T.C.
ISTANBUL GEDİK UNIVERSITY
INSTITUTE OF GRADUATE STUDIES

THE REALITY OF SOLID WASTE MANAGEMENT IN IRAQ AND WAYS OF DEVELOPMENT

MASTER'S THESIS

Mohammed Ali Abdullah AL-MOHAMMED

Engineering Management Master in English Program

JULY 2021

T.C.
ISTANBUL GEDİK UNIVERSITY
INSTITUTE OF GRADUATE STUDIES

THE REALITY OF SOLID WASTE MANAGEMENT IN IRAQ AND WAYS OF DEVELOPMENT

MASTER'S THESIS

Mohammed Ali Abdullah AL-MOHAMMED
(191281015)

Engineering Management Master in English Program

Thesis Advisor: Prof. Dr. GÖZDE ULUTAGAY
Second Advisor: Prof. Dr. Waleed M. Sh. ALABDRABA

JULY 2021

T.C.
İSTANBUL GEDİK ÜNİVERSİTESİ
LİSANSÜSTÜ EĞİTİM ENSTİTÜSÜ MÜDÜRLÜĞÜ

Yüksek Lisans Tez Onay Belgesi

Enstitümüz, Engineering Management Department İngilizce Tezli Yüksek Lisans Programı 191281015 numaralı öğrencisi Mohammed Ali Abdullah AL-MOHAMMED'in "The Reality of Solid Waste Management in Iraq And Ways of Development the Reality of Solid Waste Management in Iraq And Ways of Development" adlı tez çalışması Enstitümüz Yönetim Kurulunun 07/07/2021 tarihinde oluşturulan jüri tarafından *Oy Birliği* ile Yüksek Lisans tezi olarak *Kabul* edilmiştir.

Öğretim Üyesi Adı Soyadı

Tez Savunma Tarihi: 07/07/2021

1) Tez Danışmanı: Prof. Dr. Gözde ULUTAGAY

2) Jüri Üyesi: Dr. Öğr. Üyesi Redvan GHASEMLOUINA

3) Jüri Üyesi: Prof. Dr. Sevcan DEMİR ATALAY

DECLARATION

I, Mohammed Ali Abdullah AL-MOHAMMED, do hereby declare that this thesis titled as "The Reality of Solid Waste Management in Iraq And Ways of Development the Reality of Solid Waste Management in Iraq And Ways of Development" is original work done by me for the award of the masters degree in the faculty of Engineering Management. I also declare that this thesis or any part of it has not been submitted and presented for any other degree or research paper in any other university or institution. (07/07/2021)

Mohammed Ali Abdullah AL-MOHAMMED

DEDICATION

I dedicate this project to my parents, my colleagues, and encourage them, to all my teachers throughout my scholastic journey who have actively contributed to lighten my path. To my professors at the International Academy for Leadership and Development who have always been by my side.

PREFACE

In the beginning, My thanks and gratitude to my supervisor, Prof. Dr. GÖZDE ULUTAGAY, She always encourages and supports me with her guidance and observations, I appreciate her very much.

My thanks and appreciation for my second supervisor Prof. Dr. Waleed M. Sh. Alabdraba for his major works His supervision, direction, and encouragement of my research is invaluable, and I appreciate that.

My sincere appreciation to professor Muhammad Ahmad Najemalden who helped us collect data and official statistics.

July 2021 Mohammed Ali Abdullah AL-MOHAMMED

TABLE OF CONTENT

Page

PREFACE ..... **v**
TABLE OF CONTENT ..... **vi**
ABBREVIATION ..... **viii**
LIST OF TABLES ..... **ix**
LIST OF FIGURES ..... **xi**
ABSTRACT ..... **xii**
ÖZET ..... **xiii**
1. INTRODUCTION **1**
1.1 Overview 1
1.2 Importance of waste management 2
1.3 The Study Problem 3
1.4 Study Objectives 3
1.4.1 General Objectives 3
1.4.2 Specific objectives 3
1.5 Study Questions 4
1.5.1 General questions 4
1.5.2 Specific questions 4
1.6 Research Significance 4
1.7 Research Scope 4
2. LITERATURE REVIEW **5**
2.1 Review of Theoretical Literature 5
2.2 The Concept of Waste 8
2.3 Study Area 8
2.3.1 Baghdad Governorate 10
2.3.2 Kirkuk Governorate 11
2.4 Waste Management in the Iraqi Context 12
2.4.1 Overview of waste management in Iraq 12
2.4.2 The problem of waste management in Iraq 13
2.4.3 Waste management in Baghdad and Kirkuk Governorates 14
2.4.3.1 Baghdad governorate 14
2.4.3.2 Kirkuk governorate 20
3. METHODOLOGY **26**
3.1 Study Design 26
3.2 Research Approach 26
3.4 Population & sample size 27
3.5 Type & Sources of Data 27
3.5.1 Primary data 27
3.5.2 Secondary data 27
3.6 Data collection methods 28
3.6.1 Questionnaire 28
3.6.2 Document review 28

3.7 Validity and Reliability of Instrument 29
3.8 Methods of data analysis 30
3.8.1 Quantitative data 30
3.8.2 Qualitative data 31
3.9 Data analysis software 31
3.9.1 Statistical techniques 31
4. DATA ANALYSIS AND RESULTS 33
4.1 Analysis of interview data 33
4.1.1 Background information about participants in the interview 33
4.1.2 Presentation of interview data 33
4.2 Analysis of questionnaire 38
4.2.1 Simple percentage analysis 38
5. DISCUSSION AND CONCLUSIONS 55
5.1 Study Findings 55
5.2.1 Recommendations 57
REFERENCES 60
APPENDIX 64
RESUME 68

ABBREVIATION

COSIT : Central Organization for Statistics and Information Technology
EPA : Environmental Protection Agency
EPHA : Environmental Public Health Act
MSWM : Municipal Solid Waste Management
NSWMP : National Solid Waste Management Programme.
OECD : Organization for Economic Cooperation and Development.
SPSS : Statistical Package for the Social Sciences

LIST OF TABLES

Page

Table 1.1: Capita production of household waste 2
Table 2.1: The ideal distribution of weighted percentages of municipal solid waste's main components in the low, middle, and high-income countries..... 6
Table 2.2: Composition of municipal solid waste in the city of Baghdad 7
Table 2.3: Assesses the rate of municipal solid waste produced in large and medium cities (Kg / person / day) 7
Table 2.4: Iraq's population and overpopulation (MICS6, 2017) 9
Table 2.5: Population forecasting for the period (2016-2030)..... 15
Table 2.6: The percentages of waste components for Baghdad..... 15
Table 2.7: Population of Baghdad By District and Solid waste generation..... 16
Table 2.8: Distances and amount of waste in transfer stations 17
Table 2.9: landfill sites for the city of Baghdad since 2015..... 18
Table 2.10: Quantities of waste collected daily in Kirkuk and its distribution percentages according to the type of its source..... 24
Table 4.1: Demographic Q1, Gender 38
Table 4.2: Demographic Q2, Educational level 39
Table 4.3: Demographic Q3, Age 39
Table 4.4: Demographic Q4, Profession 40
Table 4.5: General information Q1, Do you have any waste bins in your home/store/stall? 40
Table 4.6: General information Q2, Are you sorting the waste generated in your home/store/stall? 41
Table 4.7: General information Q3, How is the waste collected inside the home or neighborhood?..... 41
Table 4.8: General information Q4, What is the average waste disposal time? 42
Table 4.9: General information Q5, How often is the waste transported from the collection area to the place designated for it? 42
Table 4.10: General information Q6, Who takes the waste from your home/store/stall for disposal?..... 43
Table 4.11: General information Q7, Where is the waste taken for disposal?..... 43
Table 4.12: General information Q8, Which waste items do you think should be sorted for recycling?..... 44
Table 4.13: Skew & Kurtosis results, with descriptive statistics 46
Table 4.14: Attitude Q1, Are you ready to compost your garden waste? 46
Table 4.15: Attitude Q2, Are you ready to compost food waste?..... 47
Table 4.16: Attitude Q3, In the future, are you willing to pay for the collection of the waste that you generate in your home/store/stall? 48
Table 4.17: Attitude Q4, The municipality does not have healthy and environmentally safe waste dumps?..... 49
Table 4.18: Attitude Q5, There are no appropriate policies and laws that enhance the effectiveness of solid waste management? 50

Table 4.19: Attitude Q6, If containers are provided for waste sorting, are you prepared to commit to throwing garbage in the designated place? 51
Table 4.20: Attitude Q7, There are unhealthy random dumpsites in your city? 52
Table 4.21: Attitude Q8, The municipality does not have enough manpower and vehicles to transport waste? 53

LIST OF FIGURES

Page

Figure 2.1: Map of Iraq 9
Figure 2.2: Average age of the Iraqi population. 9
Figure 2.3: Percentage of urban and rural areas in Iraq. 10
Figure 2.4: Map of Baghdad 10
Figure 2.5: Map of Kirkuk 11
Figure 2.6: A map of waste collection departments in Kirkuk. 12
Figure 2.7: Population in Baghdad for each year for the period (1996-2015) 14
Figure 2.8: The percentages of waste components for Baghdad. 16
Figure 2.9: Total quantity of MSW generation (2012-2015). 17
Figure 2.10: The amount of waste in transfer stations 18
Figure 2.11: Solid waste management processes 19
Figure 2.12: estimating the percentages of waste components in Kirkuk 21
Figure 2.13: A general view of the waste transfer station north of Kirkuk 22
Figure 2.14: A satellite image of the Kirkuk landfill and methods of linking to waste transfer stations 23
Figure 2.15: Percentage of the population enjoying a waste collection service in Kirkuk compared to other Iraqi governorates in the year 24
Figure 4.1: Demographic Q1, Gender, and Q2, Educational level 39
Figure 4.2: Demographic Q3, Age and Q4, Profession 40
Figure 4.3: General information Q1 and Q2 41
Figure 4.4: General information Q3 and Q4 42
Figure 4.5: General information Q5 and Q6 43
Figure 4.6: General information Q7 and Q8 44
Figure 4.7: Normality assessment 45
Figure 4.8: Attitude questions Q1 and Q2 48
Figure 4.9: Attitude questions Q3 and Q4 50
Figure 4.10: Attitude questions Q5 and Q6 52
Figure 4.11: Attitude questions Q7 and Q8 54

THE REALITY OF SOLID WASTE MANAGEMENT IN IRAQ AND WAYS OF DEVELOPMENT

ABSTRACT

Waste management operations are the collection, transportation, and disposal of residential, commercial, institutional, construction, demolition, and street sweeping areas.

The result of the daily activity of the human species needs to be properly managed. Iraq faces many problems associated with its unregulated waste systems, However, this study examined the reality of waste management in Iraq and ways to develop it.

The total number of participants in the research was 326 participants ,The data was collected in February and March 2021, interview methodology and questionnaire were used and the analysis software used for this research is IBM SPSS version 23.

The study discovered by analyzing the data results ,The municipality's weak role in waste management, the lack of fixed timetables for waste collection, and 64% agreed that there is no sorting of waste from the source, Also, the lack of cooperation and coordination between the public and the municipality, 39% agreed that most municipalities do not have healthy and environmentally safe landfills for waste disposal, 33% strongly agreed that There are no appropriate policies and laws that enhance the effectiveness of solid waste management, 49% strongly agreed that residents are ready to sort the waste in the designated place in case the containers are provided by the municipality, 53% agreed that residents are willing to pay for collecting waste from their homes or stores.

Depending on the results of the study recommended It was found that Iraq needs stations for the transfer of waste and stations for recycling plastic, paper, and metals, in addition to that there is a need for sanitary landfills that are compatible with environmental conditions.

The municipality should play a greater role and give the opportunity to invest in waste management and give the private sector a greater role in waste management process and overcome The obstacles that hinder the work of investment companies, in addition to raising community awareness by holding educational workshops in schools and universities to spread environmental awareness in society and warn of the dangers of solid waste accumulation in residential neighborhoods ,Discussions, limitations, suggestions, and recommendations give more details.

Keywords: *Management, Municipality, Solid waste, Environmentally.*

IRAK'TA KATI ATIK YÖNETİMİNİN GERÇEKLİĞİ VE GELİŞME YOLLARI

ÖZET

Katı atık yönetimi operasyonları, konutsal, ticari, kurumsal, inşaat, ve sokak süpürme alanlarının toplanması, taşınması ve bertaraf edilmesidir. İnsan türünün günlük faaliyetinin sonucunun uygun şekilde yönetilmesi gerekir. Irak, düzensiz katı atık sistemleriyle bağlantılı birçok sorunla karşı karşıyadır. Bu çalışmada Irak'taki katı atık yönetimi gerçekliği ve geliştirme yolları incelenmiştir. Araştırmaya 326 kişi katılmıştır. Veriler Şubat ve Mart 2021 döneminde yüzyüze görüşme ve anket yöntemi ile toplanmış ve IBM SPSS 23 istatistiksel yazılımı kullanılarak analiz edilmiştir.

Toplanan verilerin analiz edilmesiyle, belediyenin atık yönetimindeki rolünün zayıf olduğu, atık toplama için sabit zaman çizelgelerinin olmadığı ve halk ile belediye arasında işbirliği ve koordinasyon eksikliği olduğu sonuçlarına varılmıştır. Çalışmaya katılanların %64'ü kaynaktan gelen atıkların ayrıştırılmadığı, % 39'u çoğu belediyenin atıkların ber tarafı için sağlıklı ve çevre açısından güvenli çöp sahalarına sahip olmadığı, % 33'ü katı atık yönetiminin etkinliğini artıran uygun politikalar ve yasalar olmadığı ve % 49'u bölge sakinlerinin çöpleri ayırmaya hazır olduğu düşüncesindedir. Ayrıca, atık konteynerlerin belediye tarafından sağlanması durumunda belirlenen yerde olması durumunda , çalışmaya katılanların % 53'ü konut sakinlerinin evlerinden veya mağazalarından atık toplamak için para ödemeye razı olduklarını kabul etti.

Çalışmanın sonuçlarına göre, Irak'ta atıkların taşınması için istasyonlara ve plastik, kağıt ve metallerin geri dönüşümü için istasyonlara ihtiyaç duyulduğu, bunun yanında çevre koşullarına uygun düzenli depolama alanlarına ihtiyaç olduğu ortaya çıkmıştır.

Belediye atık yönetimine yatırım yapma fırsatı vermeli ve bu konuda daha büyük bir rol oynamalıdır. Ayrıca, katı atık yönetimi sürecinde özel sektöre daha büyük bir rol vermeli ve yatırım şirketlerinin çalışmalarını engelleyen kısıtlamaları aşmalıdır. Bunun yanında, çevre bilincini toplumda yaygınlaştırmak ve yerleşim yerlerinde katı atık birikiminin tehlikelerine karşı uyarmak için okullarda ve üniversitelerde eğitim atölyeleri düzenleyerek toplum bilincini arttırmalıdır.

Anahtar Kelimeler: *Yönetim, Belediye, Katı Atık, Çevre*

1. INTRODUCTION

1.1 Overview

Waste that is disposed of as useless or undesirable waste can be classified in several ways, based on sources, environmental hazards, facilities, and physical properties; also Depending on the source, solid waste is classified as municipal, agricultural , and industrial waste (Okecha, 2000).

Waste management is not an easy task in developing and developed countries, as it is considered of contemporary environmental problems in urban areas, developing countries lack adequate infrastructure facilities, improper planning associated with population growth, and rapid development to increase congestion on the streets. Thus it is difficult for vehicles to collect garbage and reach these places, allowing dirt to accumulate over time (Pattnaik, Reddy, 2010), (Achankeg, 2004).

Solid waste is different things for different people; Many people believe that waste is a source of income. Recognizing waste as a problem is not sufficient to prevent dumping of waste. The process of waste management is to prevent waste that harms society and the environment in a healthy way (Moore, 2012).

Waste generation and its potential impacts on health, environmental quality, all stakeholders concerned with our environment's safety and beautification have recognized the negative impacts of the un-removed solid human waste in residential neighborhoods, markets, as a result, urban residents often face a serious impact on their collective health and safety.

The government must arrive urgently to combat solid waste, reduce its negative impact on the population of the region, and reflect the cultural image of the country. More plans and programs must be put in place permanently to combat the harmful effects of environmental degradation, It is understood that it will require effective resource mobilization, for example all stakeholders' involvement in regular countermeasures to suppress the generation of unsupervised solid waste and the erratic disposal completely outside the city limits (Zerbock Olar, 2003).

1.2 Importance of waste management

The process of monitoring waste is collected, transported, treated, recycled or disposed of, to mitigate negative environmental and health consequences. It is also used to obtain resources from the recycling path, as in societies that have excessive consumption of various products, and which do not depend on rich countries.

However, the infection spread to developing countries, and their consumption increased over their production. This huge increase in consumption is accompanied by a steady increase in the volume of waste that must be disposed of every day, especially in large and densely populated cities.

See Table 1.1, as all countries suffer from this problem because of the accumulation of this waste day after day, and this waste represents a great burden on the shoulders of those in charge of these cities, as these wastes must be disposed of every day in the interest of public health (Abu Ruwaida, Al-Taher, 2003).

Table 1.1: Capita production of household waste

Country	Individual production(Kg/day)
USA	2,0
Germany	1,1
France	0,7
KSA	1,3
Kuwait	2,1
Tunisia	0,8
Iraq*	1.4

Resource: (Khayal, 2000).

