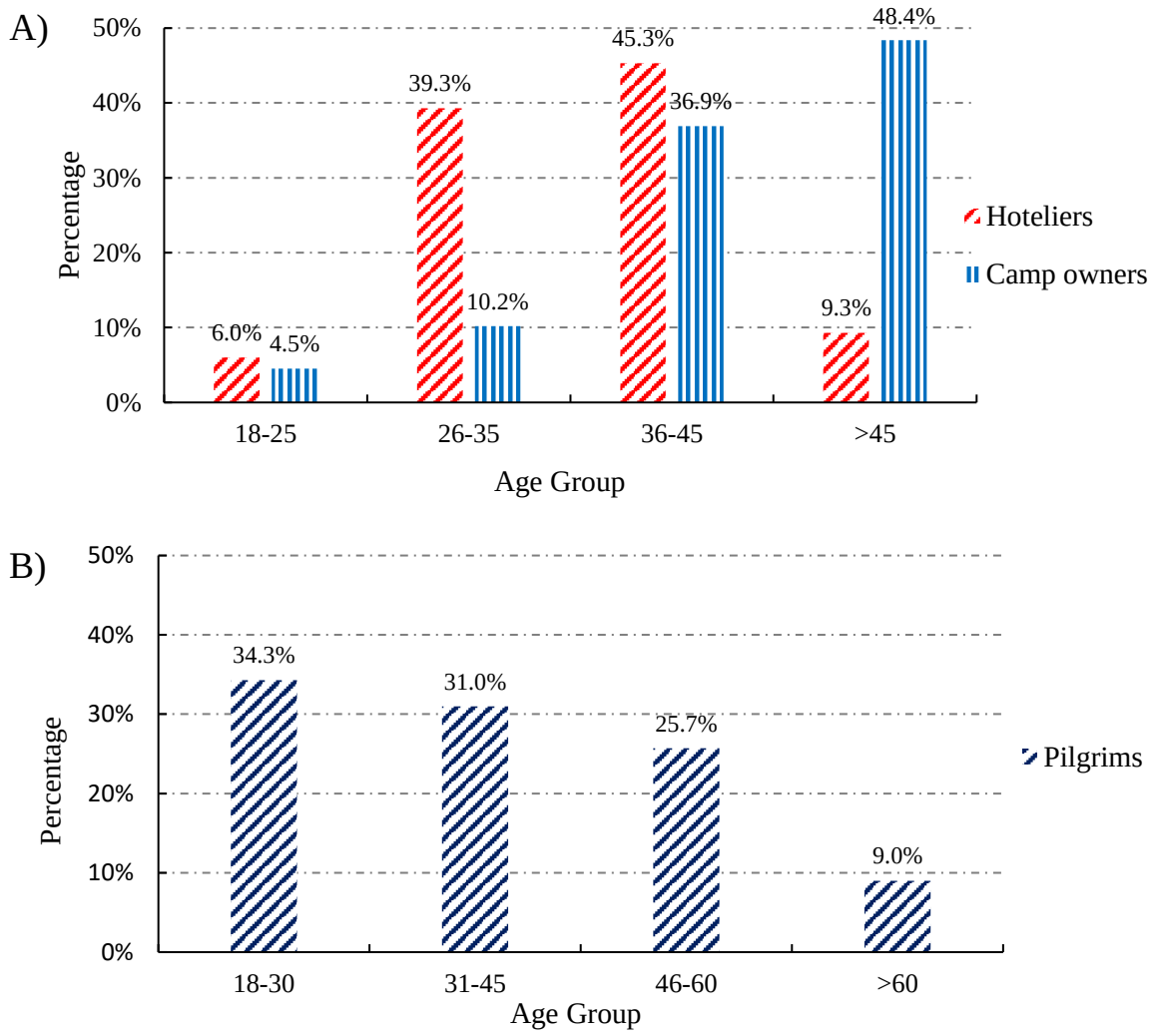

Figure 5.3: Age profile of respondents: A) Accommodation managers, B) Pilgrims

Mujtaba Husein (2018) stated that pilgrims from all social classes, genders and age groups were observed during the Arba'een, which does not align with the context of Christian pilgrimages. For both genders, the participating pilgrims were from 18 to over 60 years old. The majority were from young or middle age groups, 34.3% from 18-30 age group, 31.0% from 31-45 age group, 25.7% from 45-60 age group, and only 9.0% were from 60 and over age group. In a study conducted by Fotini Christia et al (2016), it was observed that more

than 42% of the pilgrims during the Arba'een were from 31 to 45 years old and over 36% were 18 to 30 years old.

5.2.2.3 Education Level

The responses to the level of education were presented in Figure 5.4. The proportion of university graduate among hoteliers was 75.3%, while the proportion of secondary and high schools graduates was 22%. There are no uneducated managers among hoteliers and 2.7% had only completed primary education. The education level among hoteliers in Kerbala was significantly higher than that observed among hotel managers in Turkey with 48.7% having completed higher education and 33% completed secondary and high school education. This can be attributed to the free educational system in Iraq (Issa and Jamil, 2010) and the importance of education to the hotel managers' responsibilities (Üngüren et al, 2015).

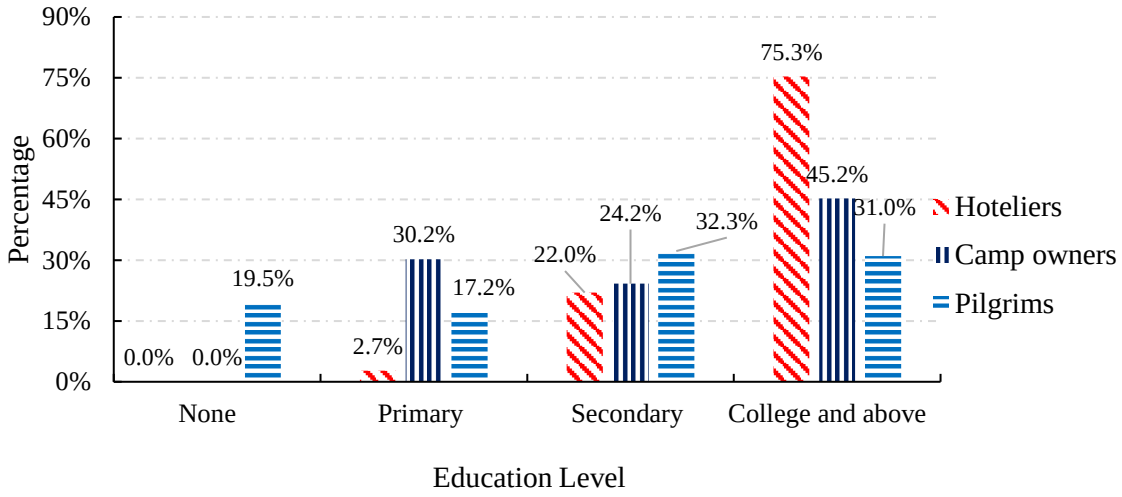

Figure 5.4: Education level profile of survey respondents

Camp owners and pilgrims are less educated than hoteliers; almost half of the camp owners (45.2%) were university graduates and the remaining completed primary education (30.2 %) and secondary education (24.2%). On the other hand, 31.0% of participating pilgrims (200 people) were university graduates, 32.3% (208 people) were secondary and high school graduates, while 17.2% (111 people) were primary school graduates and 19.5% (126 people) were not formally educated. The education level of the pilgrims' sample is higher than Iranian and Iraqi respondents in a study conducted by Fotini Christia et al (2016) (see Figure 5.5, with 31.0% of this study's participants having a university degree as compared to 4.0% of the Iraqi pilgrims and 25.5% of the Iranian pilgrims). In contrast, 19.5% of the pilgrims have no formal education compared to 8.6% of the Iranian pilgrims and 26.0% of the Iraqi pilgrims. There is an agreement that the majority of the pilgrims at the Arba'een event completed secondary education (secondary and high school). This variation in the education

level among participants could be attributed to the sampling procedure and sample size; this study targeted all pilgrims in the Arba'een regardless of their origin or age, but Fotini Christia et al (2016) focused on the Iraqi and Iranian pilgrims.

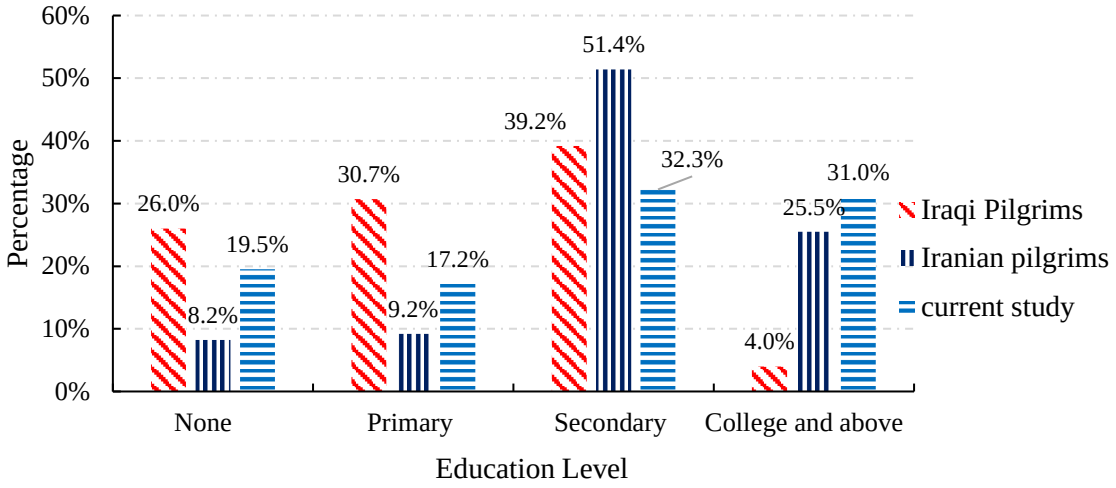

Figure 5.5: Education level of the Arba'een pilgrims (combined with information of Iraqi and Iranian pilgrims from (Fotini Christia et al, 2016)

5.2.3 Respondents' Environmental Awareness

Participation in source separation of MSW greatly affects the success of a proposed recycling programme (Babaei et al, 2015). Assessment of the factors influencing public participation rate, including environmental awareness and knowledge, is vital (Amasuomo et al, 2015; Miliute-Plepiene et al, 2016). Thus, a five-part question (question 11 in Appendixes B and C) was included in the accommodation managers' questionnaires to assess the level of understanding of MSWM aspects such as environmental impact, MSW recycling and composting. Question 10 (Appendix D) was also included in the pilgrims' questionnaire to assess their level of knowledge about recycling.

Researchers such as Chung (2008) reported that participants in self-reported questionnaires tend to project a more positive self-image. Thus, an appendix (Appendix E) was designed to gather more a truthful assessment of participants' level of knowledge about MSWM aspects such as recycling. Each knowledge category such as recycling knowledge comprises three questions for assessment. During data collection, interviewers randomly select two questions from each knowledge category to be correctly answered by the respondent. A good knowledge level is assigned to participants when they correctly answer two questions, moderate when one question was correctly answered and poor for no correct answers received.

5.2.3.1 Environmental Pollution Knowledge

The awareness of the public about the environmental problems significantly enhances their responsibility towards the environment (Babaei et al, 2015; Miliute-Plepiene et al, 2016). Therefore, a question was included to test the knowledge that the participants have about environmental pollution. A scale from poor to good was used in measuring the respondents' level of knowledge (hoteliers and camp owners) in environmental pollution (Figure 5.6). The majority of accommodation managers have moderate knowledge with 46.7% for hoteliers and 35.7% for camp owners. The percentage of camp owners with good environmental knowledge is higher than hoteliers by 14.8%. Despite the majority of hoteliers having a university degree; it seems that camp owners have more environmental knowledge. Clery and Rhead (2013) stated that the relationship between environmental concern and levels of education are less likely to exist in countries that are less wealthy.

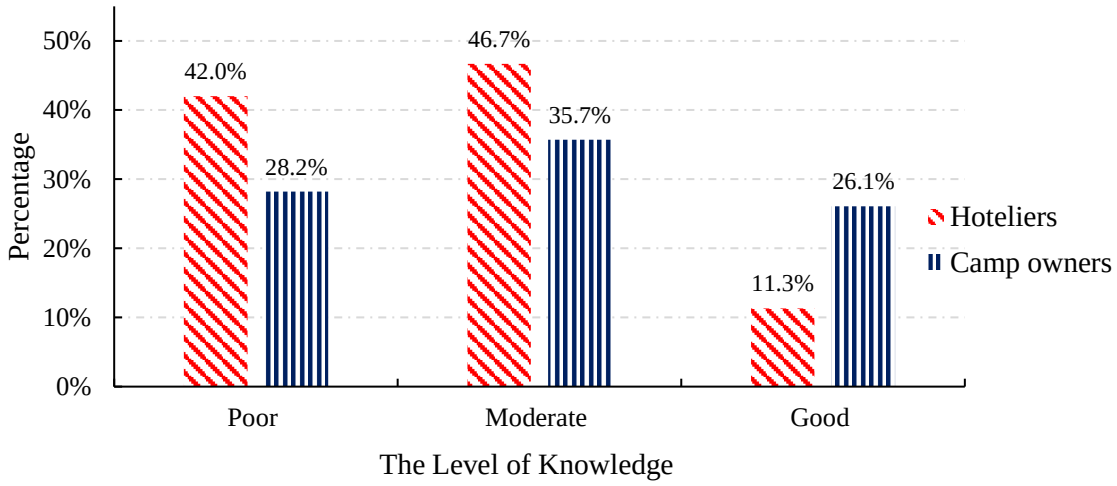

Figure 5.6: Level of environmental Knowledge among hoteliers and camp owners

5.2.3.2 Waste Pollution Knowledge

Another question was included to test the knowledge that participants have regarding the pollution resulting from MSW. The same scale was used in measuring the level of respondents' knowledge (Figure 5.7). The majority of hoteliers (46%) have a moderate level of knowledge while a high fraction of camp owners (42%) are assigned with a poor level of knowledge. About 42% of hoteliers and camp owners were assessed with a poor level of knowledge about waste pollution. However, camp owners have a higher fraction of respondents with a good level of knowledge, than hoteliers, by 16%.

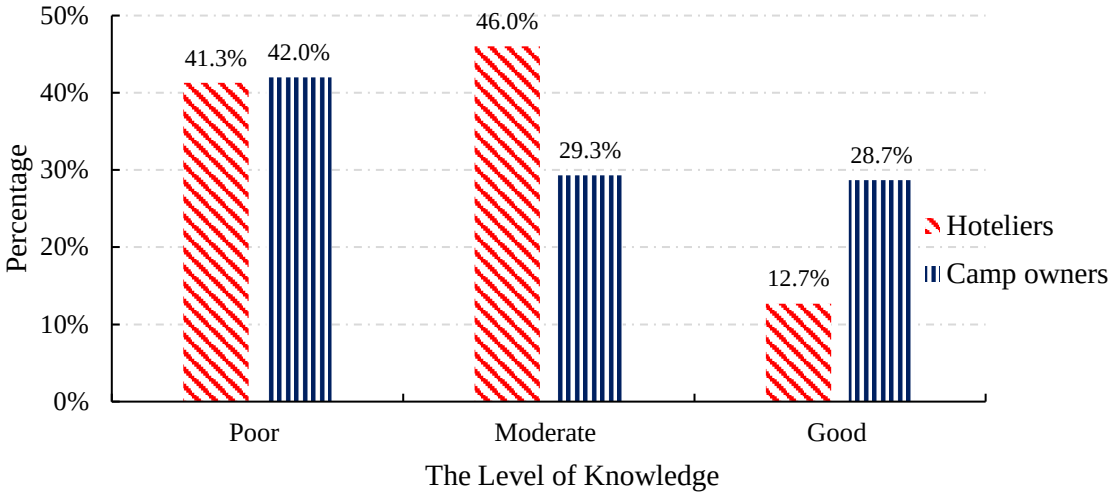

Figure 5.7: Level of knowledge about the consequences of MSW

5.2.3.3 Waste Minimisation Knowledge

Hoteliers' and camp owners' knowledge regarding the MSW minimisation concept was also examined. The same scale was used to measure the participants' level of knowledge. According to the results presented in Figure 5.8, it can be seen that about 55% of all managers have poor knowledge about MSW reduction. About 17% of respondents to this question were rated with good knowledge of MSW minimisation. According to this, more than 80% of managers have a poor to moderate level of knowledge about one of the most important concepts of MSWM, which significantly affects their participation rate. These results are in line with the general perception among municipality representatives (section 4.4.5) that public awareness of MSW subjects in Kerbala is rather low. It is also in agreement with Ezeah (2010) and Alsebaei (2014) in their statement that public awareness of MSW subjects in many developing countries is low.

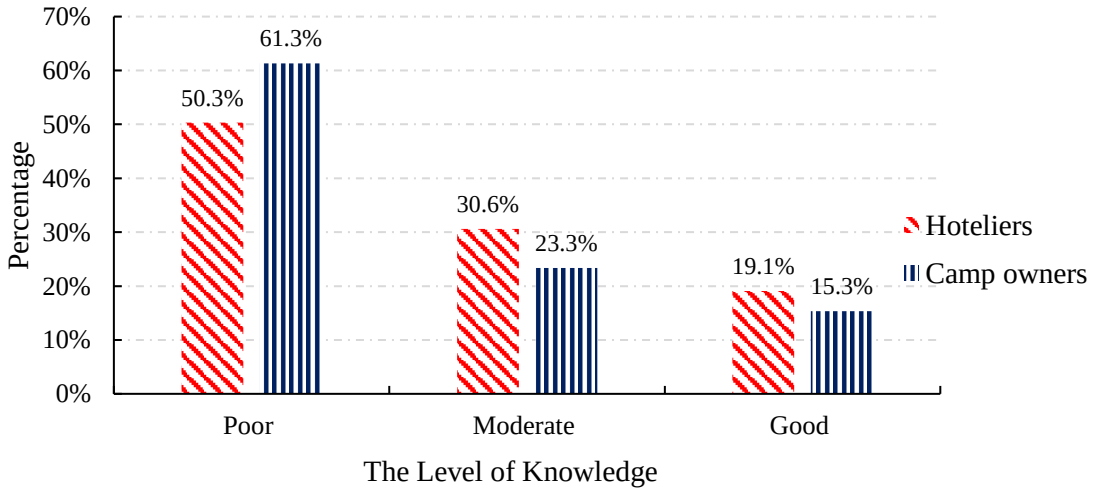

Figure 5.8: Level of knowledge regarding MSW reduction concept

5.2.3.4 Waste Recycling Knowledge

Using the same means, participants' level of understanding of MSW recycling was investigated (Figure 5.13). Approximately 55% of all respondents (hoteliers, camp owners and pilgrims) were assigned with poor knowledge about recycling. On the other hand, about 21% of respondents have a good understanding of recycling and about 23% have a moderate understanding of MSW recycling. This might also indicate that respondents had little understanding of recycling, as nearly 78% of the survey population were ranked with a poor to moderate level of knowledge. These results are in line with the general perception among municipalities' representatives (Sections 4.4.5) and the published literature (Ezeah, 2010; Purcell and Magette, 2010; Clery and Rhead, 2013) that public awareness on MSW subjects in many developing countries is rather low.

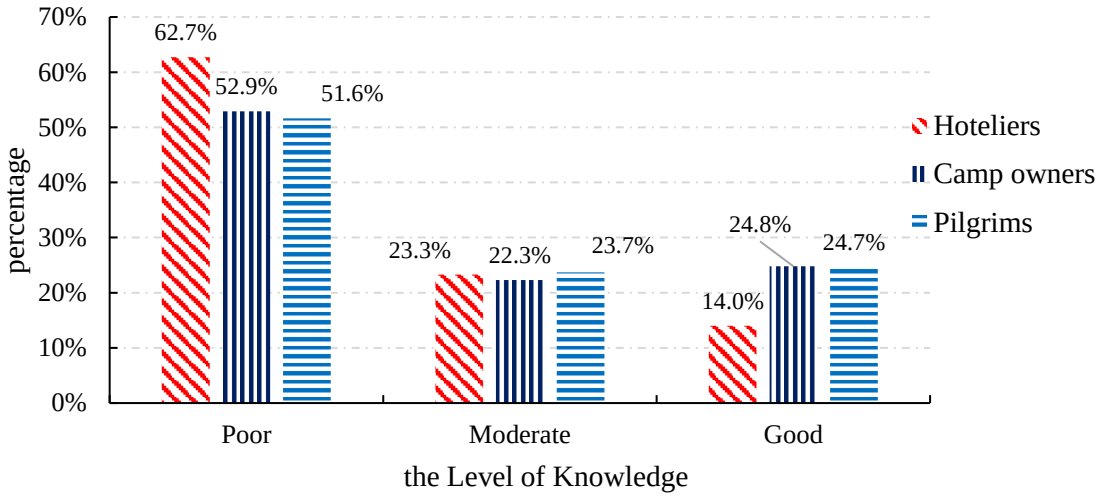

Figure 5.9: Participants' knowledge level of MSW recycling

5.2.3.5 Waste Composting Knowledge

Composting of organic waste is an important method of waste diversion that reduces the quantity of organic waste which ends up in landfills to minimise the landfill leachate and greenhouse gases formulation (Sussman et al, 2013). The public can make an effective contribution to waste diversion by composting. As hoteliers and camp owners are important organic producers during religious events (REs), this study tries to understand their level of understanding of composting. Figure 5.10 displays the results of managers' understanding level of MSW composting. The vast majority of managers were ranked with poor knowledge level, as 84% of hoteliers and 65% of the camp owners have little or no information about composting. Only 7.3% of hoteliers have good information about composting compared to 19.1% of camp owners with the same level of knowledge. Overall,

only 14% of accommodation managers have a good understanding of MSW composting. This is lower than reported in other developing countries (Ezeah, 2010).

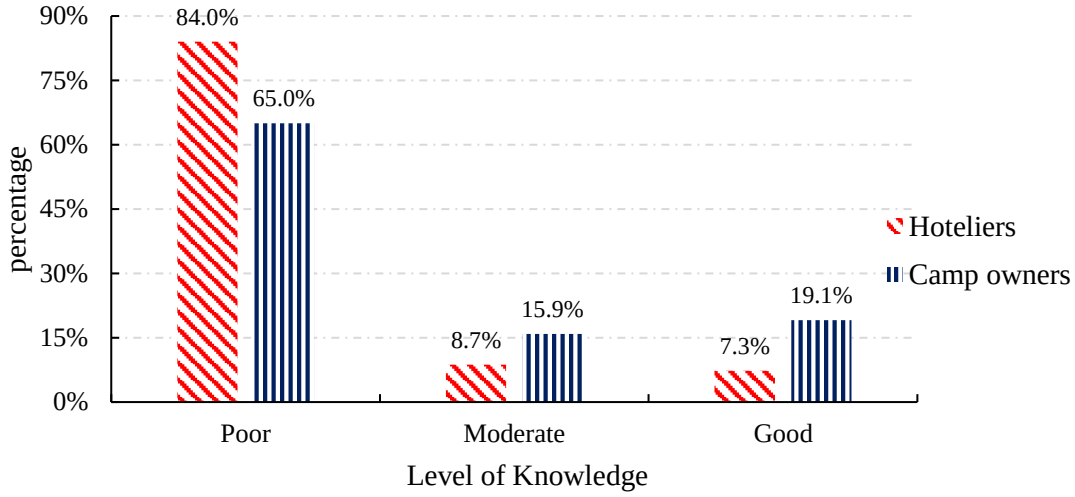

Figure 5.10: Participants' knowledge level of MSW composting

Scholars namely Vidanaarachchi et al (2006) and Grazhdani (2016) stated that the level of knowledge about MSWM affects public participation in MSWM operations and planning, as this enhances their responsibility towards the environment. The present study revealed that the majority of pilgrims, as well as the accommodation managers, have low knowledge regarding MSW subjects such as recycling. This situation can lead to significant impacts on MSWM system performance. For instance, Grazhdani (2016) reported that a 1% increase in the education level of population can lead to a waste reduction of 3 kg on the annual per capita basis. Therefore, it is very important to start educational campaigns to enhance public education and awareness about MSWM.

5.2.4 Public Perceptions on the Current MSWM during REs

The public perception of, and satisfaction with, MSWM services such as collection are important elements that drive public behaviour and attitude towards MSWM (Purcell and Magette, 2010; Miliute-Plepiene et al, 2016). Thus, respondents' satisfaction level with MSWM during REs was inspected. Moreover, the accommodation managers were asked to identify the barriers that affect MSWM. Participants were also asked to identify the body that is best equipped to manage MSW during the Arba'een.

5.2.4.1 Participants' Assessment of the Arba'een MSWM

Questions 13(Appendix D) and 23 (Appendix B and C) were designed to gauge the level of satisfaction that participants had with MSWM services provided during REs; Figure 5.11 shows results of respondents' satisfaction. From Figure 5.11, 62.4% of camp owners

indexed MSWM services as satisfactory and 17.2% indexed them as unsatisfactory. On the contrary, 58% of hoteliers rated the MSWM services as unsatisfactory while only 18% rated them as satisfactory. The majority of pilgrims (78.5%) were satisfied with the MSWM while 21.5% were unsatisfied with RE's MSWM services.

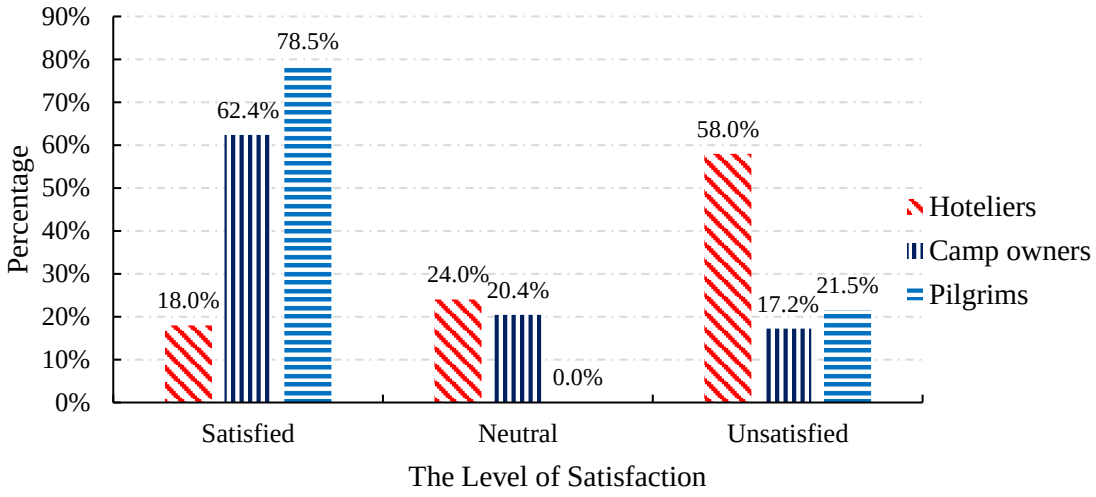

Figure 5.11: Participants' satisfaction of MSWM services during the event

The results showed significant variations in participants' satisfaction with MSWM. Most of the camp owners (62.4%) and pilgrims (78.5%) were satisfied; however, 58% of hoteliers were not satisfied with the same services. Babaei et al (2015) suggested that the type and arrangement of MSW collection service significantly influence public satisfaction. Camp owners and pilgrims believed that the MSWM authorities make great efforts during the event to collect all MSW produced. However, hoteliers considered Kerbala as a tourist destination that attracts millions of pilgrims throughout the year and MSWM authorities should make additional efforts to make the city cleaner and more attractive to tourists.

Overall, 52.9% of participants rated the services as good; 32.2% rated the services as poor and 14.9% were neither satisfied nor unsatisfied with MSWM services during the Arba'een. The public satisfaction of 52.9% is low compared to other studies e.g. 73% in Dublin (Purcell and Magette, 2010), and 81% in the southern province of Sri Lanka (Vidanaarachchi et al, 2006). This is an indication of the weak MSWM services provided in the city during REs.

5.2.4.2 Public Opinion about Services Provider

Figure 5.12 presents results from question 25 (Appendix B and C) designed to understand hoteliers' and camp owners' opinion about the best MSWM services provider. This question can provide an indirect indication of the performance of services providers, which currently

deliver all MSWM services. The majority of hoteliers (64%) believed that the private sector could deliver better services than those currently provided by the government, while 16% suggested that the co-operation between both sectors could give better performance. Only 19.3% of hoteliers believed that the best performance is already provided by the governmental sector. Among camp owners, 34.4% believe that the government sector is better and 38.2% assumes that the private sector is better while 22.9% suggested that the co-operation could provide better results. From this, it can be deduced that the majority of hoteliers (about 60%) are not satisfied with the service currently delivered, while more than 50% of camp owners are satisfied with the current services. This supports the recognition that the majority of hoteliers are not satisfied while a large percentage of camp owners are satisfied with the MSWM (Section 5.2.4.1).

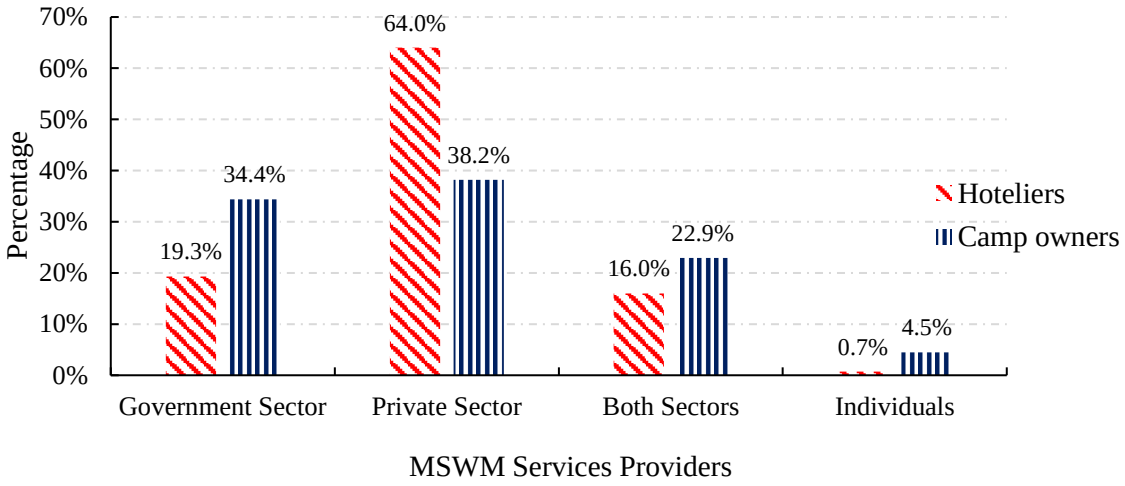

Figure 5.12: Participants' opinion about best MSWM services providers during the event

5.2.4.3 Barriers to RE's MSWM

In addition to the perspective of MSWM authorities (Section 4.5), service users (camp owners and hoteliers) were requested to provide their viewpoints about aspects that negatively influence the current operations of the event MSWM system. The hoteliers and camp owners were asked to select barriers from a list of aspects that have the potential to negatively affect MSWM operations. Figure 5.13 illustrate managers' perspective of aspects that affect MSWM operations during the Arba'een.

Figure 5.13 shows that most of the respondents (camp owners and hoteliers) cited crowding situation, low public awareness and camps' location in the street as issues that significantly influence the performance of the MSWM system during the Arba'een. Furthermore, a considerable fraction of respondents (60% of hoteliers and 33.1% of camp owners) stated that the unplanned streets of the city affect MSWM operations. Moreover, about 60% of

hostelries considered the weakness of the present MSWM system is one of the barriers that affects the MSWM operations while only 17.8% of camp owners have the same view about the MSWM system. The other barriers as identified by respondents were on the issue of inadequate and untrained labourers, streets closing and hot weather conditions.

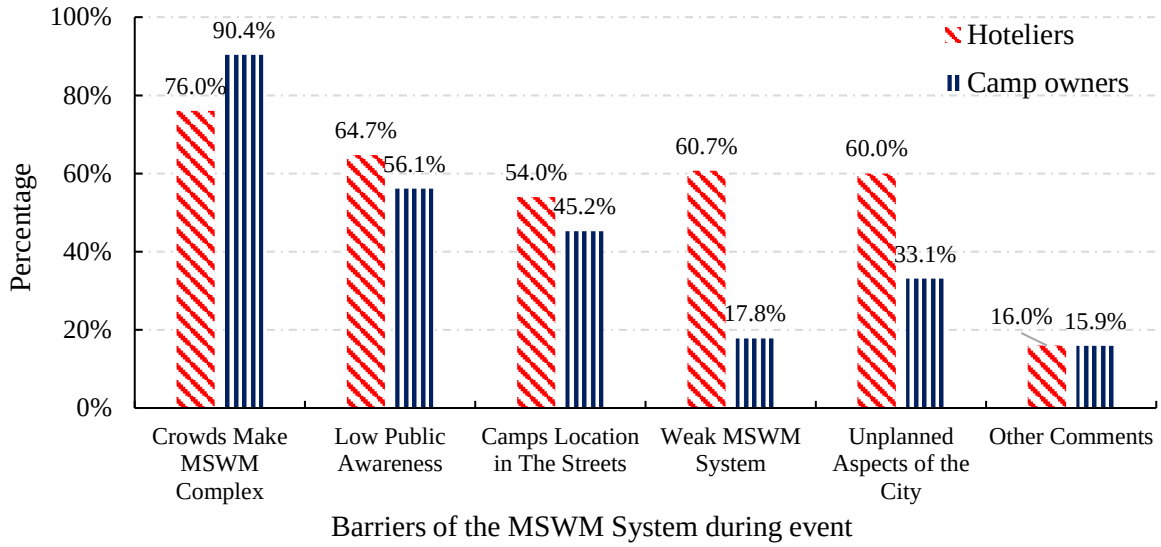

Figure 5.13: Managers' opinion of the factors affecting MSWM during events

In general, it seems that there is a strong agreement between MSWM service users and providers about the impact of the events on the MSWM operations. Stakeholders (both services users and providers) indicated that the large population density significantly affects the operations of the MSWM system (Section 4.5.2.5). They also noted that the poor environmental awareness among pilgrims and locals, the unplanned aspects of the city streets and the improper locations of camps are major barriers facing the MSWM operation during REs.

5.3 MSWG during the Arba'een

Scholars (Thanh et al, 2010; Intharathirat et al, 2015; Ghinea et al, 2016) agree that it is indispensable to elucidate MSWG and composition in communities for integrated solid waste management (ISWM) planning. Chapter 4 revealed that the absence of information on the quantity and composition of MSW produced during the Arba'een greatly impacts MSWM processes. A full-scale investigation of the MSWG rate variation requires a great deal of time and money on gathering essential data (Parisi Kern et al, 2015; Azadi and Karimi-Jashni, 2016). Thus, this research aims to estimate the quantity and composition of the MSW generated from hotels and camps during the Arba'een.