Today, local and federal authorities in Iraq are working to remove piles of waste from their environments. But these attempts are outdone by the chaotic nature of overflowing dumps and piles of solid waste emanating from household sources, institutions, markets, malls, and businesses ;that the authorities in Iraq are unable to control the indiscriminate dumping, which is a clear violation of laws and environmental sanitation regulations (Ahmed, 1988).

1.3 The Study Problem

The solid waste management process requires great effort; as we all know ,the accumulated waste creates many problems for people, including sewage blockage (floods), traffic congestion, health, and environmental risks.

Environmental pollution in urban centers due to solid waste is a major concern for the international community because pollution in any way does not comply with our good chain, health, comfort, and average per capita production of waste in the municipality of Iraq 1.4 kg/person/day. The current waste management system in Iraq will not be able to deal with Waste rates produced daily, and the change of lifestyle in Iraq has greatly affected the uncontrolled increase in the quantities of waste.

Therefore, there is an inherent and urgent need for Iraq to move towards radical solutions for waste management, the lack of financial resources, at times, leads to inefficient vehicles or the absence of waste disposal vehicles, which adds another dimension to the growing cycle of problems.

The indiscriminate and unplanned dumping, which is often a flagrant violation of the relevant rules and regulations, Also the existence of a large gap between policy formulation and implementation, all these reasons lead to an increase in the problem of waste in Iraqi cities, which necessitates an assessment of the current problems and the Developmental development solutions for it.

1.4 Study Objectives

1.4.1 General Objectives

Study is to identify the reality of waste management in Iraq and the factors that affect their effectiveness and ways of development.

1.4.2 Specific objectives

1. Verify and discover the functioning of the waste management system in Iraq.
2. Assess the current performance of municipalities in waste management.
3. Know waste disposal practices and explore the challenges facing state agencies in solid waste management.

4. Provide suggestions and recommendations for developing a waste management system and finding solutions to current problems.

1.5 Study Questions

1.5.1 General questions

"What is the reality and issues of solid waste management, and how can they be solved and developed in Iraq?"

1.5.2 Specific questions

1. Knowing the current reality of solid waste management in Iraq?
2. Assess the current situation of waste collection and transportation operations in Iraq?
3. What is the role of the city municipality in managing solid waste?
4. What should the city municipality do in managing solid waste?
5. Submit proposals to develop a waste management system?

1.6 Research Significance

Study will give the current reality of waste management to the general public, environmental management stakeholders, government, and policy makers to define management strategies to combat risks associated with solid waste mismanagement.

Submit proposals for advanced waste management solutions, and this research will be an information base for researchers interested in conducting further research in this area at a later time.

1.7 Research Scope

This study will focus on studying the reality of solid waste management in Iraq in general, in Baghdad and Kirkuk's governorates in particular, and finding appropriate ways to manage waste by providing suggestions and recommendations.

2. LITERATURE REVIEW

This chapter will start with some basic concepts and terminology related to this thesis and review the relevant literature in the study area, the reality of waste management in the Iraqi context will be investigated, then the study area will be discussed, the data presented, and the integrated waste management presentation will be finalized.

2.1 Review of Theoretical Literature

This section includes a summary of some studies and research on international and local issues that dealt with important aspects of the solid waste issue consistent with research objectives.

(Morwood, 1994) concluded that the proportion of food waste in Australia is: 23.6% of solid waste, while the rest of the other basic components such as paper, plastic, glass, and minerals accounted for 39.1%, 9.9%, 10.2%, and 6.6%, respectively.

(Abu Ruwaida, 1998) estimated that the amount of solid waste generated in the UAE is About 2.7 million tons per year (excluding construction and demolition waste), constitutes domestic solid waste about 50-60% of these wastes are mostly recyclable and reusable due to their containment Contains a large percentage of clean ingredients that include paper and plastic waste materials glass and metal. These numbers differ from the African scenario, as each From () Masundire & Sanyanga, 1999, the household solid waste in the city of Chira Nadu Chirundu in Zambia contains a high percentage of food waste, reaching 72% as for ingredients Other basic components, such as paper, plastic, and metals, have a rate of 10%, 7% and 6% Straight (Abu Ruwaida, Al-Taher, 2003).

METAP, 1999, in a study conducted in Homs, Syria, indicated that the wastes are: Biodegradable materials make up 58.9% of total household solid waste, the amount of production in the city is around 300 tons per day. On food scraps, paper, and cardboard, as well as textiles, leather, and wood While the percentage of inorganic

and degradable waste was 14.1% of the amount of waste generated in the city, which includes plastics, glass, metals, and hazardous waste in addition to stones and ash.

Table 2.1: The ideal distribution of weighted percentages of municipal solid waste's main components in the low, middle, and high-income countries

The ingredients	**The weight percentage of ingredients%**		
	Low-income	Middle-income	High-income
Food scraps	40 - 85	20 - 65	7 – 55
Paperand cardboard	1 - 10	15 – 40	15 – 50
Plastic	1 – 11	2 – 13	2 – 20
Leather / rubber	1 – 3	1 – 5	2 – 12
glass	1 – 10	1 – 10	4 - 10
Minerals	1 - 5	1 – 5	3 - 13
Sand, dirt, ash, textiles	15 – 50	15 – 40	5 – 20

From the above table, we note that the percentage of food waste is higher in low-income countries than in high-income countries; this is mainly due to the lack of pruning and preparation of foodstuffs for direct use in low-income countries.

In general, Stegman et al. (2006) estimated that the percentage of organic matter present in Household solid waste in Asian countries ranges from (85-40%), while the amount of these materials in Household solid waste constitutes 29% in European countries.

In Iraq, policies, and strategies for solid waste management, in general, are still ineffective due to the lack of a serious look in this area, and this is due to many reasons: the lack of financial resources allocated to this area and the lack of technical know-how and technical resources (Qusayr, 1978) indicated that Getting rid of waste from Baghdad by burning is considered an uneconomic issue, due to its high moisture content of 78.7% and the percentage of rotting material 90% , Able to find the weighted percentage values of the material components of municipal solid waste in the city of Baghdad and obtain the following results listed in Table (2.2).

Table 2.2: Composition of municipal solid waste in the city of Baghdad

The ingredients	Weighted percentage%
Organic waste	90
Paper	5
Plastic	1
Glass	2
Minerals	1
Other materials	1

The Canadian company (Stenley International, 1987) came up after studying the reality of the situation solid waste in the city of Baghdad indicates that the burning of solid waste is economically expensive due to the rise The moisture content of 48% and the proportion of rotting materials, which amounted to 58.64% While (Alnakeeb, 2007) in his study in Baghdad classified household solid waste There are six categories: organic, paper, plastic, glass and metal waste, and inorganic waste.

(Cointreau,2006) showed that city size is related to the rate of municipal solid waste production, in different income countries, where this relationship is positive, the larger the city, the higher the per capita production of municipal solid waste, as shown in Table (2.3), which shows the values of municipal solid waste produced in large, medium cities.

Table 2.3: Assesses the rate of municipal solid waste produced in large and medium cities (Kg / person / day)

Production rate (kg / person / day)	Low-income countries	Middle-income countries	High-income countries
Big cities	0.5 – 0.75	0.55 – 1.1	0.75 – 2.2
Medium cities	0.35 – 0.65	0.45 – 0.75	0.65 – 1.5

According to the study by the US Environmental Protection Agency (USEPA), 2008 agency found that the average per person production of municipal solid waste is in the United States It increased from (1.66 kg/person/day) to (2.09 kg/person/day) during the period between The years 1980 and 2007 were the highest recorded in municipal solid waste produced during that period In 2004, it reached (2.11 kg/person/day).

2.2 The Concept of Waste

Waste results from the daily movement of human activities. Long ago, waste generation rates and quantities boomed, and work began generating waste in the 16th century, from regions to cities because of the Industrial Revolution.

When people began to migrate to the cities, this led to a massive population explosion that increased the amounts of waste generated; Materials such as plastic, paper, and metal are beginning to appear in large quantities in cities.

Lots of people in cities and communities throw waste in open dumps. These landfills, in turn, formed breeding grounds for rats and other insects and began to pose significant public health risks (Brunner, Rechberger, 2014), (Chandler, Eighmy, Hjelmar, Kosson, Sawell, Vehlow, Sloot, 1997).

Unhealthy waste management practices led to outbreaks of epidemics that led to large numbers of deaths, today, these countries have effectively addressed many of the health and environmental pollution issues associated with waste generation, the increasing rate of urbanization and emerging developments are now leading countries to repeat the same historical mistake that developed countries had to address (Vergara, Tchobanoglous, 2012), (Wilson, 2007), (Williams, 2005).

Therefore, the only article can It is considered a waste when the owner calls it that despite this subjective nature Waste, it is important to describe clearly, what constitutes a waste because of this because the classification The materials as waste will form the basis of the regulations required to protect the population The Environment in which waste is treated or disposed of (Basu, 2009), (Cheremisin off, 2003).

2.3 Study Area

In this section, information is provided about Iraq, the country in which this research was conducted, and Baghdad and Kirkuk's cities, the study area.

Iraq is from the countries in the far east of the Arab world, from the north, Turkey, the east, Iran, the west, Syria and Jordan, and the south, Saudi Arabia and Kuwait. It extends between latitudes 29 and 27 north and between longitudes 38 and 48 east (Central Statistical Organization, 2018)

Figure 2.1: Map of Iraq

Iraq is considered from the countries suffering from overcrowding, with more than 38 million. Statistics indicate that Iraq produces 31,000 tons/day of solid waste, with per capita waste exceeding 1.4 kg/day, and Baghdad alone produces more than 1.5 million tons / A year of waste.

Table 2.4: Iraq's population and overpopulation (MICS6, 2017)

Population	
Total population	38,124,182
Population growth rate (%)	2.58
Gender ratio (male to female at birth)	102.1

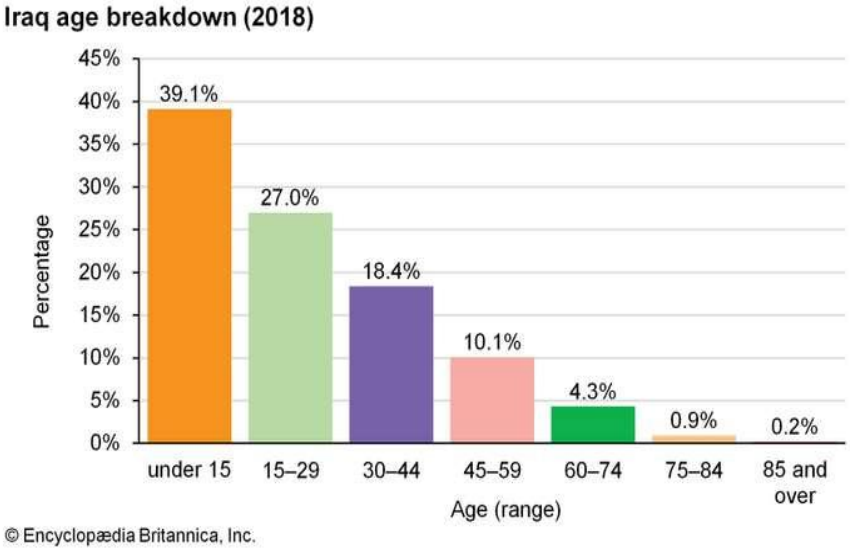

Figure 2.2: Average age of the Iraqi population.

Resource: (Hugh Kennedy, Majid Khadduri and Others, 2020).

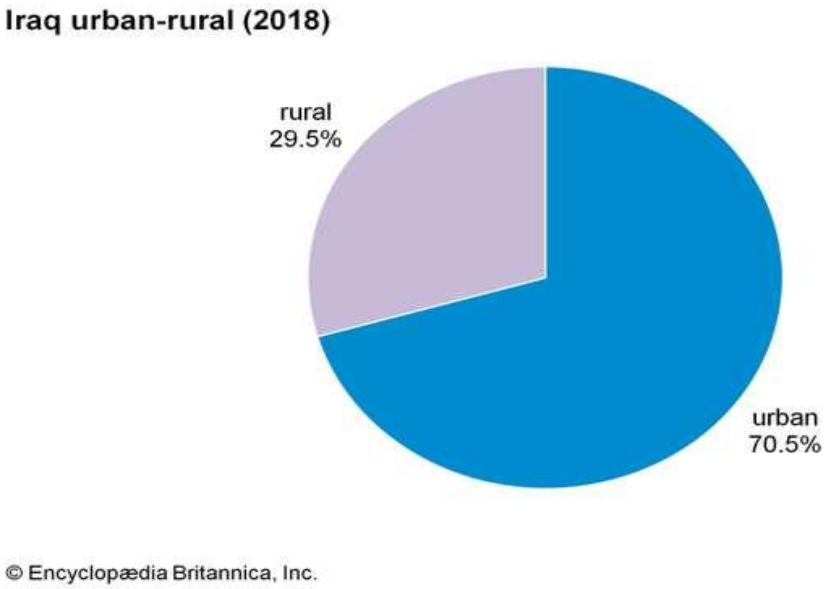

Figure 2.3: Percentage of urban and rural areas in Iraq.

Resource : (Hugh Kennedy, Majid Khadduri and Others, 2020).

2.3.1 Baghdad Governorate

Baghdad is the Iraqi capital, the largest city in Iraq, Its population is about 8 million people, and its area is 204.2 km², the city of Baghdad produces about 8-10 thousand Tons/day, and it produces more than 2.5 million tons of solid waste annually (Ammant Baghdad lraq ,2010,2012,2014,2015).

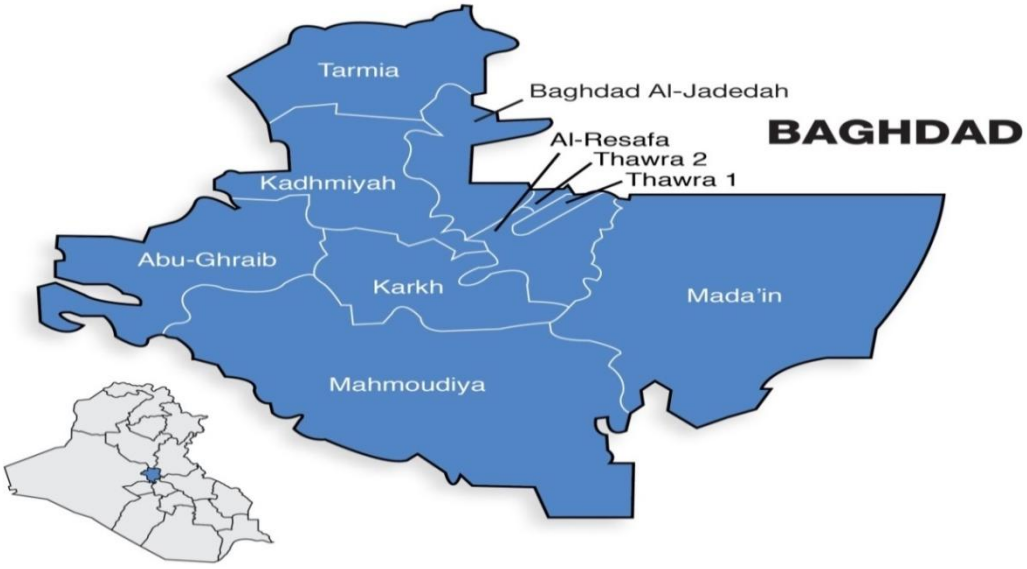

Figure 2.4: Map of Baghdad

Baghdad governorate covers an area of 5159 km2, of which 900 km2 of the area of the city of baghdad is managed by the Baghdad Municipality and is divided into (14)

municipalities. There are administrative units outside the Baghdad Municipality borders (Abu Ghraib, Mahmoudiya, Taji, Rashidiya, and Al-Madaen). The number of people in Baghdad is about (7) million people, the amount of municipal waste in Baghdad's city reached 34958605 tons/year, while Baghdad's outskirts amounted to 306016 tons /year (Ammant Baghdad lraq ,2010,2012,2014,2015).

2.3.2 Kirkuk Governorate

Kirkuk is one of the important cities in Iraq, located in the northern part of it, about 286 km north of Baghdad, and its area is about (110) km2. It touches the south, Tikrit from the southwest, Diyala from the southeast, Sulaymaniyah from the northeast, Arbil and Mosul from the north and northwest, the city is divided by a seasonal river (the Khas river) in an almost equal length, this city is inhabited by different nationalities, religions, and sects (Kurdish, Arab, Turkmen, Chaldo-Assyrian) (Muslim and Christian).

The city of Kirkuk has increased at a rate of (3% annually) as of 2010. Over the past two decades, the city's population was expected to increase from 1,050,000 people in 2008, to 1,445,556 people in the year 2020 (Al-Najjar, Walid Muhammad Suleiman, 2012).

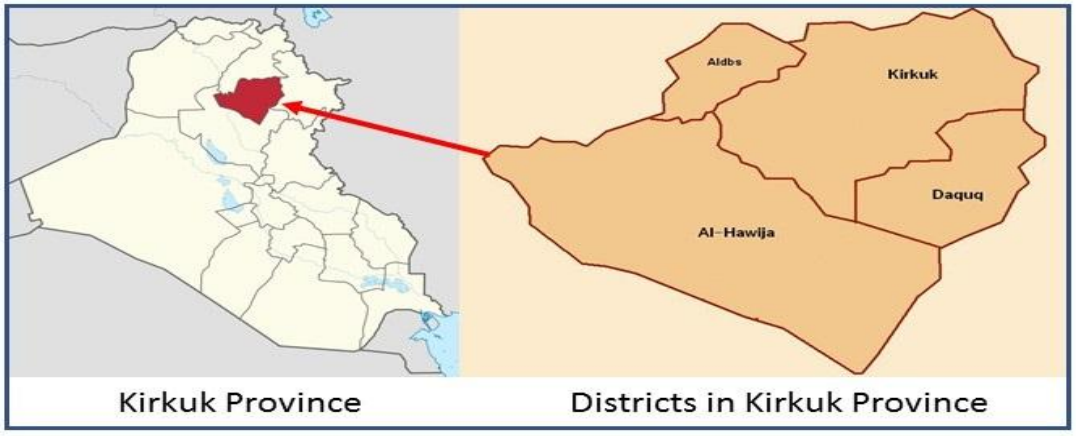

Figure 2.5: Map of Kirkuk

MSW is collected from garbage containers/bins distributed throughout Kirkuk by a fleet of vehicles. Waste collection Services include municipal waste collection (residential, commercial, industrial, and street sweeping) ;waste is collected in the city of Kirkuk by two private companies and the municipality of Kirkuk. In contrast,

waste is collected In all other cities such as Taza, Dibes, and Laylan, through their solid waste directorates.

The plan is divided the Current collection of waste from the city of Kirkuk into six adjacent sections (the boundaries between them are shown in Figure (-). Al-Khasa River separates the waste collection departments into Three sections on the eastern side of the city of Kirkuk (Sections 1, 3, and 5) and three sections on the western side (sections 2, 4, and 6) (IMSphere Consulting Inc, 2017).

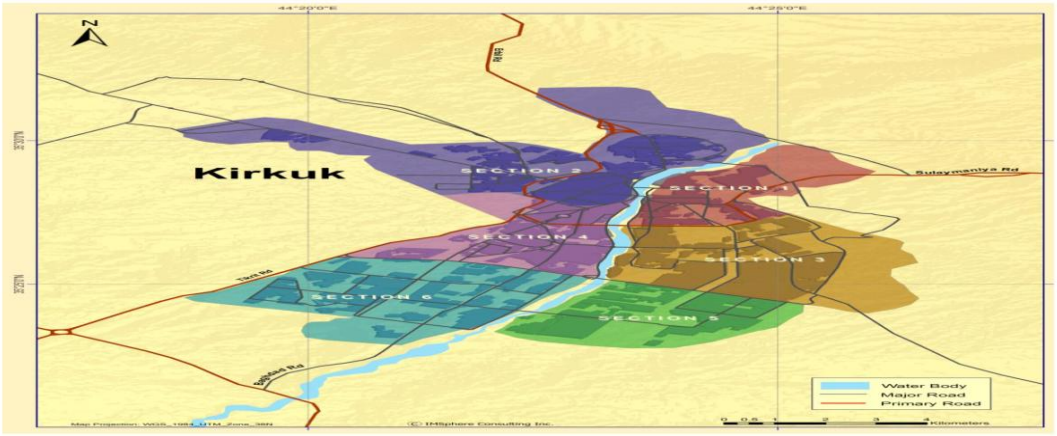

Figure 2.6: A map of waste collection departments in Kirkuk.

2.4 Waste Management in the Iraqi Context

2.4.1 Overview of waste management in Iraq

Iraq is one of the countries whose population is growing rapidly, with a population of 40 million, According to estimates, Iraq's solid waste production is estimated at 31 thousand tons per day; each person produces approximately 1.4 kilograms/day.

Most of the waste is disposed of in random and environmentally unsafe landfills across Iraq; accidental fires, groundwater pollution, surface water pollution, and greenhouse gas emissions are widespread in Iraqi landfills, In 2007 a plan was undertaken to develop waste management (NSWMP) for Iraq by collaborating with international waste management specialists.

A plan has been drawn up that Iraq will establish 33 global standard environmental landfills with a capacity of 600 million cubic meters in all Iraqi provinces by 2027; Landfills will also be built and focused on the processes of collection, transportation, individual use, and recycling (Ashraf Yahya Alnajjar, 2019).

2.4.2 The problem of waste management in Iraq

The waste problem starts from the lack of government legislation and instructions, Also the absence of public awareness of environmental problems because of the unstable security status. solid waste or garbage is everywhere, and municipalities rarely find ways to collect it And get rid of it and the laziness and indifference of the population in this area is how piles of garbage stay in place; their thickness and bedding increases day after day and accumulates on the roadsides, scratching the public taste.

The effect of solid waste is not limited to aesthetic damage in cities, nor is it limited to Damaging the direct health aspect in it, but its repercussion is clear on all resources; the solid waste problem in most third world countries can be summarized as follow (European Environment Agency, 2001):

1. The lack of advanced means to get rid of solid waste piles resulting from the activities Daily.
2. The insufficient financial resources and the lack of capabilities and equipment impede without achieving a standard Service required.
3. The method of managing all kinds of solid waste is characterized by ineffective partial solutions, resulting in negative economic, health, and environmental impacts.
4. Lack of environmental legislation related to solid waste management and its implementation.
5. The accumulation of solid waste in dumps, most of which are open and do not meet the technical and environmental conditions.
6. The ill-considered and unscientific mixing between solid waste, including hazardous waste, poses a danger to all Environmental components in final landfills.
7. The lack of an accurate database on solid waste production rates and seasonal quantities of that waste.
8. Decreased general environmental awareness, misconduct in dealing with solid waste, and lack of dissemination of Environmental culture in society.
9. Lack of encouragement of recycling and reuse operations, and lack of investment in them (Haneen Ahmed K. AL- Qaraghully, 2001).

2.4.3 Waste management in Baghdad and Kirkuk Governorates

2.4.3.1 Baghdad governorate

Baghdad's total urban population went up from 2.14 million in 1970 to 6.7 million in 2005 and increased to 7.0 million in 2015. MSWM became one of the major environmental problems in Iraq, especially in Baghdad city in the last ten years after 2003 since the sharp increase in the volume of solid waste generated and quantitative change in its composition.

Population forecasting in Baghdad for the period 2016-2030 is estimated based on:

$Pi = Po(1 + r)^n$, Pi= future population at the end period, 2030. Po = present population for a year, 2015. n = number of years. r = annual rate of growth (2.4 %). Fig – showed the Population in Baghdad for each year for the period (1996-2015) (Ammant Baghdad lraq, 2010,2012,2014,2015).

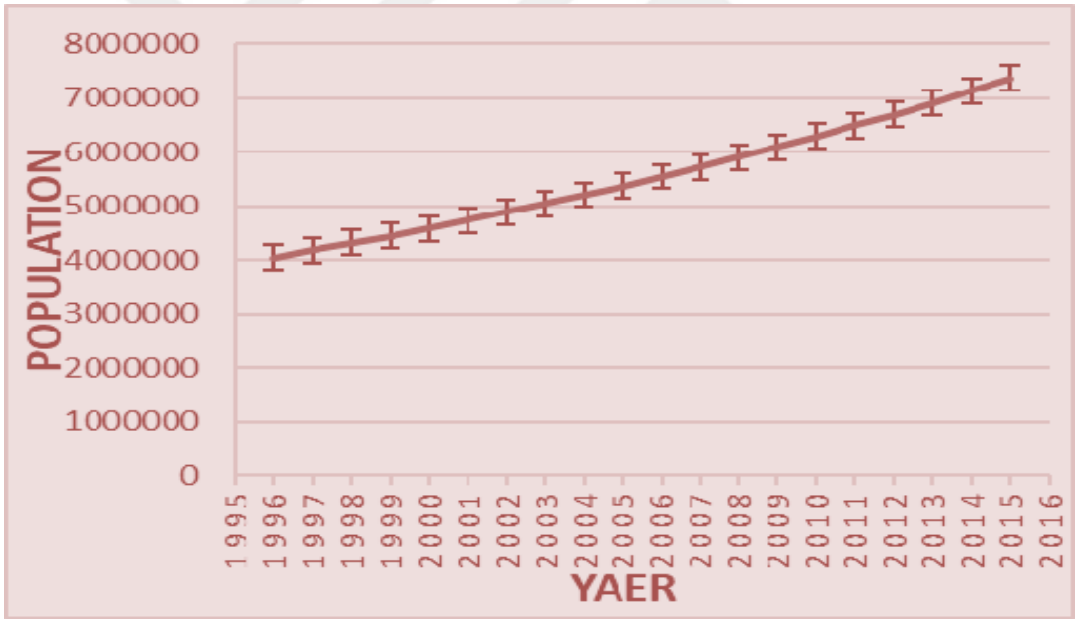

Figure 2.7: Population in Baghdad for each year for the period (1996-2015)

Daily production of solid waste in any future years is:

P*Wo $(1 + r)^n (1 + c)^n$.

P = future population at the end of period; r= Percentage of growth rate; n = difference between the future and the base years; Wo= actual production of solid waste (kg/person/year); C = percentage annual increase in solid waste (assumed C =

0.03 in the records of Ammant Baghdad) (Ammant Baghdad lraq ,2010,2012,2014,2015).

Table 2.5: Population forecasting for the period (2016-2030).

Year	Population	Year	Population
2016	7604120	2024	9783326
2017	7847452	2025	10096393
2018	8089570	2026	10419477
2019	8357724	2027	10752900
2020	8625172	2028	11096993
2021	8901177	2029	11452097
2022	9186015	2030	11818564
2023	9479967		

Resource: (Al-Rawi, Al-Tayyar, 2012).

The amount of municipal solid waste generated in the city of Baghdad is 14,342,958 tons between (2012-2015) at a rate of (0.6-1.2) kg/day. The percentage of different types of waste in the MSW in Baghdad city and Iraq are represented in Table 2.6, Organic waste was the largest percentage of waste, nearly 50%, while paper, plastics, metals, and glass came in second, third, fourth and fifth places with 18.5%, 17.7%, 7 and 6.5, respectively (Akla, Suad Abd Mahdi, 2015).

Table 2.6: The percentages of waste components for Baghdad

	Subject	Percentage%
1	Organic materials, including food	50.3
2	Paper, including cartons and cellulosic materials	18.5
3	Plastic	17.7
4	Metals (ferrous and non-ferrous)the glass	7
5	The glass	6.5

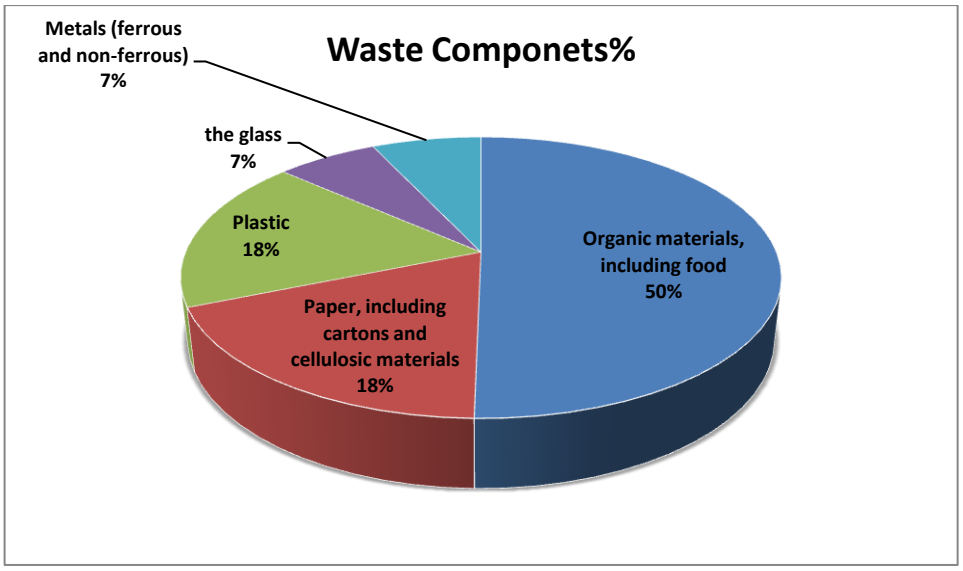

Figure 2.8: The percentages of waste components for Baghdad.

A waste management system is inefficient within the municipalities in Baghdad, causing exhaustion municipal budgets to consume large sums of money and increasing the amount of waste generation; limited financial sources are coupled with our dated machines and equipment, poor maintenance operations, and low wages.

Table 2.7: Population of Baghdad By District and Solid waste generation

	District	Population * 1000	Area (km2)	Amount of solid waste generation ton/day
1	Rusafa	350	24	600
2	Karadah	550	68	500
3	Mansour	550	126	510
4	Sadar	1550	54	1150
5	Sho'la	600	89	295
6	Shaab	390	98	270
7	Doura	300	78	260
8	Baghdad ALjadidah	650	66	325
9	Adhamiyah	350	27	270
10	Kadhimiyah	390	56	320
11	Rasheed	450	130	400
	Total	**6,630**	**885**	**5565**

Resource: (Ammant Baghdad Iraq ,2010,2012,2014,2015).

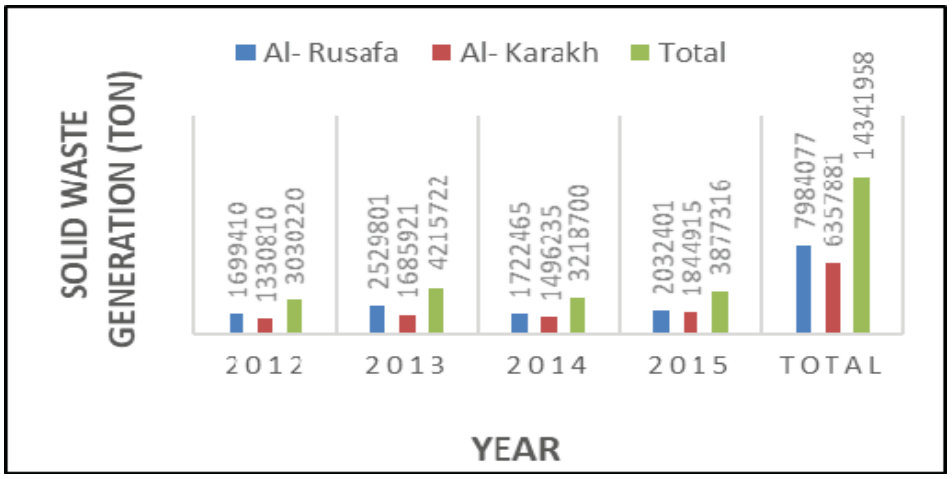

Figure 2.9: Total quantity of MSW generation (2012-2015).

Table (2.8) and Fig (2.14) indicate the number of regular transfer stations in Baghdad and the carrying capacity. Each of them amounts to (500) tons/day. The Table indicates the total amount of waste going out to landfill sites located on Baghdad's outskirts, amounting to (2273) tons/day. Suppose this figure is compared to the capacity For transformer stations. In that case, this means that their utilization is nearly halved, which increases maintenance costs and wages Workers and others, it is mentioned that there are 30 transfer stations in Baghdad, only 11 of which are regular, and the rest are irregular and do not have environmental approval (Akla, Suad Abd Mahdi, 2015).

Table 2.8: Distances and amount of waste in transfer stations

	The station Transformational	Distance from Landfill site Nahrawan (km)	Distance from Landfill site Abu Ghraib (km)	Daily rate For municipal waste Output to the site Landfill (tons)	Number Vehicles capacity 20 tons / day	Number Vehicles The capacity of 5 tons /day
1	Mansour	71	32	214	11	44
2	Karadah	46		293	15	60
3	Ghader	38		232	12	48
4	Sadar	49		229	12	48
5	Sho'la	77	38	234	12	48
6	Shaab	42		398	20	80
7	Rusafa	42		323	17	68
8	Doura	58	42	133	7	28
9	Beah	83	40	217	11	44
	Total					**2273**

Resource: (Akla, Suad Abd Mahdi, 2015)

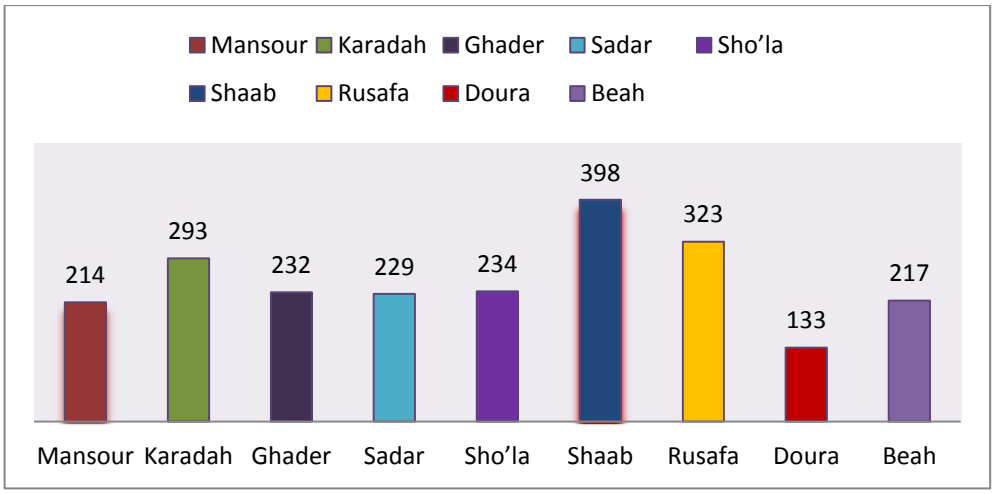

Figure 2.10: The amount of waste in transfer stations

Most of the waste in Baghdad is dumped in a sanitary randomly uncontrolled landfill; about 76% of Baghdad wastes are transported to landfill recycling, and reuse of solid waste in Baghdad city is still limited and not exceeded 20%, with no educational records related to the quality and quantity of solid waste.