5.3.1 MSW Produced by Accommodation establishments

MSWG is one of the most tangible impacts of hospitality establishments (hotels and camps) on the environment (Bohdanowicz, 2006; Ball and Abou Taleb, 2010; Pirani and Arafat, 2014). There is a wide variation between establishments when it comes to how much MSW is produced on a daily basis (Pirani and Arafat, 2014). Researchers (Snarr and Pezza, 2000; Bohdanowicz, 2005; Bohdanowicz, 2006; Ball and Abou Taleb, 2010; WRAP, 2011; Pirani and Arafat, 2014; Pirani and Arafat, 2016) have attributed this variation to a range of parameters including MSWM practice, establishment type and size, type of food, occupancy rate, guest and staff activities, guest attributes and purchasing practices. Thus, several questions (Appendix B and C) were designed with the aim of understanding the nature of hospitality establishments in Kerbala and estimating the quantity and the composition of MSW produced. This includes conducting an on-site audit at all participating accommodation establishments with the goal of estimating the quantity of MSW produced.

5.3.1.1 Hospitality Establishments Characteristics

Scholars (Bohdanowicz, 2006; Ball and Abou Taleb, 2010; WRAP, 2011; Pirani and Arafat, 2016) stated that MSWG from hospitality establishments is affected by their characteristics. Thus, accommodation questionnaires encompass seven questions (questions 4 to 10) to provide a descriptive picture of the hospitality establishments' characteristics in the city. These questions were designed to investigate the possibility of detecting an association between characteristics and MSWG from the participating accommodations; these include floor area, capacity, staff numbers, expenditures, rating and services provided.

- *Total Floor Area (Square Meter (m^2))*

The quantity and composition of the MSW generated from hospitality establishments are suggested to be influenced by their size (Pham Phu et al, 2018). Thus, a question was designed to collect information about the size of hotels (floor area and the number of floors) and camps (floor area). Table 5.2 shows the descriptive statistics of the area for hotels and camps. The average area for hotels is 292.55 m^2 while the average area for camps is 275.97 m^2. The smallest hotel was 50 m^2 while the largest was 1200 m^2. Meanwhile, the smallest camp occupied an area of 18 m^2 while the largest camp occupied an area of 3,000 m^2. The standard deviation (SD) of 215.49 revealed that 68.2% of the participated hotels' areas fall within 77 to 508 m^2. The average number of floors in the participating hotels is 5.09 where the highest hotel(s) encompasses 13 floors and the lowest one(s) has two floors.

Table 5.2: Descriptive statistic for the sizes of participating hotels and camps

Type of accommodation	Hotels		Camps
	Area (m^2)	**Number of Floors**	**Area (m^2)**
Mean	292.55	5.09	275.97
Conf. -95%	257.79	4.77	214.84
Conf. +95%	327.32	5.42	337.11
Median	205	5	185
SD	215.49	2.01	387.82
SE	17.59	0.16	30.95
Min. Value	50	2	18
Max. Value	1200	13	3000

Key: Conf. -95% = lower level of confidence; Conf. +95% = upper level of confidence; SD = standard deviation; SE = standard error; Min. Value = minimum; and Max. Value = maximum.

- *Capacity (Number of Beds)*

The capacity has been identified as a feature that influences the rate of MSWG (Ball and Abou Taleb, 2010; WRAP, 2011; Pirani and Arafat, 2016). A question was therefore included in both questionnaires (hotels and camps) to provide descriptive information about the capacity of establishments in the city. Table 5.3 illustrates the descriptive statistics of the establishments' capacities. The average capacity for hotels and camps was 130.68 and 192.26 beds, respectively. The largest hotel(s) encompasses 450 beds while the largest camp(s) contains 3,000 beds. In the case of camps, many do not provide overnight stay, which leads to a significant decrease in the average capacity. Besides, the vast majority provide food in the form of takeaways, which requires a small number of beds that are only provided for the camps' staff.

Table 5.3: Descriptive statistic for the capacities of participating hotels and camps

Type of accommodation	Hotels Capacity (No. of beds)	Camps Capacity (No. of beds)
Mean	130.68	192.26
Conf. -95%	117.09	135.77
Conf. +95%	144.27	248.75
Median	100.00	100.00
SD	84.22	358.34
SE	6.88	28.60
Min. Value	14	0
Max. Value	450	3000

- *Staff Size*

MSWG can be associated with staff activities at hotels (Pirani and Arafat, 2016). Purcell and Magette (2009) employed staff size to estimate the rate of MSWG from hotels in Dublin. The current study tries to provide a descriptive picture of the staff sizes in hotels and camps at Kerbala. The descriptive statistics of staff are shown in Table 5.4. The staff at camps ranged between 3 and 200 members with an average of 25.1, which is generally higher than that observed at hotels of 1 to 28 employees with an average of 8.38 employees. This variation can be attributed to camps and hotels activities; for instance, camps are providing diversity of free services (food, shelter, bathing, and even massage) according to pilgrims' request (Al-Modarresi, 2014; Mujtaba Husein, 2018) and this requires a large number of volunteers to work in the camp. Hotels, on the other hand, provide predefined services that require a specific amount of staff.

Table 5.4: Descriptive statistic for the staff size of participated hotels and camps

Type of accommodation	Hotels staff size (No. of staff)	Camps staff size (No. of staff)
Mean	8.38	25.10
Conf. -95%	7.39	21.18
Conf. +95%	9.37	29.02
Median	6.00	20
SD	6.125	24.86
SE	0.50	1.984
Min. Value	1	3
Max. Value	28	200

- *Expenditure*

MSW production can be related to expenditure (Thanh et al, 2010; Intharathirat et al, 2015). For this, two questions were designed to provide descriptive information regarding the expenditures of hotels and camps over the Arba'een. One question was included in the hotel's questionnaire with the goal of identifying the expenditure per guest. Another question was included in the camps questionnaire to identify the expenditure during the whole event, as it is hard to identify it per guest. This happened because many camps provide services for all pilgrims even if they are not guests at the camp. Moreover, most camp owners have information about the number of meals provided per day. Table 5.5 shows descriptive statistics of hotels' expenditure per guest per day and camps' expenditure per day.

According to Table 5.5, average hotels' expenditure per each guest is more than 13 thousand Iraqi Dinar (ID). The maximum observed expenditure per guest was 70 thousand ID while the minimum was one thousand ID. This variation in the expenditure can be attributed to services provided by hotels. For example, some hotels provide clean, comfortable, safe, inexpensive rooms that meet the basic needs without additional expensive services such as food and beverage. Other are offering mid-range and upscale services such as restaurants, lounges and private dining facilities etc. leading to an increase in expenditure. Overall, the majority of hotels in Kerbala are offering a mid-range service, particularly during the Arba'een. In the case of camps, the average expenditure is about 1.5 million ID per camp per day. The smallest camp spent 130 thousand ID per day on beverages and small snacks for pilgrims while the largest participating camp spent about 17 million per day to provide 24-hour services to all pilgrims.

Table 5.5: Descriptive statistic for the expenditures of participating hotels and camps

Type of accommodation	Hotels expenditures per guest per day (Iraqi Dinar)	Camps expenditures per camp per day (Iraqi Dinar)
Mean	13,190	1,522,000
Conf. -95%	11,580	1,205,333
Conf. +95%	14,790	1,838,667
Median	10,000	1,000,000
SD	9,964	2,009,267
SE	814	160,333
Min. Value	1,000	133,333
Max. Value	70,000	16,666,667

- *Rating and Services*

The services delivered by a hotel have a significant influence on MSWG and composition (Ball and Abou Taleb, 2010; WRAP, 2011). Questions were designed to explore the rating of hotels and the services provided by all accommodation (hotels and camps). Figure 5.14 shows the rating of the hotels. About 47% (70 hotels) fall into the Two Stars category, while only four (2.7%) fall within Four Stars category. Another 25% of hotels are rated as Three Stars and the remaining 25% were unrated and One Star. The vast majority (90.7%) of hotels were from 1-3 stars. Such hotels were offering mid-range services such as food and beverage. Figure 5.15 shows the breakdown of hotels according to the services provided. Figure 5.15 shows that the vast majority, 92.7% of hotels, were offering mid-range services such as food and beverage. Only 7.3% (11 hotels) were offering basic services to meet the

needs of the guest such as clean and comfortable rooms without food and beverage. Thus, it is expected that the mid-range services providers' hotels are more likely to produce larger amounts of MSW, particularly organic compared to the basic services providers.

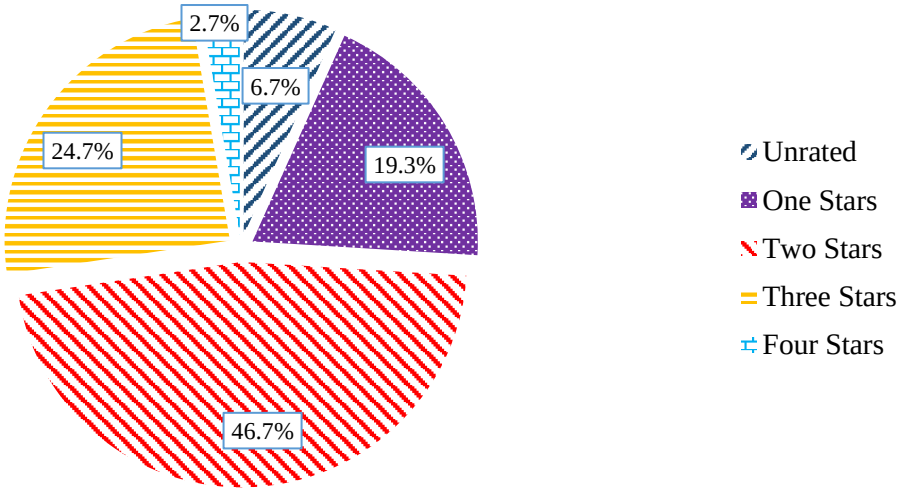

Figure 5.14: Rating of participating hotels

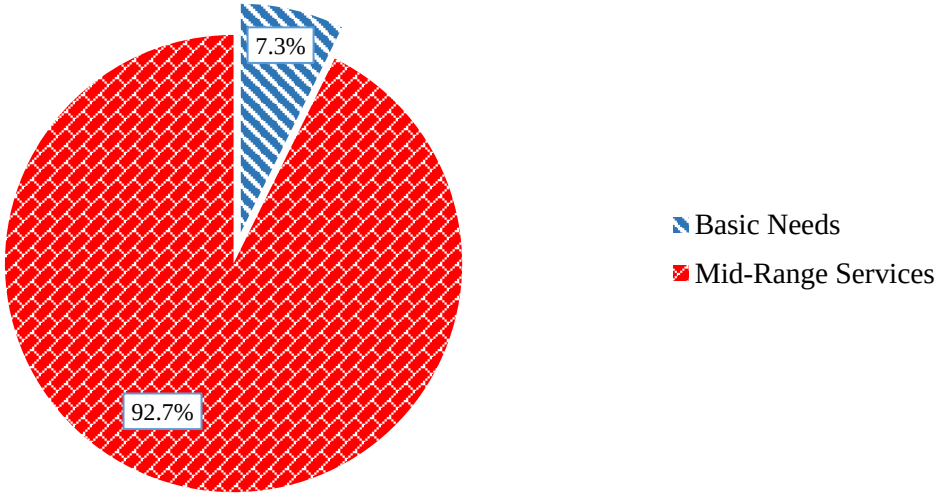

Figure 5.15: Types of services that hotels offer during the Arba'een

Two other questions were designed to understand the services provided by camps. The first question aims to identify which camps are providing free food services and how many times this food is offered over the day. The second question was designed to investigate the number of servings (meals) provided over the day. It was realised that all camps are offering free food to pilgrims. Figure 5.16 illustrates the divisions of the times that camps provide free food services. About 66% (103 camps) were offering food 3 to 4 times per day while approximately 17 % (27 camps) were offering food services once or twice a day. The remaining 17.2% were offering food services more than 4 times per day.

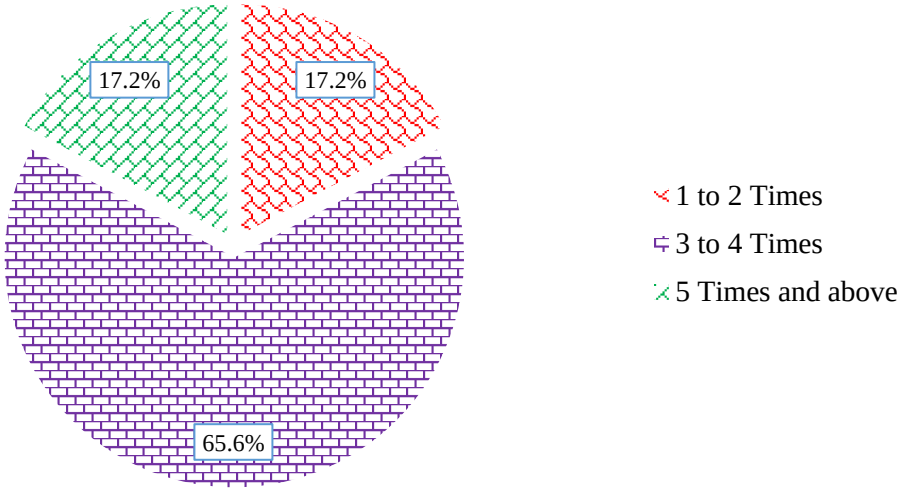

Figure 5.16: Camps free food services provision over a day during the Arba'een

The number of servings (meals) provided by each camp is shown in Figure 5.17. About 38% of camps were providing 2,000 to 4,000 servings per day while 24% are offering up to 2,000 serving per day. 31 camps (19.7%) were offering between 4,000 and 6,000 servings per day and approximately 18% were offering more than 6,000 servings per day. Some camp owners claimed that up to 30,000 servings are delivered to pilgrims each day over the entire event period.

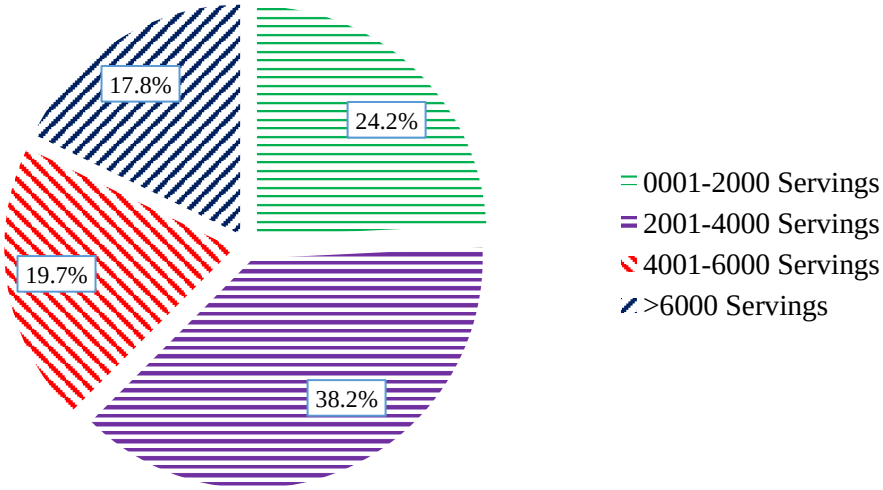

Figure 5.17: Number of servings provided by camps during the Arba'een

The above results indicated the vast majority of hotels and camps are offering mid-range and free services to pilgrims. This is in line with Mujtaba Husein (2018) statement that many camps are set up by local and international charities, to offer services such as sleeping, food stalls, beverages and refreshment. According to this, pilgrims have many free options on the menu to choose from. Thus, this activity might increase the amount of MSW produced during the Arba'een.

5.3.1.2 MSWG

To estimate the mass of MSW, the methodology developed by WRAP (2011) was followed. According to this methodology, the volume of MSW produced by each accommodation over a specified duration should be identified first. Then, the on-site density of MSW should be calculated according to a sample extracted from the total quantity of MSW. Finally, the total mass of the MSW produced can be calculated according to equation (3.1).

Two questions (12 and 13 in both questionnaires) were designed with the aim of estimating the volume of the MSW generated from hotels and camps. Camp owners and hoteliers were asked to estimate the volume of the MSW produced in their accommodation over a one day period and the number of times that MSW is collected each day. To convert volumes to weights, an on-site audit was conducted at the 307 participating accommodation establishments. This involved visual inspection to establish volume-to-weight conversion factors (densities) and general overview regarding composition. Two bins were randomly selected to calculate weight and volume. The density was estimated for each accommodation by dividing the average MSW weight in the selected bins, by the average volume of the bins. The latter factor was used to convert the daily volume of the accommodation's MSW into weight (Equation (3.1)).

To validate this estimation, ten differently ranked hotels were randomly selected from the total number of hotels, the actual amount of MSW generated from each over one day was recorded and compared with the estimated amounts (Figure 5.18). It can be seen that there was a good agreement between the observed and estimated MSWG. This indicates that the method used to estimate MSWG in this research has yielded acceptable results.

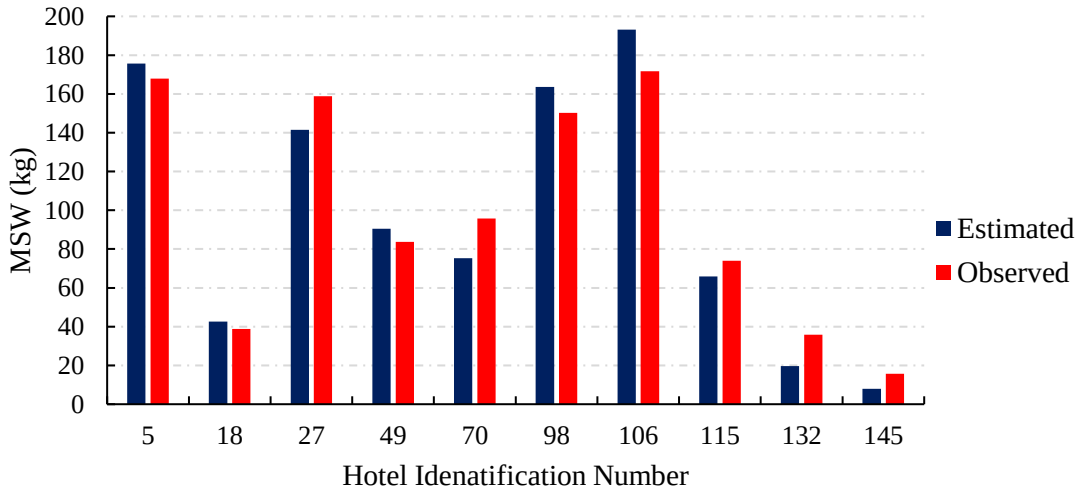

Figure 5.18: Estimated and observed MSWG from ten selected hotels

The analysis of camps' and hotels' MSWG is described in Table 5.6. The results revealed wide variations between hotels and camps with regard to the volumes and the densities of MSW produced. The volumes of MSW produced by camps ranged from 0.48 to 19.8 m^3 with a mean of 4.38 m^3 (SD = 3.59; n=157). The volumes of MSW generated by hotels were considerably smaller, ranging from 0.24 to 4.4 m^3 with an average of 1.22 m^3 (SD = 0.74; n=150). The average density of camps MSW of 95.39 kg/m^3 is higher than the average density of the MSW produced by hotels (88.01 kg/m^3). The densities of the mixed waste produced by camps and hotels are comparable to those produced by hotels in other countries. For instance, WRAP (2011) reported that the density of mixed MSW disposed of in 4-wheeled bins (mostly used by camps and hotels in Kerbala) is ranging from 10 to 290 kg/m^3 with an average of 100 kg/m^3.

Camps tend to generate more MSW than hotels per day. The mean quantity of MSW produced by hotels was 112.34 $kg.day^{-1}$ (SD = 78.32) while it was 413.25 $kg.day^{-1}$ (SD = 397.1) for camps. The rate of MSWG was estimated per guest per day for hotels while it was calculated per serving per day for camps because it was difficult to limit the number of camp users. The MSWG rate for hotels was calculated by dividing the total quantity of MSW produced by the number of guests occupying the hotel that day (Losanwe, 2013) while it was calculated for camps by dividing the total MSW quantity by the average number of servings provided per day.

Table 5.6: Descriptive statistic for MSW produced at participating hotels and camps

	Camps MSW				Hotels MSW			
	V	D	WCF	M	V	D	WCF	M
Mean	4.38	95.39	4.41	413.25	1.22	88.01	3.15	112.34
Conf. -95%	3.82	90.67	4.14	350.64	1.1	82.78	2.86	99.71
Conf. +95%	4.95	100.11	4.69	475.85	1.33	93.24	3.43	124.98
Median	3.30	98.26	4.00	285.18	1.1	83.01	3.00	97.56
SD	3.59	29.93	1.72	397.1	0.74	32.42	1.78	78.32
SE	0.29	2.39	0.14	31.69	0.06	2.65	0.15	6.39
Min. Value	0.48	28.77	1	48.52	0.24	24.46	1	7.65
Max. Value	19.8	186.7	8	2854.0	4.4	167.54	8	375.25

Key: V = Daily volume of the MSW (m^3), D = Estimated density of the MSW (kg/m^3), WCF = The collection frequency of the MSW (Times/day) and M = Total mass of the MSW produced (Kg/day).

The average rate of MSWG at hotels was 0.89 $kg.guest^{-1}.day^{-1}$ (SD 0.52; n=150) (Table 5.7). However, there was significant variation in MSWG per guest according to hotels'

categories. Four-stars hotels produced the most with a mean of 1.22 (SD = 0.52; n=4). Unrated hotels were next with an average of 1.08 (SD = 0.95; n=10). Two stars' hotels came third with a mean of 0.9 (SD = 0.52; n=70), the lowest MSW produced by one and three stars' hotels with an average of 0.83 (SD of 0.6 and 0.3, respectively).

There is considerable variation between hotels when it comes to how much MSW is generated per hotel, or even per guest, on a daily basis. This variation can be attributed to hotel size, type or category, guest and staff activities and guest attributes (Snarr and Pezza, 2000; Pirani and Arafat, 2014). For example, four-star guests produce more waste than one and three-stars hotel guests. This can be attributed to expenditure per guest or to the attributes of the guest. The average expenditure per guest at four-star hotels was 33,750 ID, this figure dramatically declining to 9,950 and 14,250 ID for one- and three-star hotels, respectively. This variation in expenditure relates to substantial differences in the services provided.

Table 5.7: Descriptive statistic for MSWG per guest at participating hotels and MSWG per serving at camps

	Camps waste (kg.servings $^{-1}$. day^{-1})	Hotels waste (kg.guest^{-1}. day^{-1})					
	Average	Average	Unrated	One Star	Two Stars	Three Stars	Four Stars
Mean	0.10	0.89	1.08	0.83	0.90	0.83	1.22
Conf. -95%	0.09	0.80	0.41	0.60	0.78	0.73	0.39
Conf. +95%	0.11	0.97	1.76	1.06	1.02	0.92	2.05
Median	0.90	0.77	0.88	0.60	0.79	0.81	1.13
SD	0.05	0.53	0.95	0.60	0.52	0.30	0.52
SE	0.004	0.04	0.3	0.11	0.06	0.05	0.26
Min. Value	0.02	0.12	0.26	0.21	0.12	0.33	0.75
Max. Value	0.29	3.51	3.51	2.32	2.68	1.82	1.88

In general, MSWG rates ranged between 0.12 and 3.51 kg.guest^{-1}.day^{-1} with an average of 0.89, which is generally lower than the global average figures reported by Losanwe (2013), approximately 1 kg per day. However, Dangi et al (2011), reported that the average MSW generated by 271 hotels in Kathmandu Metropolitan City, Nepal was 113.3 kg.day^{-1}, which is closer to the average mass of MSW produced by the hotels targeted in this study (112.34 kg.hotel^{-1}.day^{-1}).

In the case of camps, MSWG per serving ranged between 0.02 and 0.29 kg.serving^{-1}.day^{-1} with an average of 0.1 kg.serving^{-1}.day^{-1} (Table 5.7). This variation can be attributed to camp activities. For example, some camp owners claimed that they are able to estimate the pilgrims' need for food during the day and change the servings' size accordingly, to reduce the amount of food that ends up in the bins. However, others provide a constant size of servings regardless of the need, leading to many pilgrims throwing whole servings in the bins without being consumed. This practice was also observed during the Hajj, as Alsebaei (2014) stated that many food servings were found in bins without being consumed. As pilgrims have many options to choose from, this might increase the amount of MSW generated during the event, particularly the organic fraction.

5.3.1.3 The Main Component of Accommodations' MSW

To identify the main components of MSW generated by the hospitality accommodation, the managers were asked to identify the most common components in their waste, to estimate the fraction of food purchases ending up in bins and to estimate the fraction of recyclable items in their MSW (question 14 in both questionnaires). Managers' viewpoints about the main components of the MSW at their accommodation is presented in Figure 5.19. Hoteliers and camp owners agreed that the plastic waste generated is the largest component at their accommodation with average scores of 3.5 and 3.86 for hoteliers and camp owners, respectively. The organic is the second main component with an average score of about 2.9 followed by paper waste with a score of about 2.35.

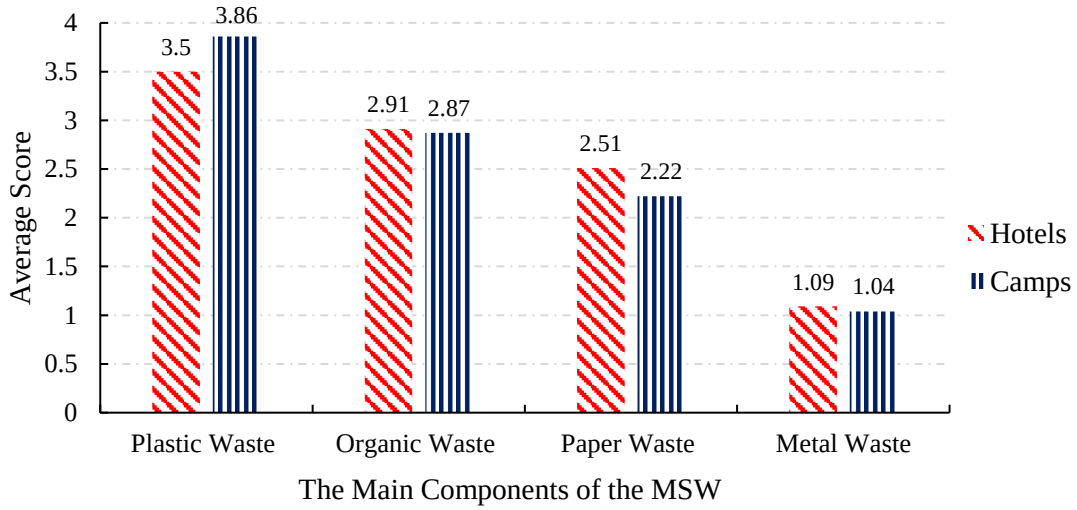

Figure 5.19: Participants' opinion on the most common components of the MSW

The responses depended on the managers' opinion. Although subjective, it provides supportive evidence about the most common components during the Arba'een. In terms of

weight, this result is in conflict with results of the field investigation of the MSW composition at the temporary transfer stations (TTSs) (Section 4.4.1.3), as the main waste components were organic (57.9%), paper (14.9%) and plastic (14.6%). However, the results are consistent when interpreted in terms of volumes. According to WRAP (2011) report, the density of food waste of 380 kg/m^3 is higher than that for the mixed paper waste of 120 kg/m^3, which in turn is higher than a plastic waste of 30 kg/m^3. Thus, the participants indicated plastic waste as the most generated waste at their accommodations due to its large volume compared to other wastes.

Figure 5.20 presents results regarding the fraction of food purchases (question 15) that end up being disposed of in bins. About 90% (274 managers) estimated that 10% or less of their cooked food and food products are regularly disposed of in bins. About 8.5% (29 managers) stated that from 11 to 30% of their food purchases were disposed of into bins, while just about 1.5% (4 managers) stated that more than 30% of their food ends up in the waste bins. This confirms that the vast majority of the accommodation managers practise control on the food servings to minimise the quantity of the food that is disposed of in bins without being consumed.

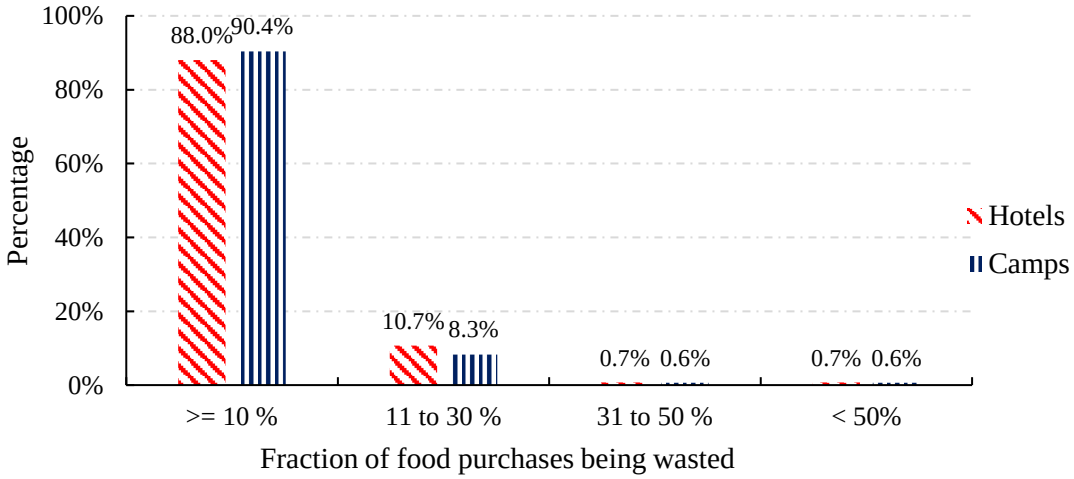

Figure 5.20: Participants' estimation of their food purchases being wasted

The results of the estimation regarding the recyclable fraction in waste (question 16) are presented in Figure 5.21. It is quite clear that a large number of accommodation managers (about 47%) believed that more than 50% of their waste is recyclable. 13% (41 managers) estimated that the recyclables fraction accounts for up to 50% while a considerable number of accommodation managers (109 managers) estimated that the recyclable materials account for less than 30%.

From the above, it can be deduced that the main components of waste generated during the Arba'een are food, plastic and paper wastes. Plastic waste is the main component generated due to its large size compared to other waste materials and there are considerable amounts of organic and paper wastes. Metal waste represents the smallest component among the event waste; this is because the majority of managers use plastic and paper plates to serve food during the event.

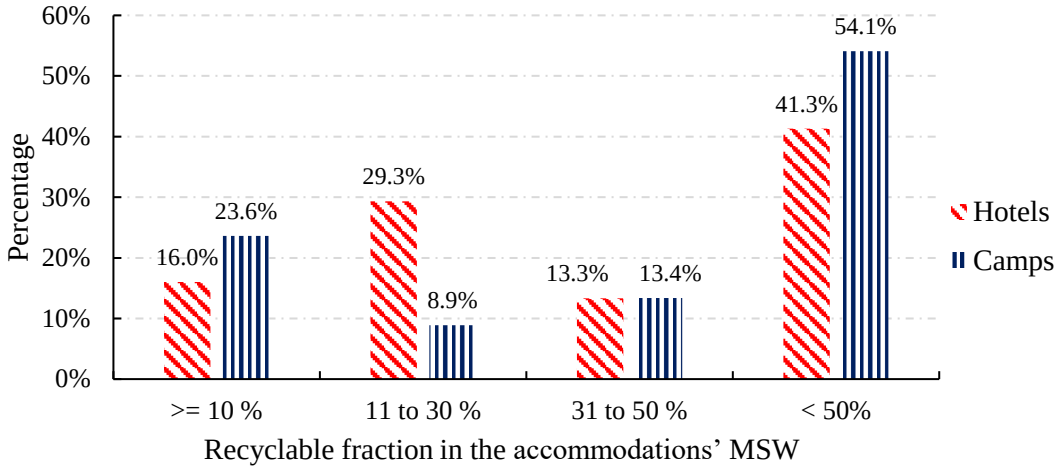

Figure 5.21: Participants' estimation of recyclable fraction in their MSW

5.3.2 Modelling MSWG for Hotels and Camps

According to the survey, MSWG at hotels and camps varies considerably. One of the objectives of this research is to define the features that influence MSWG from hotels and camps during REs. The literature (Radwan et al, 2010; Pirani and Arafat, 2014; Intharathirat et al, 2015; Azadi and Karimi-Jashni, 2016; Pirani and Arafat, 2016; Tatano et al, 2017) shows that MSWG is highly influenced by several features/parameters such as number of beds, expenditure, food habits and economic conditions. Thus, two Multiple Linear Regression (MLR) models were developed with the aim of predicting MSWG at hotels and camps during the Arba'een according to their characteristics (Section 3.8.1). The two models were developed using SPSS over two stages, stage 1 being to check assumptions of the MLR technique and data treatment, stage 2 to evaluate the developed model performance and the contribution of the explanatory variables.

5.3.2.1 Testing the Assumption of MLR and Data Treatment

- *Types of Variables*

The design assumption of MLR states that the dependent variable (DV) should be one scale variable (continuous) and the independent variables (IVs) should be two or more that are

measured at continuous or nominal level (Pallant, 2007). In the first model (Hotels MSWG), the characteristics of the hotels namely capacity (HC), staff size (HSS), expenditure (HE), floor area (HFA), location (HL), rating (HR) and waste collection frequency (HWCF) (Section 5.3.1.1) were employed as IVs to predict MSWG at hotels (the DV). While the second model (Camp MSWG) employed camps characteristics that are camp's capacity (CC), staff size (CSS), expenditure (CE), floor area (CFA), location (CL), food services (CFS) and waste collection frequency (CWCF) (Section 5.3.1.1) as IVs to predict MSWG at camps (the DV). All the IVs and the DVs were scale variables except HR, which is an ordinal variable. The HR was treated as a nominal level during analysis. Accordingly, the design assumption of MLR has been met.

- *Sample Size*

The minimum number of observations required to construct a generalizable model was calculated according to Equation (3.6). Seven IVs were used to build each model meaning that 106 observations were the minimum required. The second assumption has therefore been met since 150 field observations were made for hotels and 157 observations made for camps, more than the necessary dataset size for stepwise MLR modelling.

To perform this technique and avoid problems of overfitting (Azadi and Karimi-Jashni, 2016), two random datasets were derived by separating the total dataset for each model. The training dataset for hotels MSWG, comprising 75% of the total dataset (112 observations), was used to build the production model while, the remaining 25% of the dataset (38 observations), was used to check the performance of the developed model. Similarly, the camps dataset has been divided into training dataset comprising 80% of the total camps dataset (129 observations) and validation dataset including 20% of the total dataset (28 observations).

- *Normality of Variables IVs and DV.*

Variable distribution should be checked as this guides analysis decision making and enhances the results of the developed models. Expected normal probability plots (Q-Q plots) were employed; these plots provide a graphical comparison between the expected normal values and the actual normal values for each variable (Tabachnick and Fidell, 2013). Expected normal values are represented by a diagonal line running from lower left to upper right; normal distribution is seen when the points for observations fall along the diagonal line with limited deviations owing to random processes (Pallant, 2011). Figure 5.22 and 5.23 illustrate the distribution of all variables for the hotels and camps models, respectively.