Table 2.9: landfill sites for the city of Baghdad since 2015

	The name of the landfill site	Area / Acres	Notes
1	Old Amari	150	Closing in 2009 is located near Rusafa
2	Modern Amari	120	Closing in 2011 is located near Rusafa
3	Rakia and Fadel	120	Closed it is located on the side of Karkh
4	Old Abu Ghraib	150	Closed it is located on the side of Karkh
5	Modern Abu Ghraib	75	Works located on the side of Karkh
6	Sibiat	150	Closed it is located on the side of Karkh
7	Nahrawan	300	Works located in the side of Rusafa
8	Taji	65	Closed it is located on the side of Karkh
9	Al-Buithah	328	Under rehabilitation, it is located on the side of Karkh
10	Sha`ura and Umm Jadr	2	It is located on the side of Rusafa
	Total	1460	

Resource: Baghdad Municipality data,(2015)

It is noted from the Table that ten landfill sites are all illegal due to the lack of correct environmental requirements for these. They are considered landfill dumps, except for the Al-Buaitha site, a regular site, but it has not worked until now due to its exposure to sabotage acts, and it is now under rehabilitation; these sites constitute

a threat to the environment and health due to pollution of groundwater and air pollution as a result of the self-ignition process of waste.

Waste management system, including collection on transportation processes, is a major necessity in increasing productivity and efficiency; the collection and transportation machinery are included trash-trailer vehicles, compactors, dumpers of different sizes, tractors, and others. Heavy machinery is used to modify waste piles at collection sides and constructor clear roads leading to sites.

Baghdad governorate has implemented two waste sorting projects in Mahmoudiya / Al-Yusufiya district, with a production capacity (200). One ton/day and another in Alexandria, with a production capacity of 500 tons/day and a waste sorting project underway Implementation in the unit area requires obtaining environmental approval.

There is no efficient system for managing solid waste in all its classifications, The current system cannot meet society's needs, and waste is collected from special transport mechanisms to transfer stations, pressed, and sent to landfill sites (Baghdad Municipality data, 2015).

Figure 2.11: Solid waste management processes

In Iraq, waste problems are common in most cities and towns. Baghdad's city was chosen as a case study because it is the country's administrative capital and the highest percentage of the country's population, as it is considered the civilizational front of Iraq.

The Iraqi capital, Baghdad, has been complaining since 2003 of a problem that all successive governments after this date failed to solve, and badly damaged the capital, which was represented in the utter failure to manage, recycle and dispose of the waste file in a manner consistent with the environment and not to affect human health.

After the economic openness that the country witnessed, the increase in the standard of living of a large proportion of the residents of the capital, the expansion of its residential neighborhoods and commercial areas. The rate of waste of various kinds increased to more than nine thousand tons, according to statistics issued by the Baghdad Municipality in 2019, which is equivalent to many times what it was, Municipal bodies raised it 17 years ago to represent a great problem that has not been fundamentally solved (Baghdad Municipality data, 2015).

2.4.3.2 Kirkuk governorate

The city of Kirkuk has increased at a rate of (3% annually) as of 2010 over the past two decades; the city's population was expected to increase from 1,050,000 people in 2008 to 1,445,556 people in the year 2020.

That the rate of waste generation 0.44 kg/person/day and the density was, 469 kg / m3 This study identified the main waste components in Kirkuk As follows:(foodstuffs 67.5%), (plastic 6.3%), (metals 8.4%),(glass 2.5 and Paper1.5 %),(textile, 2.5 %),(garden waste 3 %), (solid materials 4.8 %), and (leather 2.5%) (Akla, Suad Abd Mahdi, 2015).

The Central Agency for Statistics and Information Technology (COSIT) indicated that the daily rate of collected garbage In Kirkuk governorate was 1340 tons/day in the year. 2009; however, since the areas covered by that study Not clearly defined, waste generation rates were between 1.01 and 1.45 kg/person/day (Ministry of Planning, Central Bureau of Statistics, 2016).

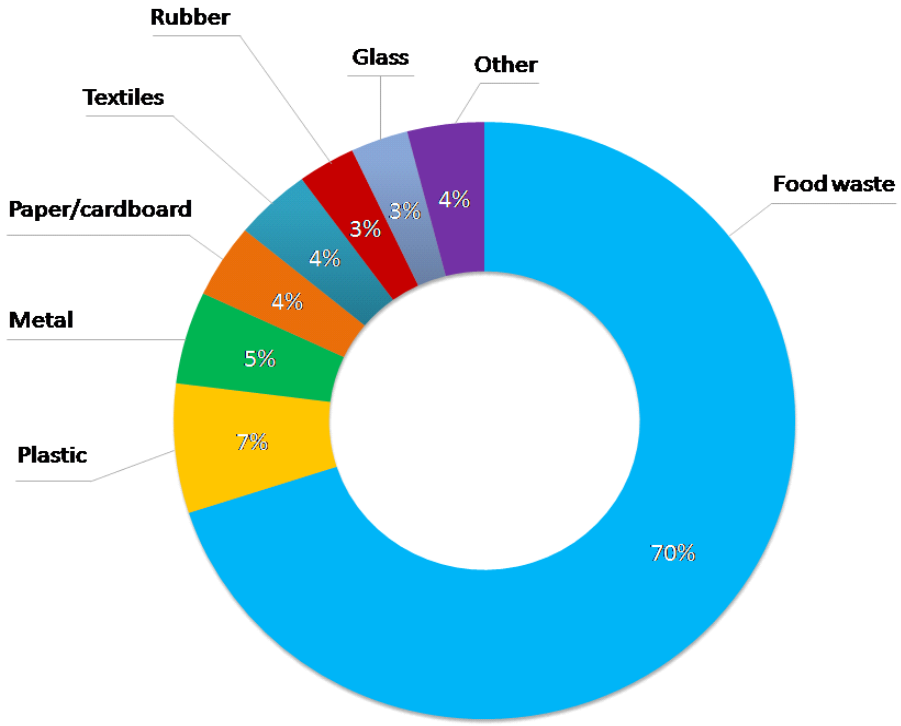

Figure 2.12: estimating the percentages of waste components in Kirkuk

Resource: IMSphere Consulting Inc (2017)

The landfill receives solid waste from the six sections of the city of Kirkuk through two transfer stations, and it also receives it regularly Direct from other areas nearer, including Laylan, Taza, and the industrial district. In general, the landfill receives waste, Non-hazardous solid, mainly municipal waste (residential, commercial, institutional, and industrial waste, And general) ,A waste transfer station serves as an intermediate facility between solid waste sources and a landfill. The purpose of a transfer station Waste is to facilitate the transfer of waste from collection vehicles of small capacity to vehicles of large capacity. What is more economical is that waste is transported over large distances in large but less frequent gears (instead of Smaller but more frequent loads) because the operating cost is on a tone basis for large transport vehicles Less than that of small transport vehicles. A waste transfer station becomes economically viable when more money is made saving (due to the use of large vehicles to transport waste) on the cost of designing, building, and operating the transfer station (IMSphere Consulting Inc, 2017).

Figure 2.13: A general view of the waste transfer station north of Kirkuk

Kirkuk has two solid waste transfer stations, the first transportation terminal (located south of the city) and finished its job in December; the second waste transfer station (located north of the city) has been completed in 2008. Was selected, the location of the southern station due to its location in the middle of the road between the city and the landfill, while a site was chosen. The northern station due to its proximity to the Kirkuk Ring Road, allowing quick and easy access From the city to the transportation station and from the station to the landfill.

Every station has it The ability to deal with 300 tons of waste per day (maximum capacity 500 - 750 tons/day), when fully operational At its capacity, eight trailers can transport 40 tons/trailer to the landfill continuously throughout the day (IMSphere Consulting Inc, 2017).

A waste disposal site, or sanitary landfill, is one of the most important elements of a solid waste management system. Kirkuk has the first engineering and environmentally constructed landfill in Iraq since 2008. The design and construction of the only Kirkuk landfill were done by US EPA guidelines for Category 1 sanitary landfills, as well as standards European Union regarding sanitary dumps; The landfill is located in the Zindana sector in the Kirkuk governorate, 18 km away, Kilometers south of Kirkuk, between Taza and Laylan (Mustafa, Mutlag , 2013).

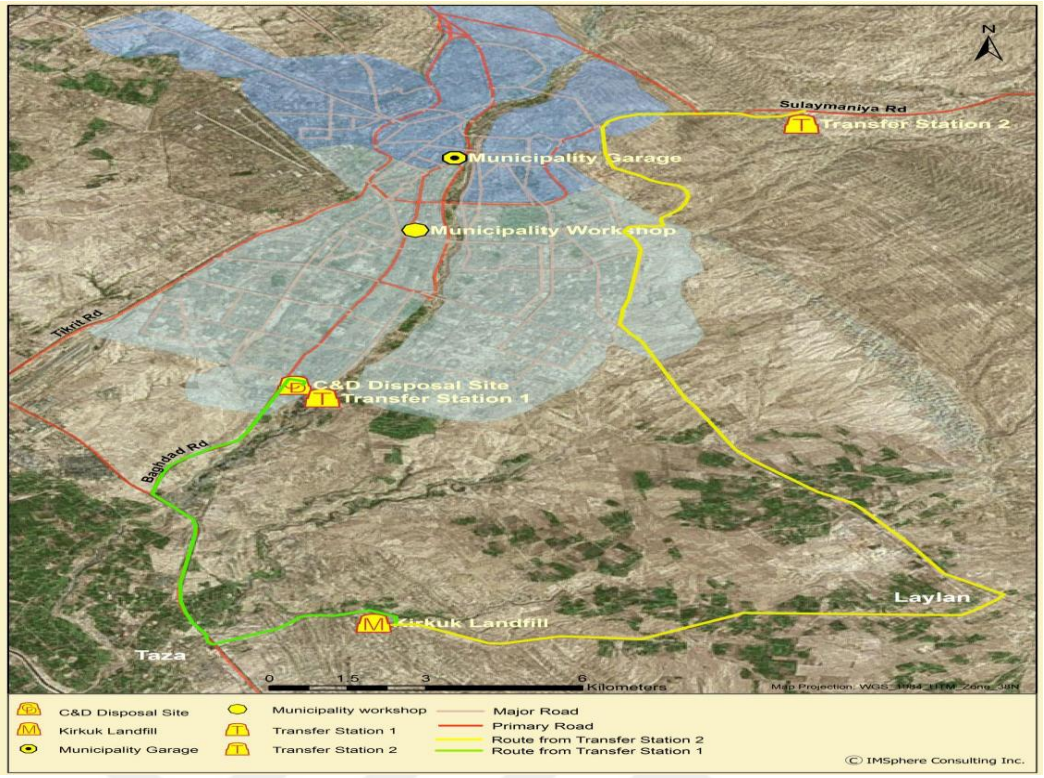

Figure 2.14: A satellite image of the Kirkuk landfill and methods of linking to waste transfer stations

The Kirkuk landfill complies with the US Environmental Protection Agency guidelines for landfill sites. Therefore, in Class 1, several considerations were taken into account during design and construction; except for Kirkuk city, all other cities in the governorate dispose of their waste in secondary dumpsites.

Throughout Kirkuk, there are 11 landfill sites without environmental approval: 4 in open land, 2 in quarries, and 4 In valleys; these sites cause serious environmental damage such as pollution of groundwater (due to the lack of a mechanism to contain Leaching of waste) and fire hazards (as a result of self-combustion of materials and ignition of gas resulting from waste decomposition).

Organic materials and potentially hazardous substances cause the production of leaches with very high concentrations of minerals Heavy, waterborne bacterial, and viral diseases (Statistics., C.O.F, 2009).

Table 2.10: Quantities of waste collected daily in Kirkuk and its distribution percentages according to the type of its source.

Average amounts of waste	Tons / day	Percentage %
Residential	776	57.91
Commercial	195	14.55
Industrial	16	1.19
Agricultural	6	0.45
C&D	341	25.45
Scrap	6	0.45

Resource: Iraq Environmental Survey (2010)

According to the environmental survey conducted in Iraq in 2010, 57% of the population in Kirkuk governorate benefit from services Waste collection, which is significantly lower than the national average). % (66 as shown in Fig (-,) Compared to other Iraqi governorates, Kirkuk can be considered an average center in terms of waste collection services. The coverage rate of waste collection services in urban and rural areas was 78.6% and 0.4% compared to the rates Wataniya is 91.3% and 7.5%, respectively (Al-Rawi, Al-Tayyar, 2012).

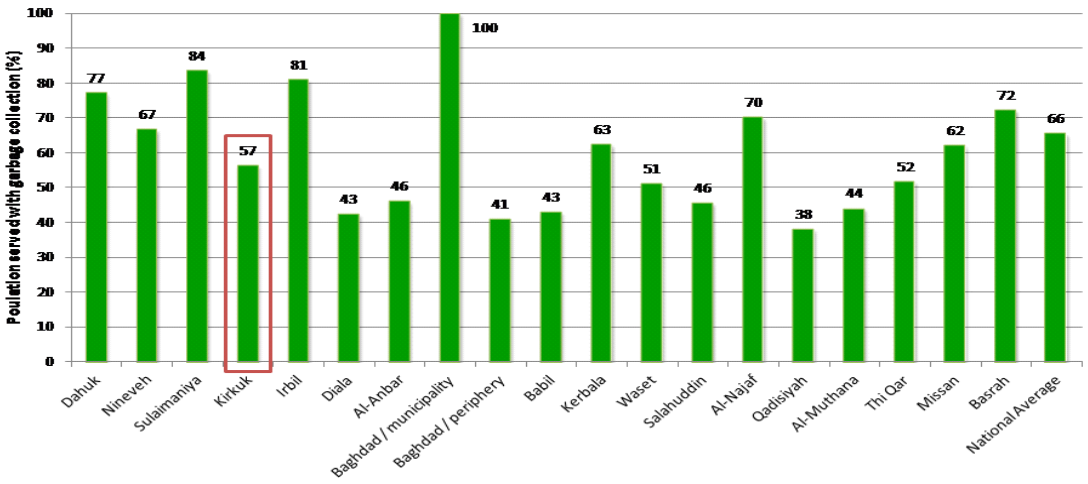

Figure 2.15: Percentage of the population enjoying a waste collection service in Kirkuk compared to other Iraqi governorates in the year

The city of Kirkuk chosen as a case study because it is considered one of the small cities in which there is a successful experience in waste management through the establishment of two transfer stations and a sanitary landfill within the environmental conditions where the landfill is considered a model and achieved progress in the field of waste management. However, recently there has been a decline in the level of operation of the landfill.

The municipality of Kirkuk is keenly aware of the environmental problems that it suffers from and is working to address them; Kirkuk is a relatively oil-rich region in Iraq, so the municipality could be funded to develop a waste management system.

3. METHODOLOGY

This chapter explains the methodologies that were used in data collection and analysis. The methodologies will include areas such as site study, research design, sampling and research population size, types of data, method of data collection, reliability of results, and methods of data analysis.

3.1 Study Design

Clarifies appropriate framework for the study, the research approach must be chosen in the research design process because it determines how to obtain information related to the study (Aaker, Kumar, George, 2000).

For a proposal for waste management in Iraq, to be more aware of the type of problem, and to understand its gaps Quantitative and qualitative studies were conducted, by collecting data from various stakeholders, in terms of the primary data collected, the questionnaire, data obtained from expert opinion (interview), the secondary data were collected by document review and the Central Statistics in the Ministry of Environment and Municipalities to achieve this study.

3.2 Research Approach

There are two types of research approach: quantitative and qualitative approach, and the researcher has integrated the quantitative and qualitative approach in analyzing the data, and the reasons are that some results are required for self-evaluation of the information obtained from the respondents (Kombo, Tromp 2006).

The research explores waste management's reality and how solid waste management can be developed in Iraq, also, know at what level is government authorities' concern about solid waste management. Therefore, using a unified approach will enable me to "collect many models (Leedy, Ormrod, 2005).

3.4 Population & sample size

The population of interest is the target of the study, which you intend to study or address. Research studies are often inappropriate or useless to study the entire population of interest. The investigator will study a sample of the population for inclusion in his study. The research study aims to generalize the results of the study from the sample to the concerned population. It is also important to describe demographics, including age, gender, socioeconomic status, and educational level (Van den Broeck, Sandøy, Brestoff, 2013).

Sampling is important for research studies because the target audience cannot be fully included in any research project. A sample consisting of a specific statistical representation of the population is good, and is large enough to answer the research question (Kamangar, Islami, 1988).

The population of this study was 320 male and female respondents between the ages of 18 and over 45, graduates of master's and doctoral studies, university and high school graduates, and among them were government employees, self-employed workers, and housewives. They were also from all the governorates of Iraq, and their answers to the questionnaire questions varied, and the number of respondents to the interview was 6 respondents. Interviews were conducted with several specialists in the solid waste issue, including university professors, government officials, and private companies. Several questions were presented to them and they were obtained. On the answers from them, they will be analyzed and their details will be presented in Chapter 4.

3.5 Type & Sources of Data

3.5.1 Primary data

Primary data constitute direct information that the researcher collects for his study. The primary data for this study were collected from all regions of Iraq and 360 respondents were randomly selected (Saunders, Lewis, Thornhill, 2003).

3.5.2 Secondary data

Usually, the secondary data is the data previously collected for various uses, in this study, the secondary data included an extensive literature review, articles, statistical

data, qualitative information, and published reports of similar studies by different authors (Saunders, Lewis, Thornhill, 2003).

3.6 Data collection methods

Methods focus on secondary and primary data sets, data collection important role in statistical analysis, and there are various methods used to collect information, all of which are divided into two parts, primary and secondary data (Douglas, 2015).

In this study, the researcher will use questionnaires, document reviews, and interviews as a method of data collection.

3.6.1 Questionnaire

The questionnaire is a general term that encompasses all the data technologies in which every person is asked to answer the same set of questions in a pre-defined; the main tool for gaining preliminary information in practical research is questionnaires because the researcher can decide on the sample and the types of questions to be asked (Saunders, Lewis, Thornhill, 2009).

In this study, 320 respondents participated in the questionnaire 21 respondents were neglected for not answering correctly and accurately from the community groups identified by the researcher each respondent is requested to reply to an identical list of questions mixed to prevent biases. Initially, the questionnaire design coded and mixed up from a specific topic based on uniform structures.

Some of the survey questions developed were based on the five-component Likert scale. Responses to each statement were provided using a five-point Likert scale, where one = "Strongly Agree" to Five = "Strongly Disagree." Responses are summarized to produce a score for the measures, and other questions were based on the one-word answers the researcher needed (Mukisa, 2009).

3.6.2 Document review

The documents can obtain quantitative and qualitative data and the information needed to know the reality of waste. Governmental authorities provide many documents through which they were able to extract relevant information ,although I was hoping to easily find and access many documents such as; Annual reports, survey Reports, Planning, and other relevant documents, I could not easily access

some of the national statistics, studies, and plans [46].” These documents are used within the theoretical context of the waste situation in Iraq in Chapter 2.

3.6.3 Interview

The interview is a commonly practiced data collection tool in the social sciences. They are used widely due to their power. As a research method, the interview provides various details and insights that do not appear in quantitative materials.

That enables the researcher to assimilate fruitful data such as personal or personal opinions on the interviewees' experiences. The interviewee assesses the reality of waste management, the problems facing municipalities, and how that leads to the development of their management through interviews; for example, official documents rarely show minute details in a file trash management; thus, an interview can present the hidden story of a particular topic (May, 2001), (Zølner, Rasmussen, Hansen, 2007).

Despite growing pressure to encourage new ways of thinking about research methodology, it was only recently that interviewing methodologists began to realize this ,“We cannot raise interview results from the contexts in which they were, collecting them and claiming to be objective data without constraints (Fontana, Frey, 1998).

Interviews made with several specialists in the solid waste issue, and their number is six people, five of them are males and one female, including university professors, government officials, and private companies, they presented with several questions and answers were obtained from them, they will be analyzed and their details will be presented in Chapter 4.

3.7 Validity and Reliability of Instrument

Reliability is "the extent to which measurements can be repeated when different people measure on a different occasion, under different conditions, and is assumed using alternative tools that measure construction or skill." It can also be defined as the degree to which the building scale is stable or reliable. For example, when many people guess your weight, the weight value may not necessarily be correct because it will conflict with the exact value, and hence the measurement is unreliable. If different people use a weighing scale to give your weight value, you will likely get

the same value every time a measurement is taken; hence this measurement is reliable.

“The extent to which a scale adequately provides the basic structure it is meant to measure,” the term construct refers to the skill, knowledge, trait, or position that a researcher is researching, reliability and validity constitute the psychometric properties of measurement scales that are very important in assessing measures of adequacy and accuracy of scientific research (Robson,2011),(Drost, 2011).

When the researcher conducts a study under some circumstances, The reliability of the data from the research tools is affected by two errors: random and systematic error, the random error is attributed to a set of and uncontrollable external factors that randomly affect some observations (Nunnally, 1978), (Rosenthal, Rosnow, 1991).

Validity is the extent to which a tool measures validity. Validity attempts to explain the truth of the search results. For example, does an IQ test measure intelligence? Validity is measured using both theoretical and experimental evidence. A theoretical evaluation is where a building idea is translated; This is done by a committee of arbitrators or university lecturers who evaluate the suitability of each component, as validity depends on a quantitative analysis that includes statistical techniques (Zohrabi, 2013).

3.8 Methods of data analysis

3.8.1 Quantitative data

Quantitative data were obtained from the primary and secondary data discussed above in this chapter ,analysis software used for this research is IBM SPSS version 23. This task involved identifying, classifying, and assigning a code or numeric character to the data, which is only done in one pre-coded way; In this study, all responses were pre-coded, they were taken from the list of responses, the data analyzed using IBM SPSS version 23 analysis software, within the data analysis framework; Statistics described, graphic analysis and data explored. The analysis included exploring the relationship between variables. A comparison of how groups affect each other using statistical methods, simple proportional analysis, factor analysis, and T-test (Byrne, 2012), (Landau, Everitt, 2004).

3.8.2 Qualitative data

Qualitative data analysis is used to triangulate quantitative data analysis; Interview methodology, official documents, and government reports were used to support the study findings. (Kreuger & Neuman, 2006:434-435) Analysis of qualitative data is less standardized with a wide variety of quality approaches Research corresponding to many approaches to data analysis, Results of qualitative data analysis The analysis of qualitative data takes the form of relatively imprecise, pervasive, and context-dependent words, but quantitative researchers use the language of statistical relationships in Analytics.

3.9 Data analysis software

A combination of qualitative and quantitative research methodologies was used to obtain comprehensive responses; Quantitative data were processed and analyzed with IBM SPSS version 23 computer software, qualitative data will be analyzed theoretically and part of it has been copied, processed, and discussed in light of the theoretical framework.

3.9.1 Statistical techniques

The statistical techniques used for this research are Simple Percentage Analysis, Factor Analysis, and T-test.

- Simple Percentage Analysis: This analysis is used on the analysis of the demographic part of the research survey for a better understanding of the targeted respondents, it depends on the frequency distribution of the data collected and doesn't have a role in the hypothesis testing.
- T-test: An Independent Samples T-test compares the means for two groups. It helps you to compare the means of two sets of data. For example, you could run a T-test to see if the average test scores of males and females are different
- ANOVA: compares the means for more than two groups and see if there is a difference between them or not. Analysis software used for this research is IBM SPSS version 23. IBM SPSS: (SPSS) is one of the common software that is used in the analysis of social and behavioral science with a lot of

statistical techniques that help in analyzing surveys' primary data (Landau, Everitt, 2004).

4. DATA ANALYSIS AND RESULTS

Qualitative and quantitative research data are analyzed, described interpreted systematically according to the research objectives and questions.

This chapter includes the analysis done for the data collected; it includes the Simple percentage analysis and T-test in addition to the ANOVA test to compare the attitude of the demographic groups to waste management.

4.1 Analysis of interview data

4.1.1 Background information about participants in the interview

All the specialists were of different degrees: academics, the government sector, and the private sector, all the interviews were conducted in a way using correspondence by email and communication, and the participants were cooperating in a way Large.

Five of the respondents were male and one female, only one of the respondents was among 20 And 30 years, four between 40 and 50 years old, and the last respondent was 70 years old. Five participants, one of whom has a bachelor's degree, and the other an environmental researcher, two of whom had the rank of assistant teacher, and two had a doctorate ,Work experience or teaching time ranged from 01 to 10 years (1); 11 to 20 years (2); 21 - 30 Years (2) Over 40 years old (1).

4.1.2 Presentation of interview data

The purpose of the interview is to identify issues relevant to waste management during the interpretation process that would contribute to Developing a tool suitable for the quantitative stage of this research that can be easily observed.

Four themes, in particular, emerged from the analysis of the interview, namely The efficiency of municipalities in waste management and recycling, and how to take and dispose of waste, this is also reflected in the research problem, which is poor waste management.

1. The current system of the municipality

The responses assigned to this category represent the perspectives and perceptions of the respondents on the role and efficiency of the municipality for managing solid waste. With an overview and a comparison with the literature, some Responses implicitly indicated that

One of the respondents mentioned a scientific researcher at the Ministry of Environment:

"*The municipality has a weak role due to the lack of adequate logistical support in terms of the lack of human resources and waste collection and transportation mechanisms".*

Another respondent agreed with him, a professor at the University of Baghdad:

"A role that is not in the required form and is limited to collecting and transporting waste and not disposing of it in environmentally safe places, in addition to not distributing containers to the areas as required, and the community not cooperating with the municipality".

The following quotes from other respondents support the previous view:

"The municipality collects - according to specific periods or timetables - from residential neighborhoods or areas that generate this waste. The period is usually not fixed and depends on the presence of collection vehicles and the availability of manpower at the municipality".

"Irregularly collecting waste from homes, shops, and streets, and throwing it in an unsanitary landfill".

"The role of the city's municipality is limited to collecting waste from the city's neighborhoods and disposing of it in two irregular sites".

2. The Municipal Role in MSW

The municipality has a great responsibility towards the issue of waste management, and it must fully assume its role, respondents were asked about this role, as one of the respondents a scientific researcher at the Ministry of Environment said:

"*The municipality must organize the collection and transportation operations, provide mechanisms for this, and provide a landfill that conforms to the*

environmental specifications, with setting up a fence for the site to avoid people or animals entering the landfill, as well as separating hazardous waste from municipal waste".

A representative of the Energy World Company for Training and Development, which works in the field of waste management, said:

"*Establishing special times and a regular schedule for collecting waste and transporting waste to intermediate stations and creating a typical sanitary landfill area, Establishing a factory for recycling and sorting waste and cooperating with investment companies in this field".*

Other respondents white other perceptions of the municipality's role as follows:

"*Putting containers of several colors for each color a special type of waste to sort the waste from the source in each region and then transfer it to recycling plants Giving more room for investment companies to help tackle the waste problem Training workers and appointing environmental specialists to work efficiently in the disposal of solid waste Maintenance of machinery, filling the shortage and purchasing new ones with greater efficiency".*

"*It is necessary to know the quantities generated, the number of vehicles and manpower and set a time limit for waste collection, as well as the provision of infrastructures such as landfill sites and bags. It is necessary to think about treating and reducing waste by recycling, sorting, and the requirements of these activities, including machines and sites, without providing bags or containers for the sealed areas".*

"*Establishing an integrated waste management program that includes regular collection according to specific and studied paths, then sorting it from the source and in the intermediate stations, after which the organic waste is transferred to the compost production plants and the rest, is transferred to the sanitary landfill sites*".

3. Waste disposal practices

Waste disposal is one of the things that need great effort. Respondents were asked about how to dispose of waste efficiently, and the answers were varied. One of the respondents is talking about his city and a doctor specializing in waste management at the University of Mosul, said:

"*The waste is disposed of in the city of Mosul through sanitary landfill in two sites designated for this purpose: Al-Kawjali (the left side) and Al-Sahaji (the left side). The method of waste disposal does not comply with the internationally approved sanitary landfill conditions".*

Another respondent from another city, a university doctor specializing in waste management at the University of Baghdad, had a different opinion, said:

"*There is no environmentally safe place for waste, and there is no coordination between the municipal sectors, and it is dumped in random places in most areas".*

Other respondents from different cities had answers about the waste disposal method as follows:

"The place is somewhat acceptable, but there is a weakness in the mechanism of collection and transportation is not regular so there must be the management of these operations".

"It is taken to an unacceptable place and an area close to residential areas, waste is disposed of by burning or random throwing, and there is no systematic way to dispose of it".

"*Waste is collected from residential neighborhoods, homes, homes, and commercial areas by municipal workers and vehicles, where it is taken to the so-called landfill sites outside the city, these sites are just open areas where waste is disposed of by throwing it there without any treatment".*

"*The waste is taken to two sites, one on the left side in the Kukjali area and the other on the right side in the Al-Sahhaji area, and these two sites match the environmental determinants in choosing a sanitary landfill site, but the current burial operations are irregular and do not comply with the conditions and requirements of a sanitary landfill of solid waste".*

4. Solid waste management development

Respondents were asked about how to develop The reality of waste management and devise radical solutions to this issue , One the respondents, a university doctor at the University of Mosul, who specializes in waste management, said:

“Encouraging the sorting mechanism from the source, either through home sorting directly or through the containers designated for this in the different neighborhoods with the development of a mechanism to motivate and encourage citizens.

Establishing a program to define regular paths for waste compressors according to (GIS) applications after determining the quantities of waste in different neighborhoods with a mechanism to motivate and encourage citizens.

Establishing intermediary stations for sorting, collecting, and transporting waste to places of use, and transporting organic waste to composting plants, which must be near the sites of sanitary landfill.

Landfilling of materials leftover from sorting and fertilization in landfill sites, following the conditions of proper sanitary landfill”

Another respondent, a scientific researcher at the Environment Ministry, said:

"Start educating the community by establishing educational workshops to cultivate awareness in the community, establishing sites to receive waste from people and paying a fee for that to encourage them, as well as separating hazardous medical waste from municipal waste, establishing factories for the production of fertilizer and using it in agriculture, activating environmental protection laws and applying them in reality".

Other respondents had different opinions and perceptions as follows:

“Establishing healthy and environmentally safe landfills in each governorate to get rid of waste, the municipality must play a greater role and allow investing in waste management, establishing plants for recycling solid waste elements, Spreading community awareness, and warning of the dangers of solid waste accumulation in residential neighborhoods”.

“A private company that manages waste from the collection stages, providing containers, freezing, recycling, and sanitary landfill by providing modern machinery and a sufficient number of workers”.

“Establishing regular landfill sites that depend on scientific methods in landfill, such as creating cells to ensure the safe landfill of waste and reduce the phenomenon of burning and the random spread of waste inside landfill sites.

The need to develop a national strategy for treating solid waste in general and medical waste in particular, with finding a comprehensive and integrated solution to manage the waste problem with the participation of all concerned parties, in particular the Ministry of Health and Environment, the directorates of municipalities and civil society organizations.

Refrain from employing children under the age of 18 years, as it contravenes the instructions of the ministries of labor and health.

Providing the necessary work supplies for workers such as shoes, gloves, masks, and clothes for work, while providing health insurance for workers, engineers and technicians, Preparing municipal directorates, preparing the mechanisms used to collect and lifting waste, and appointing skilled drivers to lead them".

4.2 Analysis of questionnaire

4.2.1 Simple percentage analysis

To understand the targeted respondents and their answers, a simple percentage analysis was done such analysis gives an accumulated summary of the respondent's answers according to the frequency distribution of the data collected, it is calculated by the following formula: Percentage = (Number of Respondents * 100) / Total Number of Respondents. The total responses collected were 320 responses, however after initial data screening 21 responses were considered as unengaged and were removed from the study, so only 299 responses were accepted for analysis.

The first part of this analysis represents the Demographic data which provides an idea about the respondent's characteristics it includes questions as below:

Table 4.1: Demographic Q1, Gender

	Frequency	**Percent**	**Cumulative Percent**
Male	188	62.9%	63.1%
Female	111	37.1%	100.0%
Total	299	100.0%	

The gender of the respondents' clients to the researcher as shown in Table 4.1 shows that more than half of the respondents are male, and they account for 63% of the total responses, while only 37% of the total respondents are female.

The results indicate that the number of male respondents was more cooperative than the female respondents who asked to fill out the questionnaires.

Table 4.2: Demographic Q2, Educational level

	Frequency	Percent	Cumulative Percent
Baccalaureate	46	15.4%	15.4%
Bachelor degree	103	34.4%	49.8%
Master / PhD	150	50.2%	100.0%
Total	299	100.0%	

Table 4.2 shows that half of the respondents have a master's or PDH degree, they represent 50% of the total responses, on the other hand, 35% have a bachelor's degree, the remaining 15% are school students.

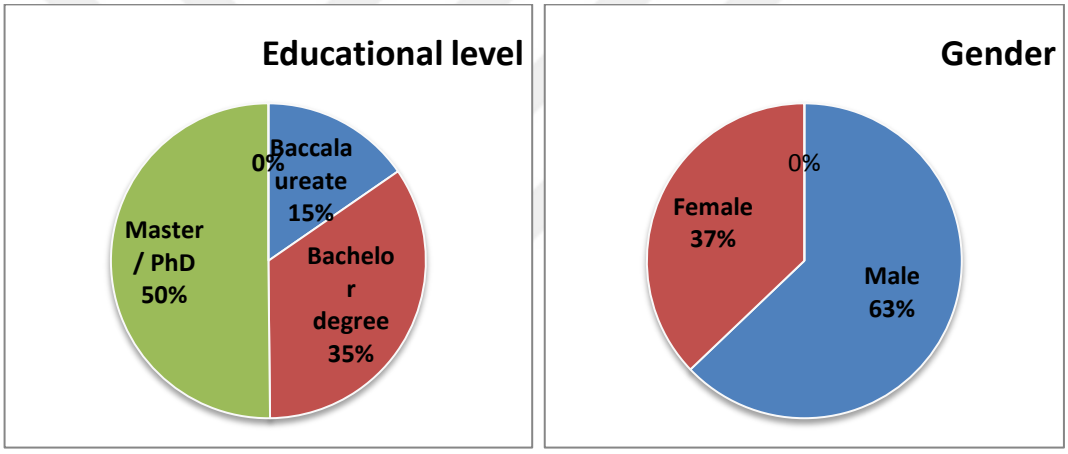

Figure 4.1: Demographic Q1, Gender, and Q2, Educational level

Table 4.3: Demographic Q3, Age

	Frequency	Percent	Cumulative Percent
18 – 25 years or less	47	15.7%	15.7%
26 – 35 years	114	38.1%	53.8%
36 – 45 years	73	24.4%	78.3%
Above 45 years	65	21.7%	100.0%
Total	299	100.0%	

Table 4.3 shows that almost half of the respondents are between 26 and 35 years old, they represent 38% of the total responses, on the other hand, 25% are between 36 and

45 years old, the remaining are either less than 26 years old or more than 45 years old.