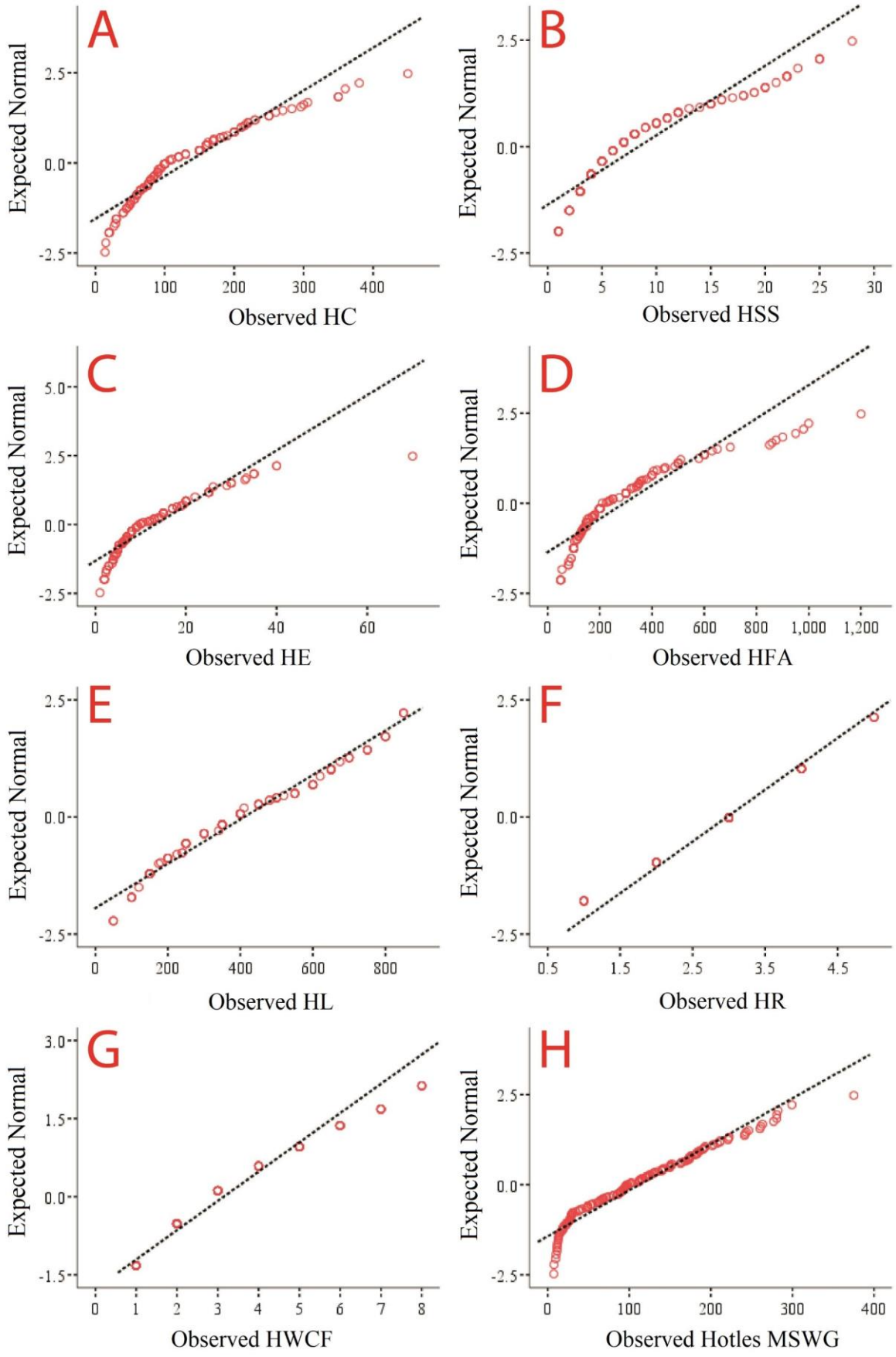

Figure 5.22: Expected normal probability plots for the original hotels IVs and DV: (A) HC, (B) HSS, (C) HE, (D) HFA, (E) HL, (F) HR, (G) HWCF and (H) hotels MSWG

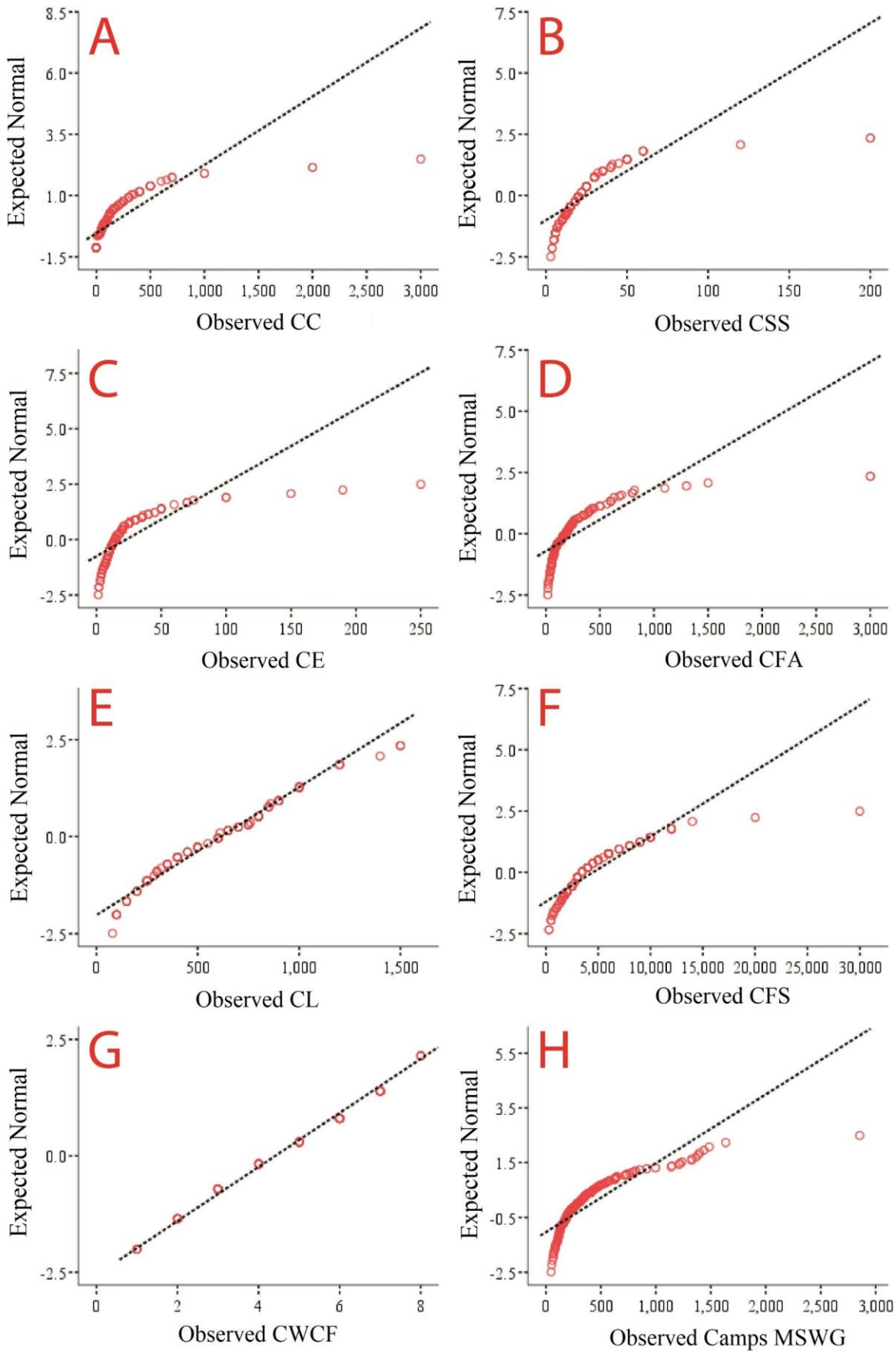

Figure 5.23: Expected normal probability plots for the original camps IVs and DV: (A) CC, (B) CSS, (C) CE, (D) CFA, (E) CL, (F) CFS, (G) CWCF and (H) camps MSWG

As seen in the above graphs, the data do not adhere to the diagonal line which means that they are not normally distributed (the variables have several extreme values that skewed the distribution), violating assumptions of normality. For example, hotels expenditures ranged between 1 to 70 thousand ID with an average of 13 thousand ID (Table 5.5) indicating that there are too many observations lies between 1 and 13 thousand ID and several cases are significantly higher than the average (27 thousand ID or higher). In this case, hotels expenditures variable is skewed from a normal distribution (Figure 5.22 C). There are many methods available such as Box-Cox, Johnson, logarithmic, and square root transformations (Field, 2009; Tabachnick and Fidell, 2013) to transform data into a normal distribution. The selection of an appropriate method for variables transformation depends on its skewness and distribution (Tabachnick and Fidell, 2013). Three transformation methods have been used here; logarithmic, cubic root and fourth root transformations (Field, 2013). Logarithmic transformation was applied to several variables that are HC, HSS, HFA, HE, HA, CSS, CE, CFA and camps MSWG using Equation (5.1). The cubic root transformation was applied to Hotels MSWG and CC using Equation (5.2) while the fourth root transformation was only applied on the CFS using Equation (5.3). The remaining variables that are HL, HR, HWCF, CL, and CWCF were already normally distributed and no further treatment was required. Figure 5.24 and 5.25 show the expected normal probability plots (Q-Q plots) to the treated hotels and camps variables.

$$X' = Ln(X) \tag{5.1}$$

$$X' = \sqrt[3]{X} \tag{5.2}$$

$$X' = \sqrt[4]{X} \tag{5.3}$$

Where
X' is the transferred score
X is the actual score.

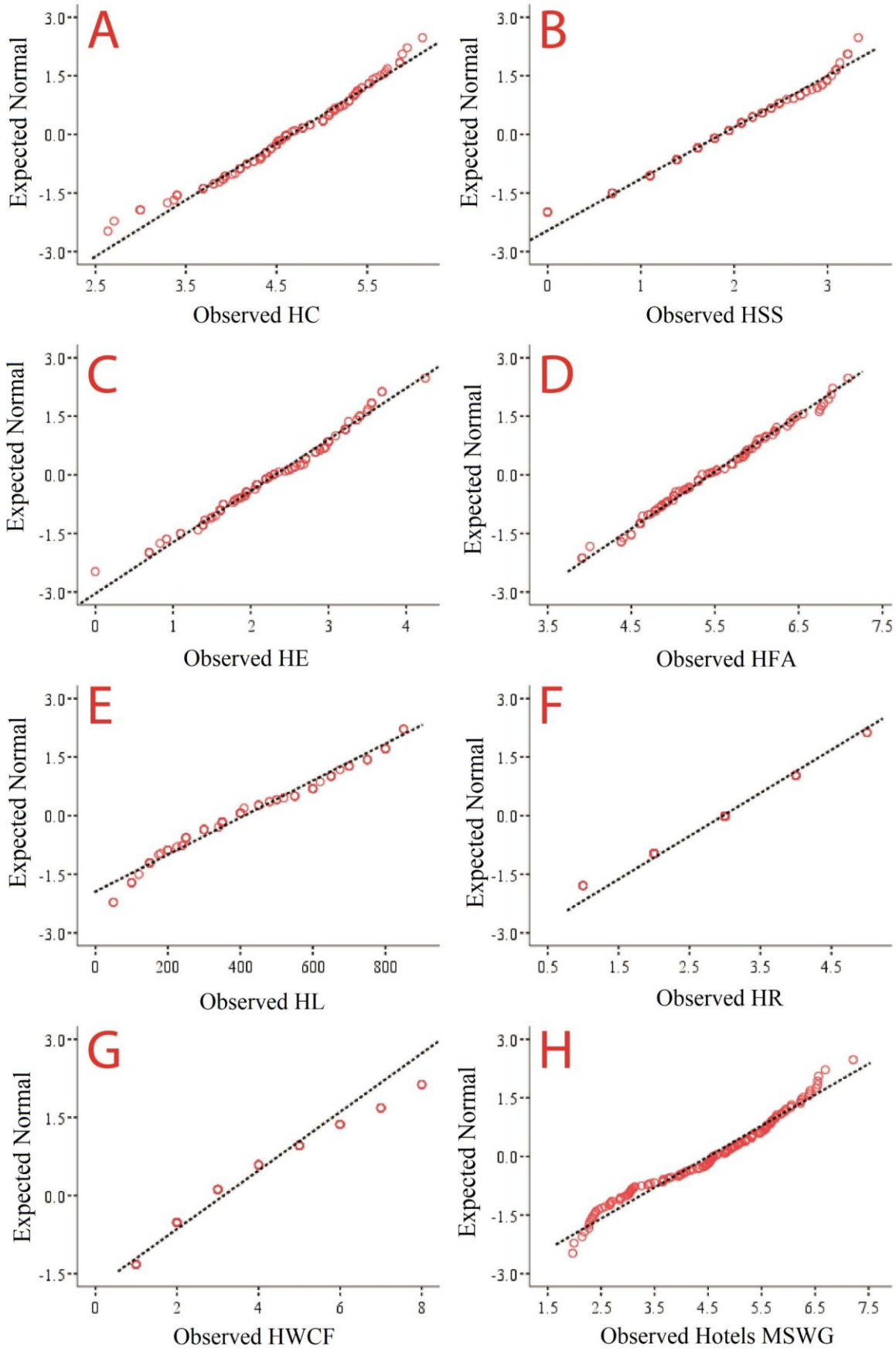

Figure 5.24: Expected normal probability plots for the treated hotels IVs and DV: (A) HC, (B) HSS, (C) HE, (D) HFA, (E) HL, (F) HR, (G) HWCF and (H) hotels MSWG

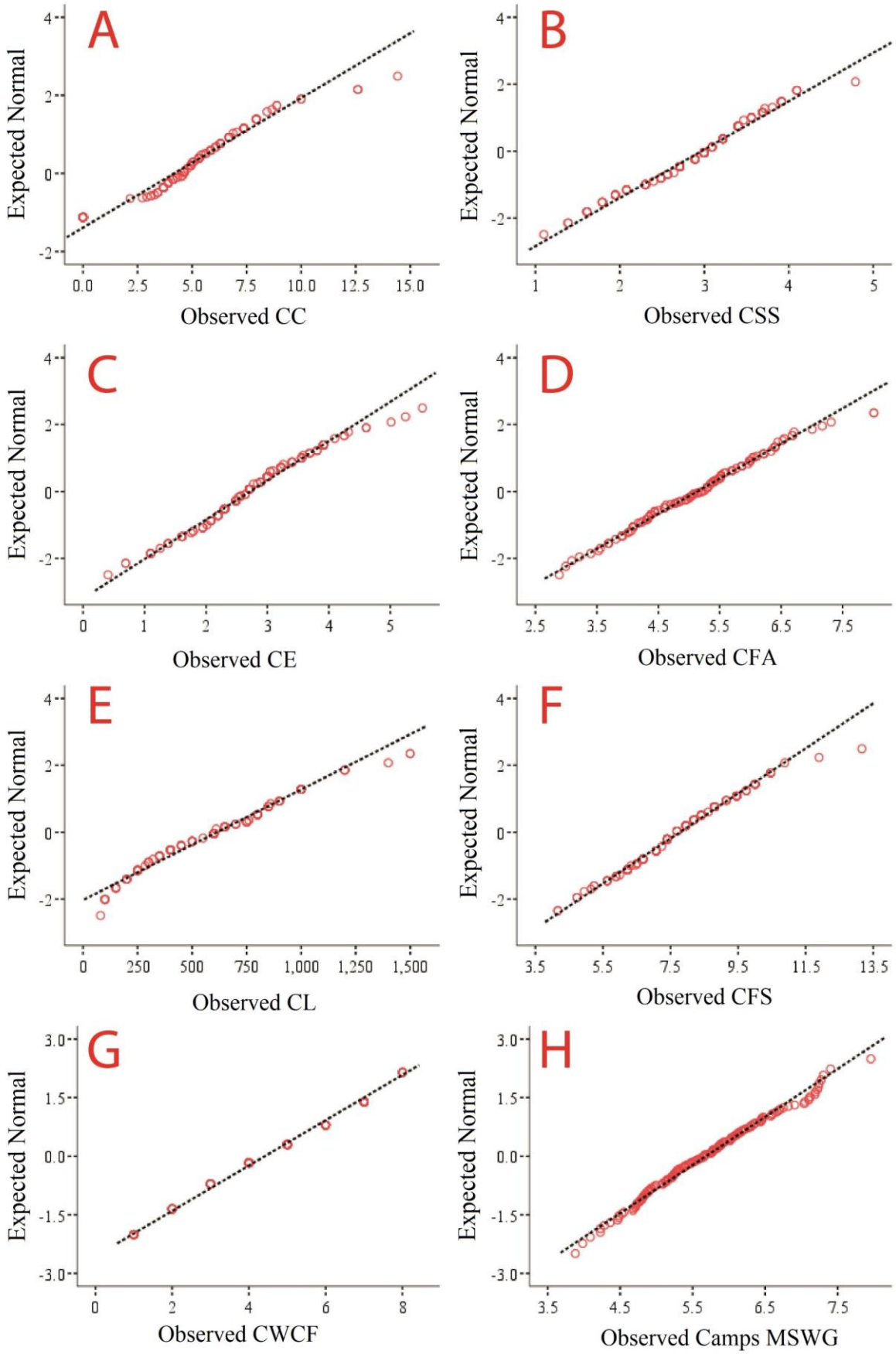

Figure 5.25: Expected normal probability plots for the treated camps IVs and DV: (A) CC, (B) CSS, (C) CE, (D) CFA, (E) CL, (F) CFS, (G) CWCF and (H) camps MSWG

From Figure 5.24 and 25, it can be clearly seen that the observation points for each variable fall along the diagonal line with limited deviation because of process randomness, meaning that the distributions of the IVs and the DVs are normal.

- *Linearity of IVs*

To test the relationship between the IVs and the DVs for hotels' and camps' MSWG individually, partial regression plots were generated between each IV and the DV for hotels and camps models. Multivariate scatter plots matrixes were also generated to investigate the relationships among all variables for each model. Figure 5.26 shows the multivariate scatter plots matrix for camps variables and Figure 5.27 illustrates partial regression plots between camps IVs and DV. It can be clearly seen for both figures that all the IVs show linear relationships with each other and the quantity of the MSW produced by camps and none show a nonlinear relationship with the DV. Similarly, Figure 5.28 and 5.29 illustrate relationships between the hotels' IVs and the MSWG from hotels. It can be seen that each IV has a linear relationship with the quantity of MSW produced by hotels and no IV has developed a curvilinear relationship. Accordingly, the assumption of linearity between each IV and the DV has been met.

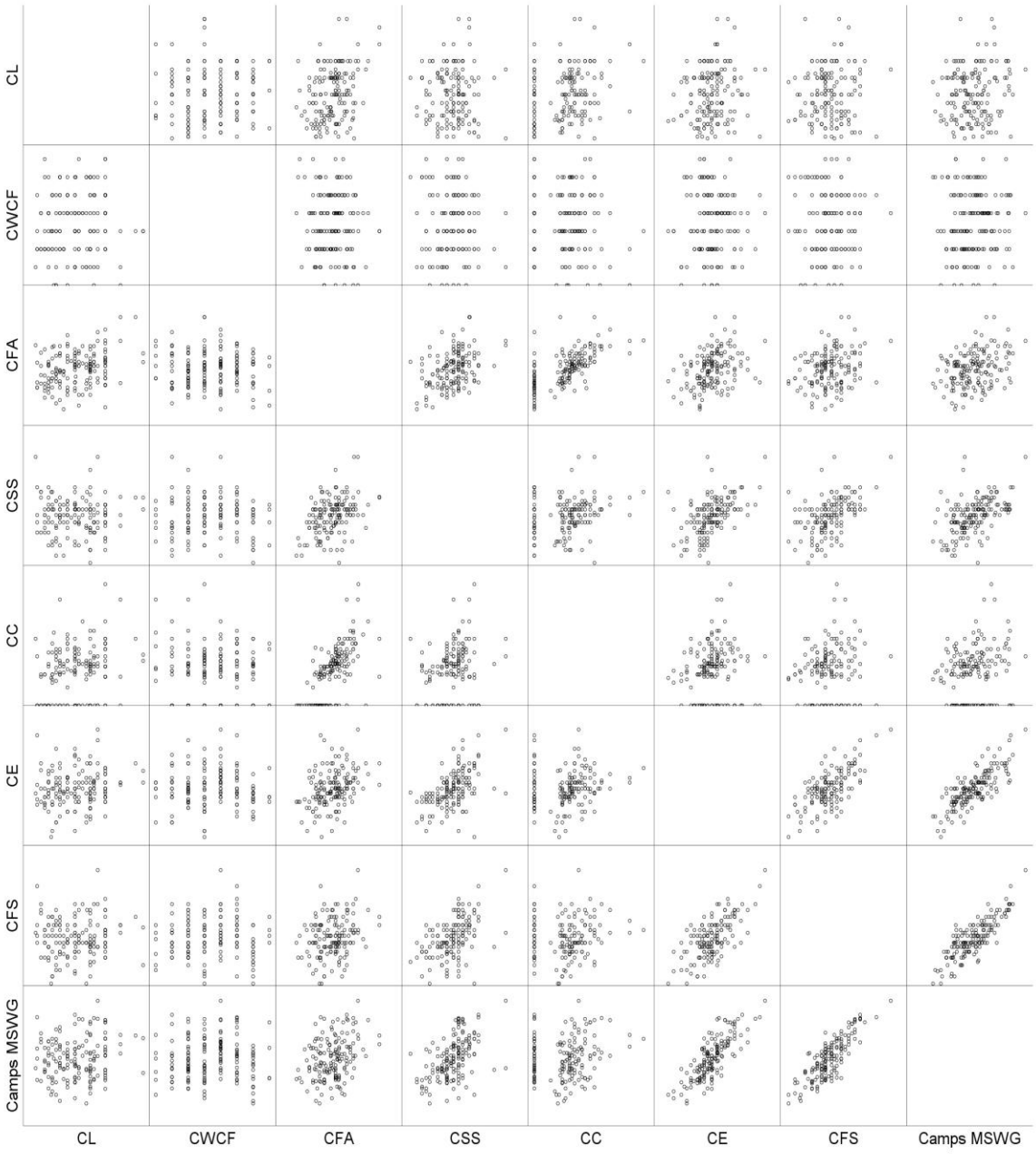

Figure 5.26: Multivariate scatter plots matrix for camps variables that are CL, CWCF, CFA, CSS, CC, CE, CFS and camps MSWG

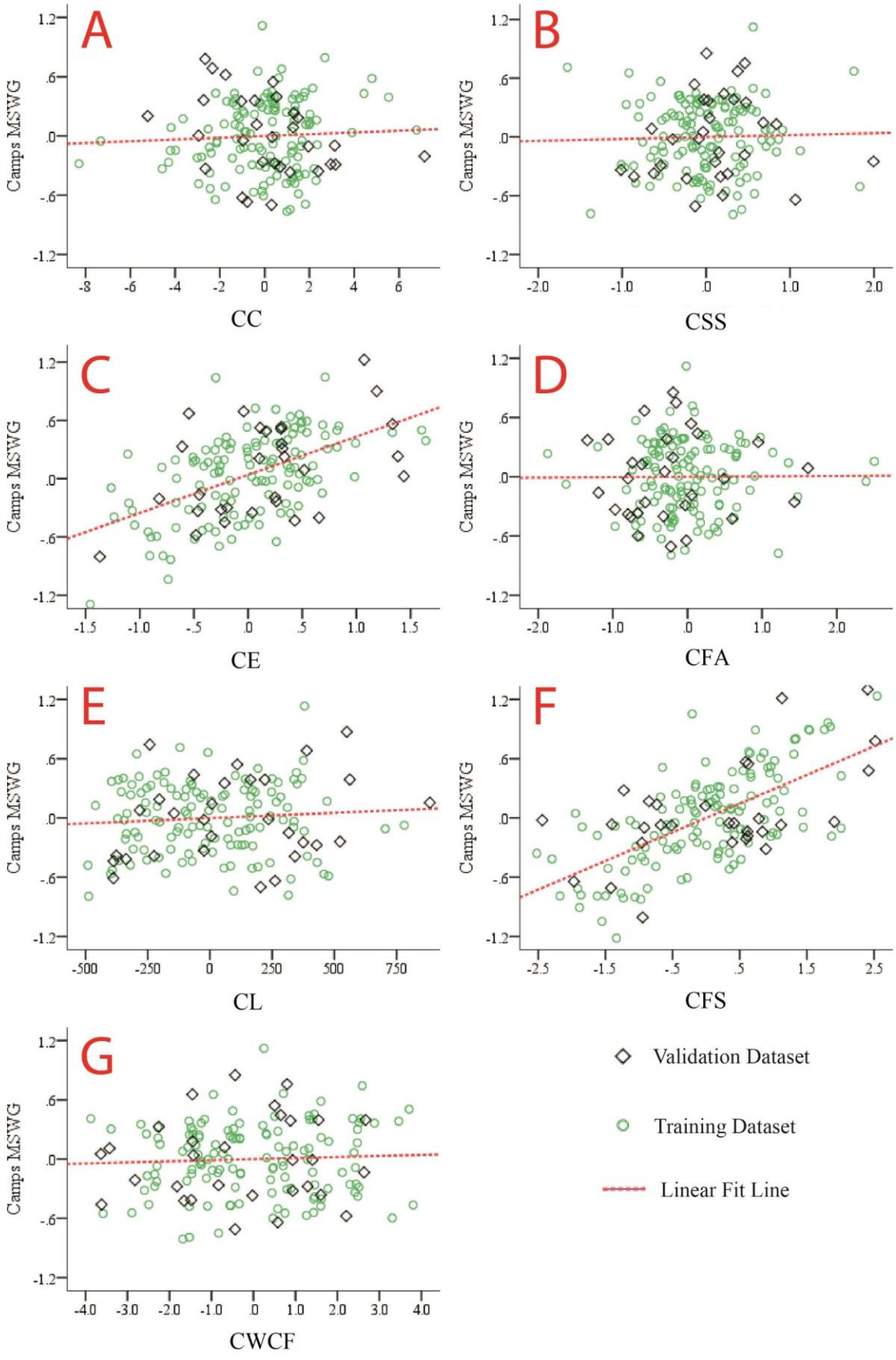

Figure 5.27: Partial regression plots between camps' IVs and MSWG from camps: (A) CC, (B) CSS, (C) CE, (D) CFA, (E) CL, (F) CFS and (G) CWCF

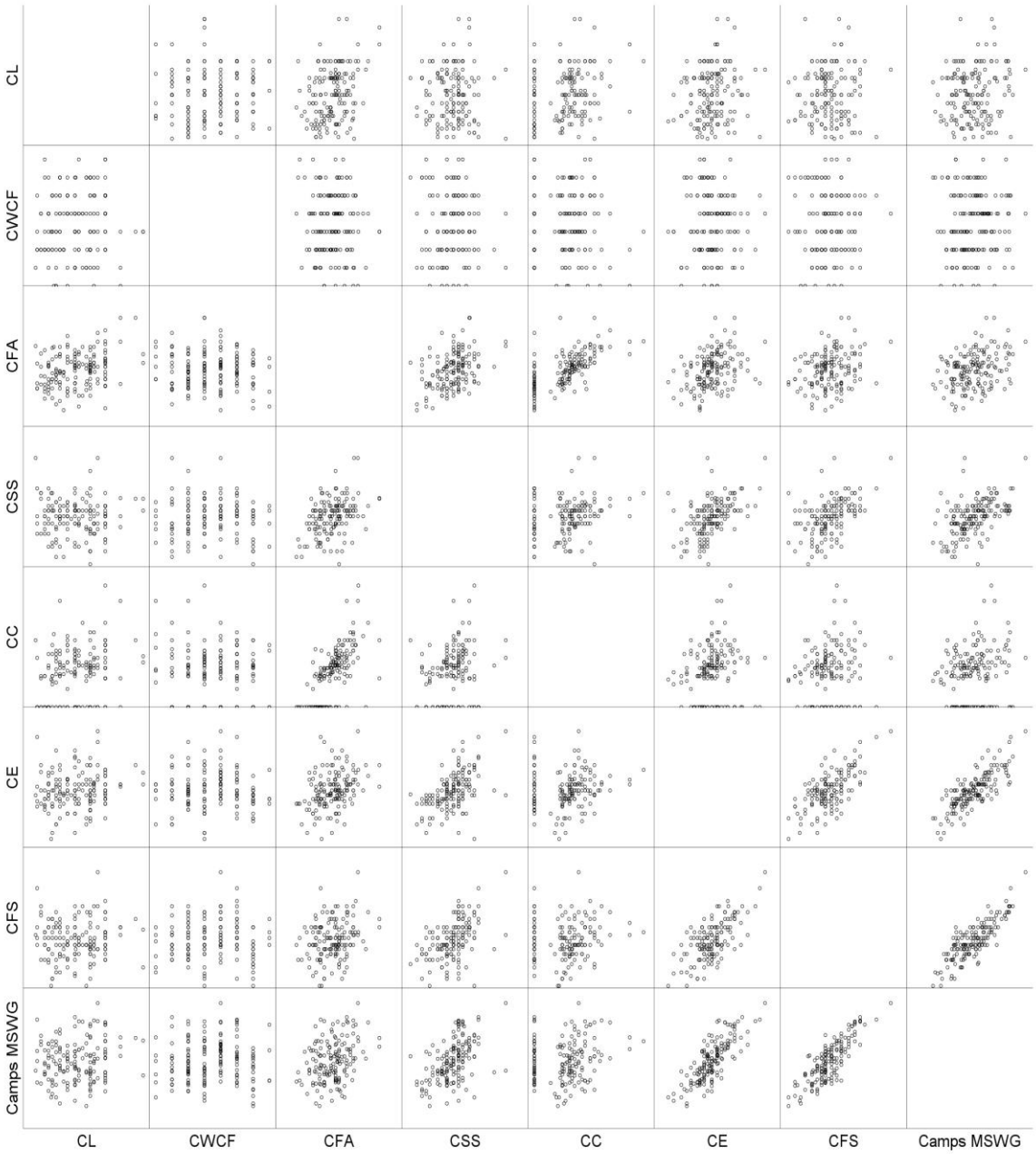

Figure 5.28: Multivariate scatter plots matrix for hotels variables that are HL, HWCF, HFA, HSS, HC, HE and camps MSWG

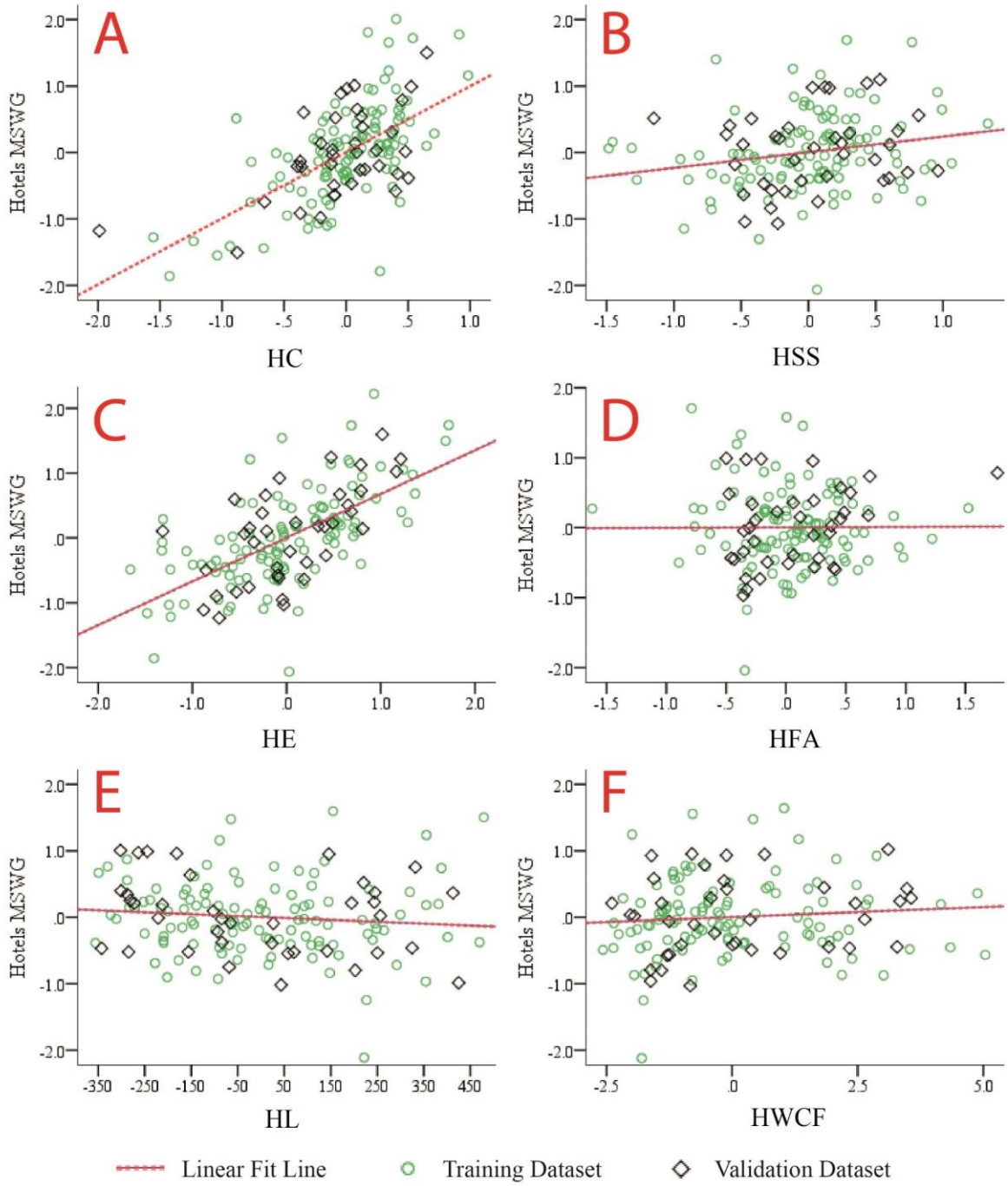

Figure 5.29: Partial regression plots between Hotels' IVs and MSWG from hotels: (A) HC, (B) HSS, (C) HE, (D) HFA, (E) HL and (F) HWCF

On the other hand, standardised residuals against the (unstandardised) predicted values scatterplot provide proper information to test the assumption of linearity (collectively) (Laerd Statistics, 2015). Figure 5.30 and 5.29 show the distribution of the standardised residuals for hotels and camps models, respectively. The figures show no systematic pattern of the residual, indicating that the relationships between IVs and DVs are likely to be linear. Thus, the assumption of linearity has been achieved.