Table 4.4: Demographic Q4, Profession

	Frequency	Percent	Cumulative Percent
Employee	164	54.8%	54.8%
Free business	50	16.7%	71.6%
Housewife	19	6.4%	77.9%
Student	66	22.1%	100.0%
Total	299	100.0%	

Table 4.4 shows that half of the respondents are employees they represent 55%, the other half are either free businessmen, or housewives, or students

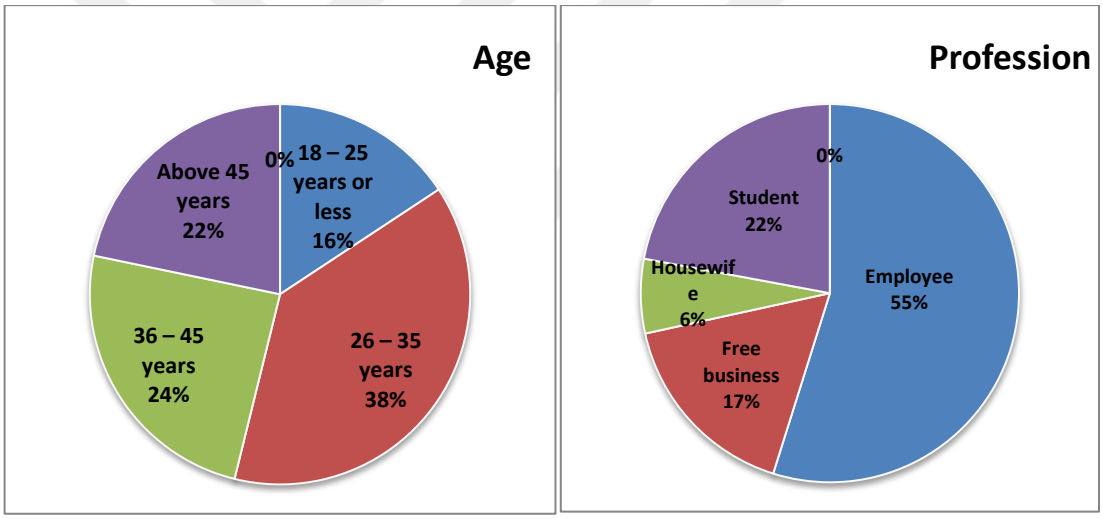

Figure 4.2: Demographic Q3, Age and Q4, Profession

The second part of this analysis represents the general information questions which provide information about the respondents' information waste management process in their area.

Table 4.5: General information Q1, Do you have any waste bins in your home/store/stall?

	Frequency	Percent	Cumulative Percent
Yes	266	89%	89%
No	33	11%	100%
Total	299	100.0%	

Table 4.5 shows that almost all of the respondents have waste bins in their home/store/stall, they represent 90%.

Table 4.6: General information Q2, Are you sorting the waste generated in your home/store/stall?

	Frequency	Percent	Cumulative Percent
Yes	109	36.5%	36.5%
No	190	63.5%	100.0%
Total	299	100.0%	

Table 4.6 shows that more than half of the respondents do not sort their waste generated in their homes or stores, and they represent 64%.

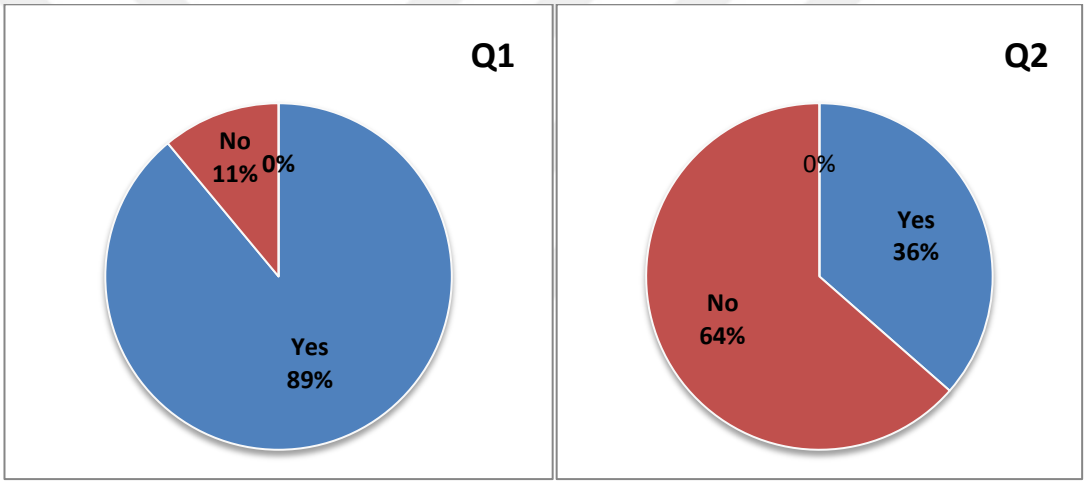

Figure 4.3: General information Q1 and Q2

Table 4.7: General information Q3, How is the waste collected inside the home or neighborhood?

	Frequency	Percent	Cumulative Percent
Container with lid	125	41.8%	41.8%
Container without lid	39	13.0%	54.8%
In bags	135	45.2%	100.0%
Total	299	100.0%	

Table 4.7 shows that almost half of the respondents are collecting their waste in bags, they represent 45%, the other half collects their waste using a container with a lid, represent 41%.

Table 4.8: General information Q4, What is the average waste disposal time?

	Frequency	Percent	Cumulative Percent
One day	123	41.1%	41.1%
Two days	89	29.8%	70.9%
Three days	55	18.4%	89.3%
More than that	32	10.7%	100.0%
Total	299	100.0%	

Table 4.8 shows that almost half of the respondents confirmed that the average waste disposal time is one day, they represent 41%.

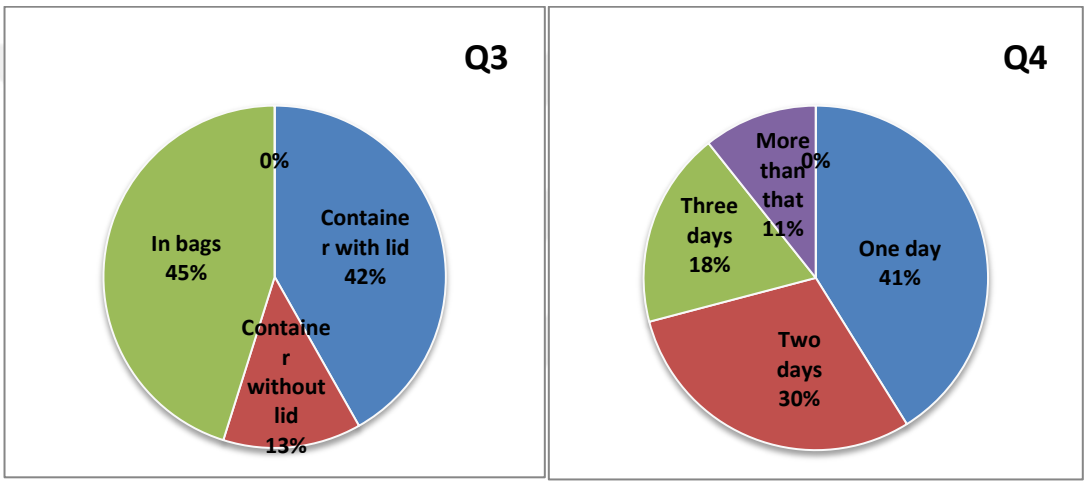

Figure 4.4: General information Q3 and Q4

Table 4.9: General information Q5, How often is the waste transported from the collection area to the place designated for it?

	Frequency	Percent	Cumulative Percent
Once a week	86	28.8%	28.8%
Twice	66	22.1%	50.8%
Three times	54	18.1%	68.9%
There are no regular appointments	93	31.1%	100.0%
Total	299	100.0%	

Table 4.9 shows that Less than half of the respondents confirmed that there is no regular appointment for collecting waste in their area, they represent 31%, on the other hand, 29% confirmed that the collecting process of waste is done once a week.

Table 4.10: General information Q6, Who takes the waste from your home/store/stall for disposal?

	Frequency	Percent	Cumulative Percent
A private waste company	56	18.7%	18.7%
The city's municipality	142	47.5%	66.2%
Me	101	33.8%	100.0%
Total	299	100.0%	

Table 4.10 shows that half of the respondents are confirmed that the city's municipality takes the waste, they represent 48%, on the other hand, 34% confirmed that they take it themselves from their home/store / or stall.

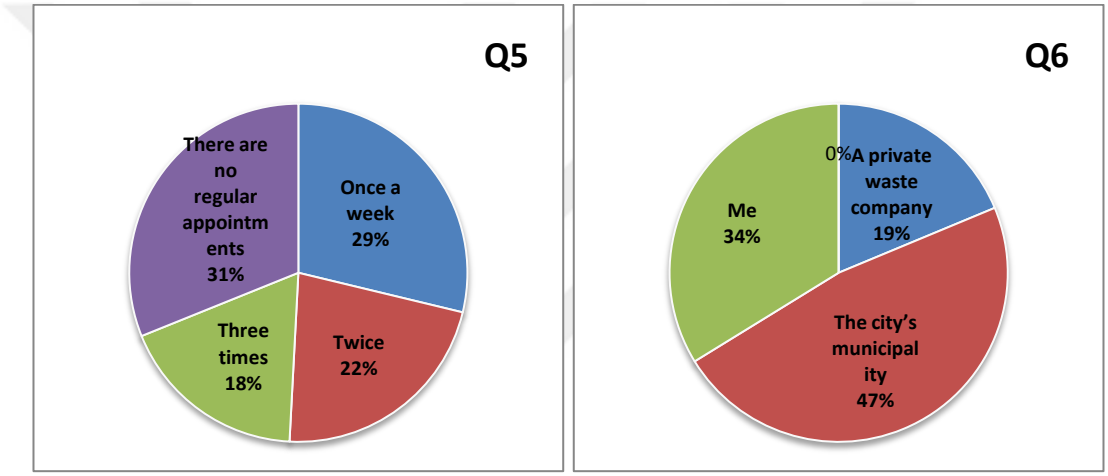

Figure 4.5: General information Q5 and Q6

Table 4.11: General information Q7, Where is the waste taken for disposal?

	Frequency	Percent	Cumulative Percent
A pit for burning	38	12.7%	12.7%
Sanitary landfill	33	11.0%	23.7%
Random dump	86	28.8%	52.5%
Sorting or recycling plant	11	3.7%	56.2%
I do not know	131	43.8%	100.0%
Total	299	100.0%	

Table 4.11 shows that almost half of the respondents do not know where the waste is taken after disposal, they represent 44%, on the other hand, 29% confirmed that is taken to a random dump.

Table 4.12: General information Q8, Which waste items do you think should be sorted for recycling?

	Frequency	Percent	Cumulative Percent
Glass	10	3.3%	3.3%
Hard plastics	50	16.7%	20.1%
Metals	7	2.3%	22.4%
Paper	2	.7%	23.1%
Plastic	35	11.7%	34.8%
All above	195	65.2%	100.0%
Total	299	100.0%	

More than table 4.12 shows that half of the respondents prefer to recycle glass, hard plastic, metal, paper, and plastic, which accounts for 65%.

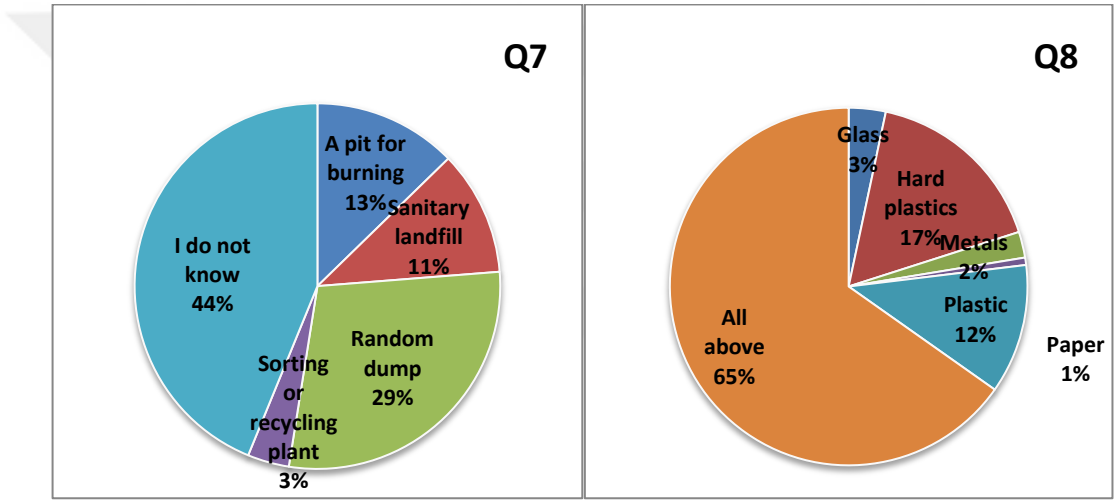

Figure 4.6: General information Q7 and Q8

The Third part of this analysis represents the attitude toward recycling and waste management these questions are analyzed using the simple percentage analysis and T-test in addition to the ANOVA test to compare the demographic groups' attitude toward waste management.

T-test and ANOVA test are parametric tests that have some conditions to be conducted, the first condition is that the data collected needs to be more than 30 samples, and in this research, the data collected are 299. The second condition is that the data needs to be normally distributed, according to figure 4.7 below it is concluded that the data is normally distributed.

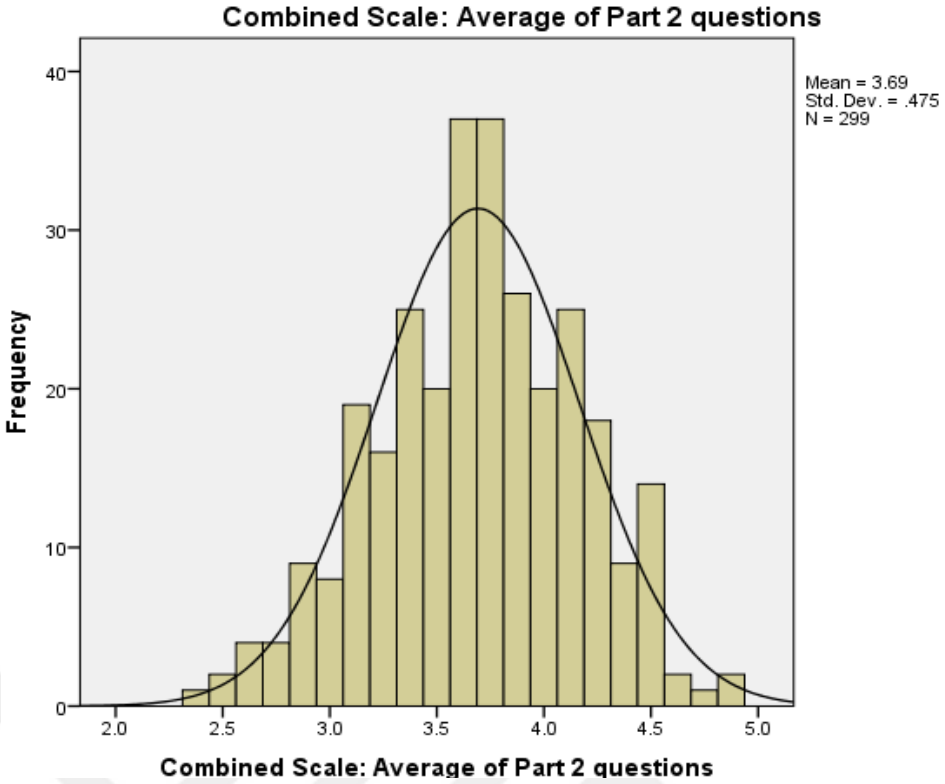

Figure 4.7: Normality assessment

Part of Normality assessment is making sure that there is no Skew and Kurtosis:

- Skew: "when the data distribution is not asymmetrical around its mean, either below or above the mean" (Kline, 2011) for not having a Skew the Skew analysis results must be between 3 and -3.
- Kurtosis: "when the data have a higher or lower peak comparing to normal distribution" for not having a Kurtosis the Kurtosis analysis results must be between 8 and -8.

According to the results shown below table, it can be concluded that there is no Skew and Kurtosis. The below table also includes the mean and standard deviation of each question.