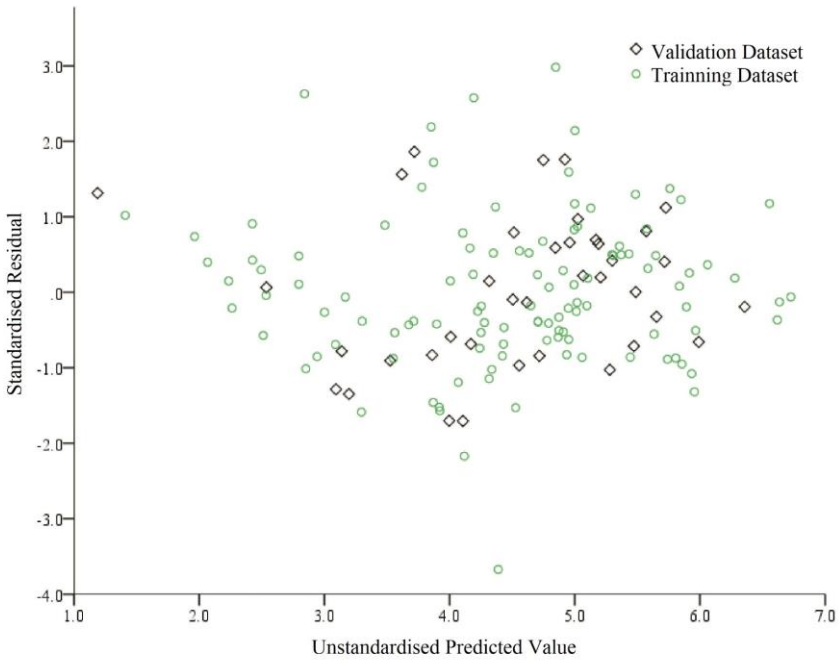

Figure 5.30: Scatterplot of standardised residuals against unstandardised predicted value for hotels

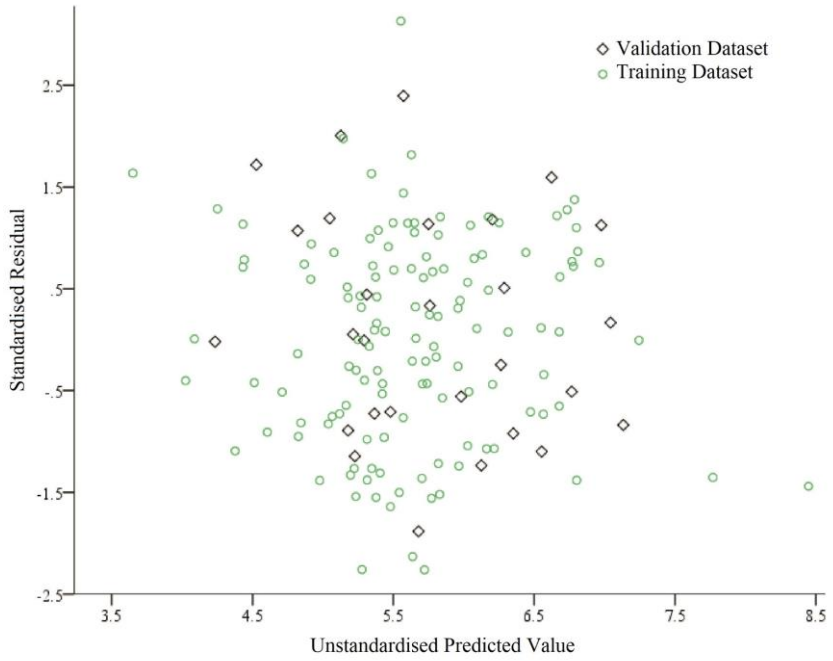

Figure 5.31: Scatterplot of standardised residuals against unstandardised predicted value for camps

- *The Homoscedasticity of the Residuals*

The scatter plot standardised residuals against the (unstandardised) predicted values scatterplot (Figure 5.30 and 5.29) are also useful to test the assumption of homoscedasticity. Since the variances of the residuals form roughly rectangular distribution and there is no

clear systematic distribution to the residuals e.g. curvilinear, or higher on one side than the other, the homoscedasticity of the residuals is also met for both regression models.

- *Independence of Observations*

The MLR assumes that errors of prediction are independent of one another as autocorrelation of errors over a sequence of cases makes the model estimation too small or large (Tabachnick and Fidell, 2013). To test this type of error, the Durbin-Watson statistic is useful to measure the autocorrelation over a set of observations (Pallant, 2007). This test was conducted to investigate the presence of autocorrelation among hotels' and camps' data (Table 5.8). The values of Durbin-Watson statistic for the training datasets and the validation datasets for the hotel and camps were within the range of 1.5 to 2.5. Therefore, it can be assumed that there is no autocorrelation in the hotels' and camps' data and this assumption has also not been violated.

Table 5.8: Summary of the independence of observations and the outliers tests

Model	Durbin-Watson Statistic		Std. residual outside the range of -3 to 3		Max. Mahalanobis Distance	Max. Cook's Distance
	Training Dataset	Validation Dataset	No. of cases	Values		
Hotels	1.922	2.239	1	3.655	12.20	0.108
Camps	1.807	1.897	1	3.114	14.87	0.082

- *Absence of Outliers*

During the initial screening, it was observed that one case had a standardised residual of 3.655 among hotels observations and one case had a standardised residual of 3.114 among camps observations (Table 5.8). Since the two cases might be outliers, the Mahalanobis distances were calculated and compared with the critical values shown in Table 3.3. The maximum acceptable Mahalanobis distance for the seven IVs is 24.32. These critical values were compared with the maximum calculated Mahalanobis distance for the field observations (12.20 for hotels and 14.87 for camps) confirming the absence of extreme outliers (Table 5.8).

In addition, to check whether these points may have an influence on the results of the MLR models, Pallant (2011) recommends calculation of the Cook's distances of these points, where any point with a Cook's distance of more than 1.0 presents a possible problem. The maximum Cook's distances for hotels observations and camps observations have been

determined, the results shown in Table 5.8 indicating that these cases exert a negligible influence on the models, as the maximum Cook's distance value was below 1.0.

- *Multicollinearity*

Multicollinearity among IVs, another assumption of MLR that measures a linear relationship between two IVs, has been examined by calculating Variance inflation factor (VIF) values for accommodation's characteristics (Equation (3.7)). Table 5.9 confirms the absence of multicollinearity as the highest calculated VIFs for hotels and camps were 1.908 and 2.070, respectively, which are considerably less than the critical value of 10. Accordingly, the IVs used to build the prediction models for hotels' MSWG and camps' MSWG meet the assumption of multicollinearity.

Table 5.9: Summary of multicollinearity statistics and models' coefficients

DV	IVs		VIF	Tolerance	*p*	Beta
Hotels MSWG	HC		1.746	0.573	0.000	0.573
	HSS		1.908	0.524	0.033	0.129
	HE		1.221	0.819	0.000	0.407
	HFA		2.380	0.420	0.408	---
	HL		1.116	0.896	0.549	---
	HR	One Star	1.262	0.792	0.877	---
		Two Stars	1.056	0.947	0.149	---
		Three Stars	1.248	0.801	0.745	---
		Four Stars	1.100	0.910	0.162	---
	HWCF		1.050	0.953	0.538	---
Camps MSWG	CC		1.031	0.970	0.005	0.115
	CSS		1.449	0.690	0.821	---
	CE		1.896	0.528	0.000	0.408
	CFA		2.070	0.483	0.874	---
	CL		1.161	0.861	0.697	---
	CFS		1.864	0.537	0.000	0.553
	CWCF		1.005	0.995	0.745	---

Key: *p* = statistical significant

5.3.2.2 Evaluating the Contribution of IVs and the Performance of the Model

- *Contribution of IVs to the Built Models*

The statistical significance of the accommodation's features defines whether they apply tangible or negligible influences on the results of the proposed MLR models to estimate MSWG. Any feature that has a *p*-value of more than 0.05 can be excluded owing to its negligible contribution.

Based on the results of the statistical analysis (Table 5.9), three among the hotels' features, HC, HSS and HE, are significantly contributing to the quantity of the MSW generated by hotels while the remaining features (HFA, HL, HR and HWCF) have no significant contribution. These features have therefore been omitted from the hotels model. The Beta values for features HC, HSS and HE have been determined to measure the strength of influence of each on the developed hotels MSWG model. The results obtained in Table 5.9 illustrate that the hotel capacity (HC) exerts the greatest influence on the suggested model followed by hotel expenditure (HE) and hotels staff size (HSS).

MLR analyses for camps' MSWG revealed that CC, CE and CFS are significantly contributing to the quantity of MSW produced by camps. Other features, CSS, CFA, CL and CWCF, do not exert significant contribution to the developed camps' MSWG model and therefore have been ignored. The beta values for the significant features (CC, CE and CFS) were calculated to decide which feature is the best in predicting MSWG from camps. Table 5.9 illustrates that the CFS exerts the greatest influence on the suggested model followed by CE and CC.

- *Models Performance*

After confirming that the assumptions for MLR have been satisfied, cross-validation MLR models were developed to predict MSWG by hotels and camps. Equation (5.4) estimates MSWG by hotels according to hotels' features, particularly capacity, expenditure and staff size while Equation (5.5) estimates MSWG by camps according to the services provided, the expenditure and the capacity of the selected camp.

$$Hotels\ MSWG = (-2.241 + 1.040 \ln HC + 0.649 \ln HE + 0.213 \ln HSS)^3 \quad (5.4)$$

$$Camps\ MSWG = e^{(2.124 + 0.304(CFS)^{\left(\frac{1}{4}\right)} + 0.387 \ln CE + 0.032(CC)^{\left(\frac{1}{3}\right)})} \quad (5.5)$$

It is essential to check the ability of these models to explain changes in MSWG by hotels and camps. The best way to do this is by calculating the coefficient of determination (R^2), where R^2 represents the degree of concordance between actual MSWG observations and estimated MSWG by the suggested models. R^2 for hotels MSWG model was 0.799 which means that the proposed model is able to explain 79.9% of the variation in MSWG by hotels according to their features (Table 5.10). R^2 for camps MSWG model was 0.803 indicating that 80.3% of the variation in the quantity of MSW produced by camps can be explained

using the developed camps' MSWG model. In addition, the Adjusted R^2 was calculated using equation (3.9) to understand the impact of the data set size and the number predictive variables. The Adjusted R^2 results confirm hotels MSWG model was able to explain 79.3% of the variation in MSWG by hotels while camps MSWG model able to explain 79.8% of the variation in MSWG according to their features (Table 5.10). These values are comparable with those obtained by others including Azadi and Karimi-Jashni (2016) and Parisi Kern et al (2015) who obtained R^2 values of 0.78 and 0.69, respectively.

Table 5.10: Summary of developed MLR models

Model	R	R^2	Adjusted R^2	*p*
Hotels MSWG	0.894	0.799	0.793	0.000
Camps MSWG	0.896	0.803	0.798	0.000

In addition, the statistical significance of the suggested model is an essential parameter that has to be checked at this stage. According to Tabachnick and Fidell (2013), the significance of a proposed model must be less than 0.05 to accept it. A significance value of <0.000 for the hotels' MSWG model and camps' MSWG model was obtained (Table 5.10). This significance value indicates that the built models were better at predicting the quantity of MSWG from hotels and camps than the mean models.

In order to investigate the agreement between the observed and predicted MSWG, the models were applied to the randomly selected validation dataset (25% of the hotels' dataset and 20% of the camps dataset). Figure 5.32 and 5.33 illustrate relationships between the predicted and observed MSWG at hotels and camps for both training datasets and the validation dataset. For the hotels' MSWG model, the R^2 value for the validation dataset was 0.788, which is comparable to the R^2 of the proposed model of 0.799. For the camps' MSWG model, the R^2 values were 0.743 and 0.803 for the validation dataset and training dataset, respectively. The outcomes obtained show a meaningful agreement between these values indicating that the proposed models were able to estimate the change in MSWG from hotels and camps according to their characteristics. These findings indicate that the MLR models produced an accurate and valid representation of the data and can be applied to the populations of hotels and camps.

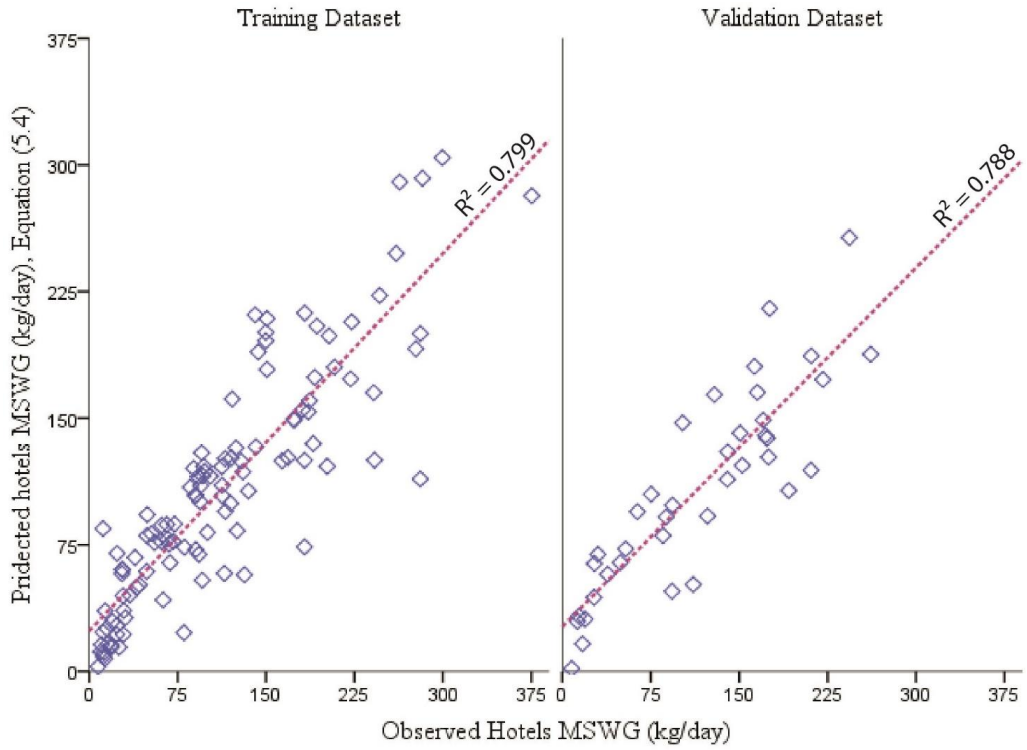

Figure 5.32: Relationships between predicted and experimental MSWG at hotels

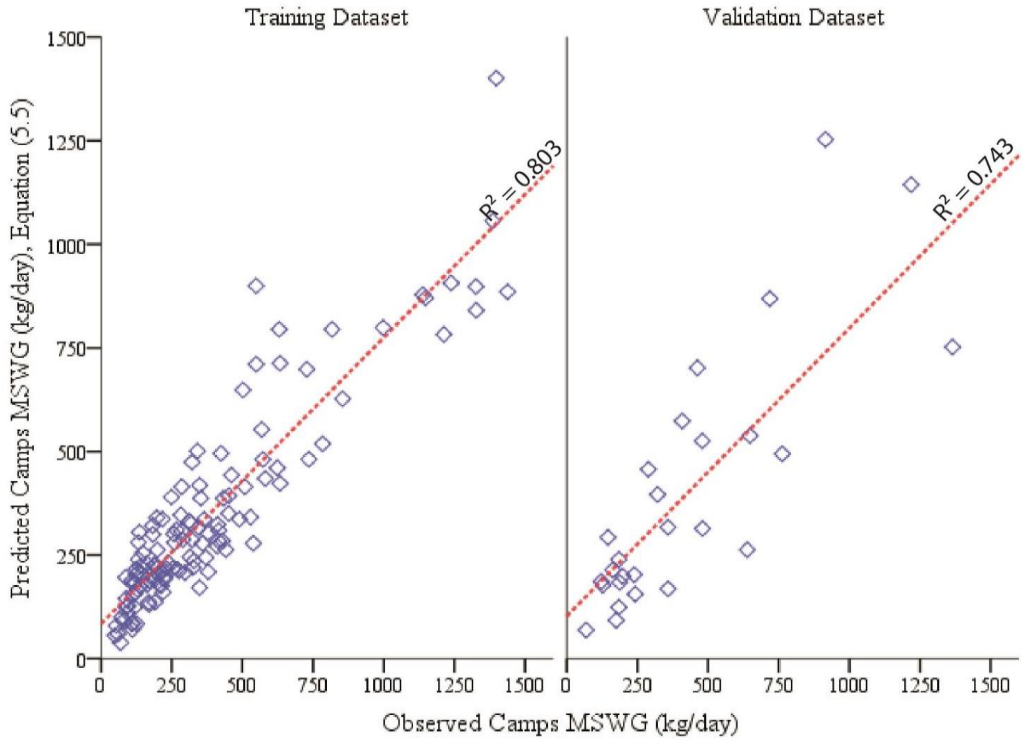

Figure 5.33: Relationships between predicted and experimental MSWG at camps

5.3.2.3 Discussion

The field survey conducted helped establish a foundation regarding MSWG from hotels and camps during the Arba'een; this information has not been available before. MLR analysis

conducted confirmed that the features of hotels and camps influence MSWG, as several researchers (Earle and Townsend, 1991; Ball and Abou Taleb, 2010; Pirani and Arafat, 2014) reported.

MSWG from hotels was found to be influenced by the establishment capacity. The relationship between the HC and the hotel's MSWG is positive; larger hotels tend to produce more MSW than smaller hotels. The existence of this relationship is supported by many scholars, such as Purcell and Magette (2009), Ball and Abou Taleb (2010), Pham Phu et al (2018) and Pirani and Arafat (2014). The present study also showed that HE is one of the important aspects that control the hotel's MSWG. Hotels that spend more on purchasing practices produce larger quantities of MSW. Researchers such as Snarr and Pezza (2000) indicated that MSWG at hospitality establishments is affected by the purchasing activities. Besides, MLR analysis demonstrated that HSS also affects hotels' MSWG, as Purcell and Magette (2009) and Ball and Abou Taleb (2010) reported. This seems to support the previous findings with what many researchers have suggested, that is, MSWG from hospitality establishments depends on the features of the establishment.

Purcell and Magette (2009) and Pham Phu et al (2018) studies show that the area and the rating of a hotel significantly affect MSWG. However, this study showed that these two aspects do not apply a significant influence of the quantity of MSW produced by hotels in Kerbala city during REs. This could have happened due to the impact of other aspects such as the services of hotels and the attributes of the guests. From section 5.3.1.1, it can be clearly seen that hotels are offering mid-range services including food and beverage. It is unknown whether these services are similar or different e.g. hotels serving breakfast, breakfast and dinner or complete dining services. Therefore, this might mean that hotels' services have had an impact on MSWG, which has led to a decrease in the impact of HFA and HR. This was reported by Snarr and Pezza (2000) and Pham Phu et al (2018) who stated that guest activities, size of the meal functions and purchasing practices are important factors that influence MSWG.

Similarly, Boateng et al (2016) stated that establishment location had a significant influence on MSWG that is situated in a principal street. Therefore, hotels located closer to the centre of the REs receive a frequent collection service (section 4.4.3) and are expected to generate more MSW than those located in outskirts areas due to demand and occupancy rate. However, MLR analysis revealed that HL and HWCF do not apply tangible influence on MSWG. The event size led to the consumption of the full capacity of the hotels in the city

regardless of their location. This has led to minimising the impact of the location of the hotel's MSWG.

Likewise, MSWG from camps was found to be significantly influenced by CC and CE whereas CFA, CL, CWCF have insignificant influence. The relationship between CC as well as CE and camp's MSWG is positive. Besides, CFS was found to be the most influential factor on Camp's MSWG. This agrees with Snarr and Pezza (2000) who stated that the size of the meal an is an important factor that influences MSWG. However, unlike hotels, the CSS does not apply a significant influence on the camp's MSWG, which can be attributed to the activities of the staff. Camp staff are groups of volunteers that help to provide services without any financial returns. Therefore, a large number of volunteers may work in some camps, although its services are less compared to others. Besides, many camps provide different services such as massage (Mujtaba Husein, 2018), which requires higher numbers of staff and produces lower MSW.

As explained in Chapter 4, the city of Kerbala does not have any previous records regarding MSWG and its sources during REs. Thus, the strong association between some features of the city's accommodations and MSWG could be used to estimate MSWG from these accommodation establishments. The success of this modelling implies that there is no need to spend large efforts and resources on collecting such data. The developed model can provide accurate information on MSWG, assisting decision makers to develop ISWM (e.g. introducing a recycling scheme) during REs periods. The models' results, for example, can provide reliable information about MSWG at each street during large REs enabling MSWM authorities to design an adequate storage system, identify the collection fleet capacity and plan the collection routes to be compatible with the quantity of MSWG at each area.

5.4 Accommodation Managers' Intention to Recycle

After identifying MSWG from the accommodation, several questions were designed to explore the managers' intention to separate waste at source, their preferred option to separate their waste and the actions that might encourage MSW separation among managers and pilgrims.

5.4.1 Managers' RI

5.4.1.1 Managers' Willingness to Sort Waste at Source

Figure 5.34 presents the results from a question (question 17) designed to assess managers' willingness to sort their MSW at source while the event is ongoing. The camp owners are

more likely to separate their MSW than hoteliers, as 88.5% of the camp owners were willing to separate the waste compared to 68% of the hoteliers. The willing proportions were higher than expected, thus, the participants were asked to state the reason behind their choice to sort the MSW during the events.

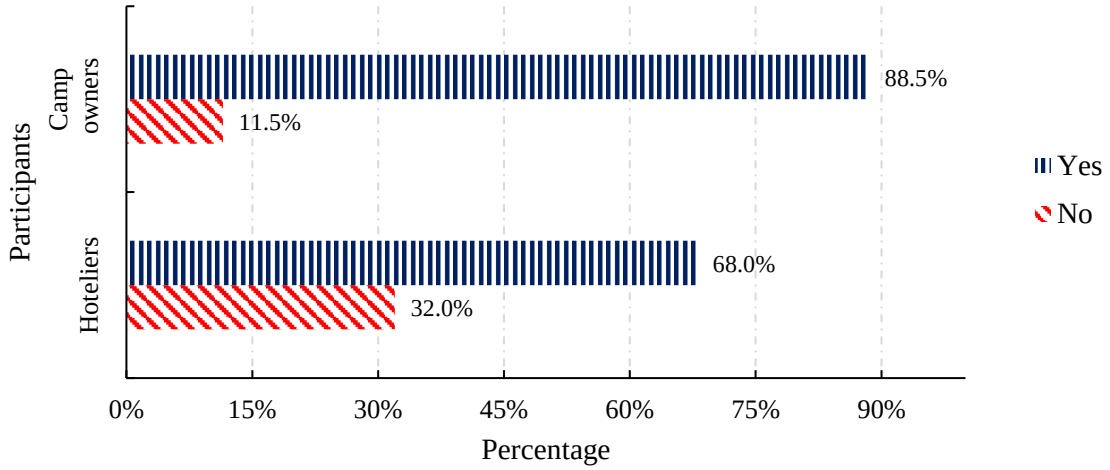

Figure 5.34: Managers' willingness to sort waste at their accommodations

The responses to an open-ended question (question 18) were categorised into several options to reflect the reasons behind managers' choice of MSW sorting at source and are presented in (Figure 5.35-A). The vast majority of the willing managers attributed this to their desire to improve the city infrastructure (84.3% of hoteliers and 87.1% of camp owners) because it is a tourist destination and attracts millions of pilgrims each year. A considerable fraction (53.5 % of hoteliers and camp owners) believed that a recycling scheme would have a significant impact on the economic situation of the city. A large fraction of camp owners believed it is their responsibility (43.2%) while only 16.7% of hoteliers believed that it is their responsibility. These reasons are in agreement with the results obtained by Babaei et al (2015). The highest fraction of participants are willing to participate in a recycling scheme due to their tendency to receive more MSWM services while the lowest fraction is the respondents' tendency to receive financial rewards. Accordingly, it is recommended to raise environmental awareness among managers to stimulate the sense of responsibility among them and raise the level of participants' willingness to take part in MSWM activities.

However, Keramitsoglou and Tsagarakis (2013) stated that recycling programme success depends on the availability of recycling opportunities to the public. Around 11.5% of the camp owners were unwilling to practice MSW recycling for several reasons including the lack of awareness among the public (88.9%), space and time limitations (44.4%) and the absence of a proper MSWM system (33.3%). Other reasons were stated by the camp owners

that prevent them from participating in recycling such as the absence of incentives (rewards and penalties), and shortage of staff at camps (Figure 5.35-B). While, the majority of unwilling hoteliers stated that the reasons behind their choice are the lack of awareness (77.1%), the weakness of the MSWM system and the shortage of time and space (68.8%). In this sense, scholars observed adverse impacts on public involvement in a recycling programme when the recycling infrastructure was not available within a reasonable distance from their locations (Grodzińska-Jurczak, 2003; Babaei et al, 2015). This observation was clearly the most important imperative barrier for the managers' involvement willingness. As the managers showed a high tendency to take part in recycling during REs (about 78%), the introduction of source separation during REs through supplying recycling containers and educational campaigns would be more likely road to promote recycling programmes than other interventions.

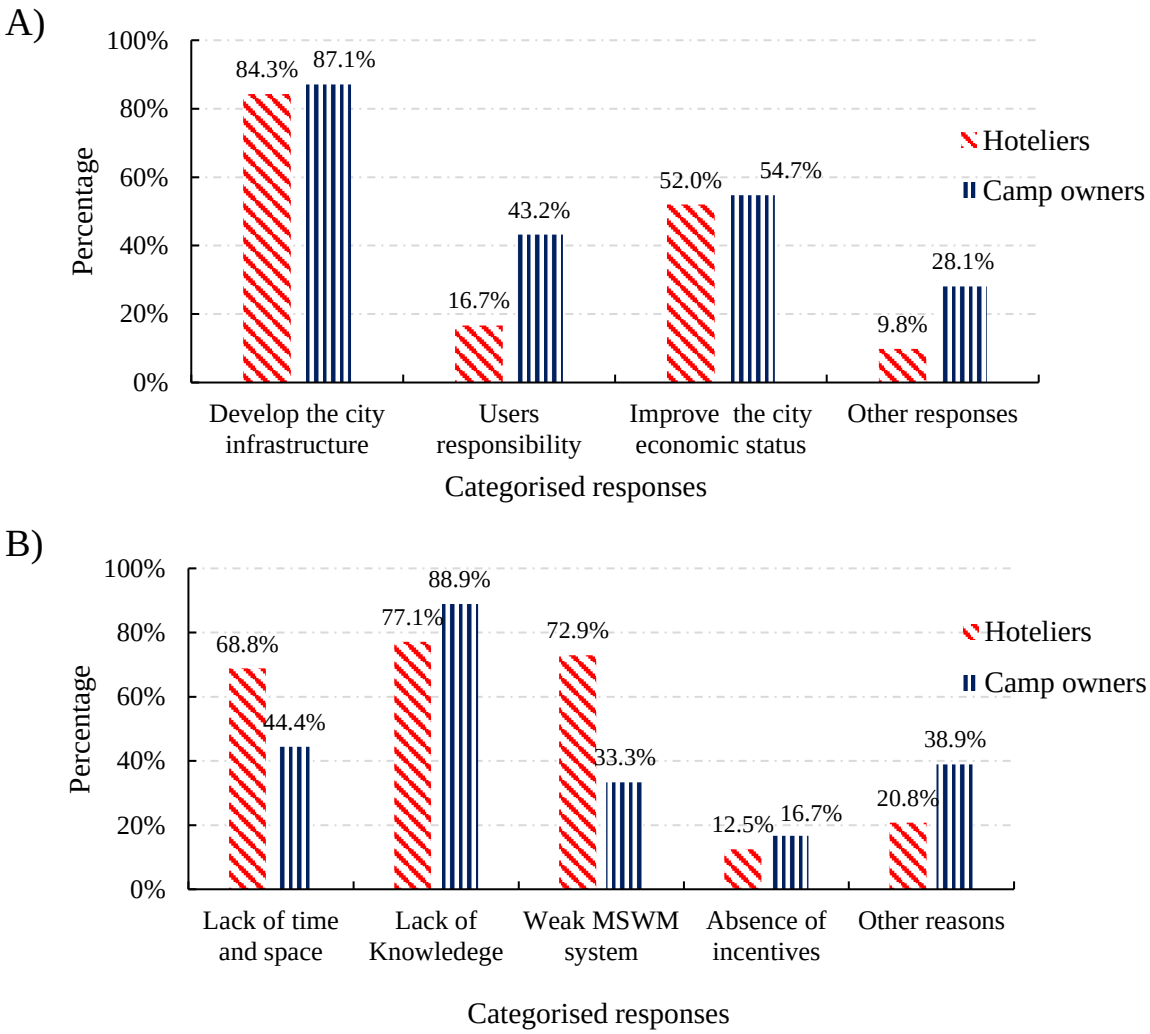

Figure 5.35: Reasons behind managers' willingness to sort MSW at source: A) willing managers 88.5% of camp owners and 68% of hoteliers, B) unwilling managers 11.5% of camp owners and 32% of hoteliers

5.4.1.2 Options to Encourage MSW Source Separation among Participants

With the aim of increasing the efficiency of a recycling scheme through REs, it is essential to enhance the cooperation between the public (hoteliers and camp owners) and MSWM authorities (KM, KMS and HSA). Ascertaining the public preference for practising MSW source separation is vital. Therefore, questions (19, 20 and 21) were designed to obtain the actions that might encourage the managers to sort their waste while the Arba'een is ongoing. Figure 5.36 shows results from questions designed to identify managers' preferences on using private bins to sort at source or public bins. It can be deduced from Figure 5.36 that the majority of managers (about 72%) prefer to use private bins in order to sort waste at source while about 27% were in favour of using public bins. Accordingly, supplying containers to each hotel and camp is more likely to enhance participation rate in MSW recycling.

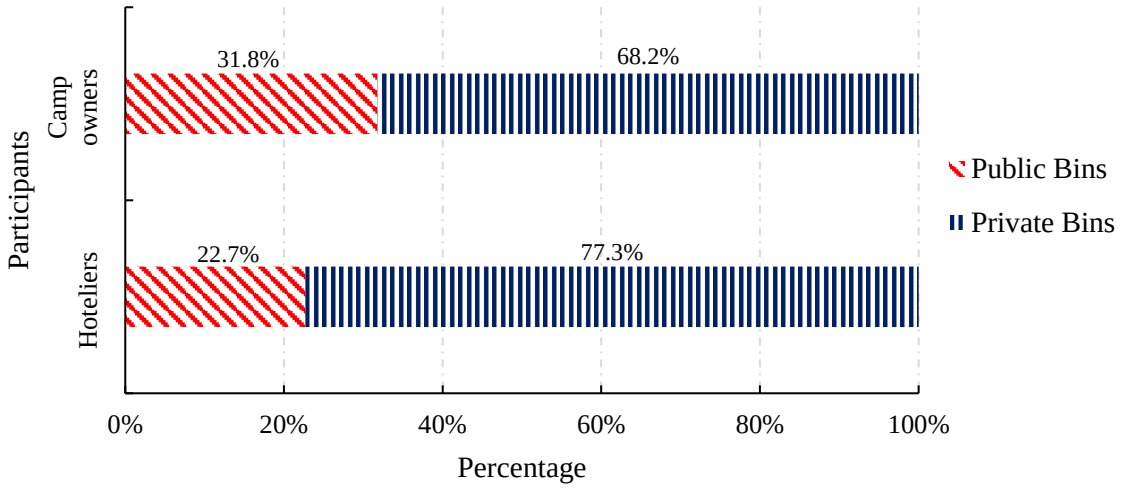

Figure 5.36: Managers' preference to use private bins or public bins in MSW source

Also, the managers were asked to state whether they prefer to separate MSW into six categories (Plastic, Paper, Glass, Metal, Organic and Other materials) or three categories (Recyclable, Organic and Other materials). According to Figure 5.37, around 80% of 241 willing managers expressed that MSW separation into three distinct parts is more convenient than its separation into six parts due to time and space limitation. Accordingly, implementing MSW source separation into three distinct parts is more likely to have more acceptance than separation into six distinct parts.

In addition, a question was included in the questionnaires to ask the managers to select an action that MSWM authorities could do to enhance their participation in recycling. Figure 5.38 shows that the majority of managers (about 77%) selected the provision of recycling bins to start recycling. The remaining 23% of the managers were equally divided among

law enforcement (about 7.5%), financial incentives (about 7.5%) and staff training (about 6.5%) options to increase their participation in recycling. The results here confirm that the main obstacle facing recycling during the Arba'een is the absence of proper infrastructure.

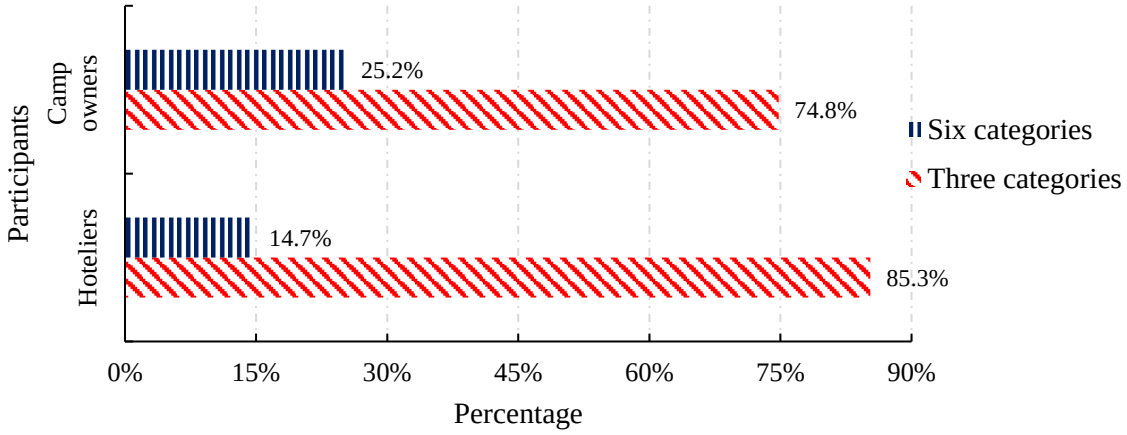

Figure 5.37: Managers' preference to separate their MSW into categories

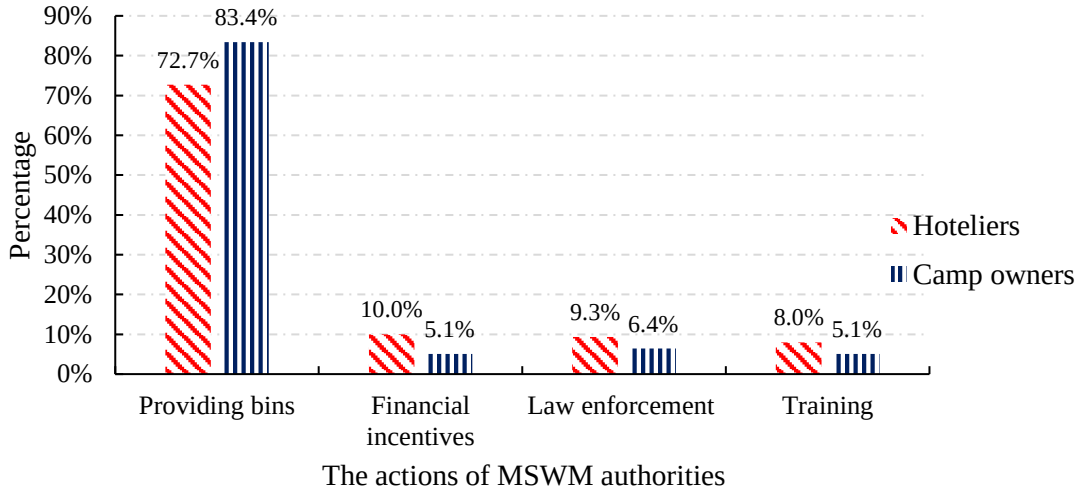

Figure 5.38: Managers' responses to the actions that MSWM authorities could do to encourage MSW source separation during REs

On top of this, a further question (question 22) was included in the questionnaires asking the managers to suggest actions that could enhance the pilgrims' participation in source separation during REs. Managers' responses were categorised into several actions and presented in Figure 5.39. The majority suggests that providing public bins in the major roads at the centre of the event and increasing publicity and awareness among pilgrims (72.1% and 65.7% respectively) might enhance pilgrims' motivation to take part in recycling. The imposition of fines and rewards has been proposed by 17.5% of the managers to increase pilgrims' participation in the separation of MSW during REs.