Table 4.13: Skew & Kurtosis results, with descriptive statistics

	Mean	Std. Deviation	Skewness	Kurtosis
Q1: Are you ready to compost your garden waste?	3.85	.806	-.695	.699
Q2: Are you ready to compost food waste?	3.83	.924	-.812	.379
Q3: In the future, are you willing to pay for the collection of the waste that you generate in your home/store/stall?	3.71	.875	-.661	.213
Q4: The municipality does not have healthy and environmentally safe waste dumps?	3.47	1.224	-.409	-.857
Q5: There are no appropriate policies and laws that enhance the effectiveness of solid waste management?	3.45	1.256	-.419	-.952
Q6: If containers are provided for waste sorting, are you prepared to commit to throwing garbage in the designated place?	4.30	.837	-1.271	1.580
Q7: There are unhealthy random dumpsites in your city?	3.95	1.106	-1.130	.721
Q8: The municipality does not have enough manpower and vehicles to transport waste?	2.97	1.197	.011	-.958

Below are the results of each question with the demographic groups' comparative questions results:

Table 4.14: Attitude Q1, Are you ready to compost your garden waste?

	Frequency	Percent	Cumulative Percent
Strongly disagree	2	.7%	.7%
Disagree	17	5.7%	6.4%
Neutral	59	19.7%	26.1%
Agree	166	55.5%	81.6%
Strongly Agree	55	18.4%	100.0%
Total	299	100.0%	

- Half of the respondents agreed that they are ready to compost your garden waste, they represent 56%.
- Comparing gender groups using the T-test, the P-value of 0.854 shows that there is no difference between gender attitudes related to this question.

- Comparing educational level groups using the ANOVA test, the P-value of 0.873 shows that there is no difference between education level attitudes related to this question.
- Comparing between age groups using the ANOVA test, the P-value of 0.383 shows that there is no difference between age attitudes related to this question.
- Comparing professional groups using the ANOVA test, the P-value of 0.628 shows that there is no difference between professional attitudes related to this question.

Table 4.15: Attitude Q2, Are you ready to compost food waste?

	Frequency	**Percent**	**Cumulative Percent**
Strongly disagree	4	1.3%	1.3%
Disagree	29	9.7%	11.0%
Neutral	46	15.4%	26.4%
Agree	155	51.8%	78.3%
Strongly Agree	65	21.7%	100.0%
Total	299	100.0%	

- Half of the respondents agreed that they are ready to compost food waste, they represent 52%.
- Comparing gender groups using the T-test, the P-value of 0.879 shows that there is no difference between gender attitudes related to this question.
- Comparing educational level groups using the ANOVA test, the P-value of 0.631 shows that there is no difference between education level attitudes related to this question.
- Comparing between age groups using the ANOVA test, the P-value of 0.741 shows that there is no difference between age attitudes related to this question.
- Comparing professional groups using the ANOVA test, the P-value of 0.886 shows that there is no difference between professional attitudes related to this question.

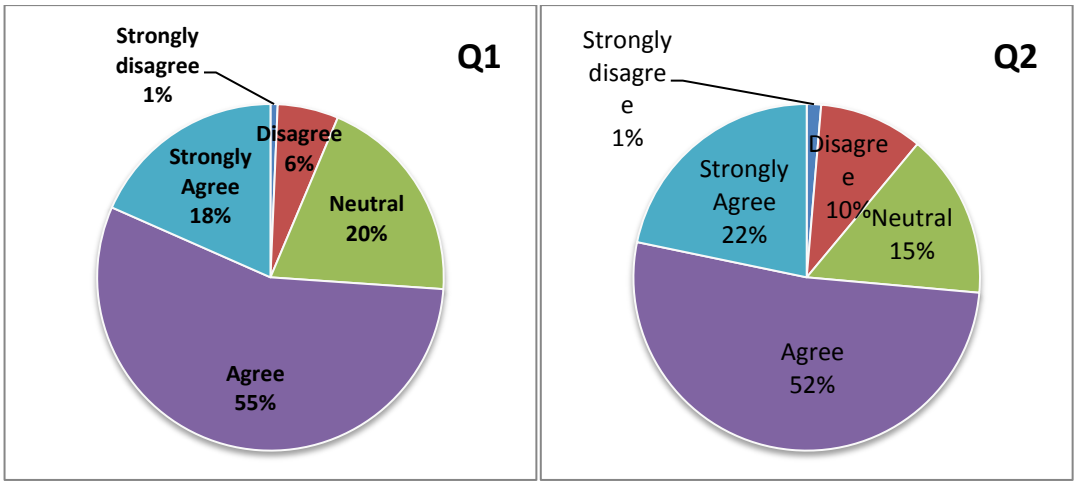

Figure 4.8: Attitude questions Q1 and Q2

Table 4.16: Attitude Q3, In the future, are you willing to pay for the collection of the waste that you generate in your home/store/stall?

	Frequency	Percent	Cumulative Percent
Strongly disagree	3	1%	1%
Disagree	30	10%	11%
Neutral	63	21.1%	32.1%
Agree	159	53.2%	85.3%
Strongly Agree	44	14.7%	100%
Total	299	100.0%	

- Half of the respondents agreed that they are willing in the future to pay for the collection of the waste that they generate in their home/store/stall, they represent 53%.
- Comparing gender groups using the T-test, the P-value of 0.796 shows that there is no difference between gender attitudes related to this question.
- Comparing educational level groups using the ANOVA test, the P-value of 0.419 shows that there is no difference between education level attitudes related to this question.
- Comparing between age groups using the ANOVA test, the P-value of 0.562 shows that there is no difference between age attitudes related to this question.

- Comparing professional groups using the ANOVA test, the P-value of 0.429 shows that there is no difference between professional attitudes related to this question.

Table 4.17: Attitude Q4, The municipality does not have healthy and environmentally safe waste dumps?

	Frequency	**Percent**	**Cumulative Percent**
Strongly disagree	21	7.0%	7.0%
Disagree	52	17.4%	24.4%
Neutral	62	20.7%	45.2%
Agree	93	31.1%	76.3%
Strongly Agree	71	23.7%	100.0%
Total	299	100.0%	

- Half of the respondents confirmed that the municipality does not have healthy and environmentally safe waste dumps, 24% strongly agreed on that and 31% agreed on that.
- Comparing gender groups using the T-test, the P-value of 0.773 shows that there is no difference between gender attitudes related to this question.
- Comparing educational level groups using the ANOVA test, the P-value of 0.421 shows that there is no difference between education level attitudes related to this question.
- Comparing between age groups using the ANOVA test, the P-value of 0.629 shows that there is no difference between age attitudes related to this question.
- Comparing professional groups using the ANOVA test, the P-value of 0.214 shows that there is no difference between professional attitudes related to this question.

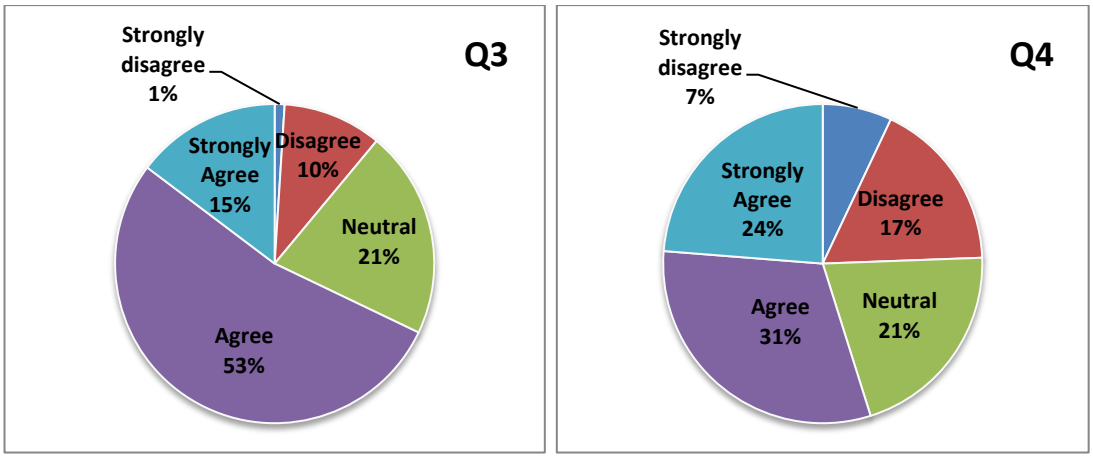

Figure 4.9: Attitude questions Q3 and Q4

Table 4.18: Attitude Q5, There are no appropriate policies and laws that enhance the effectiveness of solid waste management?

	Frequency	Percent	Cumulative Percent
Strongly disagree	23	7.7%	7.7%
Disagree	58	19.4%	27.1%
Neutral	49	16.4%	43.5%
Agree	98	32.8%	76.3%
Strongly Agree	71	23.7%	100.0%
Total	299	100.0%	

- Half of the respondents confirmed that there are no appropriate policies and laws that enhance the effectiveness of solid waste management, 33% strongly agreed on that and 24% agreed on that.
- Comparing gender groups using the T-test, the P-value of 0.101 shows that there is no difference between gender attitudes related to this question.
- Comparing educational level groups using the ANOVA test, the P-value of 0.863 shows that there is no difference between education level attitudes related to this question.
- Comparing between age groups using the ANOVA test, the P-value of 0.529 shows that there is no difference between age attitudes related to this question.

- Comparing professional groups using the ANOVA test, the P-value of 0.413 shows that there is no difference between professional attitudes related to this question.

Table 4.19: Attitude Q6, If containers are provided for waste sorting, are you prepared to commit to throwing garbage in the designated place?

	Frequency	**Percent**	**Cumulative Percent**
Strongly disagree	2	.7%	.7%
Disagree	11	3.7%	4.3%
Neutral	28	9.4%	13.7%
Agree	112	37.5%	51.2%
Strongly Agree	146	48.8%	100.0%
Total	299	100.0%	

- Half of the respondents strongly agreed that if containers are provided for waste sorting, they are prepared to commit to throwing garbage in the designated place, they represent 49% of the total responses.
- Comparing gender groups using the T-test, the P-value of 0.266 shows that there is no difference between gender attitudes related to this question.
- Comparing educational level groups using the ANOVA test, the P-value of 0.834 shows that there is no difference between education level attitudes related to this question.
- Comparing between age groups using the ANOVA test, the P-value of 0.613 shows that there is no difference between age attitudes related to this question.
- Comparing professional groups using the ANOVA test, the P-value of 0.103 shows that there is no difference between professional attitudes related to this question.

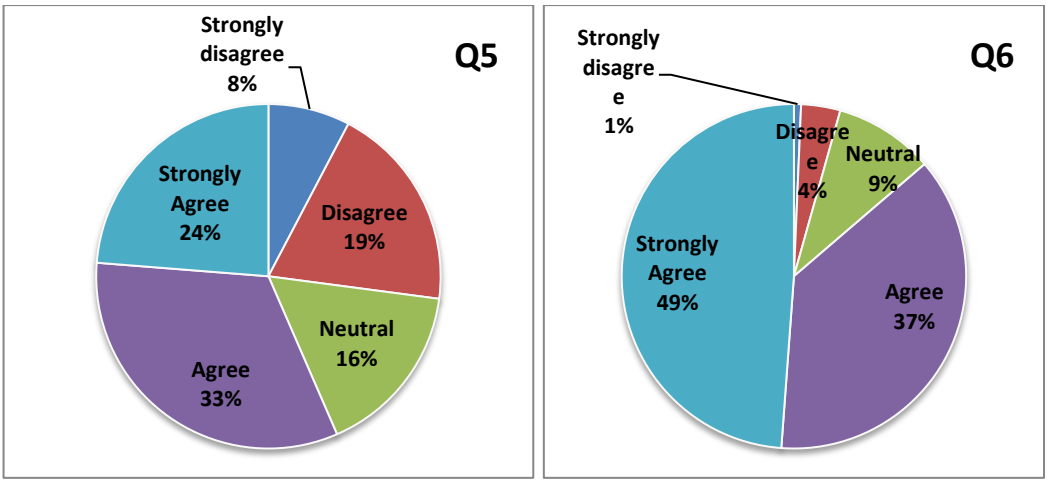

Figure 4.10: Attitude questions Q5 and Q6

Table 4.20: Attitude Q7, There are unhealthy random dumpsites in your city?

	Frequency	Percent	Cumulative Percent
Strongly disagree	16	5.4%	5.4%
Disagree	18	6.0%	11.4%
Neutral	40	13.4%	24.7%
Agree	116	38.8%	63.5%
Strongly Agree	109	36.5%	100.0%
Total	299	100.0%	

- Almost half of the respondents agreed that there are unhealthy random dumpsites in your city, they represent 39% of the total responses.
- Comparing gender groups using the T-test, the P-value of 0.817 shows that there is no difference between gender attitudes related to this question.
- Comparing educational level groups using the ANOVA test, the P-value of 0.088 shows that there is no difference between education level attitudes related to this question.
- Comparing between age groups using the ANOVA test, the P-value of 0.973 shows that there is no difference between age attitudes related to this question.

- Comparing professional groups using the ANOVA test, the P-value of 0.617 shows that there is no difference between professional attitudes related to this question.

Table 4.21: Attitude Q8, The municipality does not have enough manpower and vehicles to transport waste?

	Frequency	Percent	Cumulative Percent
Strongly disagree	36	12.0%	12.0%
Disagree	78	26.1%	38.1%
Neutral	76	25.4%	63.5%
Agree	77	25.8%	89.3%
Strongly Agree	32	10.7%	100.0%
Total	299	100.0%	

- The percentages of this question are almost equal, 26% agreed that The municipality does not have enough manpower and vehicles to transport waste, 26% disagreed and 25% are neutral.
- Comparing gender groups using the T-test, the P-value of 0.340 shows that there is no difference between gender attitudes related to this question.
- Comparing educational level groups using the ANOVA test, the P-value of 0.465 shows that there is no difference between education level attitudes related to this question.
- Comparing between age groups using the ANOVA test, the P-value of 0.443 shows that there is no difference between age attitudes related to this question.
- Comparing professional groups using the ANOVA test, the P-value of 0.727 shows that there is no difference between professional attitudes related to this question.

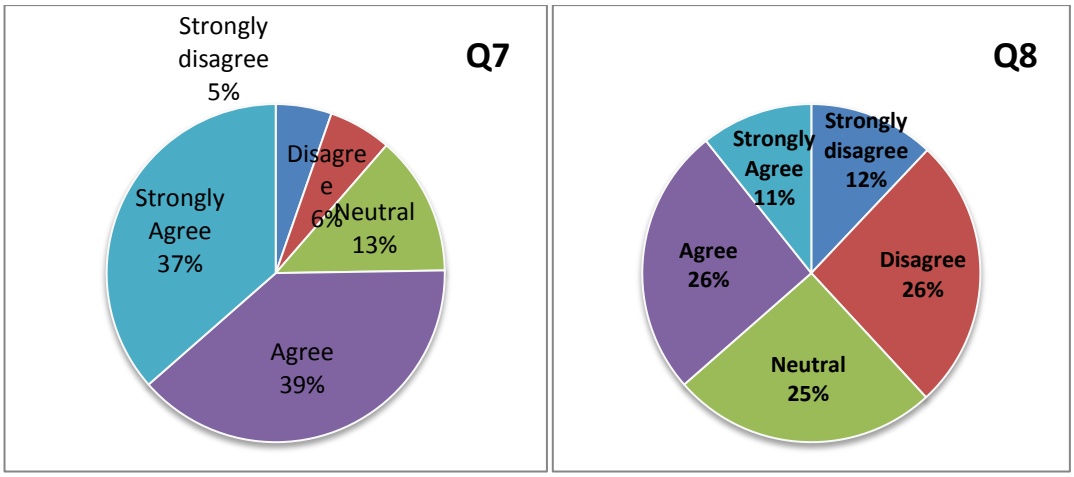

Figure 4.11: Attitude questions Q7 and Q8

4.3 Limitations

There were major limitations of this study that affected the study ,however, it did not affect the quality and complete completeness of the results of this study.

4.3.1 Lack of or difficulty obtaining data

The study was the lack of data on waste generation in Iraq in public databases, the lack of official government studies and reports on waste management, and the difficulty in obtaining data from the municipalities.

4.3.2 Interviews

The researcher's presence outside the country of study created restrictions in the interviews that were planned to be face-to-face, but due to the difficulty of travel and the Corona pandemic, the researcher was not able to conduct face-to-face interviews, and the interviews were satisfied by emails and contacts with the respondents

4.3.3 Time

Time was an influencing factor in this study, the process of collecting data, sorting it, and selecting respondents for the interviews took a lot of time. I was planning to collect more data and would like more interviews, but I had to make do with this much due to time constraints.

5. DISCUSSION AND CONCLUSIONS

The main objective of the project was to study the situation of waste in Iraq and to suggest ways to develop this system. Interview methodology and questionnaires were used and SPSS software was used as a tool for analyzing the questionnaire results.

5.1 Study Findings

The interview data was found from different cities in Iraq, The respondents agreed on the municipality's weak role in waste management, which is represented by the lack of logistical support, such as human resources and advanced mechanisms for waste collection, the lack of fixed timetables for waste collection, the lack of waste sorting from the source as well as The lack of regular sites compatible with the environmental conditions for the safe disposal of waste and the disposal of waste in unsanitary dumpsites. Finally, the community does not cooperate with the municipalities, Therefore, the municipality has a great responsibility to create a solid waste management program, which includes collecting solid waste by storing it in containers at the source it generates, then transporting it to a sorting plant and then to the final disposal sites (sanitary landfill), as well as continuing. To develop a solid waste management program by returning some recyclable solid waste or converting organic waste into organic fertilizer, or converting it into thermal and electrical energy, in addition to continuous awareness of citizens about the need to cooperate with municipalities.