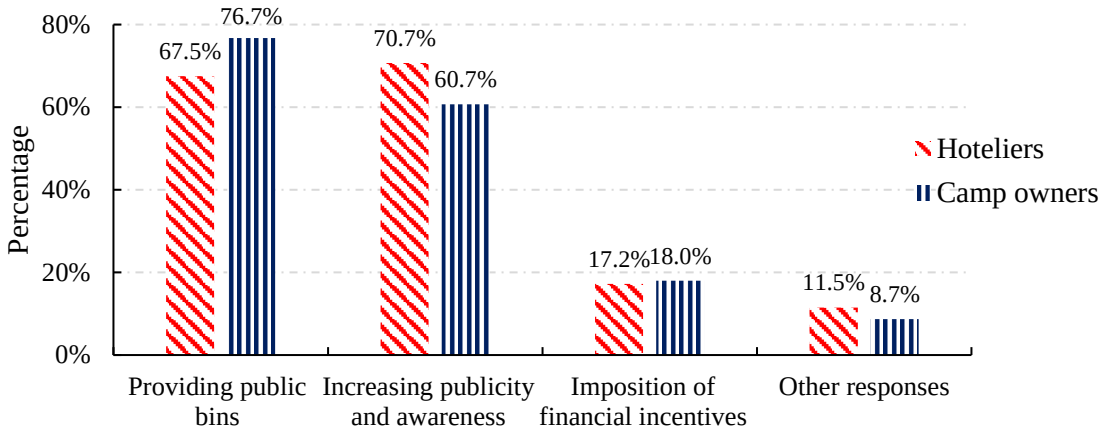

Figure 5.39: Managers' suggestions to increase pilgrims' participation in MSW recycling during REs

From the above, it can be deduced that the absence of proper infrastructure is one of the main barriers to implementing recycling during the Arba'een. The results showed that there is a high tendency among managers to take part in recycling. Besides, as there was a significant preference among managers to establish a private container system for MSW source separation and recycling during events, the successful implementation of this system requires giving proper MSWM services, promotion of public awareness, and modification of public attitude and behaviour.

5.4.2 Factors Affecting RI among Managers

Following the above, the question is whether the managers' RI is affected by their demographic e.g. level of knowledge or even their accommodation's characteristics. The literature states that socio-economic and demographic factors are highly cited as the factors affecting public participation in MSW recycling (Babaei et al, 2015; Grazhdani, 2016; Miliute-Plepiene et al, 2016; Sheau-Ting et al, 2016). Yet, the effects of those may vary according to the location and conditions. Thus, logistic regression (LR) models were developed to investigate the aspects that might influence managers' RI during events. Two models were developed using IBM SPSS-23 over two stages, stage 1 being to check assumptions of the LR technique and data treatment, stage 2 to evaluate the developed model performance and the contribution of the IVs. The hotelier's recycling intention (HRI) model aims to identify the aspects affecting a hotelier's willingness to participate in MSW recycling while the camper's recycling intention (CRI) model aims to identify the aspects affecting a camper's willingness.

5.4.2.1 Testing the Assumption of the LR and Data Treatment

- *Types of Variables*

The design assumption of binary LR states that the DV should be one dichotomous (a nominal variable with two outcomes) and the IVs should be one or more measured at continuous or nominal scale (Laerd Statistics, 2015). In the HRI model, hotelier's education level (HEL), age group (HAG), Recycling knowledge (HRK), and satisfaction level (HSL) as well as the characteristics of the hotels namely HC, HFA, HL, HR, HWCF and MSWG were employed as predictive IVs to predict HRI (the DV). The CRI model employed camper's age group (CAG), education level (CEL), recycling knowledge (CRK), satisfaction level (CSL) as well as camp's characteristics namely CC, CFA, CL, CWCF and MSWG (Section 5.3.1.1 and 3.8.2) as explanatory IVs to investigate CRI as a response variable (the DV). All the IVs were nominal or scale variables while the DVs were nominal. Therefore, the design assumption of LR has been met.

- *The ratio of Cases to IVs*

Equation (3.16) was used to calculate the minimum number of cases required to develop generalizable prediction models. For HRI model, ten IVs were used to build the prediction model meaning that 150 observations were the minimum required a number of cases. On the other hand, the CRI model was developed using nine IVs and 135 cases were required to build a generalizable model. The second assumption has therefore been met since 150 field observations were made for hotels and 157 observations made for camps, more than the necessary dataset size for LR modelling.

- *Linearity in LR*

To test the linearity assumption in LR, the Box-Tidwell approach (Hosmer and Lemeshow, 2000) is used. The interactions between each continuous IV and its natural logarithm are added to the LR models. Table 5.11 shows the results of direct LR to test the linearity assumption between the continuous IVs and the logit transformation of DV for each model. All the terms developed have no significant contribution to the developed models. Accordingly, the assumption of linearity for LR is met.

Table 5.11: Direct LR to test the linearity assumption

Model	Term	Wald Chi-Square	*p*
HRI	Ln(HC)*HC	1.621	0.203
	Ln(HFA)*HFA	1.775	0.183
	Ln(HL)*HL	0.263	0.608
	Ln(HWCF)*HWCF	0.107	0.743
	Ln(MSWG)*MSWG	1.957	0.162
CRI	Ln(CC)*CC	0.019	0.891
	Ln(CFA)*CFA	0.067	0.796
	Ln(CL)*CL	0.003	0.995
	Ln(CWCF)*CWCF	0.724	0.395
	Ln(MSWG)* MSWG	0.006	0.939

- *Multicollinearity*

Multicollinearity among IVs has been examined by calculating VIF values for IVs in each model (Equation (3.7)). Table 5.12 confirms the absence of multicollinearity as the highest calculated VIFs for hotels' variables and camps' variables were 8.447 and 6.818, respectively, which are considerably less than the critical value of 10. Accordingly, the IVs used to build the prediction models for HRI and CRI meet the assumption of multicollinearity.

Table 5.12: Summary of multicollinearity statistics for managers' intention models

Model	IVs		VIF	Tolerance
HRI	HEL	Secondary Education	8.008	0.125
		Higher Education	8.447	0.118
	HAG	26-35	4.939	0.202
		36-45	5.001	0.200
		>45	2.560	0.391
	HRK	Moderate knowledge	1.667	0.600
		Good knowledge	1.684	0.594
	HR	One star	3.319	0.301
		Two stars	4.696	0.213
		Three stars	4.346	0.230
		Four stars	1.930	0.518
	HSL	Neutral	1.236	0.809
		Satisfied	1.170	0.855
	HC		3.556	0.281
	HFA		2.310	0.433
	HL		1.155	0.866
	HWCF		1.181	0.847
	MSWG		2.671	0.374
CRI	CEL	Secondary Education	1.540	0.649
		Higher Education	2.281	0.438
	CAG	26-35	3.089	0.324
		36-45	6.246	0.160
		>45	6.818	0.147
	CRK	Moderate knowledge	1.703	0.587
		Good knowledge	2.585	0.387
	CSL	Neutral	1.791	0.558
		Satisfied	1.797	0.556
	CC		1.231	0.812
	CFA		1.306	0.766
	CL		1.241	0.806
	CWCF		1.066	0.938
	MSWG		1.130	0.885

- *Outliers*

A case with a standardised residual value of more than 2.5 should be carefully examined and excluded from the analysis if this is believed necessary (Pallant, 2011; Laerd Statistics, 2015). During the initial run, two cases were identified as outliers in the HRI model while five cases were found to be outliers in the CRI model (Table 5.13). These were inspected in

further detail to determine why these cases are outliers and to remove them from the analysis if this is deemed necessary. However, they were kept in the models because these cases were not phenomenal. Like several other cases, the respondent refused to participate in a future recycling plan despite the fact that they have similarities with other respondents that are willing to practice recycling such as education level, age and environmental awareness.

Table 5.13: Outlier cases with standardised residual greater than 2.5

Model	Observed RI	Predicted RI	Standardised residual
HRI	No	Yes	-3.286
	No	Yes	-3.774
CRI	No	Yes	-4.528
	No	Yes	-2.951
	No	Yes	-7.662
	No	Yes	-4.515
	No	Yes	-4.687

5.4.2.2 Evaluating the IVs Contribution and Models Performance.

- *The Contribution of IVs*

The statistical significance of the included factors defines whether they apply tangible or negligible influences on the results of the proposed LR models to forecast the probability of managers' willingness to practise waste source separation during REs. Features that have a *p*-value of less than 0.05 can be considered as significant contributors to the developed models. Table 5.14 shows the results of the Likelihood ratio test. For HRI, the results illustrate that the relationship between HL and RI during REs is positive and significant. However, the statistical significance of the remaining factors (HEL, HAG, HRK, HR, HSL, HC, HFA, HWCF and MSWG) were more than 0.05 indicating that those IVs do not contribute to the variation of the hoteliers' RI or cannot explain the variation in RI. Thus, all the insignificant factors (HEL, HAG, HRK, HR, HSL, HC, HFA, HWCF and MSWG) were excluded from the HRI model. Similarly, all the factors included in the CRI model have an insignificant contribution to the RI of the camps' managers except CAG ($p = 0.000$). Accordingly, all the insignificant factors (CEL, CRK, CSL, CC, CL, CFA, CWCF and MSWG) were excluded from the CRI model.

Table 5.14: Likelihood ratio test for HRI and CRI models

Model	IVs	-2 Log Likelihood of Reduced Model	*p*
HRI	Intercept	153.404	.
	HEL	158.236	0.089
	HAG	157.710	0.230
	HRK	157.524	0.127
	HR	158.553	0.272
	HSL	155.344	0.379
	HC	154.589	0.279
	HFA	154.081	0.411
	HL	163.183	0.002
	HWCF	155.371	0.161
	MSWG	154.831	0.232
CRI	Intercept	69.468	.
	CEL	70.438	0.616
	CAG	97.220	0.000
	CRK	74.838	0.068
	CSL	71.174	0.426
	CC	69.472	0.951
	CFA	69.825	0.550
	CL	71.058	0.207
	CWCF	69.496	0.866
	MSWG	71.341	0.171

Table 5.15 shows RI models' parameters for hoteliers and camp owners. The B coefficients (B column in Table 5.15) are used in Equations ((3.10) and (3.2)) to determine the effect of an IV on the probability of an event occurring (willingness to participate in MSW recycling). The Wald test is used to determine the statistical significance of the contribution of each IV to the developed model. For the HRI model, The Wald test suggests that there is a significant increase (p = 0.026) in HRI when the distance between the location of the hotel and the centre of the event increases. This indicates that the managers of the hotels that are located at the outer edge of the event are more likely to participate in recycling than managers of the hotels that are closer to the centre of the event. For CRI, the B coefficients for CAG show that the older participants (>45 years) had more intention to recycle than the other groups. However, there are insignificant differences between the groups aged from 26 to 35 years and the group aged from 18 to 25 (Table 5.15), indicating that older managers are more likely to practice recycling than younger managers.

Table 5.15: LR models predicting the likelihood of RI among hoteliers and camp owners

Model	IVs			B	Wald	*p*
HRI	Intercept			-0.023	0.004	0.952
	HL			0.002	4.928	0.026
CRI	Intercept			-0.288	0.142	0.706
	CAG	(CAG0)	18-25	-	-	-
		(CAG1)	26-35	0.288	0.099	0.753
		(CAG2)	36-45	2.890	9.807	0.002
		(CAG3)	>45	3.899	13.857	0.000

- *Assessing Developed Models*

After confirming that the assumptions for LR have been satisfied, stepwise LR models were developed to forecast the intention of hoteliers and camp owners to practise MSW source separation during events. Based on Table 5.15, Equations (3.10) and (3.2), Equation (5.6) represents the probability of hoteliers to participate in MSW recycling during REs while Equation (5.7) represents the probability of camp owners' participation. A cut-off value of 0.5 was used to distinguish the participants' intention regarding participating in MSW source separation during REs, where a value of ≤0.5 indicates that the respondent has no intention to recycle while a value of >0.5 indicates a positive intention.

$$HRI = \frac{e^{-0.023+0.002HL}}{1+e^{-0.023-0.002HL}} \tag{5.6}$$

$$CRI = \frac{e^{-0.288+0.288CAG1+2.890CAG2+3.899CAG3}}{1+e^{-0.288+0.288CAG1+2.890CAG2+3.899CAG3}} \tag{5.7}$$

It is essential to check the ability of these models to explain changes in hoteliers' and camp owners' intention to practice MSW source separation during REs. The Hosmer and Lemeshow goodness of fit test and the log-likelihood test provide an overall indication of the performance of the proposed models (Pallant, 2011). For the log-likelihood Test, a *p*-value of less 0.05 indicates that the developed model with all IVs included is better at predicting the DV compared to the model with no IV included (in this model, SPSS assumed that every hotelier and camper would participate in MSW recycling). From Table 5.16, the significance of Chi-square for the log-likelihood test of HRI model is significant ($p = 0.022$), indicating that proposed model (HRI with HL used as predictors) was better than the SPSS proposed model with no IVs included. In the case of CRI, the value of log-likelihood test significance is less than 0.05, indicating that the CRI model with CAG included as an IV was better than the SPSS proposed model.

For the Hosmer-Lemeshow Goodness of Fit test, a poor fit model is indicated by a significance value of less than 0.05 (Tabachnick and Fidell, 2013). For both models (HRI and CRI), the chi-square value for the Hosmer-Lemeshow Test are 7.134 and 0.000 with a significance level of 0.522 and 1.000 for HRI and CRI models, respectively. The statistical significance values are larger than 0.05 supporting that the developed models are better than the SPSS models in predicting the managers' intention of practising MSW source separation during REs.

Table 5.16: HRI and CRI Models fit tests

Test		HRI	CRI
log-likelihood Test	Chi-square	5.209	32.475
	p	0.022	0.000
Hosmer and Lemeshow Test	Chi-square	7.134	0.000
	p	0.522	1.000

Additionally, the Cox & Snell and Nagelkerke pseudo p^2 provide information on the usefulness of the developed models (HRI and CRI). Pseudo p^2 values offer an indication of the amount of variation in the DV explained by the model (from 0 to approximately 1) (Pallant, 2011; Tabachnick and Fidell, 2013). From Table 5.17, it can be deduced that the explained variation in hoteliers' intention to separate the MSW based on the HRI model ranges from 3.4% to 4.8%, depending on whether Cox & Snell p^2 or Nagelkerke p^2 methods are used, respectively. While, the two values are 0.187 and .367, suggesting that between 18.7% and 36.7% of the variability in camp owners' RI is explained by the age of the managers used in the CRI model. Pseudo p^2 values obtained in the current study are comparable to those obtained by other researchers such as Alsebaei (2014).

Table 5.17: Summary of developed LR models

Test	HRI	CRI
Cox & Snell pseudo p^2	0.034	0.187
Nagelkerke pseudo p^2	0.048	0.367

5.4.2.3 Discussion

The results of the questionnaire survey and the statistical analysis demonstrated that the demographics of the accommodation managers and the characteristics of the accommodation establishments have a weak influence on their RI. This is consistent with other studies exploring the relationship between RI and citizens' demographic, where it was found education level (Nixon and Saphores, 2009), age (Schultz et al, 1995) and gender

(Clery and Rhead, 2013) display insignificant effects on the recycling willingness. However, many other researchers reported a significant relationship between participants' demographics and RI and behaviour (Pirani and Arafat, 2014; Grazhdani, 2016; Oztekin et al, 2017; Pham Phu et al, 2018).

Miafodzyeva and Brandt (2012) summarised the findings of studies between 1990 and 2010 on the subject of household recycling behaviour and reported that the relation between sorting behaviour and socio-demographic is poor whereas environmental concern plays an important role in households' decision to sort MSW. The questionnaire survey showed that a high fraction of the hoteliers (68%) and the camp owners (88.5%) were willing to sort MSW during the Arba'een in spite of the majority of them having poor knowledge about MSW recycling (section 5.2.3). This high willingness might be due to the impact of other unrecorded factors such as the spiritual value of the event itself. The managers attributed their positive intention to participate in recycling during REs to enhance the infrastructure of the city as it improves the attractiveness of Kerbala because it is a religious destination. Accordingly, the event's impact on the managers' RI to participate in MSWM development scheme might reduce the impact of their personal characteristics. This is consistent with Alsebaei (2014) and Miafodzyeva et al (2013) statement that the surrounding environment can influence individuals' intention to participate in MSW recycling.

This helped to establish a baseline regarding managers' willingness to practise MSW recycling during REs, a subject that has never been investigated in the city of Kerbala, particularly during major REs. The positive intention among managers indicates that the introduction of a source separation and recycling scheme during REs could be successful. Besides, further investigation is required to study whether the managers' intention is changing during non-event days. This can provide an indication of the impact of the event itself on the managers' intention. Besides, a detailed investigation is required to identify whether there are other aspects that might influence the recycling intention of the accommodation managers such as the attributes of their guests.

5.5 Pilgrims' Intention to Recycle

With the aim of investigating the possibility of introducing a recycling scheme during REs, cooperation between MSW generators (pilgrims) and collection authorities is essential. Ascertaining pilgrims' preferences for MSW recycling is therefore important. Accordingly, several questions were included in the pilgrims' questionnaire to explore the pilgrims' activities and their intention to recycle during REs. Besides, multinomial LR analysis was

conducted to define the activities and the demographics of the pilgrims that have a significant influence on their optional and compulsory recycling intention during REs.

5.5.1 Pilgrims' Activities and RI

5.5.1.1 Pilgrims' Activities

Questions were designed to provide a descriptive picture of the pilgrims' activities while they are in Kerbala (Questions 4 - 9 in Appendix D), as it might affect their RI during the Arba'een. This includes identifying the number of days the pilgrim stays in Kerbala; determining the number of food servings that each pilgrim consumes during each day; the number of waste bottles consumed by each pilgrim and where the pilgrims normally dispose of their MSW.

The first question (question 4) was designed to identify the number of days the pilgrims spent to complete the rituals of the event. The Arba'een lasts up to 15 days (Abdulredha et al, 2018), but it is not necessary for pilgrims to remain in the city throughout it. Unlike other events, pilgrims have the choice to remain or leave Kerbala after they finish the rituals of the Arba'een. Figure 5.40 presents the results on the duration that pilgrims spent in the city during the Arba'een. The majority of the pilgrims (53.8%) stay for four days or more to complete the rituals of the event. About 20% (126 pilgrims) stay for three days. 107 pilgrims (16.6 %) selected two days as the period of their stay while 10% (65 pilgrims) stay for only one day in Kerbala. Besides, the descriptive statistics revealed that four days (or more) is the mode and median in the case of the pilgrims' staying duration.

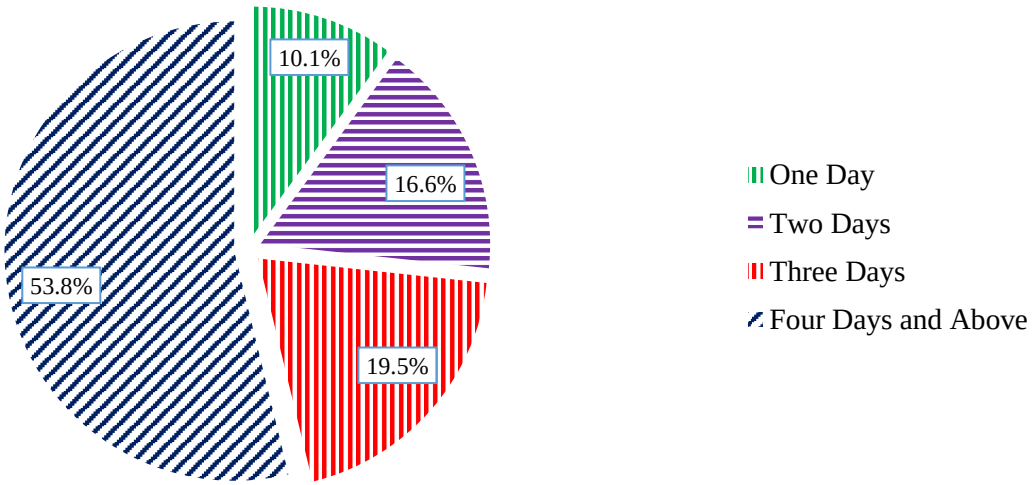

Figure 5.40: Pilgrims' staying duration in Kerbala during the Arba'een

Question five focuses on the habit of eating as a possible factor that could affect the RI of the pilgrims. There were four possible answers for this question: always, sometimes, rarely

and never eat in Kerbala's camps. Figure 5.41 presents the frequency of the answers to this question. All the participants stated that they eat in Kerbala's camps with various intensity and no one selected 'never eat at the camps'. The vast majority (86.4%) stated they always do eat in camps and 11.8% stated they sometimes eat while only 1.9 % (12 of 645 pilgrims) rarely do. It can be concluded that all the pilgrims had the habit of eating at camps during the Arba'een, which confirms the assumption that the camps are main MSW producers during REs, particularly organic waste.

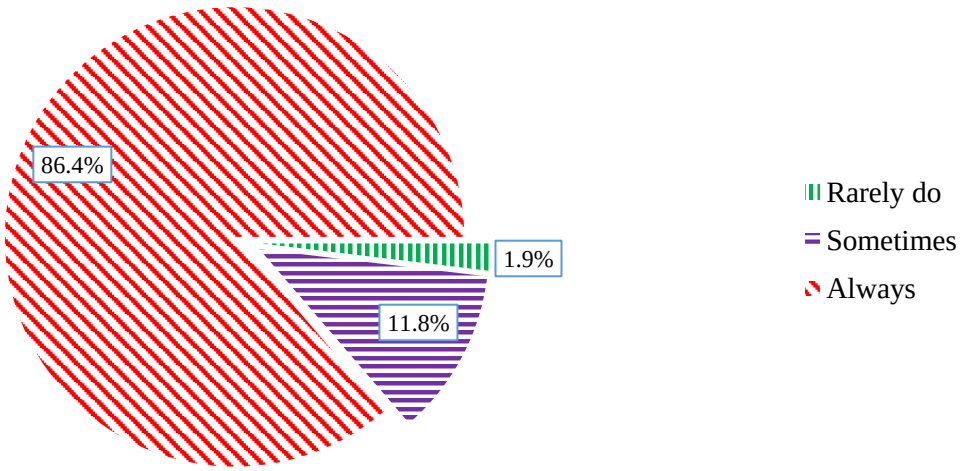

Figure 5.41: Pilgrims' response to the question (Do you eat in Kerbala camps?)

Additionally, questions were designed to determine the number of times that the pilgrims are eating in the camps each day. Figure 5.42 - 5.44 present results from those questions (6-8) of the pilgrims' questionnaire. From Figure 5.42, it can be seen that the pilgrims prefer bottled water over tap water. Only 2.8% consume tap water compared to 64% using bottled water for drinking purposes while 33.2% of the pilgrims have no preferred choice. From Figure 5.43, the mode of water consumption among pilgrims per day is more than six times per day. From this, it can be deduced that the vast majority generate large quantities of plastic waste as a consequence of water consumption. This confirms the claims of the accommodation managers that the plastic waste constitutes a major component of the MSW produced at Kerbala during REs.

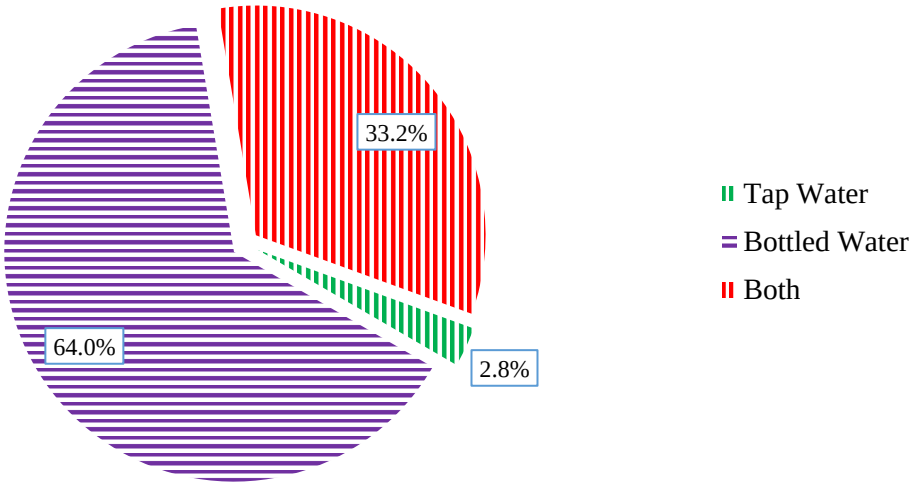

Figure 5.42: Pilgrims' preference in the consumption of tap water or bottled water

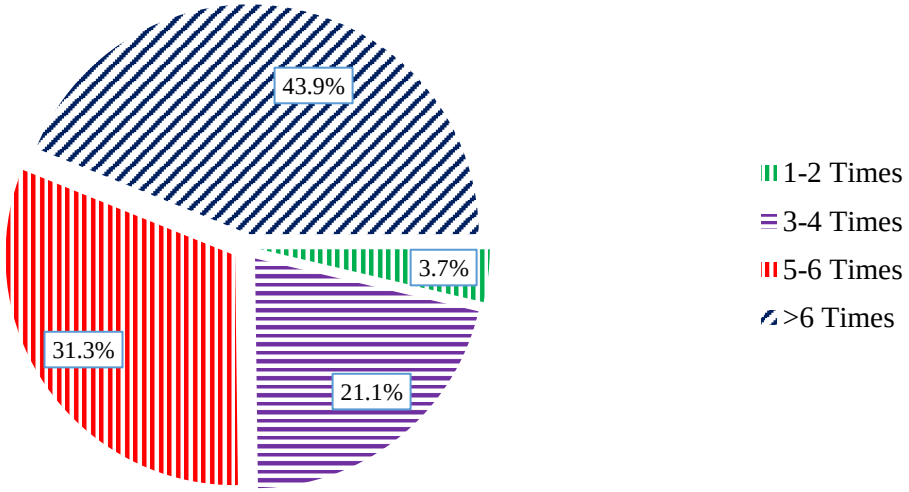

Figure 5.43: Frequency of water consumption over one day by pilgrims

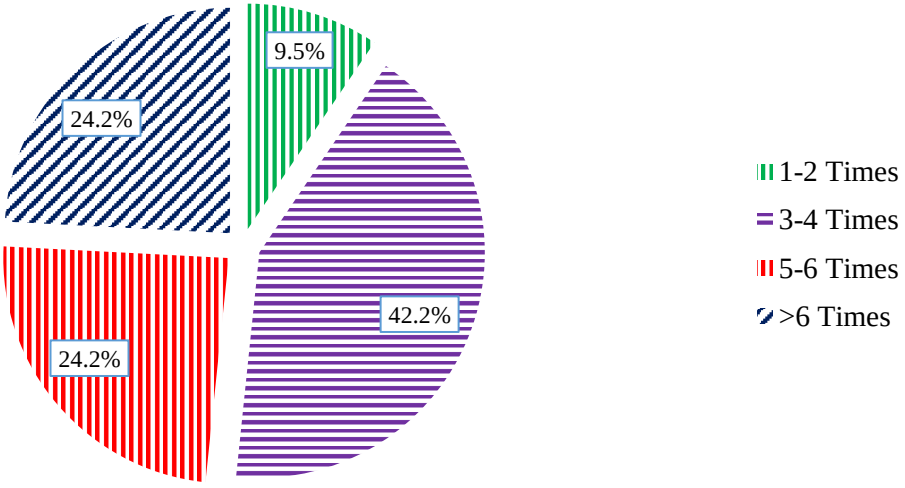

Figure 5.44: Frequency of food consumption by each pilgrim per day

Figure 5.44 presents the food consumption among pilgrims at camps during REs. The mode (42.2 % of the pilgrims) of food consumption was 3 to 4 meals per day. However, there are a considerable fraction of the pilgrims (48.4% of pilgrims) who consume more than five

meals per day due to the availability of free food at the event. Besides, about 10% of the pilgrims stated they eat at the camps once or twice a day.

Question (9) was designed to identify the relationship between the pilgrims' waste disposal behaviour and their willingness to participate in recycling. Figure 5.45 shows the answers to this question as percentages. The vast majority (72.7%) stated that they dispose of their waste at bins (communal or camps) while 27.3% disposed of their MSW anywhere. This behaviour could provide an indication of the future behaviour of the pilgrims regarding MSW recycling activities.

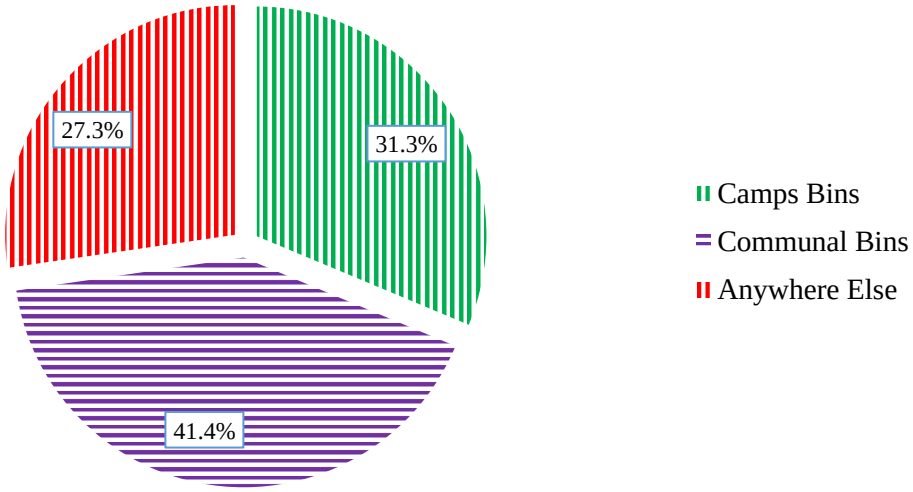

Figure 5.45: Pilgrims' MSW disposal behaviour

5.5.1.2 Pilgrims' Willingness to Recycle

Two questions (12 and 13) measured the fraction of the pilgrims' intending to participate in MSW source separation during events with the options of 'Yes', 'No' or 'maybe' in the case of optional source separation or compulsory source separation (forced by law without defining any penalties). Figure 5.46 shows the frequencies of the answers for the optional and compulsory options. The mode of both recycling intentions for pilgrims is positive (about 76.5% of the pilgrims were willing to participate in recycling). The pilgrims' RI if the practice is compulsory seems to be slightly higher than the optional practice. The pilgrims tended to select 'Maybe' more when the practice is optional than compulsory. Based on the pilgrims' responses, 72% of the pilgrims' would participate in MSW source separation during REs if the scheme or the practice were optional and about 80% would do if it were compulsory.

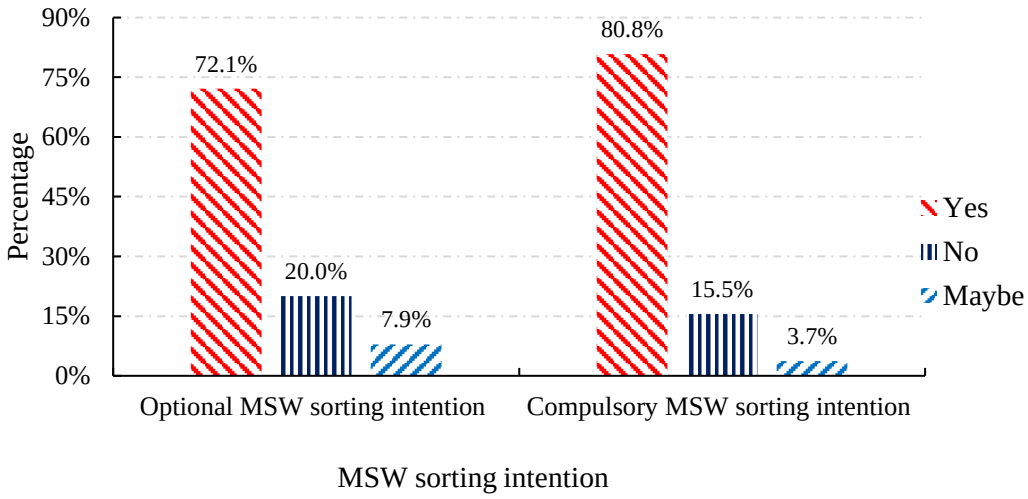

Figure 5.46: Pilgrims' intention to participate in MSW source separation if the recycling scheme is optional or compulsory

The results revealed that the vast majority of the pilgrims were willing to be involved in MSW recycling. The pilgrims' intention towards participation in MSW recycling scheme during REs is similar to the intention of the accommodation managers implying that the implementation of such a system in Kerbala during REs might be successful. The Arba'een pilgrims are more willing to participate in MSW recycling than the pilgrims of the Hajj. If Optional, about 72% of the pilgrims during the Arba'een are willing to sort the MSW compared to 44% of the participants during the Hajj. If compulsory, more than 80% of the pilgrims stated a positive intention towards participation in an MSW recycling scheme during the Arba'een compared to 60% of the pilgrims during the Hajj. It is important to understand the pilgrims' variables that affected their recycling intention during the Arba'een in order to introduce a successful recycling scheme.

5.5.2 The Factors Affecting RI among Pilgrims

As stated in section 3.8.2, LR models can be used to investigate the aspects that might influence pilgrims' RI during REs. Two models were developed using SPSS over two stages, stage 1 being to check assumptions of the LR technique and data treatment, stage 2 to evaluate the developed model performance and the contribution of the explanatory IVs. Optional pilgrims' recycling intention (OPRI) model was developed to identify the factors that might influence the optional RI among pilgrims. The compulsory pilgrims' recycling intention (CPRI) model was built to identify the aspects influencing the compulsory RI.