The study showed that the research sample agreed that:

1. There is no sorting of waste from the source, and the waste is collected together without any sorting by citizens.
2. Most of the respondents emphasized that there are no regular municipal waste collection appointments.

3. Most of the respondents emphasized that the municipality is in the process of collecting waste from their homes and shops and is responsible for managing waste in their cities.
4. Most of the respondents do not know where the waste is disposed of, while 30% assured that the waste is disposed of in random dumps.
5. The largest percentage of the sample prefers to recycle glass, cardboard, paper, and plastic, through the establishment of recycling laboratories.
6. The study showed that the largest percentage of the sample agreed to compost their food and garden waste.
7. The study showed that residents are willing to pay for collecting waste from their homes or stores.
8. The study showed that most of the municipalities do not have healthy and environmentally safe dumps for waste disposal
9. Most of the respondents emphasized that there are no appropriate policies and laws that enhance the effectiveness of waste management.
10. The study showed that residents are ready to sort waste in the designated place if containers are provided by the municipality.
11. The study showed that the respondents had their opinions divided between agreeing and disagreeing that the municipality does not have enough manpower and vehicles necessary for waste management in their cities.

5.2 Conclusions & Recommendations

To this end, it was found that Iraq needs stations for the transfer of waste, and stations for recycling plastic, paper, and metals, in addition to that there is a need for healthy landfills that comply with environmental conditions, the municipality has a great responsibility to create a solid waste management program, which includes collecting solid waste by storing it in containers at the source it generates, then transporting it to a sorting plant and then to the final disposal sites (sanitary landfill), as well as continuing, to develop a solid waste management program by returning some recyclable solid waste or converting organic waste into organic fertilizer, or converting it into thermal and electrical energy, in addition to continuous awareness of citizens about the need to cooperate with municipalities.

The study discovered by analyzing the data results following:

The municipality's weak role in waste management, the lack of fixed timetables for waste collection, and 64% agreed that there is no sorting of waste from the source, Also, the lack of cooperation and coordination between the public and the municipality, 39% agreed that most municipalities do not have healthy and environmentally safe landfills for waste disposal, 33% strongly agreed that there are no appropriate policies and laws that enhance the effectiveness of solid waste management , 49% strongly agreed that residents are ready to sort the waste in the designated place in case the containers are provided by the municipality, 53% agreed that residents are willing to pay for collecting waste from their homes or stores.

The current waste management system in Iraq is insufficient and has not been modernized since 2003, the quantities of waste in Iraq are increasing year by year due to population increase and rapid growth.

In summary, our research paper is an attempt to clarify waste management procedures in Iraq and to present the opportunities involved in dealing with this problem, This study may refer to make use of garbage(food solid waste) in a landfill to produce Methane biogas (sustainability development) and purified of water leachate from solid waste landfills, and we hope to stimulate more research on this topic, which represents a real challenge in Iraq.

5.2.1 Recommendations

In view of the above conclusion, the following recommendations/suggestions are hereby made:

1. Establishing an appropriate program to sort the waste in its sources before it reaches the landfill by providing multiple containers in residential neighborhoods
2. Utilizing the applications of the geographic information system (GIS) to identify suitable places and sites for dumping waste.
3. The municipality should play a bigger role and allow investing in waste management and Giving the private sector a greater role in the solid waste management process and overcoming obstacles that hinder the work of investment companies.

4. Establishing plants for recycling solid waste and making use of it economically.
5. Planning for the construction of sanitary landfills in conformity with the environmental conditions in the governorates suffering from random dumpsites.
6. Modernizing old waste transport vehicles by introducing modern types of technology to keep pace with civilized development.
7. Educating the community by holding educational workshops in schools and universities to spread environmental awareness in the community and a warning about the dangers of solid waste accumulation in residential neighborhoods.
8. Encouraging people to compost food and garden waste and establish factories to produce fertilizers and use them in agriculture.
9. Activating appropriate legal policies and legislation that enhance the effectiveness of solid waste management and applying them in reality.
10. The municipality must establish a solid waste management program that includes collecting solid waste by storing it in containers from the source that it generates, then transporting it to the sorting plant and then to the final disposal sites (sanitary landfill).
11. Establish sites to receive waste from people and pay a fee for that, and encourage them to separate waste from the source.
12. Distributing garbage bags to residential homes and placing containers near residential homes and shops, to ensure that waste does not accumulate in residential neighborhoods and markets.
13. Encouraging the sorting mechanism from the source, either through home sorting directly or through the containers designated for this in the different neighborhoods with the development of a mechanism to motivate and encourage citizens.
14. Establishing a program to define regular paths for waste compressors according to (GIS) applications after determining the quantities of waste in

different neighborhoods with a mechanism to motivate and encourage citizens.

15. Establishing intermediary stations for sorting, collecting, and transporting waste to places of use, and transporting organic waste to composting plants, which must be near the sites of sanitary landfill.
16. Landfilling of materials leftover from sorting and fertilization in landfill sites, following the conditions of proper sanitary landfill.

REFERENCES

Okecha S.A. (2000). Pollution and Conservation of Nigeria Environment. T Afrique International Associates Owerri Nigeria.

Pattnaik, S., & Reddy, M. V. (2010). Resources, Conservation and Recycling Assessment of Municipal Solid Waste management in Puducherry (Pondicherry), India. "Resources, Conservation&Recycling,"54(8),512–520. https://doi.org/10.1016/j.resconrec.2009.10.008

Achankeg, E. (2004). Sustainability in municipal solid waste management in Bamenda and Yaounde, Cameroon. *Department of Geographical and Environmental Studies, Doctor of* (December), 405.

Moore, S. A. (2012). Garbage matters: Concepts in new geographies of waste. *Progress in Human Geography*, *36*(6), 780–799. https://doi.org/10.1177/0309132512437077.

Zerbock Olar, (2003). Urban Solid Waste Management: Waste Reduction in Developing Nations. Michigan Technological University. Accessed Online November 15th, 2006. http://www.cee.mtu.edu/peacecorps/documents_july03/Waste_reduction_and_i cineration_FINAL.pdf>.

Abu Ruwaida, Al-Taher, (2003). Solid Waste Management and Recycling in the United Arab Emirates - Reality and Ambition, General Secretariat of Municipalities, Dubai, p.8

Khayal, Secretary Al-Sayed, (2000). Municipal Solid Waste Management in Cities, Central Department of Waste, Hazardous Materials and Waste, Cairo, Egypt, p. 5.

Ahmed. Said Fadel, (1988). Analyzing the municipal services structure in the city of Baqubah and ways of its development in light of the city's urban expansion. Research submitted to the National Planning Institute 1988. p. 60

Brunner, P. H., & Rechberger, H. (2014). Waste to energy—a key element for sustainable waste management. Waste Management, 37, 3-12,

Chandler, A. J., Eighmy, T. T., Hjelmar, O., Kosson, D. S., Sawell, S. E., Vehlow, J., Sloot, H. A. (1997). Municipal Solid Waste Incinerator Residues. Amsterdam: Elsevier.

Vergara, S. E., & Tchobanoglous, G. (2012). Municipal Solid Waste and the Environment: A Global Perspective. Environment and Resources, 37(37), 277-309.

Wilson, D. C. (2007). Development drivers for waste management. Waste Management & Research the Journal of the International Solid Wastes & Public Cleansing Association Iswa, 25(3), 198-207.

Williams, P. T. (2005). Waste Treatment and Disposal. London, New York: John Wiley & Sons.https://doi.org/10.1002/0470012668

Basu, R. (2009). Solid Waste Management-A Model Study. *Sies Journal of Management, 6,* 20-24.

Cheremisin off, N. P. (2003). Handbook of solid waste management and waste minimization technologies [electronic resource]. Oxford: Butterworth-Heinemann.

Central Statistical Organization (2018), Statistical Summary for Iraq.

Hugh Kennedy, Majid Khadduri and Others (2020), Iraq, Encyclopædia Britannica, October 08, https://www.britannica.com/place/Iraq.

Multiple Indicator Cluster Survey MICS6.

Ammant Baghdad lraq (Unpublished data information 2010,2012,2014,2015).

Al-Najjar, Walid Muhammad Suleiman (2012), "Study Collection And treatment of solid waste for the city of Kirkuk and its effects Environmental Engineering, Master Thesis, Department of Environmental Engineering, College of Engineering, University of Baghdad.

Ashraf Yahya Alnajjar, (2019). Solid Waste Management in Iraq, University of Technology (Iraq), EcoMENA http://www.ecomena.org

European Environment Agency (2001). Kongens Nytorv 6, DK-1050 Copenhagen K, Denmark.

Haneen Ahmed K. AL- Qaraghully (2001). Study of Composition & Generation Rate of domestic Solid Waste for Tikrit City & Determination of The Optimal Site for Sanitary Landfilling, Tikrit Journal of Engineering Sciences/Volume/19 Issue/December 4)Tikrit, Iraq.

S.M. Al-Rawi, T. A..Al-Tayyar,(2012). Two decades comparison of solid waste composition and generation in Mosul city, J. of Eng. Science, Tikrit, Vol. 19, No. 1, pp.25-43.

Akla, Suad Abd Mahdi. (2015). Assessment of the environmental impact of a hypothetical landfill site. Higher diploma research In Environmental Impact Engineering, University of Technology, Department of Building and Construction Engineering.

Baghdad Municipality data,(2015). Department of Solid Waste and Environment.

Ministry of Planning, Central Bureau of Statistics. (2016) Environmental Survey of Medical Services Activity in Iraq for a year.

Mustafa, S.S., A.H. Mutlag, (2013). Kirkuk municipality waste to electrical energy International Journal of Electric Power and Energy Systems.. 44 (1): p.

Statistics., C.O.F,(2009). Iraq Environmental Statistics Report.

Iraq Environmental Survey (2010). .(Water - Sanitation - Municipal Services): Baghdad, Iraq.

Aaker A, Kumar VD, George S. (2000). Marketing Research. New York: John Wiley & Sons

Leedy, P., D & Ormrod, J., E (2005). *Practical Research: Planning and Design,* New Jersey, Pearson Education International.

Douglas, M. (2015). "Sources of data." Retrieved on 22nd September 2017 from http://www.onlineetymologydictionary/data

Van den Broeck J, Sandøy IF, Brestoff JR.(2013). The Recruitment, Sampling, and Enrollment Plan. In Epidemiology: Principles and Practical Guidelines (pp. 171-196). Springer Netherlands.

Kamangar F, Islami F. (1988). Sample size calculation for epidemiologic studies: principles and methods. Archives of Iranian Medicine (AIM). 2013 May 1;16(5).

Saunders M, Lewis P, Thornhill A. (2009). Research Methods for Business Student. 5th ed. Edinburgh Gate: Pearson Education Limited.

Robson, C. (2011). Real-world research: A resource for users of social research methods in applied settings. Chichester, U.K.: Wiley.

Drost, E., A. (2011). Validity and reliability in social science research. Education Research and Perspectives, 38 (1), 105-124.

Nunnally, J. C. (1978). Psychometric Theory. McGraw-Hill Book Company, pp. 86-113, 190-255.

Rosenthal, R. and Rosnow, R. L. (1991). Essentials of Behavioral Research: Methods and Data Analysis. Second Edition. McGraw-Hill Publishing Company, pp. 46-65.

Zohrabi, M. (2013). Mixed-Method Research: Instruments, Validity, Reliability and Reporting Findings. Theory and Practice in Language Studies, 3(2), 254-262

May, T. (2001). *Social research: Issues, methods, and process.* Buckingham: Open University Press.

Zølner, M., Rasmussen, I., and Hansen, A. (2007). 'Qualitative interviews: Studying network narratives' in *Methods in democratic network governance*, edited by Bogason, P., and Zølner, M. New York: Palgrave Macmillan.

IMSphere Consulting Inc (2017). Strategic Environment Assessment Report – Kirkuk Governorate,cha3.

Mukisa Philemon Kirunda,(2009).' Public Participation in Solid Waste Management: Challenges and Prospects A case of Kira Town Council, Uganda. The University of Agder, Kristiansand

Fontana, A. and Frey, J.H. (1998). "Interviewing, the art of science", in Denzin, N.K. and Lincoln, Y.S. (Eds), Collecting and Interpreting Qualitative Materials, Sage, Thousand Oaks, CA

Byrne, B. M., (2012). *Structural Equation Modeling with Mplus Basic Concepts, Applications, and Programming.* 2nd ed. New York: Taylor & Francis Group, LLC.

Landau, S. & Everitt, B. S., (2004). *A Handbook of Statistical Analyses using SPSS.* 1st ed. London: Chapman & Hall/CRC Press LLC.

Kombo D. K. and Tromp. D. L .A. (2006). *Proposal and Thesis Writing: An introduction*. Nairobi: Paulines Publications Africa.

Saunders, M., Lewis, P., & Thornhill, A. (2003). Research Methods for Business Students (3rd ed.). England: Prentice-Hall.

APPENDIX

Appendıx A: Questionnaire

Part 1:

1- Gender:

-Male

-female

2- Educational level:

-Master / PhD

-Bachler

-Baccalaureate

3- Your Age:

18–25years

26–35years

36–45years

Above 45 years

4- Profession:

-Student

-Employee

-free business

-Housewife

Part 2:

5. Do you have any waste bins in your home/store/stall?

A) Yes

B) No

6. Are you sorting the waste generated in your home/store/stall?

A) Yes

B) No

7. How is the waste collected inside the home or neighborhood?

-In bags

-Container with lid

-Container without lid

8. What is the average waste disposal time?

-Day

-Two days

-Three days

-More than that

9. How often is the waste transported from the collection area to the place designated for it?

-Once a week,

-Twice,

-Three times,

-There are no regular appointments,

-There is no garbage collection vehicle

10. Who takes the waste from your home/store/stall for disposal?

A) me

B) A private waste company

C) The city's municipality

11. Where is the waste taken for disposal?

a) Random dump

b) A pit for burning

c) Sanitary landfill

d) Sorting or recycling plant

d) I do not know

12. Which waste items do you think should be sorted for recycling?

a) Hard plastics

b) Plastic

c) Glass

d) Paper

e) Metals

f) all above

Part 3:

Questions	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	1	2	3	4	5
13. Are you ready to compost your garden waste?					
14. Are you ready to compost food waste?					
15. In the future, are you willing to pay for the collection of the waste that you generate in yours?					
16. The municipality does not have healthy and environmentally safe waste dumps?					
17. There are no appropriate policies and laws that enhance the effectiveness of solid waste management?					
18. If containers are provided for waste sorting, are you prepared to commit to throwing garbage in the designated place?					
19. There are unhealthy random dumpsites in your city?					
20. The municipality does not have enough manpower and vehicles to transport waste?					
21. What is your suggestion to develop solid waste management in your city?					

Appendıx B: Interviews

Part 1:

1- Gender:

2- Educational level:

3- Age:

4- work experience:

Part 2:

1. Where is the waste taken in your city (is it disposed of in acceptable places? How is it disposed of?
2. What is the role of the city municipality in managing solid waste?
3. What should the city municipality do in managing solid waste?
4. What items of waste do you think should be sorted for recycling?
5. What is your suggestion to develop solid waste management in Iraq?

References for questions Interviews and Questionnaire:

- **Mukisa Philemon Kirunda, (*2009*).** Public Participation in Solid Waste Management: Challenges and Prospects A case of Kira Town Council, Uganda. The University of Agder, Kristiansand
- **Mohamed Jama Farah, (2019),** Challenges of Solid Waste Management and factors influencing its effectiveness: A case study in Burao Municipality, Burao, Somaliland. The Unıversıty of Burao, September.
- **Upendra Mani Pradhan, (2008),** Sustaınable Solıd Waste Management In A Mountaın Ecosystem: Darjeelıng, West Bengal, Indıa. University of Manitoba Winnipeg, Manitoba November.

RESUME

EDUCATION:

- Bachelor's degree **Environmental Engineering** / College of Engineering / University of Mosul.
- **Graduating year:** 2017-2018 .

Research title / Design of a water purification plant for 100,000 people.

- Master's degree **Engineering Management Program**/ Institut Of Science And Technology/ Istanbul Gedik University, Turkey.
- Graduating year: 2020-2021 .

Research title / The reality of solid waste management in Iraq and ways to develop it.

COMPUTER SKILLS:

- Microsoft Office (Word &Excel…etc.).
- Computer use professionally.
- Internet essentials (E-mail, communications, research, maintain and installation of internet devices).
- AutoCAD

LANGUAGE:

- Arabic: Native language
- English: (90% reading, 90% writing and 80% Speaking).

EXPERIENCE:

& Team management
& Scientific reports and research
& Office work
& Engineering projects
& financial management

OTHER SKILLS:

- Analytical Skills.
- Planning Skills.
- Ability to work simultaneously with multiple tasks and under time pressures in a fast growing program environment.
- Willingness and ability to work efficiently with a wide diverse group of people

- Good reporting skills.
- Proventechnical knowledge and skills in the field of procurement .
- Excellent interpersonal and communication skills & problem solving skills.
- Uncommonly self-motivated , capable of working without supervision and committed to

successfully meeting production , cost , safety and environment goals.