5.5.2.1 Testing the Assumption and Data Treatment

- *Types of IVs and DVs*

The design assumption of multinomial LR states that the DV should be one multinomial variable (a nominal variable with more than two outcomes) and the IVs should be one or more measured at continuous or nominal scale (Laerd Statistics, 2015). The DV for the OPRI model was the optional RI whereas the DV for the CPRI model was the compulsory RI. The IVs for both models were the other items in the questionnaire including pilgrim's education level (PEL), age group (PAG), gender (PG) and recycling knowledge (PRK). Besides, other pilgrims' activities such as staying duration (PSD) in Kerbala, eating habits (PEH), average number of meals consumed each day (NMPP), drinking habits (PDH), number of water bottles consumed per day (NWBPP), waste disposal behaviour (PWDB) and satisfaction level about the current MSWM activities (PSL). All the IVs were nominal or categorical variables while the DVs were nominal with three outcomes. Therefore, the design assumption of multinomial LR has been satisfied.

- *The ratio of Cases to IVs*

Equation (3.16) was used to calculate the minimum number of cases required to develop generalizable prediction models. For all models, eleven IVs were used to build the prediction model meaning that 165 observations were the minimum required a number of cases. The second assumption has therefore been met since 645 field observations made for pilgrims which are significantly more than the necessary dataset size for multinomial LR modelling.

- *Linearity in LR*

The interaction between each scale IV and the logit transformation of the DV significantly influenced the outcome of the LR models (Field, 2009; Pallant, 2011; Tabachnick and Fidell, 2013). As all included IVs were multinomial and categorical variables; this test is not required and the assumption of linearity for LR is met.

- *Multicollinearity*

Multicollinearity among IVs has been examined by calculating VIF values for IVs in each model (Equation (3.7)). Table 5.18 shows the multicollinearity diagnostic of all included variables. The VIF test for PEH, PDH and NWBPP variables shows a slight indication of a multicollinearity problem as the VIFs' values for some categories in those variables were more than seven. Therefore, those three IVs were excluded from the analysis as it might

influence the outcome of the developed models. The remaining IVs used to build the prediction models for OPRI and CPRI, meet the assumption of multicollinearity, as VIFs' values for the remaining factors were significantly lower than the critical value of 10.

Table 5.18: Summary of multicollinearity statistics for pilgrims' intention models

Model	IVs		Tolerance	VIF
OPRI and CPRI	PEL	Primary	0.594	1.683
		Secondary	0.329	3.037
		Collage and above	0.302	3.306
	PAG	31-45 years	0.610	1.640
		46-60 years	0.560	1.785
		>60 years	0.641	1.560
	PG	Male	0.865	1.156
	PSD	Two days	0.427	2.344
		Three Days	0.393	2.541
		More than three days	0.319	3.138
	PEH	Sometimes	0.145	6.908
		Always	0.137	7.300
	NMPP	3-4 per day	0.280	3.576
		5-6 per day	0.314	3.183
		More than 6 per day	0.281	3.561
	PDH	Bottled water	0.110	9.061
		Bottled and tap water	0.109	9.167
	NWBPP	3-4 per day	0.164	6.103
		5-6 per day	0.129	7.739
		More than 6 per day	0.115	8.703
	PWDB	Communal bins	0.592	1.689
		Anywhere else	0.592	1.690
	PRK	Moderate	0.750	1.333
		Good	0.613	1.633
		Very good	0.815	1.227
	PSL	Satisfied	0.730	1.369
		Unsatisfied	0.784	1.276
		Very unsatisfied	0.852	1.173

- *Outliers*

Case with a standard residual value of more than 2.5 should be carefully examined and excluded from the analysis if this is believed necessary (Pallant, 2011; Laerd Statistics, 2015). During the initial run for both models, three cases were identified as outliers in OPRI (Table 5.19) while eight cases were identified as outliers in CPRI. Those cases were inspected in further detail to determine why they were outliers and to remove them from the analysis if this is deemed necessary. Besides, the overall performance of all the models was inspected after omitting the outlier. The inspection shows that the increase in accuracy of

the developed models was less than 2%, indicating that those cases do not significantly influence the performance of the developed models. Thus, they were considered as not outliers and the multinomial LR models with all cases will be interpreted.

Table 5.19: Outlier cases with standardized residual greater than 2.5 for OPRI and CPRI models

Model	Observed RI	Predicted RI	Standard residual
OPRI	No	Yes	2.568
	Maybe	Yes	2.824
	Maybe	Yes	2.669
CPRI	No	Yes	2.602
	Maybe	Yes	2.762
	Maybe	Yes	2.746
	Maybe	Yes	2.722
	Maybe	Yes	2.719
	Maybe	Yes	2.599
	Maybe	Yes	2.596
	Maybe	Yes	2.593

5.5.2.2 Evaluating the Models Performance and IVs Contribution.

- *OPRI Model Results*

After confirming that the assumptions for LR have been satisfied, stepwise multinomial LR models were developed to ascertain the effects of several aspects on the likelihood of pilgrims' participation in MSW recycling during REs. Table 5.20 shows the Pseudo p^2 values of the multinomial LR and models' fit tests for the optional pilgrims' sorting model (OPRI).

Table 5.20: OPRI Model fit tests and summary of developed econometric model

Test	Values	*p*
Cox & Snell pseudo p^2	0.148	-
Nagelkerke pseudo p^2	0.190	-
McFadden p^2	0.106	-
log-likelihood Test	103.386	0.000
Pearson Goodness of fit Test	1110.262	0.283

To check the ability of this model to explain changes in pilgrims' intention, Pearson goodness of fit test and the log-likelihood test provide an overall indication of the performance of the proposed models (Pallant, 2011). From Table 5.20, the significance of Chi-square for log-likelihood tests of the OPRI model is significant (p = 0.000), indicating that the proposed model was better than the SPSS proposed models with no IVs included.

Pearson goodness of fit test is 1110.262 (p = 0.283), supporting that the developed model is better than the SPSS models in predicting the managers' intention of practising MSW source separation during large events. Besides, it can be seen that pseudo p^2 value varies between 0.106 to 0.190, suggesting that 11% to 19% of the variation, in the optional intention of the pilgrims to separate the MSW, is explained based on the developed model using several factors.

Table 5.21 shows the results of the Likelihood ratio test to identify whether included factors apply tangible or negligible influences on the intention of the pilgrims (Field, 2009; Pallant, 2011; Tabachnick and Fidell, 2013). Aspects with a p-value of >0.05 are significant contributors to the intention of the optional pilgrims' recycling. The results obtained in Table 5.9 illustrate that PEL, PAG, PWDB and PRK have a significant influence on pilgrims' intention to optimally practise recycling during the event with significant values of 0.011, 0.001, 0.005 and 0.000, respectively. However, the significance of the remaining factors (PG, PSD, NMPP and PSL) were more than 0.05. This indicates that those aspects have insignificant influence on OPRI. Accordingly, the significant aspects that are PEL, PAG, PWDB and PRK were included in the OPRI model.

Table 5.21: Likelihood ratio test for OPRI model

IVs	-2 Log Likelihood of Reduced Model	p
Intercept	804.374	.
PEL	821.012	0.011
PAG	827.682	0.001
PG	809.869	0.064
PSD	808.851	0.612
NMPP	811.319	0.326
PWDB	819.272	0.005
PRK	837.019	0.000
PSL	806.557	0.902

Table 5.22 shows optional RI models' parameters for pilgrims. This table is divided into two parts; the first part is for the model's parameters for the answer 'Yes' based on the answer 'No' as a reference whereas the second part is for the answer 'Maybe' based on the same reference. The second part of the table is not important because this research is investigating the factors that influence pilgrims' RI, whereas it is difficult to consider the 'Maybe' response as a positive or as a negative. Thus, the prediction model will be estimated for the answer 'Yes' based on 'No' as a reference only.

From Table 5.22, it can be seen that the pilgrims with no degree group (uneducated participants) had less intention to recycle while the primary and secondary educated pilgrims had more intention. However, the significant values for education level categories were more than 0.05, indicating that those differences were insignificant. This might have happened due to the interaction with other unrecorded factors. Similar behaviour was observed among the pilgrims during the Hajj event in Mina (Alsebaei, 2014), where insignificant differences were observed between the uneducated pilgrims and the university graduate pilgrims. Therefore, a detailed investigation is required to understand the relationship between the OPRI and the pilgrims' education level.

Table 5.22: Optional recycling models' parameters for 'Yes' and 'Maybe' responses

Model	IVs			B	Wald	*p*
OPRI for 'Yes' response and 'No' is the reference category.	Intercept			4.785	16.832	0.000
	PEL	PEL1	None	-0.499	1.79	0.181
		PEL2	Primary	0.042	0.013	0.909
		PEL3	Secondary	0.582	3.279	0.070
		PEL4	College and above	0	.	.
	PAG	PAG1	18-30 years	-2.109	15.988	0.000
		PAG2	31-45 years	-1.449	8.101	0.004
		PAG3	46-60 years	-0.929	3.463	0.063
		PAG4	More than 60 years	0	.	.
	PWDB	PWDB1	Camps bins	0.264	0.889	0.346
		PWDB2	Communal bins	0.189	0.497	0.481
		PWDB3	Anywhere else	0	.	.
	PRK	PRK1	Poor knowledge	-2.839	7.417	0.006
		PRK2	Moderate knowledge	-1.746	2.745	0.098
		PRK3	Good knowledge	-1.317	1.518	0.218
		PRK4	Very good knowledge	0	.	.
OPRI for 'Maybe' response and 'No' is the reference category.	Intercept			1.635	0.999	0.317
	PEL	PEL1	None	0.797	1.842	0.175
		PEL2	Primary	0.247	0.153	0.695
		PEL3	Secondary	0.431	0.641	0.423
		PEL4	College and above	0	.	.
	PAG	PAG1	18-30 years	-1.031	2.023	0.155
		PAG2	31-45 years	-1.128	2.492	0.114
		PAG3	46-60 years	-0.692	1.021	0.312
		PAG4	More than 60 years	0	.	.
	PWDB	PWDB1	Camps bins	-0.95	4.438	0.035
		PWDB2	Communal bins	-1.005	5.354	0.021
		PWDB3	Anywhere else	0	.	.
	PRK	PRK1	Poor knowledge	-1.951	1.773	0.183
		PRK2	Moderate knowledge	-1.053	0.503	0.478
		PRK3	Good knowledge	-0.373	0.062	0.804
		PRK4	Very good knowledge	0	.	.

In terms of PAG; it was obvious from Table 5.22 that the group of 18 to 30 and the group of 31 to 45 years old had the least potential to recycle. However, there was no significant difference between the pilgrims of the 46 to 60 years old group and the pilgrims of more than 60 years old. Accordingly, it can be deduced that elderly pilgrims have a more positive intention toward recycling compared to younger pilgrims. This is in agreement with Gonzalez-Torre and Adenso-Diaz (2005) and Nixon and Saphores (2009) where it was found that elderly people show more desire to get involved in MSW recycling.

Another factor that affected the pilgrims' RI was their MSW disposal practice during the event. Pilgrims who were disposing of their MSW at bins had more intention to recycle than pilgrims who were disposing of their MSW anywhere that they believe it is suitable. However, the statistical significance of 0.346 and 0.481 suggest that these differences were not significant.

Table 5.22 also shows that pilgrims' knowledge about MSW recycling is an important factor that affects their willingness to participate in MSW recycling. Pilgrims with poor knowledge are significantly less likely to participate in MSW recycling. Insignificant differences were observed between pilgrims with moderate or good knowledge and pilgrims with a very good level of knowledge about MSW recycling. This is in agreement with Pakpour et al (2014) and Pearson et al (2012) statement that citizens' recycling attitudes can be influenced by their corresponding knowledge towards MSW recycling.

Based on Table 5.22 and Equations (3.10) and (3.2), Equation (5.8) represent the probability of pilgrims to participate in MSW source separation during REs. A cut-off value of 0.5 was used to distinguish the participants' intention regarding participating in MSW source separation, where a value of ≤0.5 indicates that the respondent has no intention to recycle while a value of >0.5 indicates a positive intention.

$$OPRI_{Yes} = \frac{e^{4.785+X1+X2+X3+X4}}{1+e^{4.785+X1+X2+X3+X4}} \tag{5.8}$$

Where,

$X1: -0.499PEL1 + 0.042PEL2 + 0.582PEL3$
$X2: -2.109PAG1 - 1.449PAG2 - 0.929PAG3$
$X3: 0.264PWDB1 + 0.189PWDB2$
$X4: -2.839PRK1 - 1.746PRK2 - 1.317PRK3$

- *CPRI Model Results*

Table 5.23 shows the Pseudo p^2 values of the multinomial LR and models fit tests for CPRI model. To check the ability of this model to explain changes in pilgrims' intention, Pearson goodness of fit test and the log-likelihood test were used (Pallant, 2011). From Table 5.23, the significance of Chi-square for log-likelihood tests of the CPRI model is 0.000, indicating that the proposed model was better than the SPSS proposed models with no IVs included. Pearson goodness of fit test is 1051.625 (p = 0.781), supporting that the developed model is better than the SPSS models in predicting pilgrims' intention for practising in recycling. Besides, it can be seen that pseudo p^2 value varies from 0.097 to 0.156, suggesting that 9.7% to 15.6% of the variation in the compulsory intention of the pilgrims is explained based on the developed model using several factors.

Table 5.23: CPRI Model fit tests and summary of developed econometric model

Test	Values	*p*
Cox & Snell pseudo p^2	0.107	-
Nagelkerke pseudo p^2	0.156	-
McFadden p^2	0.097	-
log-likelihood Test	73.225	0.000
Pearson Goodness of fit Test	1051.625	0.781

Table 5.24 shows the results of the Likelihood ratio test to identify whether included factors apply tangible or negligible influences on the outcome (Field, 2009; Pallant, 2011; Tabachnick and Fidell, 2013). Aspects with a statistical significance of <0.05 are significant contributors to CPRI. The results obtained in Table 5.9 illustrate that PG, PWDB, PRK and PSL have a significant influence on their intention to practise recycling if it is obligatory with significant values of 0.003, 0.008, 0.000 and 0.034, respectively. In contrast, the *p* values of the remaining factors that are PEL, PAG, PSD and NMPP were more than 0.05, indicating that those aspects have insignificant influence on the compulsory intention of pilgrims. Accordingly, the significant aspects that are PG, PWDB, PRK and PSL were included in the CPRI model.

Table 5.24: Likelihood ratio test for CPRI model

IVs	-2 Log Likelihood of Reduced Model	*p*
Intercept	617.032	.
PEL	625.017	0.239
PAG	628.749	0.069
PG	628.537	0.003
PSD	621.141	0.662
NMPP	617.959	0.988
PWDB	648.350	0.000
PRK	634.539	0.008
PSL	630.694	0.034

Table 5.25 shows the CPRI model's parameters. Similarly, it is divided into two parts; the first is for the model's parameters for the answer 'Yes' based on 'No' as a reference whereas the second part is for 'Maybe' based on the same reference. The second part of the table is not important because the present research is investigating the factors that influence pilgrims' sorting intention whereas it is difficult to consider the 'Maybe' response as a positive or as a negative. Thus, the prediction model will be estimated for the answer 'Yes' based on 'No' as a reference only.

From Table 5.25, it can be seen that there is a significant difference (p = 0.002) between men and women in terms of participation in MSW recycling (if it is forced by law). This implies that women have greater potential to participate in recycling programmes than men. This result is in tandem with studies by Ekere et al (2009) and Scheinberg et al (1999) who found women more involved in recycling than men.

PWDB is another factor that significantly influences the respondents' intention to sort their waste. Pilgrims who were disposing of their waste at camp bins had more intention to sort their MSW than pilgrims who were disposing of their MSW at wherever they saw fit. The pilgrims who were disposing of the waste at the communal bins had less intention to participate in recycling when it was enforced by law. This might have happened due to the interaction with other unrecorded factors. Accordingly, a detailed investigation is required to understand the relationship between the pilgrims' RI and their MSWM and disposal behaviour.

Table 5.25: Compulsory recycling models' parameters for 'Yes' and 'Maybe' responses

Model	IVs			B	Wald	*p*
CPRI for 'Yes' response and 'No' is the reference category.	Intercept			2.336	8.916	0.003
	PG	PG1	Female	0.846	9.852	0.002
		PG2	Male	0	.	.
	PWDB	PWDB1	Camps bins	0.746	4.369	0.037
		PWDB2	Communal bins	-0.691	5.891	0.015
		PWDB3	Anywhere else	0	.	.
	PRK	PRK1	Poor knowledge	-0.927	2.514	0.113
		PRK2	Moderate knowledge	-0.299	0.242	0.623
		PRK3	Good knowledge	0.418	0.405	0.525
		PRK4	Very good knowledge	0	.	.
	PSL	PSL1	Very satisfied	0.034	0.003	0.954
		PSL2	Satisfied	-0.337	0.329	0.566
		PSL3	Unsatisfied	-0.581	0.881	0.348
		PSL4	Very unsatisfied	0	.	.
CPRI for 'Maybe' response and 'No' is the reference category.	Intercept			1.613	1.895	0.169
	PG	PG1	Female	1.102	4.694	0.03
		PG2	Male	0	.	.
	PWDB	PWDB1	Camps bins	-1.025	1.858	0.173
		PWDB2	Communal bins	-1.691	8.959	0.003
		PWDB3	Anywhere else	0	.	.
	PRK	PRK1	Poor knowledge	-2.139	4.659	0.031
		PRK2	Moderate knowledge	-0.956	0.884	0.347
		PRK3	Good knowledge	-0.478	0.193	0.66
		PRK4	Very good knowledge	0	.	.
	PSL	PSL1	Very satisfied	-0.694	0.687	0.407
		PSL2	Satisfied	-0.894	1.12	0.29
		PSL3	Unsatisfied	-21.268	.	.
		PSL4	Very unsatisfied	0	.	.

Table 5.25 also shows that PRK slightly affects their willingness to recycle. The group of participants with higher knowledge about recycling have more potential to sort than have other groups; this potential gradually decreases as the level of knowledge about recycling decreases. Thus, a higher level of recycling knowledge could lead to a higher intention to sort, if it is required by law. Insignificant differences were observed between pilgrims with poor, moderate or good knowledge and pilgrims with a very good level of knowledge about recycling. This is in agreement with Pakpour et al (2014) and Pearson et al (2012) statement that citizens' recycling attitudes can be influenced by their corresponding knowledge towards recycling.

In terms of PSL about current MSWM operation, it was obvious from Table 5.22 that the group of satisfied pilgrims' had the highest potential to recycle. However, these differences

were insignificant with values of 0.954, 0.566 and 0.348. Accordingly, it can be deduced that pilgrims' satisfaction with the MSWM operation applies an insignificant influence on their willingness to participate in a recycling scheme.

Based on Table 5.22 and Equations (3.10) and **Error! Reference source not found.**(3.2), Equation (5.9) represents the probability of pilgrims to participate in MSW source separation during large REs if it is forced by law. A cut-off value of 0.5 was used to distinguish the participants' intention regarding participating in MSW source separation during events, where a value of ≤0.5 indicates that the respondents have no intention to separate the MSW during events while a value of >0.5 indicates a positive intention.

$$CPRI_{Yes} = \frac{e^{2.336+X1+X2+X3+X4}}{1+e^{2.336+X1+X2+X3+X4}} \quad (5.9)$$

where
$X1: 0.846PG1$
$X2: 0.746PWDB1 - 0.691PWDB2$
$X3: -0.927PRK1 - 0.299PRK2 + 0.418PRK3$
$X4: 0.034PSL1 - 0.337PSL2 - 0.581PSL3$

5.5.2.3 Discussion

Many researchers (Schultz et al, 1995; Ekere et al, 2009) have reported that several factors affect public RI such as education level, age, gender and environmental awareness. However, other scholars (Nixon and Saphores, 2009; Miafodzyeva and Brandt, 2012) have provided evidence of cases where it was not possible to establish a relationship between those factors and the decision to participate in recycling. Research (Schultz et al, 1995; Gonzalez-Torre and Adenso-Diaz, 2005; Miafodzyeva and Brandt, 2012) confirmed that the variation in the relationship between participating in a recycling project and other factors is subject to the time and place variation of the project. Therefore, analyses were conducted to define the variables that affect pilgrims' RI, specifically in Kerbala during the Arba'een.

Based on the results of the multinomial LR for the pilgrims' questionnaire, level of education and OPRI are not significantly related. Besides, in CPRI, the level of education does not apply any impact on RI. This indicates that pilgrims' willingness to recycle does not change with the change in their educational level. This is in line with Berglund (2006) and De Feo and De Gisi (2010a), who found no significant dependence on years of education. Based on this, it can be said that there is no or weak interaction between PEL and RI whether it was optional or forced by law.

Moreover, gender is linked to very interesting results. While some scholars (Saphores et al, 2006; Ekere et al, 2009) reported that women engage more voluntarily in pro-environment behaviour and are more involved in MSWM-related activities, the mainstream of research shows gender to be an insignificant factor (Miafodzyeva and Brandt, 2012). The regression analyses showed that gender does not affect the OPRI. This means that there is no difference between males and females in terms of willingness to recycle. However, the CPRI model shows a significant difference between males and females in terms of participation intention, where women have a higher RI than males. Based on this, it can be concluded that there is an interaction between the gender and following the rules that are imposed by law. Thus, women are more likely to implement MSW source separation when the law forces it.

Age is another important factor that has been investigated in this study. Some scholars (Saphores et al, 2006; De Feo and De Gisi, 2010a) have found a relationship between RI and age, while others (Barr et al, 2001; Hage and Soderholm, 2008) report no significant relationship. The OPRI model showed that there is a significant relationship between PAG and RI. Pilgrims of 46 years or older seem to be more willing to recycle than pilgrims of 45 years or younger. In line with this, Saphores et al (2006) reported that people whose age is more than 36 years have more intention to participate in recycling. However, the CPRI model revealed that the PAG has lost its power and showed no relationship with RI. Law enforcement increased the willingness among younger pilgrims to participate in the recycling, which in turn reduced the impact of age on the participation willingness of the pilgrims. From the above, it can be said that older pilgrims have a higher probability to participate in recycling scheme during REs when it is optional.

Furthermore, the level of knowledge and personal concerns about recycling, as a motivational factor, is a leading factor considered by many researchers (Miafodzyeva and Brandt, 2012). From the current study analyses, it can be concluded that there is a significant relationship between PRK and OPRI. Pilgrims with poor knowledge are significantly less likely to participate in recycling compared to the other three groups. This is in line with the general trend that the level of knowledge and personal concerns about recycling governs individuals' RI and behaviour (Tonglet et al, 2004; Kurz et al, 2007; De Feo and De Gisi, 2010a). However, the CPRI model shows that the level of knowledge does not apply a significant influence on RI. Law enforcement increased the willingness among participants who have poor and moderate knowledge about recycling and reduced the influence of knowledge on individuals' intention. Accordingly, it can be deduced that pilgrims that have

a higher level of knowledge and personal concerns regarding recycling have a higher intention to participate in recycling when it is optional.

Other factors, namely the pilgrims' satisfaction about the MSWM services and the activities of the pilgrims while they are in Kerbala, have been investigated in this study. Multinomial LR analyses showed that the pilgrims' activities do not apply any influence on RI. The pilgrims' satisfaction with MSW services also has no influence on RI. In line with this, Alsebaei (2014) reported that the level of satisfaction about the cleanliness of the camps in Mina did not apply significant influence on the RI of the pilgrims during the Hajj.

Finally, some studies linked RI to the variable of past behaviour as an influential factor (Barr et al, 2010). However, the OPRI model demonstrated that MSW disposal behaviour does not affect the RI of the pilgrims. This is supported by Knussen and Yule (2008) who found that past behaviour is not a significant predictor of the intention to recycle. However, the CPRI model showed that pilgrims who disposed of their waste at the camps' bins are more willing to participate in recycling programmes that the pilgrims who disposed of their waste anywhere, while pilgrims who disposed of their waste at the communal bins are less willing to participate in recycling programmes. This might have happened due to the impact of the arrangement of the storage system infrastructure. Thus, the relationship between past behaviour and the intention to sort needs to be studied and investigated more in future research.

The current study established a baseline regarding pilgrims' intention towards participation in MSW recycling during REs. The analyses demonstrated that level of knowledge and personal concerns about recycling is one of the main factors that influence participants' willingness to participate in recycling programmes during REs despite the fact that the majority of the pilgrims have a poor level of knowledge about recycling. Thus, the introduction of a recycling programme during REs should be accompanied by information campaigns and education programmes to enhance the level of awareness among pilgrims. This action could significantly increase the participation rate in such programmes. This is in line with the Kerbala MSWM authorities' suggestions (Section 4.5.1.2) that more action should be taken to enhance the environmental awareness among pilgrims which, in turn, opens many opportunities to enhance the current MSWM system adopted in Kerbala, particularly during REs. However, future research is required to test the real behaviour of the pilgrims by applying exemplary projects. Besides, it is important to investigate the changes in real pilgrims' sorting behaviour if the project is optional or obligatory, as this

study found that pilgrims' RI is changing when the project is changing from optional to compulsory.

5.5.2.4 Prediction of Future Behaviour from Stated RI

Based on the methodology detailed in section 3.8.2.3 about predicting future behaviour based on the stated RI of participants, Table 5.26 displays the percentages of the expected future behaviour of the respondents to the questionnaire survey (hoteliers, camp owners and pilgrims) based on their stated RI. Figure 5.47 summarises the expected percentage of participants that would sort their MSW based on their intention. It can be clearly seen that about 44% of the camps' managers are expected to actually participate in an MSW recycling programme based on their stated RI in the questionnaire survey whereas around 38% and 34% of the pilgrims and hoteliers, respectively would participate in MSW recycling during REs.

Table 5.26: Estimated future recycling behaviour of participants (hoteliers, camp owners and pilgrims') based on stated intention

	Participants	Hoteliers	Camp owners	Pilgrims	Total
Stated intention	Participants with strong intention (Yes)	102	139	465	706
	Participants with weak intention (Maybe)	0	0	51	51
	Participants with no intention (No)	48	18	129	195
	Total sample size	150	157	645	952
Expected actual behaviour based on stated intention	Participants that had strong intention and expected to participate in MSW recycling system. (49%)	49.98	68.11	227.85	345.94
	Participants that had weak intention and expected to participate in MSW recycling system. (26%)	0	0	13.26	13.26
	Participants that had no intention and expected to participate in MSW recycling system. (3.8%)	1.824	0.684	4.902	7.41
	Total number of participants expected to participate in MSW recycling system based on their stated intention.	51.80	68.79	246.01	366.61
	Percentage of participants that are expected to perform MSW sorting during events.	34.5%	43.8%	38.1%	38.5%

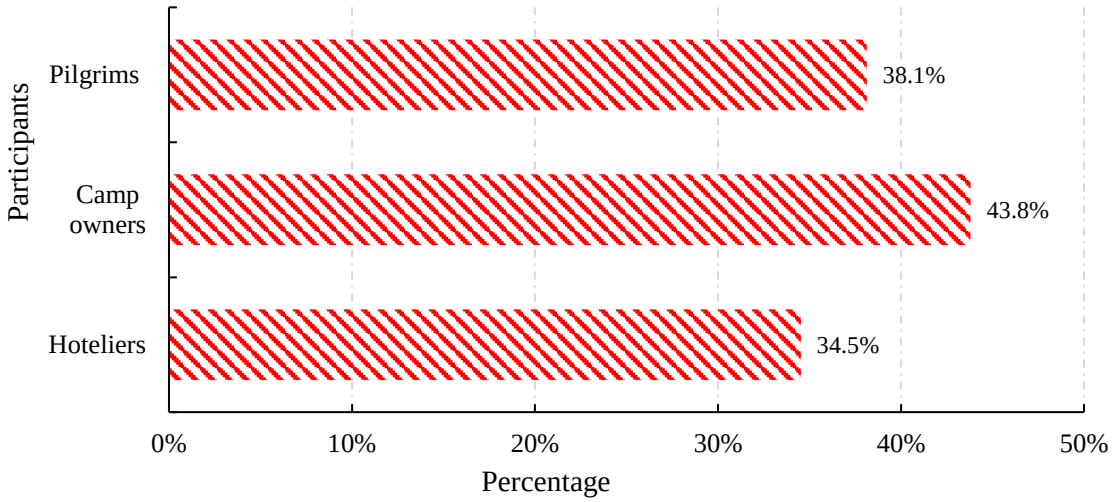

Figure 5.47: Estimated percentage of respondents that expected to participate in the MSW recycling scheme during REs

5.6 **Summary**

This chapter sought to estimate the quantity of MSW produced by hospitality establishments during the Arba'een and explore the potential associations between the characteristics and the quantity of waste generated from each (hotels and camps) to determine whether a significant association exists that allows an accurate estimation of the amount of MSW produced. Besides, the intention of accommodation managers and pilgrims to participate in MSW recycling as well as potential variables that could influence this intention were also explored. Descriptive statistics, stepwise MLR, stepwise binary LR and stepwise multinomial LR were employed for these purposes.

It was found that there are wide variations between hotels and camps with regards to MSWG. The camps tend to generate more MSW than hotels per day with an average of 112.34 and 413.25 $kg.day^{-1}$ for hotels and camps, respectively. MLR analyses showed that features which affected hotels' MSWG are HC, HSS and HE per guest whereas CC, CE during the whole event and CFS (servings provide per day) influence Camps' MSWG. Based on these features, built models are able to explain about 80% of the variation in MSWG by hotels and camps. This enables the local authorities to estimate the quantities and identify the sources of MSW generated during REs in order to develop the current MSW system such as introducing a recycling scheme.

It was also found that the vast majority of participants (hoteliers, camp owners and pilgrims) has a poor level of knowledge about MSW recycling. However, the majority of the respondents stated that they are willing to participate in the MSW recycling scheme during

REs. Based on their stated intention, it is expected that about 38% of the pilgrims would participate in recycling whereas 34% of the hotel managers and 44% of the owners of the camp would perform recycling during events. The accommodation managers preferred to separate their waste at their accommodation establishments into three categories (recyclable, organic and other materials) using private containers. LR analyses showed that HL is the only aspect that affects HRI whereas CAG significantly influences CRI. On the other hand, it was found that there was a significant association between OPRI and PAG and PRK. Older pilgrims with a higher level of knowledge were more likely to participate in recycling schemes. The significant association also exists between CPRI and PG. Women have a higher intention to participate in recycling during REs than men when it is forced by law.

Chapter 6
Conclusions and Recommendations

6.1 Introduction

This study was conducted with the aim to gain a better understanding of the municipal solid waste management (MSWM) system employed during religious events (REs) in developing countries. The literature study of current MSWM practices in developed and developing countries, particularly during REs showed that many aspects militate against MSWM efforts in developing countries such as lack of data, a deficit of funds, poor planning and limited public involvement. The available academic research has predominantly focused on MSWM in developed countries and there was limited research focus on MSWM in developing countries in addition to the paucity of literature on MSWM during large REs. The limited information suggests that developing nations are still struggling with MSW collection and disposal. Thus, to achieve a better understanding of the MSWM employed during REs, the Arba'een has been selected as a case study, because it is one of the largest REs in the country and the world in addition to the fact that the MSWM system adopted during this event or other REs in the country has never been investigated.

This study adopts mixed methods research approach, employing composition analysis, questionnaire surveys and interviews with the stakeholders (hoteliers, camp owners, pilgrims and MSWM authorities) and on-site observations as key methods for generation of data. During the Arba'een in 2016, fieldwork was conducted to collect information about the MSWM, which included conducting nine interviews with MSWM authorities' staff and a face-to-face survey with 645 pilgrims, 157 camp owners and 150 hoteliers. It also included an examination of MSW composition at transfer stations, MSW audit at hospitality establishments (hotels and camps) and field observation. The system was assessed based on the opinion of the key stakeholders, field observations and the Wasteaware framework. Besides, numerical models were built to estimate the quantities of MSW produced by pilgrims' accommodation (hotels and camps) based on their features (capacity, area etc.). Besides, MSWM services users' (hoteliers, camp owners and pilgrims) intention to participate in a recycling scheme and the variables influence this intention were studied with a view of investigating the possibility of introducing a recycling scheme at REs.

This chapter summarises the main findings of this study and provides recommendations for future work.

6.2 Conclusions

The main conclusions of the assessment of the MSWM applied during the Arba'een are summarised as follows:

- REs generate large amounts of MSW over a short period. The Arba'een event produces about 48 kt over 15 days every year. About 80 kt of waste is estimated to be generated from all REs in Kerbala every year, accounting for about 14% of the total MSW produced in the city in the whole year.

- The composition of the MSW produced during REs is comparable to those generated during the non-event days. The main components of the event's MSW were organic (57.9%), paper (14.9%) and plastic (14.6%) materials which are comparable to those produced in Kerbala during non-event days.

- The MSWM adopted during REs is weak. The system suffers from poor MSW storage (high incidences of bins overflowing and illegal disposal), incompetent collection (about 30% of the event's area was not covered) and uncontrolled MSW final disposal (all the waste produced is disposed of in a dumpsite without minimum general site management).

- Resource management and recovery schemes during REs are not in place. Almost all the MSW produced during the REs is disposed of in a dumpsite without materials recovery. MSWM authorities estimated that IRS, which is working on its own in poor environmental conditions, recovers only ~5% of the event's MSW.

- The key stakeholder's (the users and the non-government providers) are not participating in MSWM services planning and delivery. This practice led to a negative impact on the operations of the MSWM system including poor disposal behaviour among users, low public cooperation and insufficient collection coverage.

- The financial situation of the event's MSWM is unsustainable where the majority of its funding comes from the Iraqi government and all services are delivered free of charge during REs.
- MSWM operation during REs is suffering from poor strategic planning. The management authorities have failed to introduce updated legislation and a plan to address current and future MSWM needs in the city, particularly during REs.

- It was concluded that the main barriers against developing MSWM system in Kerbala are lack of key data, poor planning, lack of regulation enforcement, funding limitations, inadequate resources, low public attitude and poor stakeholders' involvement in MSWM operations planning and delivery.

- The application of Wasteaware indicators showed that priority actions to develop MSWM in Kerbala are improving the management of the current disposal facility; introducing a formal recycling programme with active inclusion of the public and IRS; and installing an effective information system that systematically captures key waste data.

Besides, MSWG from hospitality establishments was predicted through conducting a survey at 307 accommodation establishments (hotels and camps) and regression analyses. On this basis, the following conclusions have been drawn:

- The quantity of MSW produced by hotels and camps considerably varies. Camps MSWG ranges from 48 to 2854 kg with an average of 413 kg, while hotels produce an average 112 kg with a minimum of 8 kg and a maximum of 375 kg.

- MSWG from hospitality establishments can be modelled according to some of their features and services with a coefficient of determination of about 80%.

- The quantity of MSW produced by hotels was found to be positively correlated with their capacities, expenditures and staff sizes; the capacity was the most influential feature, while staff size was the lowest. Other features that are area, location, rating and waste collection frequency do not apply significant influence on the quantity of MSW produced by hotels.

- Camps' MSWG was found to be influenced by their capacities, expenditures and services; the services were the most influential feature, while the capacities were the lowest. Other features (staff size, area, location and waste collection frequency) have no statistically significant association with the quantity of MSW produced by camps.

- This city does not have any previous records regarding MSWG from hospitality establishment; the success of the prediction models implies that there is no need to spend a great deal of time and money on collecting such data. The novel models develop in this study can provide accurate and essential information about MSWG,

assisting decision makers to develop integrated measures for MSWM over REs periods.

Furthermore, public readiness to participate in MSW recycling during REs was studied by conducting questionnaire surveys with 952 respondents and logistic analyses. Accordingly, the following conclusions have been drawn:

- MSWM system users (hoteliers, camp owners and pilgrims) have very poor knowledge about MSWM aspects such as recycling and composting; only 14% of the hoteliers, 25% of the campers and the pilgrims showed good knowledge about MSWM recycling.

- The vast majority of the hoteliers (68%), the camp owners (about 88%) and pilgrims (72%) have a positive intention toward recycling. It is expected that about 34% of the hoteliers, 44% of the camp owners and 38% of the pilgrims actually perform recycling at the Arba'een. This indicates that implementing MSW recycling during the Arba'een could be feasible.

- The pilgrims have a greater positive intention to participate in recycling when it is compulsory (81%) than when it is optional (72%), indicating RI and behaviour varies with the change in motivation (forced by law).

- Hotel location contributes to the variation in hoteliers' positive RI; hoteliers' RI is positively correlated with the distance between the centre of the event and hotel's location. Hostelries variables, namely education level, age group, recycling knowledge and satisfaction level as well as hotels features that are rating, capacity floor area, waste collection frequency and MSWG have an insignificant contribution to the hoteliers' positive RI.

- Camp owners' age group significantly influences their positive RI; older camp owners are more likely to participate in MSW recycling. The remaining variables of the owners (education level, recycling knowledge, satisfaction level) and the factors of the camps (capacity, floor area, location, waste collection frequency and MSWG) do not contribute to the variation in camp owners' intention toward recycling.

- The factors affecting optional and compulsory RI among pilgrims are slightly different. Recycling knowledge influences optional and compulsory RI of pilgrims while the duration that pilgrims spend at Kerbala and the number of servings

consumed have insignificant influence. Pilgrims level of education and age have a positive influence on optional RI; older and educated pilgrims have a higher intention to participate in an optional recycling programme. The gender and the satisfaction about MSWM services influence compulsory RI; females have a higher likelihood to practice recycling than males if the recycling programme is enforced by low.

This research's main contribution is that the finding of this study established a baseline regarding MSWM during REs in Iraq and can be used to address part of the lack of data on MSWM systems in developing countries. The research approach can be replicated at other developing countries or cities that host REs to evaluate the performance of the MSWM system. It can provide reliable information to assist decision-makers to prioritise actions to develop MSWM systems in cities that host comparable REs such as Baghdad and Najaf. This includes improving storage systems, upgrading collection services and introducing recycling programmes, which result in a reduction in negative consequences generated by MSWM services during REs.

6.3 Recommendations and Future Work

Based on the investigation and the outputs above, a number of municipal actions and further research studies can be carried out to improve the current operations of MSWM in Kerbala, particularly during REs. The following points are a recommendation for decision makers as actions to improve the current MSWM in the city of Kerbala based on the results of this research:

- Decision makers can use the results of this study to prioritise their actions to develop the performance of the MSWM system adopted in the city of Kerbala to be coordinated with the performance of the MSWM systems in cities with a similar income level.

- Challenges constraining MSWM are traceable to the absence of a comprehensive strategy for MSWM and implementation guidelines. It is recommended to draw up medium- and long-term MSWM strategies that should explicitly specify realistic targets for MSW prevention, resource recovery and disposal, particularly during REs.

- Decision makers are recommended to draw a full review of all legislative aspects relating to MSWM with a view to strengthening and aligning them to the objectives of the MSWM hierarchy model.

- The MSWM authorities are recommended to upgrade existing MSWM facilities (landfill and transfer stations) to comply with environmental regulations in Iraq. In addition, new facilities need to be established for MSWM that accommodate the quantity of MSW generated in the city, particularly during REs such as fully engineered landfill and state-of-art transfer stations.

- This study also recommends the development of an information system, which can accurately capture waste data (e.g. generation rate) and a research unit with responsibility for advancing waste research and the management of a waste data bank.

- A MSW recycling system needs to be established in Kerbala city and extended to be applied during REs with proper infrastructure, as has happened in other large events, such as the Olympics. Since the vast majority of camps owners were willing to participate in MSW recycling, it is preferable to start implementing a MSW sorting project in the camps and to study the possibility of extending it to public areas.

- It is also recommended to coordinate, support and streamline the operations of IRS by way of incentives and training in sustainable recycling and composting as a business. Besides, MSWM authorities in Kerbala need to cooperate with other related governmental and non-governmental originations to establish a framework for MSWM in Kerbala during REs based on the experience of organisers of other large events.

- It is recommended to design an efficient public education programme on MSWM, as it was found that environmental concern among MSWM system users is poor. REs usually attract millions of pilgrims and a big deal of media attention. These events can be used as a platform to increase public environmental awareness by using short, informative, and attractive teaching tools.

- Stimulate Kerbala authorities to enact a law that obliges pilgrims to sort their MSW at Kerbala when a full-scale recycling project is implemented.

The following points are a recommendation for future work:

- Additional research is required regarding the chemical characteristics of REs MSW. Further study that accesses a larger number of REs in the city would provide data from a wider range of venues and enable firmer conclusions to be drawn.

- Future studies are recommended to discover the physical and chemical compositions of MSW produced by hospitality establishments in addition to fully understanding the effects of the accommodation services' and guests' attributes on MSW composition.

- Further research is required to enhance the prediction accuracy of the developed MSWG models by including other features such as the attributes of the guests and types of food services.

- Further research is recommended to study and monitor the actual recycling behaviour among users in addition to exploring and recording the factors that affect this behaviour. This includes studying the relationship between behaviour and intention.

- Future investigates is recommended to study the variation in recycling behaviour if the recycling scheme is optional or compulsory, as it is found that there is a difference between the pilgrims' RI depending on whether the project is optional or forced by law.

- The impact of pilgrims' nationalities on their RI is recommended to be investigated to understand the effect of pilgrims' origins on their decisions to participate in MSW recycling during REs.

- Future investigation is recommended to assess the environmental impact of the current MSWM in Kerbala during REs and any other suggested development such as recycling.

- Other cities such as Najaf that host religious events are recommended to employ this study approach to evaluate their performance regarding MSWM during REs.

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Appendix A. Municipality Representatives' Interview

LIVERPOOL JOHN MOORES UNIVERSITY
MUNICIPALITIES INFORMATION SHEET

Title of the Project:
An investigation of municipal solid waste management during the Arba'een pilgrimage in Kerbala, Iraq.

Name of Researcher and School/Faculty
Muhammad Abdulredha - the Department of Civil Engineering

Dear Participant
You are being invited to take part in a research study. Before you decide it is important that you understand why the research is being done and what it involves. Please read the following information. Ask us if there is anything that is not clear or if you would like more information. Take your time to decide if you want to take part or not.

1. What is the purpose of the study?
To study and evaluate the present solid waste management system in Kerbala city during religious events, and identify the main challenges for this system, in order to investigate the possibility of introducing a new integrated waste management system.

2. Do I have to take part?
No. It is up to you to decide whether to take part or not. Participation is **voluntary** and you can withdraw from the project anytime.

3. What will happen to me if I take part?
I would like to invite you to participate in this important study. If you wish to take part in this study. You will have an interview, which will take a maximum of 15 minutes to answer. The interview is in three (3) parts. Part one requests general information about your background, Part Two requests Planning and Development information on Physical Characteristics of solid waste, Types and number of the storage bin, collection systems, waste generation, transfer stations and Disposal sites. Part Three requests information about the Vehicles used and human resources.

Note: the interview will be audio recorded only if you do not have enough time so the researcher can write your answers.

4. Are there any risks/benefits involved?
No risks are involved. The main benefit is that you will contribute to developing a waste management system in Kerbala.

5. Will my taking part in the study be kept confidential?
Yes, your answers will be treated as **confidential** and used only for the purpose of the research.

This study has received ethical approval from LJMU's Research Ethics Committee (*16/CIV/002*)

Contact Details of Researcher
Muhammad Abdulredha
Department of Civil Engineering, Liverpool John Moores University,
Tel: 00447404791603, **E-mail:** **m.a.abdulredha@2015.ljmu.ac.uk**
If you have any concerns regarding your involvement in this research, please discuss these with the researcher in the first instance. If you wish to make a complaint, please contact researchethics@ljmu.ac.uk and your communication will be re-directed to an independent person as appropriate.

LIVERPOOL JOHN MOORES UNIVERSITY
MUNICIPALITIES CONSENT FORM

Title of Project: **ID: - - - - -**

An investigation of municipal solid waste management during the Arba'een pilgrimage in Kerbala, Iraq.

Name of Researcher and School/Faculty

Muhammad Abdulredha - the Department of Civil Engineering

1. I confirm that I have read and understood the information provided for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and that this will not affect my legal rights. ☐
3. I understand that any personal information collected during the study will be anonymised and remain confidential. ☐
4. I understand that the interview will be audio recorded and happy to move forward. ☐
5. I know that parts of our conversation can be used literally in publications and progressive research, but this quote will become anonymous. ☐
6. I agree to take part in the above study. ☐

Name of Researcher Date Signature

Name of Person taking consent Date Signature
(If different from the researcher)

Note: When completed 1 copy for participant and 1 copy for the researcher

LIVERPOOL JOHN MOORES UNIVERSITY
MUNICIPALITIES INTERVIEW GUIDE

Municipalities' Representatives Interview guide
Survey interview on investigating municipal solid waste management system in Kerbala during Religious Events.

General information

1. The name of the Municipality……..……
2. Division or institution name……
3. Position of the respondent……
4. Years of Experience in Present Position

☐ ≤3 years
☐ 4 to 6 years
☐ 7 to 10 years
☐ > 10 years

5. Academic Qualification

☐ High School
☐ B.Sc.
☐ M.Sc.
☐ PhD

Key waste-related data

1. Are you able to provide the following data?

☐ Per capita solid waste generation in the city and during events?.....
☐ Daily waste generation in the city and during events?.....
☐ Annual waste generation in the city and during events? ……..……
☐ The increase in the rate of solid waste generation in the city and during events?.....
☐ The main components of the waste stream in the city and during events.

Main components	Percentage	Source	Main components	Percentage	Source
Organic			Metal		
Paper			Moisture content		
Plastic			Density		

2. Has the events waste generation increased in the latest years?

☐ Yes, what could be the reason?
☐ No

3. Has the city waste generation increased in the latest years?

☐ Yes, what could be the reason?.....
☐ No

4. Are there any projections for the waste generation in the next 5 to 15 years?

☐ Yes, what they are?.....
☐ No

Stakeholders in waste management

5. Please list the institutions involved in the waste management in Kerbala and their respective role.

Institution	Role
1.	
2.	
3.	

6. Do you find the institutional arrangement for solid waste management effective?

☐ Yes.
☐ No, why?.....

7. Is the capacity of the waste management system being adequate in Kerbala?
☐ Yes
☐ No, why?.....
8. Is there a management information system (MIS) in place, which regularly measured, collected and monitored solid waste management data?
☐ Yes, can you please elaborate?.....
☐ No

Financial sustainability

9. What is your source of finance?.....
10. Is the annual budget cover the full costs of providing SWM service?
☐ Yes (*go to question 12*)
☐ No
11. If no, what proportion of the required budget are you able to acquire?……
12. Has adequate provision been made for necessary capital investments, both to extend collection coverage and to upgrade standards of waste disposal?
☐ Yes, can you please elaborate?.....
☐ No
13. Do the residents pay for waste management services?
☐ Yes, can you please elaborate?.....
☐ No
14. Do local businesses and institutions pay for waste management services?
☐ Yes, can you please elaborate?.....
☐ No
15. Do the visitors or campers pay for waste management services of the events?
☐ Yes, can you please elaborate?.....
☐ No
16. Is there any disposal charge that covers (at least) the operating cost of the treatment or disposal?
☐ Yes, can you please elaborate?.....
☐ No
17. Are there any potential sources of additional funds such as donations?
☐ Yes, can you please elaborate?.....
☐ No

Personal

18. What categories of staff are employed in the waste department normally and during events?

Category	No. employed	Are they enough	Note
1.			
2.			
3.			

19. Is it easy to attract staff to the waste sector?
☐ Yes
☐ No, Why?.....
20. Do you have a program for staff training?
☐ Yes, can you please elaborate?.....
☐ No, Why?.....

21. Do you provide appropriate protection and regular health-checks for the workers?
☐ Yes, please elaborate…….
☐ No, why?.....

Machinery/equipment for waste management

22. How do you acquire machinery/equipment and who provides them?……..…
……

23. What machinery/equipment do you have?

Equipment	Number	Are they enough	Note
1.			
2.			

24. Are you able to adequately maintain the machinery/equipment?
☐ Yes
☐ No, why?.....

Current waste collection service in Kerbala

25. What is the percentage of the total population who have access to a reliable waste collection service for both in the city and in the events?
☐ 99-100% (*go to question 27*)
☐ 90-<99%
☐ 70-<90%
☐ 45-<70%
☐ <45%

26. How do peoples without Solid waste collection service dispose of their waste?.....…
…….

27. What are the arrangements for waste collection in the city?.....
…….....

28. What is the incidence of waste appearance around waste collection points in the city and events?
☐ Very high
☐ High
☐ Medium to high
☐ Medium
☐ Low

29. The incidence of waste accumulation, illegal dumps and open burning in low-income areas is …
☐ Very high
☐ High
☐ Medium to high
☐ Medium
☐ Low

30. Do you consider littering/indiscriminate disposal of waste a major problem?
☐ Yes, what is the reasons for littering?.....
☐ No

31. Do you have any by-law against littering/indiscriminate disposal of waste?
☐ Yes, what are its provisions and enforcement? ……..……
☐ No

32. Are you able to provide enough litter bins in public places?
☐ Yes
☐ No, why?.....

33. Are the schedules to empty litter bins regular?
☐ Yes, how regularly the litter bins are emptied?.....
☐ No, why?.....

34. Do you have a storage bin standardization policy?

☐ Yes, can you please elaborate?.....
☐ No

35. Is the distribution of storage bin during events planned?
☐ Yes, can you please elaborate?.....
☐ No

36. What the average distance between bins during events?
☐ 10 to 20 meters
☐ 21 to 50 meters
☐ 51 to 100 meters
☐ Other, can you please specify?.....

37. Is the waste collection route planned during events?
☐ Yes, can you please elaborate?.....
☐ No

38. What is the average speed of the collection truck during events?
☐ ≤5 (km/h)
☐ 6-10 (km/h)
☐ 11-15 (km/h)
☐ 15-20 (km/h)

Current waste treatment or disposal in Kerbala

39. Is there any recent strategy focus on solid waste management hierarchy to be implemented at the city?
☐ Yes, can you please elaborate?.....
☐ No

40. Do you have a policy focus on the '3Rs' (reduction, reuse and recycling)?
☐ Yes, can you please elaborate?.....
☐ No

41. What is the proportion of clean, source separated materials of the total quantity of collected waste?
☐ 0-9%
☐ 10-24%
☐ 25-44%
☐ 45-64%
☐ ≥65%

42. What solid waste management facilities are operated in the city and during events?

Type of facility	Operation capacity	Location/name	EPA approval	Note
1.				
2.				

43. Are you able to secure enough suitable land for the siting of waste disposal facilities?
☐ Yes
☐ No, why?.....

44. Are there effective mechanisms in place for facility siting?
☐ Yes, please elaborate…….
☐ No

45. The treatment or disposal facility is
☐ Fully engineered facility
☐ Partially engineered facility
☐ Controlled facility
☐ Semi-controlled facility
☐ Uncontrolled facility

46. Who manages and maintains the disposal sites?.....

47. Do you know of any environmental problems associated with the treatment or disposal sites?

☐ Yes, what they are? ……
☐ No

48. How is waste treated at the disposal site? (e.g. incinerated, landfilling, recycled etc.)…… ……

49. Is there any control over any potential emissions from waste treatment or disposal?
☐ Yes, can you please elaborate?.....
☐ No

50. Which of the following are problems that associate with the waste management system? (*Please tick all that apply*)
☐ Lack of trained personnel
☐ Lack of machinery and equipment
☐ No proper institutional set-up
☐ Lack of legislation
☐ Lack of planning (short, medium and long term)
☐ Poor cooperation by government agencies
☐ Limited land areas and land tenure issues
☐ Presence of scavengers and waste pickers
☐ Lack of control on hazardous waste
☐ Inappropriate technologies/processes
☐ Illegal dumping
☐ Lack of awareness among the public
☐ Low monitoring
☐ Crowding status during events
☐ Locations of the camps during events
☐ Streets blocking during events
☐ Low public cooperation
☐ Other problems, can you please specify?.....

Informal waste collection and recycling sector inclusivity

51. Is there an informal solid waste collector in the city?
☐ Yes, what is their role?.....
☐ No (*go to question 55*).

52. Is there any organization or structure that represents private and informal waste collector?
☐ Yes, can you please elaborate?.....
☐ No

53. Is the informal sector included in the planning and implementation of waste management service?
☐ Yes, can you please elaborate?.....
☐ No

54. Are there any efforts to integrate informal waste collectors in the waste management service?
☐ Yes, can you please elaborate?.....
☐ No

Public education and involvement

55. Do you carry out public education programmes on waste managing and disposal?
☐ Yes, can you please elaborate?.....
☐ No

56. Do you have an appropriate mechanism to involve citizens in decisions that directly affect them?
☐ Yes, can you please elaborate?.....
☐ No

57. Do you have an appropriate mechanism for public feedback on solid waste management services?

☐ Yes, can you please elaborate?.....
☐ No (*go to question 59*)

58. Have you achieved any change in behaviours of the public regarding their waste management practices?

☐ Yes, can you please elaborate?.....
☐ No

59. Do authorities have a legal obligation to consult with and involve citizens in decisions that directly affect them?

☐ Yes, can you please elaborate?.....
☐ No

Would you like to make any other comments?

……
……
……
……
……

Thank you for your time and assistance.

Appendix B. Hoteliers' Questionnaire

LIVERPOOL JOHN MOORES UNIVERSITY
HOTELIERS' INFORMATION SHEET

Title of the Project:
An investigation of municipal solid waste management during the Arba'een pilgrimage in Kerbala, Iraq.

Name of Researcher and School/Faculty
Muhammad Abdulredha - the Department of Civil Engineering

Dear Participant
You are being invited to take part in a research study. Before you decide it is important that you understand why the research is being done and what it involves. Please take time to read the following information. Ask us if there is anything that is not clear or if you would like more information. Take time to decide if you want to take part or not.

1. What is the purpose of the study?
To study and evaluate the present Solid Waste Management System in Kerbala city during major events, and identify the main challenges for this system, in order to investigate the possibility of introducing new integrated waste management system.

2. Do I have to take part?
No. It is up to you to decide whether to take part or not. Participation is **voluntary** and you can withdraw from the project anytime.

3. What will happen to me if I take part?
It is planned to survey of selected Hotels for this study. Your Hotel has been selected randomly for this research and I would like to invite you to participate in this important study. If you wish to take part in this survey, the researcher will visit your place with a representative to the holy shrine authorities to help you to understand the questionnaire and obtain your answers for several questions regarding waste disposal and economic information, which will take maximum 15 minutes. Then, the researcher will conduct an on-site audit with the aim of estimating the quantity of solid waste produced at your hotel. This includes weighting the waste generated at your hotel and visual inspection to identify the most dominant components of the hotel waste.

4. Are there any risks/benefits involved?
No risks are involved. The main benefit is that you will contribute to developing a waste management system in Kerbala.

5. Will my taking part in the study be kept confidential?
Yes, your answers will be treated as **strictest confidential** and use only for the purpose of the research.

This study has received ethical approval from LJMU's Research Ethics Committee (*16/CIV/002*)

Contact Details of Researcher
Muhammad Abdulredha
Department of Civil Engineering, Liverpool John Moores University,
Tel: 00447404791603, **E-mail**: m.a.abdulredha@2015.ljmu.ac.uk
If you any concerns regarding your involvement in this research, please discuss these with the researcher in the first instance. If you wish to make a complaint, please contact researchethics@ljmu.ac.uk and your communication will be re-directed to an independent person as appropriate.

LIVERPOOL JOHN MOORES UNIVERSITY
HOTELIERS' CONSENT FORM

Title of the Project: **ID: - - - - -**

An investigation of municipal solid waste management during the Arba'een pilgrimage in Kerbala, Iraq.

Name of Researcher and School/Faculty
Muhammad Abdulredha - the Department of Civil Engineering

1. I confirm that I have read and understood the information provided for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and that this will not affect my legal rights. ☐

3. I understand that any personal information collected during the study will be anonymised and remain confidential ☐

4. I agree to take part in the above study. ☐

Name of Researcher Date Signature

Name of Person taking consent Date Signature
(if different from researcher)

Note: When completed 1 copy for participant and 1 copy for the researcher

LIVERPOOL JOHN MOORES UNIVERSITY
HOTELIERS' QUESTIONNAIRE

Hoteliers' questionnaire

Survey questionnaire on investigating municipal solid waste management system in Kerbala during Religious Events.

**Required*

General information

1. Please mark your age. *
   Mark only one square
- ☐ 18-25
- ☐ 26-35
- ☐ 36-45
- ☐ Older than 45

2. Please mark your gender. *
   Mark only one square
- ☐ Male
- ☐ Female

3. Please mark your education level. *
   Mark only one square
- ☐ College and above
- ☐ Secondary education
- ☐ Primary education
- ☐ None
- ☐ Prefer not to say

4. Please estimate the distance from this hotel to the holy shrines. *
   ……

5. This hotel is rated as….*
   Mark only one square
- ☐ Popular
- ☐ One Star
- ☐ Two Stars
- ☐ Three Stars
- ☐ Four Stars

6. Please State the size of the hotel (number of beds)... *
   ……

7. Please state the area of the hotel and number of floors (area in square meters) *
   ……

8. Please state the number of staff (in total including hotel management)... *
   ……

9. Please state estimated hotel expenses per each guest per day including the costs of hotel management, staff, room services and food services. *
   ……

10. Do you provide meals to guests at the hotel? *
    Mark only one square
- ☐ Yes, how many meals do you provide? ……..
- ☐ No.

11. Please identify your level of knowledge of the listed subjects…. *
    Please use Appendix 1 to complete this part, mark only one oval per row

	Poor	Moderate	Good	Not sure
Environmental pollution	◯	◯	◯	◯
Pollution resulted from solid waste	◯	◯	◯	◯
Waste reduction	◯	◯	◯	◯

Waste recycling	☐	☐	☐	☐
Waste composting	☐	☐	☐	☐

Solid waste quantity

Waste containers Sizes

12. Please estimate the daily volume of the waste produced by your hotel. *
Mark only one square
- ☐ Less than 240 L bin
- ☐ Equal to 240 L bin
- ☐ More than 240 L bin. Please specify.....
Density: …… (Kg/m3)
Actual Waste weight:……..(Kg)

13. How many times per day the waste is collected from the hotel during events? *
Mark only one square
- ☐ Once / day
- ☐ Twice / day
- ☐ Three-time / day
- ☐ More than three/day. Please specify.....

14. Using the scale of 1 to 4 (1=least common, 4=most common), what is the most common category in the hotel wastes? *
Mark only one oval per row

	1	2	3	4
Organic wastes	☐	☐	☐	☐
Plastic wastes	☐	☐	☐	☐
Paper wastes	☐	☐	☐	☐
Metal Wastes	☐	☐	☐	☐

15. How much of the hotel cooked food or food purchases end up being thrown into the waste bin at the end of the day? *
Mark only one square.
- ☐ Less than 10%
- ☐ 10-30%
- ☐ 31-50%
- ☐ More than 50 %

16. An estimate of recyclable items comes from the total wastes being disposed of in the bin at the end of the day. *
Mark only one square.
- ☐ Less than 10%
- ☐ 10-30%
- ☐ 31-50%
- ☐ More than 50 %

Solid waste recycling

17. Are you willing to sort hotel waste during religious events? *
Mark only one square.
- ☐ Yes.
- ☐ No, Please leave question 19.

18. Please indicate the reasons for your answer in the previous question (17). *
……

……
……

19. How would you prefer to sort the waste? *
Mark only one square.
- ☐ Into six categories (Plastic, Paper, Glass, Metal, organic and other material)
- ☐ Into three categories (recyclables, organic and others)

20. Which of the following bins do you prefer? *
Mark only one square.
- ☐ Public bins
- ☐ Private bins

21. You would recycle the hotel solid waste if….*
Mark only one square.
- ☐ Your staff trained
- ☐ Have recycling bins
- ☐ The law enforces you
- ☐ Have financial incentives

22. Please suggest actions that motivate the pilgrims to recycle their wastes. *

……
……
……

Waste management strategy

23. Please index your Level of satisfaction about waste management services in Kerbala during events. *
Mark only one square.
- ☐ Satisfied
- ☐ Neutral
- ☐ Unsatisfied
- ☐ I am not sure

24. In your opinion, which of the following factors could be considered as barriers to waste management in Kerbala during mega-events.
Please tick all that apply
- ☐ Waste management system in the city is weak.
- ☐ Unplanned aspects of the city make waste management complicated.
- ☐ Camps location in the streets and city entrances.
- ☐ The crowd makes waste transportation complex.
- ☐ Low public awareness
- ☐ Other, please specify……

……
……
……

25. In your opinion, who is best equipped to manage the waste problem in Kerbala during events? *
Mark only one square.
- ☐ Government institutions
- ☐ Private Sector
- ☐ Government and Private Sector
- ☐ Individuals

Any other comments

……
……
……
……

Thank you for completing the questionnaire.

Appendix C. Camp owners' Questionnaire

LIVERPOOL JOHN MOORES UNIVERSITY
CAMP OWNERS' INFORMATION SHEET

Title of the Project:
An investigation of municipal solid waste management during the Arba'een pilgrimage in Kerbala, Iraq.

Name of Researcher and School/Faculty
Muhammad Abdulredha - the Department of Civil Engineering

Dear Participant
You are being invited to take part in a research study. Before you decide it is important that you understand why the research is being done and what it involves. Please take time to read the following information. Ask us if there is anything that is not clear or if you would like more information. Take time to decide if you want to take part or not.

1. What is the purpose of the study?
To study and evaluate the present Solid Waste Management System in Kerbala city during major events, and identify the main challenges for this system, in order to investigate the possibility of introducing new integrated waste management system.

2. Do I have to take part?
No. It is up to you to decide whether to take part or not. Participation is **voluntary** and you can withdraw from the project anytime.

3. What will happen to me if I take part?
It is planned to survey of selected service-camps for this study. Your service-camp has been randomly selected for this research and I would like to invite you to participate in this important study. If you wish to take part in this survey, the researcher will visit your place with a representative to the holy shrine authorities to help you to understand the questionnaire and obtain your answers for several questions regarding waste disposal and economic information, which will take maximum 15 minutes. Then, the researcher will conduct an on-site audit with the aim of estimating the quantity of the solid waste produced at your service-camp. This includes weighting the waste generated at your service-camp and visual inspection to identify the most dominant components of the service-camp waste.

4. Are there any risks/benefits involved?
No risks are involved. The main benefit is that you will contribute to developing a waste management system in Kerbala.

5. Will my taking part in the study be kept confidential?
Yes, your answers will be treated as **strictest confidential** and use only for the purpose of the research.

This study has received ethical approval from LJMU's Research Ethics Committee (*16/CIV/002*)

Contact Details of Researcher
Muhammad Abdulredha
Department of Civil Engineering, Liverpool John Moores University,
Tel: 00447404791603, **E-mail**: m.a.abdulredha@2015.ljmu.ac.uk
If you any concerns regarding your involvement in this research, please discuss these with the researcher in the first instance. If you wish to make a complaint, please contact researchethics@ljmu.ac.uk and your communication will be re-directed to an independent person as appropriate.

LIVERPOOL JOHN MOORES UNIVERSITY
CAMP OWNERS' CONSENT FORM

Title of the Project: **ID: - - - - -**

An investigation of municipal solid waste management during the Arba'een pilgrimage in Kerbala, Iraq.

Name of Researcher and School/Faculty
Muhammad Abdulredha - the Department of Civil Engineering

1. I confirm that I have read and understood the information provided for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and that this will not affect my legal rights. ☐

3. I understand that any personal information collected during the study will be anonymised and remain confidential ☐

4. I agree to take part in the above study. ☐

Name of Researcher Date Signature

Name of Person taking consent Date Signature
(if different from researcher)

Note: When completed 1 copy for participant and 1 copy for the researcher

LIVERPOOL JOHN MOORES UNIVERSITY
CAMP OWNERS' QUESTIONNAIRE

Camp owners' Questionnaire

Survey questionnaire on investigating municipal solid waste management system in Kerbala during Religious Events.

**Required*

General information

1. Please mark your age. *
   Mark only one square
- ☐ 18-25
- ☐ 26-35
- ☐ 36-45
- ☐ Older than 45

2. Please mark your gender. *
   Mark only one square
- ☐ Male
- ☐ Female

3. Please mark your education level. *
   Mark only one square
- ☐ College and above
- ☐ Secondary education
- ☐ Primary education
- ☐ None
- ☐ Prefer not to say

4. Please estimate the distance from this camp to the holy shrines. *

……

5. Please state the area of this camp (area in square meters) *

……

6. How many staff member do you have in the camp? *

……

7. Please State the size of the camp (number of beds)... *

……

8. What is your total expenditure on the camp during events in Iraqi dinar? *

……

9. Do you provide meals to the pilgrims in the camp? *
   Mark only one square
- ☐ Yes, how many meals do you provide? ……..
- ☐ No, (*Go to question 11*).

10. How many meals do you provide to the visitors over the day?*

……

11. Please identify your level of knowledge of the listed subjects…. *
    Please use Appendix 1 to complete this part, mark only one oval per row

	Poor	Moderate	Good	Not sure
Environmental pollution	◯	◯	◯	◯
Pollution resulted from solid waste	◯	◯	◯	◯
Waste reduction	◯	◯	◯	◯
Waste recycling	◯	◯	◯	◯
Waste composting	◯	◯	◯	◯

Solid waste quantity

Waste containers Sizes

12. Please estimate the daily volume of the waste produced from your camp. *
Mark only one square
- ☐ Less than 240 L bin
- ☐ Equal to 240 L bin
- ☐ More than 240 L bin. Please specify.....
Density: …… (Kg/m3)
Actual Waste weight:……..(Kg)

13. How many times per day the waste is collected from your camp? *
Mark only one square
- ☐ Once / day
- ☐ Twice / day
- ☐ Three-time / day
- ☐ More than three/day. Please specify.....

14. Using the scale of 1 to 4 (*1=least common, 4=most common*), what is the most common category in the hotel wastes? *
Mark only one oval per row

	1	2	3	4
Organic wastes	◯	◯	◯	◯
Plastic wastes	◯	◯	◯	◯
Paper wastes	◯	◯	◯	◯
Metal Wastes	◯	◯	◯	◯

15. How much of the camp-cooked food or food purchases end up being thrown into the waste bin at the end of the day? *
Mark only one square.
- ☐ Less than 10%
- ☐ 10-30%
- ☐ 31-50%
- ☐ More than 50 %

16. An estimate of recyclable items comes from the total wastes being disposed of in the bin at the end of the day. *
Mark only one square.
- ☐ Less than 10%
- ☐ 10-30%
- ☐ 31-50%
- ☐ More than 50 %

Solid waste recycling

17. Are you willing to sort the camp waste during religious events? *
Mark only one square.
- ☐ Yes.
- ☐ No, *Please leave question 19*.

18. Please indicate the reasons for your answer in the previous question (17). *
……
……
……

19. How would you prefer to sort the waste? *
Mark only one square.

- ☐ Into six categories (Plastic, Paper, Glass, Metal, organic and other material)
- ☐ Into three categories (recyclables, organic and others)

20. Which of the following bins do you prefer? *
Mark only one square.
- ☐ Public bins
- ☐ Private bins

21. You would recycle the camp solid waste if….*
Mark only one square.
- ☐ Your staff trained
- ☐ Have recycling bins
- ☐ The law enforces you
- ☐ Have financial incentives

22. Please suggest actions that motivate the pilgrims to recycle their wastes. *

..……
..……
..……

Waste management strategy

23. Please index your Level of satisfaction about waste management services in Kerbala during events. *
Mark only one square.
- ☐ Satisfied
- ☐ Neutral
- ☐ Unsatisfied
- ☐ I am not sure

24. In your opinion, which of the following factors could be considered as barriers to waste management in Kerbala during events.
Please tick all that apply
- ☐ Waste management system in the city is weak.
- ☐ Unplanned aspects of the city make waste management complicated.
- ☐ Camps location in the streets and city entrances.
- ☐ The crowd makes waste transportation complex.
- ☐ Low public awareness
- ☐ Other, please specify……
……
……
……

25. In your opinion, who is best equipped to manage the waste problem in Kerbala during events? *
Mark only one square.
- ☐ Government institutions
- ☐ Private Sector
- ☐ Government and Private Sector
- ☐ Individuals

Any other comments

..……
..……
..……..……
……

Thank you for completing the questionnaire.

Appendix D. Pilgrims' Questionnaire

LIVERPOOL JOHN MOORES UNIVERSITY
PILGRIMS' INFORMATION SHEET

Title of the Project:
An investigation of municipal solid waste management during the Arba'een pilgrimage in Kerbala, Iraq.

Name of Researcher and School/Faculty
Muhammad Abdulredha - the Department of Civil Engineering

Dear Participant
You are being invited to take part in a research study. Before you decide it is important that you understand why the research is being done and what it involves. Please take time to read the following information. Ask us if there is anything that is not clear or if you would like more information. Take time to decide if you want to take part or not.

1. What is the purpose of the study?
To study and evaluate the present Solid Waste Management System in Kerbala city during major events, and identify the main challenges for this system, in order to investigate the possibility of introducing new integrated waste management system.

2. Do I have to take part?
No. It is up to you to decide whether to take part or not. Participation is **voluntary** and you can withdraw from the project anytime.

3. What will happen to me if I take part?
would like to invite you to participate in this important study. If you wish to take part in this survey. You will receive a questionnaire, which will take maximum 5 minutes to answer. The questionnaire is in one part. This part requests general information about your background, your activities while you are visiting Kerbala and your knowledge about waste management. Recycling and re-use are processes of recovering and convert the waste material into reusable material to prevent waste of potentially useful materials.

4. Are there any risks/benefits involved?
No risks are involved. The main benefit is that you will contribute to developing a waste management system in Kerbala.

5. Will my taking part in the study be kept confidential?
Yes, your answers will be treated as **strictest confidential** and use only for the purpose of the research.

This study has received ethical approval from LJMU's Research Ethics Committee (*16/CIV/002*)

Contact Details of Researcher
Muhammad Abdulredha
Department of Civil Engineering, Liverpool John Moores University,
Tel: 00447404791603, **E-mail**: m.a.abdulredha@2015.ljmu.ac.uk
If you any concerns regarding your involvement in this research, please discuss these with the researcher in the first instance. If you wish to make a complaint, please contact researchethics@ljmu.ac.uk and your communication will be re-directed to an independent person as appropriate.

LIVERPOOL JOHN MOORES UNIVERSITY
PILGRIMS' CONSENT FORM

Title of the Project: **ID: - - - - -**

An investigation of municipal solid waste management during the Arba'een pilgrimage in Kerbala, Iraq.

Name of Researcher and School/Faculty
Muhammad Abdulredha - the Department of Civil Engineering

1. I confirm that I have read and understood the information provided for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and that this will not affect my legal rights. ☐

3. I understand that any personal information collected during the study will be anonymised and remain confidential ☐

4. I agree to take part in the above study. ☐

Name of Researcher Date Signature

Name of Person taking consent Date Signature
(if different from researcher)

Note: When completed 1 copy for participant and 1 copy for the researcher

LIVERPOOL JOHN MOORES UNIVERSITY
PILGRIMS' QUESTIONNAIRE

Pilgrims questionnaire
Survey questionnaire on investigating municipal solid waste management system in Kerbala during Religious Events.

** required. Please mark only one square per row.*

Question	**Answers (Please tick the right option, *e.g. X*)**			
	1	2	3	4
1. Please mark your education level*	☐None	☐Primary Education	☐Secondary Education	☐College and above
2. Please mark your age*	☐18-30	☐31-45	☐46-60	☐More than 60
3. Please mark your gender*	☐Male	☐Female	☐	☐
4. How many days you will stay in Kerbala?*	☐One day	☐Two days	☐Three days	☐> three days
5. Do you eat in Kerbala Camps?*	☐Always	☐Sometimes	☐Rarely	☐Never
6. How many meals do you eat in Kerbala daily?*	☐1 to 2 meals	☐3 to 4 meals	☐5 to 6 meals	☐> 6 meals
7. Do you drink tap water or bottled water?*	☐Tap water	☐Bottled water	☐Both	☐
8. How many 500 ml water bottles do you consume daily?*	☐1 to 2 bottle	☐3 to 4 bottle	☐5 to 6 bottle	☐> 6 bottle
9. Where do you dispose of your waste while you are visiting Kerbala?*	☐Camps bins	☐Communal Bins	☐Anywhere Else	☐
10. Please identify your level of knowledge on waste recycling and reuse.* *use appendix 1*	☐Very good	☐good	☐Fair	☐ Poor
11. If it is optional, do you think you will sort your solid waste while you are in Kerbala?*	☐Yes	☐No	☐Maybe	
12. If it is compulsory, do you think you will sort your solid waste while you are in Kerbala?*	☐Yes	☐No	☐Maybe	
13. Are you satisfied about the level of cleanliness in Kerbala during the events *	☐Very Satisfied	☐Satisfied	☐Unsatisfied	☐Very Unsatisfied

Thank you for completing the questionnaire.

Appendix E. Questionnaires' Appendix

**Please randomly select two questions at each section*

Environmental pollution

26. Which of the following options is not a pollutant?
- ☐ Light
- ☐ Wind
- ☐ Noise
- ☐ I do not know

27. For waste generation: using disposable cups better than washing cups each time after use.
- ☐ True
- ☐ False
- ☐ I do not know

28. What proportion of the world's water is suitable for human use?
- ☐ Less than 1%
- ☐ 3%
- ☐ 23%
- ☐ I do not know

Pollution resulted from solid waste

29. What waste means for you?
- ☐ Things without a usefulness
- ☐ Things without a purpose
- ☐ Both of the above
- ☐ I do not know

30. Organic rotting in the landfill generates Harmful gas, which is…
- ☐ Oxygen
- ☐ Nitrogen
- ☐ Methane
- ☐ I do not know

31. Which of the following materials will not break (decay) in a Landfill?
- ☐ Plastic bottles
- ☐ Food residuals
- ☐ Clothing
- ☐ I do not know

Waste reduction

32. What is waste reduction means?
- ☐ Use something repeatedly.
- ☐ The process of converting wastes into their primary materials
- ☐ Use less of something, creating smaller amounts of waste.
- ☐ I do not know

33. Consumers are encouraged to reduce their waste by
- ☐ Buying in bulk
- ☐ Changing to re-useable products
- ☐ Buying items with less packaging
- ☐ All of the above
- ☐ I do not know

34. Select the correct hierarchical order of the three Rs.
- ☐ Reduce, reuse, and recycle
- ☐ Reuse, recycle and reduce
- ☐ Recycle, reduce and reuse
- ☐ I do not know

Waste recycling and reuse

35. Which of the following materials cannot be recycled?
- ☐ Milk cartons
- ☐ Glass containers
- ☐ Plastic water bottles
- ☐ None of the Above
- ☐ I do not know

36. How many times can glass be recycled?
- ☐ Glass cannot be recycled
- ☐ Once
- ☐ Four times
- ☐ Forever
- ☐ I do not know

37. What does reuse mean?
- ☐ The process of converting wastes into their primary materials
- ☐ Using something again for its original purpose or another purpose
- ☐ Use less of something, creating smaller amounts of waste.
- ☐ I do not know

Composting

38. What is the compost?
- ☐ Materials resulting from the decomposition of waste of all kinds
- ☐ Chemical compounds resulting from the decomposition of organic wastes such as food residues, and tree leaves
- ☐ Materials resulting from the decomposition of organic wastes such as food residues, and tree leaves
- ☐ I do not know

39. Which of the following options can you put in the composting bin?
- ☐ Fruits wastes
- ☐ Dairy products wastes
- ☐ Meat wastes
- ☐ I do not know

40. The moisture content of 50-60% is necessary for waste composting process.
- ☐ Yes
- ☐ No
- ☐ I do not know

Appendix F. Samples Sizes Calculations

Required Sample Size for Targeted Population

Equation 1 was used to estimate the sample size required in this study (Rea and Parker, 2014).

$$N = \frac{Z^2[C(1-C)]A}{Z^2[C(1-C)] + (A-1)ME^2} \quad (1)$$

Where

N is the minimum required sample size

A represents the population size (in this study, Kerbala encompasses 667 hotels, 600 service camps and 20 million pilgrims)

C represents the sample true proportion. The sample proportion was unknown in this study. Therefore, 0.5 was used to yield the highest sample size (Rea and Parker, 2014).

Z represents the abscissa of the normal curve that cuts off an area at the tails. In this study, the most commonly set at 1.96 for the 95% confidence level was used.

ME represents the margin of error. Given the time constraints, low available budget and event's crowded situation, 8% were selected in this study.

Required Sample Size for MSW Composition Analyses

Equation 2 was applied to estimate the sample size required in this study according to ASTM D5231-92 (2003) standard method.

$$N = \left(\frac{t^* * SD}{\bar{X} * e}\right)^2 \quad (2)$$

N = the minimum required sample size.

t^* = student t statistics corresponding to the desired level of confidence.

SD = estimated standard deviation.

$\bar{X}$ = estimated mean.

e = the desired level of precision.

According to ASTM D5231-92 (2003) standard method, the t statistics, the estimated standard deviation, the estimated mean and the desired level of precision need to be identified to calculate the required sample size. ASTM D5231-92 (2003) standard method provide a table (Table 1) to estimate these parameters. As the MSW generated in the city of Kerbala during religious events is not source separated and recycled, this waste is considered as corrugated. Accordingly, the estimated mean ($\bar{X}$) and the estimated standard deviation (S) are 0.14 and 0.06, respectively. The student t statistics (t^*) for infinity sample size within 10% desired precision is 1.645. These estimated parameters were applied in

Equation 2 to find that the initial sample size is 50 samples. To make sure that the generated sample size is representative, the initial sample size of 50 samples was used to find the student t statistics (t^*). The student t statistics (t^*) for 50 samples within 10% desired precision was found to be 1.677. Then, the process was repeated again using the new student t statistics (t^*) of 1.677 to find the required sample size. Accordingly, it was found that 52 samples are required to represent the waste generated in the city with 10% desired precision. Since the new sample size of 52 samples was within 10% of the initial calculated sample size of 50 samples, a sample of 52 observatio0n was accepted as a representative sample to the quantity of MSW produced during the Arba'een event.

Table 1: Estimated parameters to calculate sample size for MSW components analysis. Adopted from ASTM D5231-92 (2003) standard method.

Values of Mean ($\bar{x}$) and Standard Deviation(SD) for Sampling to Determine MSW Component Composition			**Values of t Statistics (t^*) as a Function of Number of Samples and Confidence Interval**		
Component	standard deviation (SD)	mean ($\bar{X}$)	Number of Samples	90%	95%
Newsprint	0.07	0.10	15	1.761	2.145
Corrugated	0.06	0.14	20	1.729	2.093
Plastic	0.03	0.09	23	1.717	2.074
Yard waste	0.14	0.04	31	1.697	2.042
Food waste	0.03	0.10	41	1.684	2.021
Wood	0.06	0.06	46	1.679	2.014
Other organics	0.06	0.05	51	1.676	2.009
Ferrous	0.03	0.05	61	1.671	2.000
Aluminium	0.004	0.01	189	1.653	1.973
Glass	0.05	0.08	201	1.653	1.972
Other inorganics	0.03	0.06	∞	1.645	1.960

Appendix G. Interviews Themes

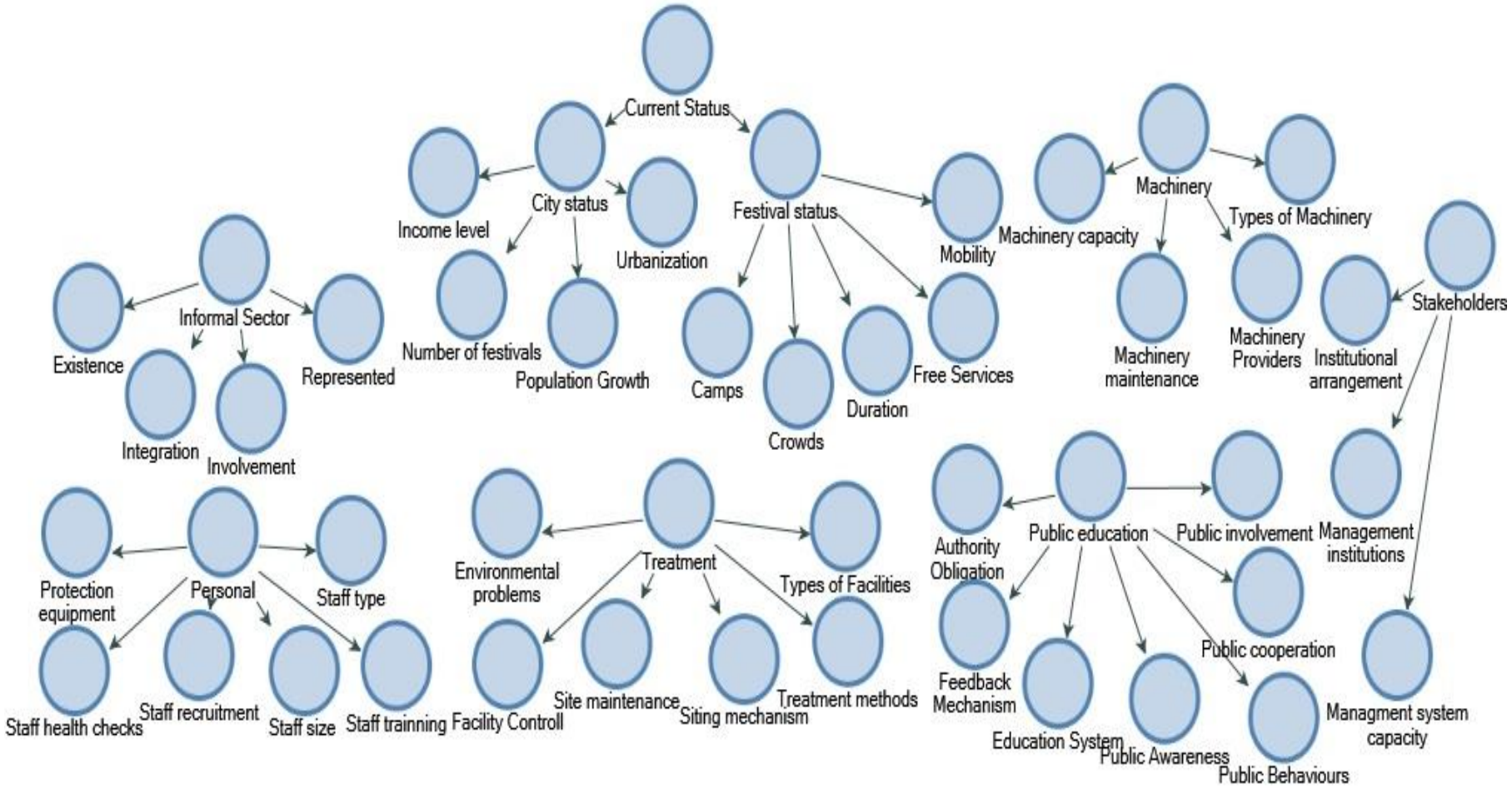

Figure 1: Generated themes regarding current MSWM operation, machinery and equipment, human resources, stakeholders' involvement, informal sector activities, public education and MSW treatment.

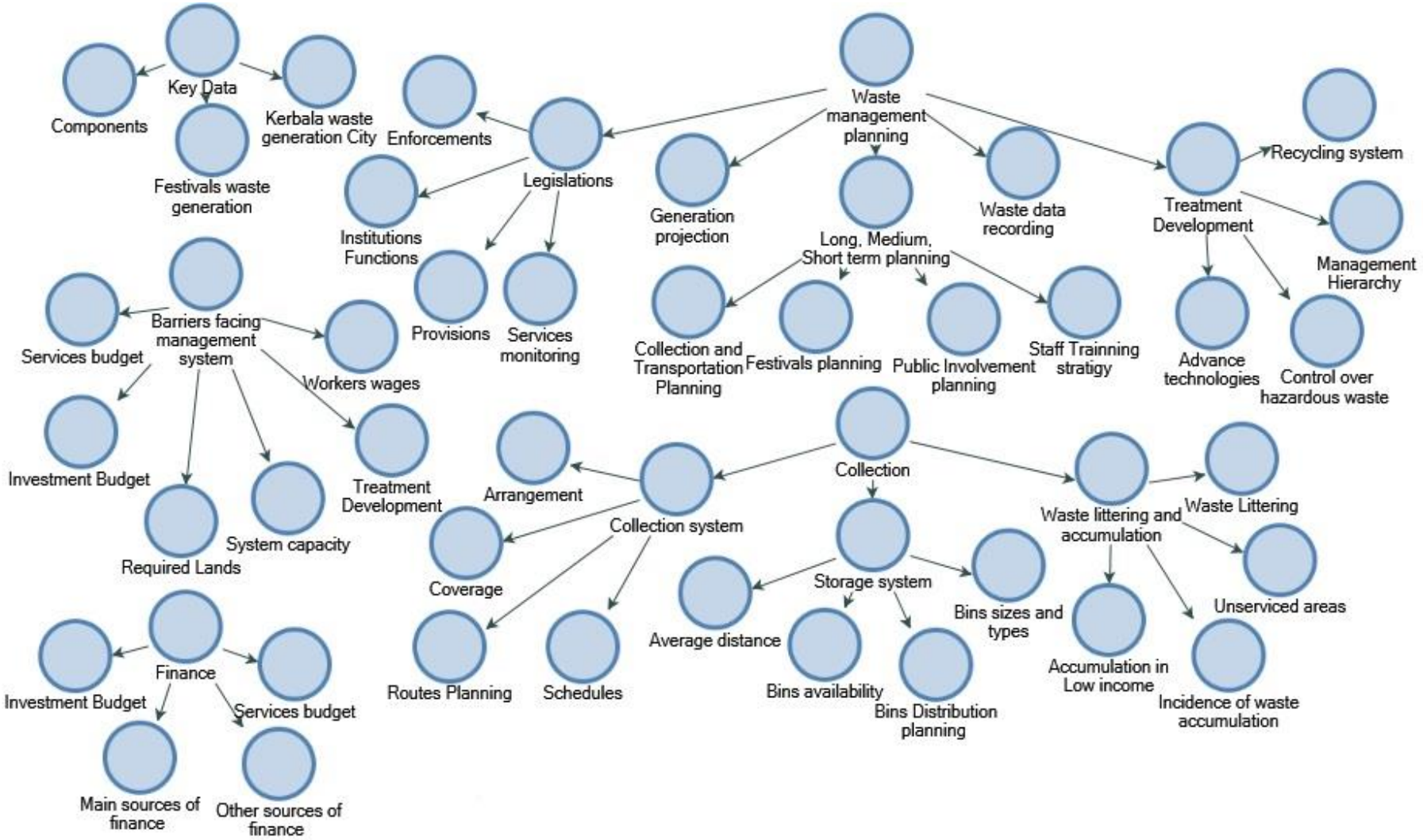

Figure 2: Generated themes regarding MSWM planning, waste data, MSW collection, barriers facing MSWM operations and financial aspects.

Appendix H. Wasteaware Benchmark Indicators Framework

Table 1: Background information of a targeted city, Wasteaware benchmark indicators. Adapted from Wilson et al (2015).

No	Indicator or criterion	Description	Score
B1	Country income level	World Bank income category	The World Bank categorises countries on the basis of their GNI/capita, which are low, lower-middle, upper-middle and high- income
B1.1	World Bank classification	Income category of the country according to the World Bank	
B1.2	Gross National Income (GNI)	Gross national income (GNI) per capita for the country	$ per capita
B2	Population of the city	The total population of the city	Capita
B3	Solid waste generation	Total municipal solid waste generation	Tonne per year

Table 2: Key Waste-related data indicators of a city, Wasteaware benchmark indicators. Adapted from Wilson et al (2015).

No	Indicator or criterion	Description	Score
W1	MSWG per capita	The total MSW generated per capita	Kg/capita/year
W2	MSW composition	Summary composition of MSW as generated	Provide full sets of whatever data are available on MSW components
W2.1	Organic	Organics (food and green wastes)	%
W2.2	Paper	Paper fraction of the waste as generated	%
W2.3	Plastic	Plastic fraction of the waste as generated	%
W2.4	Metal	Metal fraction of the waste as generated	%
W2.5	MSW density	MSW density	
W2.6	Moisture content	MSW moisture content	

Table 3: Physical Components indicators of a city MSWM system (1.Waste collection performance), Wasteaware benchmark indicators. Adapted from Wilson et al (2015).

No	Indicator or criterion	Description	Score
1.1	SW collection coverage	% of inhabitants who have access to a reliable waste collection service	Low (0-49%): 0, Low/Medium (50-69%): 5, Medium (70-89%): 10, Medium/High (90-98%): 15, High (99-100%): 20.
1.2	SW captured by the management system	% of SW generated that is collected and delivered to an official facility	Low (0-49%): 0, Low/Medium (50-69%): 5, Medium (70-89%): 10, Medium/High (90-98%): 15, High (99-100%): 20.
1.3	Quality of the SW collection and street cleaning service	An indicator to assess the quality of the waste collection/ street cleaning service	Assessed using best professional judgment against the criteria listed below.
1.3.1	Appearance of SW collection points	Presence of accumulated waste around collection points/containers	Very high incidence: 0, High incidence: 5, Medium incidence: 10, Low incidence: 15, Very low incidence: 20.
1.3.2	Effectiveness of street cleaning	Presence of litter and of overflowing litter bins	
1.3.3	Efficiency of collection in low income areas	Presence of accumulated waste/illegal dumps/open burning	
1.3.4	Effectiveness of SW transport	Appropriate public health and environmental controls of waste transport	No compliance: 0, Low compliance: 5, Medium compliance: 10, Medium/High compliance: 15, High compliance: 20.
1.3.5	Effectiveness of supervision and management control	Appropriate service implementation, management and supervision in place	
1.3.6	Health and safety of collection workers	Use of appropriate personal protection equipment and supporting procedures	

Table 4: Physical Components indicators of a city MSWM system (2. Waste Treatment and Disposal performance), Wasteaware benchmark indicators. Adapted from Wilson et al (2015).

No	Indicator or criterion	Description	Score
2.1	Controlled treatment or disposal of MSW	% of the total MSW destined for treatment or disposal that goes to engineered or controlled facility	Low (0-49%): 0, Low/Medium (50-74%): 5, Medium (75-84%): 10, Medium/High (85-94%): 15, High (95-100%): 20.
2.2	Environmental protection in MSW treatment and disposal	Assessment of the degree of environmental protection in MSW treatment and disposal sites based on a cumulative score of six criteria listed below	Assessed using best professional judgment against the criteria listed below.
2.2.1	Control over MSW reception and general site management	Focuses on general site management such vehicular access to the site, site security, site fencing waste reception	No control: 0, Low level of control: 5, Medium level of control: 10, Medium/High level of control: 15, High level of control: 20.
2.2.2	Control over MSW treatment and disposal	Focuses on the degree of organization, management and engineering of the treatment and disposal sites	
2.2.3	Monitoring and verification of environmental controls	Focuses on the existence of robust licensing procedures, regular inspection and verification scheme by an independent regulatory body or the facility itself.	No compliance: 0, Low compliance: 5, Medium compliance: 10, Medium/High compliance: 15, High compliance: 20.
2.2.4	Control of greenhouse emissions and/or energy recovery	Focuses on the control of site fires and management of landfill gas and emissions and energy recovery	
2.2.5	Technical competence in the planning, management and operation of treatment and disposal	Assess the level of technical competence of the authority	
2.2.6	Health and safety	responsible for service, the management of the treatment and disposal and the onsite staff	

Table 5: Physical Components indicators of a city MSWM system (3. Resources recovery), Wasteaware benchmark indicators. Adapted from Wilson et al (2015).

No	Indicator or criterion	Description	Score
3.1	Recycling rate	% of total MSW generated which is recycled including materials recycling composting and anaerobic digestion.	Low (0-9%): 0, Low/Medium (10-24%): 5, Medium (25-44%): 10, Medium/High (45-64%): 15, High (>65%): 20.
3.2	Quality of 3Rs – reduce, reuse, recycle – provision	This indicator assesses the quality of recycling provision.	Assessed using best professional judgment against the criteria listed below.
3.2.1	Source separation of 'dry recyclables	Based on the % of the total quantity of materials collected for recycling that are collected as clean, source separated materials	(> 75%) = 20, (51 – 75 %) = 15, (26 – 50 %) = 10, (1 – 25 %) = 5, (None) = 0.
3.2.2	Quality of recycled organic materials	A qualitative assessment of the likely quality of the recycled product (i.e. animal feed and compost)	No separation: 0, Some separation to reduce contamination: 5, Organic separated in a treatment facility: 10, All separated at source: 15, All separated at source and meets a formal quality standard: 20.
3.2.3	Focus on the top levels of the waste hierarchy	An assessment of the degree of both policy and practical focus on promoting reduction and reuse in 'higher waste generating cities'; and on the '3Rs' – reduction, reuse, recycling – in 'lower waste generating cities'	No focus: 0, Low focus: 5, Medium focus: 10, Medium/High focus: 15, High level of focus: 20.
3.2.4	Integration of community and/or informal recycling sector with the formal SWM system	An assessment of how far and how successfully efforts have been made to include the informal recycling sector (in low and middle-income countries)	
3.2.5	Environmental protection in recycling	Environmental impacts of the recycling chain, from collection through to the separation and processing of the separated materials.	No compliance: 0, Low compliance: 5, Medium compliance: 10, Medium/High compliance: 15, High compliance: 20.
3.2.6	Occupational health and safety	Use of appropriate personal protection equipment and supporting procedures	

Table 6: Governance factors indicators of a city MSWM system (4. Inclusivity-users' Inclusivity), Wasteaware benchmark indicators. Adapted from Wilson et al (2015).

No	Indicator or criterion	Description	Score
4.1	User inclusivity	Represents the degree to which users, or potential users, of the waste management services are included in the planning, policy formation, implementation and evaluation of those services	Assessed using best professional judgment against the criteria listed below.
4.1.1	Equity of service provision	Assessment of the extent to which all citizens receive a high level of SWM service provision – irrespective of income level	No compliance: 0, Low compliance: 5, Medium compliance: 10, Medium/High compliance: 15, High compliance: 20.
4.1.2	The right to be heard	Assessment of the legal right to be heard – do authorities have a legal obligation to consult with and involve citizens in decisions which directly affect them	
4.1.3	Level of public involvement	Evidence of public involvement at appropriate stages of the SWM decision making, planning and implementation process.	
4.1.4	Public feedback mechanisms	The existence and use of public feed-back mechanisms on SWM services	No compliance: 0, Low compliance: 5, Medium compliance: 10, Medium/High compliance: 15, High compliance: 20.
4.1.5	Public education and awareness	Implementation of a comprehensive, culturally appropriate public education, behavioural change and/or awareness raising programme	
4.1.6	Effectiveness in achieving behaviour change	Change in habits and behaviours of both the public and businesses regarding their waste management/handling practices	

Table 7: Governance factors indicators of a city MSWM system (4. Inclusivity-Providers' Inclusivity), Wasteaware benchmark indicators. Adapted from Wilson et al (2015).

No	Indicator or criterion	Description	Score
4.2	Provider inclusivity	Represents the degree to which non-municipal service providers from the formal private, community or 'informal'[1] sectors are included in the planning and implementation of solid waste and recycling services and activities	Assessed using best professional judgment against the criteria listed below.
4.2.1	Legal framework	Assesses the degree to which laws and/or other legal instruments are in place and implemented at national or local level, which enables the private sector to deliver MSWM services on a stable basis.	No compliance: 0, Low compliance: 5, Medium compliance: 10, Medium/High compliance: 15, High compliance: 20.
4.2.2	Representation of the private sector	Organisations or structures in place which represent the private waste sector and actively participate within MSWM planning forums, task forces, committees and/or steering-groups	
4.2.3	Role of the 'informal' and community sector	Evidence of acknowledgement and protection of the organised 'informal' and community sectors role within the formal SWM system	No compliance: 0, Low compliance: 5, Medium compliance: 10, Medium/High compliance: 15, High compliance: 20.
4.2.4	The balance of public vs. private sector interests in delivering services	Assessment of the degree to which institutional or legal incentives are in place, nationally and/or locally, which actively encourage private sector participation in SWM	
4.2.5	Bid processes	Evidence of the private sector being included within open, transparent and accountable bid processes for the provision of SWM services	

Table 8: Governance factors indicators of a city MSWM system (5. Financial Sustainability), Wasteaware benchmark indicators. Adapted from Wilson et al (2015).

No	Indicator	Description	Score
5.1	Cost accounting	Extent to which the MSWM accounts reflect accurately the full costs of providing the service and the relative costs of the different activities within MSWM; and whether the accounts are open to public scrutiny	No compliance: 0, Low compliance: 5, Medium compliance: 10, Medium/High compliance: 15, High compliance: 20.
5.2	Coverage of the available budget	Is the annual budget adequate to cover the full costs of providing the service?	Covers ≤ 50% of operating costs: 0, Covers most operating costs: 5, Covers full operating costs: 10, Providing allowance for necessary improvements and costs of capital: 15, Covers full cost of providing a high quality service: 20
5.3	Local cost recovery – from households	Percentage of the total number of households both using and paying for primary waste collection services The focus here is on the number of households, NOT on the percentage of the total costs.	None = 0, < 25% = 5, 25 – 49% = 10, 50 - 74% = 15, 75 - 100% = 20
5.4	Affordability of user charges	Are practices or procedures in place to support charges for those who can least afford to pay?	No compliance: 0, Low compliance: 5, Medium compliance: 10, Medium/High compliance: 15, High compliance: 20.
5.5	Pricing of disposal	Degree to which all the wastes coming to the final (treatment or) disposal site(s) are charged at a rate that covers (at least) the operating costs of (treatment or) disposal	No charge: 0, Covers some operation costs: 5, Covers full operating costs: 10, Covers all operation costs: 15, Covers all operating, maintenance, capital costs, and sets aside savings for future closure and aftercare: 20.
5.6	Access to capital for investment	Assesses the provision of an adequate capital for investments, both to extend collection coverage to any un-served areas; to upgrade standards of waste disposal; and to replace existing vehicles, equipment and sites at the end of their life.	No compliance: 0, Low compliance: 5, Medium compliance: 10, Medium/High compliance: 15, High compliance: 20

Table 9: Governance factors indicators of a city MSWM system (5. Financial Sustainability), Wasteaware benchmark indicators. Adapted from Wilson et al (2015).

No	Indicator	Description	Score
5.1	Cost accounting	Extent to which the MSWM accounts reflect accurately the full costs of providing the service and the relative costs of the different activities within MSWM; and whether the accounts are open to public scrutiny	No compliance: 0, Low compliance: 5, Medium compliance: 10, Medium/High compliance: 15, High compliance: 20.
5.2	Coverage of the available budget	Is the annual budget adequate to cover the full costs of providing the service?	Covers ≤ 50% of operating costs: 0, Covers most operating costs: 5, Covers full operating costs: 10, Providing allowance for necessary improvements: 15, Covers full cost of providing a high quality service: 20
5.3	Local cost recovery – from households	Percentage of the total number of households both using and paying for primary waste collection services The focus here is on the number of households, NOT on the percentage of the total costs.	None = 0, < 25% = 5, 25 – 49% = 10, 50 - 74% = 15, 75 - 100% = 20
5.4	Affordability of user charges	Are practices or procedures in place to support charges for those who can least afford to pay?	No compliance: 0, Low compliance: 5, Medium compliance: 10, Medium/High compliance: 15, High compliance: 20.
5.5	Pricing of disposal	Degree to which all the wastes coming to the final (treatment or) disposal site(s) are charged at a rate that covers (at least) the operating costs of (treatment or) disposal	No charge: 0, Covers some operation costs: 5, Covers full operating costs: 10, Covers all operation costs: 15, Covers all operating, maintenance, capital costs, and sets aside savings for future closure and aftercare: 20.
5.6	Access to capital for investment	Assesses the provision of an adequate capital for investments, both to extend collection coverage to any un-served areas; to upgrade standards of waste disposal; and to replace existing vehicles, equipment and sites at the end of their life.	No compliance: 0, Low compliance: 5, Medium compliance: 10, Medium/High compliance: 15, High compliance: 20

Table 10: Governance factors indicators of a city MSWM system (6. Sound institutions and proactive policies), Wasteaware benchmark indicators. Adapted from Wilson et al (2015).

No	Indicator	Description	Score
6.1	Adequacy of national framework for solid waste management (SWM)	Assesses the adequacy of the national MSWM framework – including the degree of implementation.	Assessed using best professional judgment against the criteria listed below.
6.1.1	Legislation and regulations	Is there a comprehensive national law(s) in place to address SWM requirements?	No compliance: 0, Low compliance: 5, Medium compliance: 10, Medium/High compliance: 15, High compliance: 20
6.1.2	Strategy/policy	Is there an approved and recent national strategy for MSWM and clear policies in place and implemented?	
6.1.3	Guidelines and implementation procedures	Are there clear guidelines for local authorities on how to implement the laws and strategy? Are there effective mechanisms in place for facility siting?	
6.1.4	National institution responsible for implementing SWM policy	Is there a single institution at the national level which is charged with the responsibility of implementing, or coordinating the implementation of, MSWM strategy/policy	Low: 0, Low/Medium: 5, Medium: 10, Medium/High: 15, High: 20
6.1.5	Regulatory control / enforcement	Is there a well-organised and adequately resourced environmental regulatory agency? Does it enforce the legislation to ensure a 'level playing field' for all?	No compliance: 0, Low compliance: 5, Medium compliance: 10, Medium/High compliance: 15, High compliance: 20
6.1.6	Extended producer responsibility (EPR) or Product Stewardship (PS)	Has engagement been made with national and international companies who produce the packaging, electronic goods and other products that end up as MSW? Do they share at least some of the costs of the SWM service and/or recycling?	

Table 11: Governance factors indicators of a city MSWM system (6. Sound institutions and proactive policies), Wasteaware benchmark indicators. Adapted from Wilson et al (2015).

No	Indicator	Description	Score
6.2	Degree of local institutional coherence	A measure of the institutional strength and coherence of the city's MSWM functions	Assessed using best professional judgment against the criteria listed below.
6.2.1	Organisational structure/coherence	The degree to which all SWM responsibilities are concentrated into a single organisation or department, that can be held accountable for performance	No compliance: 0, Low compliance: 5, Medium compliance: 10, Medium/High compliance: 15, High compliance: 20
6.2.2	Institutional capacity	An assessment of the organisational strength and capacity of the department responsible for SWM	
6.2.3	City-wide SWM strategy and plan	Is there a recent strategy or plan in place & being implemented at the city (or regional) level for SWM?	
6.2.4	Availability and quality of SWM data	Is there a management information system (MIS) in place? Are data regularly measured, collected and monitored?	No compliance: 0, Low compliance: 5, Medium compliance: 10, Medium/High compliance: 15, High compliance: 20
6.2.5	Management, control and supervision of service delivery	A measure of the strength of control by the city as 'client' for SWM, over the on-the-ground delivery of SWM services	
6.2.6	Inter-municipal (or regional) cooperation	Waste collection is often delivered at a local level, while treatment and disposal may require cooperation city-wide or at a regional level. Regulatory control may be organised at regional or national level. How well does such cooperation work?	

Appendix I. Ethical Approval

Abdulredha, Muhammad

From: Williams, Mandy
Sent: 31 May 2016 14:40
To: Abdulredha, Muhammad
Cc: Jordan, David; Al Khaddar, Rafid; Lempereur, Brett
Subject: Approved

Importance: High

Follow Up Flag: Follow up
Flag Status: Flagged

Dear Muhammad

With reference to your application for Ethical Approval:

16/CIV/002 - Muhammad Abdulredha, PGR - Solid Waste Management for Kerbala City during Major Events (Rafid Alkhaddar/David Jordan/Brett Lempereur)

The University Research Ethics Committee (UREC) has considered the above application and I am pleased to inform you that ethical approval has been granted and the study can now commence.

Approval is given on the understanding that:

- any adverse reactions/events which take place during the course of the project are reported to the Committee immediately;
- any unforeseen ethical issues arising during the course of the project will be reported to the Committee immediately;
- the LJMU logo is used for all documentation relating to participant recruitment and participation e.g. poster, information sheets, consent forms, questionnaires. The LJMU logo can be accessed at http://www2.ljmu.ac.uk/corporatecommunications/60486.htm

Where any substantive amendments are proposed to the protocol or study procedures further ethical approval must be sought.

Applicants should note that where relevant appropriate gatekeeper / management permission must be obtained prior to the study commencing at the study site concerned.

For details on how to report adverse events or request ethical approval of major amendments please refer to the information provided at http://www2.ljmu.ac.uk/RGSO/93205.htm

Please note that ethical approval is given for a period of five years from the date granted and therefore the expiry date for this project will be May 2021. An application for extension of approval must be submitted if the project continues after this date.

LIVERPOOL JOHN MOORES UNIVERSITY

Mandy Williams, Research Support Officer
(Research Ethics and Governance)
Research and Innovation Services
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