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The reality of solid waste management in Iraq and ways of development

A B S T R A C T

Solid waste management operations are collecting, transportation, and disposal of residential, commercial, institutional, construction, demolition, and wide street areas; the result of the daily activity of humans needs to be properly managed. Iraq faces many problems associated with its unregulated solid waste systems. First, however, this study examined the reality of solid waste management in Iraq and ways to develop it. The total number of participants in this research was 326 participants .The data collected in February and March 2021, interview methodology and questionnaire which used, and the analysis software used for this research is IBM SPSS version 23; the two methodologies were used and combined to reach the largest possible amount of qualitative and quantitative information that may be absent from the researcher and to reach good results and outputs for the research, for reasons including obtaining more and deeper information to reach the largest segment of society and to achieve the goals of the thesis and obtain good results by integrating the two methodologies.

The study concluded by analyzing the data, The municipality's weak role and the lack of regular timetables in organizing waste collection and transportation operations, and 64% agreed that there are not 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 municipality provides the containers, 53% agreed that residents are willing to pay for collecting waste from their homes or stores. After analyzing the study results, Iraq needs stations for sorting and transporting waste and stations for recycling plastic, paper and metals. Also, there is a need for sanitary landfills compatible with environmental conditions, and the municipality should play a greater role and give the private sector a greater role in the solid waste management process and overcome obstacles that hinder the work of investment companies, in addition to raising community awareness through holding educational workshops. For example, in schools and universities to spread environmental awareness in the community.

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واقع ادارة النفايات في العراق وسبل تطويرها

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الخلاصة

إدارة النفايات الصلبة هي عمليات جمع ونقل وتخلص من النفايات في المناطق السكنية والتجارية والمؤسسية والبناء والهدم والشوارع الواسعة ، نتيجة النشاط اليومي للجنس البشري يحتاج إلى إدارتها بشكل صحيح, يواجه العراق العديد من المشاكل المرتبطة بأنظمة النفايات الصلبة غير المنظمة.
هذه الدراسة تناولت واقع إدارة النفايات الصلبة في العراق وسبل تطويرها, بلغ العدد الإجمالي للمشاركين في البحث 326 مشاركًا, تم جمع البيانات في فبراير ومارس 2021 ، وتم استخدام منهجية المقابلة والاستبيان. برنامج التحليل المستخدم
الاصدار IBM SPSS.23
اكتشفت الدراسة من خلال تحليل نتائج البيانات ضعف دور البلدية وعدم وجود جداول زمنية منتظمة في تنظيم عمليات جمع النفايات ونقلها ، واتفق 64٪ على عدم وجود فرز للنفايات من المصدر. أيضا ، قلة التعاون والتنسيق بين الجمهور والبلدية ، اتفق 39٪ على أن معظم البلديات ليس لديها مطامر صحية وآمنة بيئيا للتخلص من النفايات ، و 33٪ وافقوا بشدة على عدم وجود سياسات وقوانين مناسبة تعزز فعالية إدارة النفايات الصلبة ، وافق 49٪ بشدة على استعداد السكان لفرز النفايات في المكان المخصص في حالة توفير البلدية للحاويات ، واتفق 53٪ على استعداد السكان للدفع مقابل جمع النفايات من منازلهم أو متاجرهم.
وبعد تحليل نتائج الدراسة تبين ان العراق بحاجة الى محطات لفرز ونقل النفايات ومحطات لتدوير البلاستيك والورق والمعادن. كما أن هناك حاجة لمدافن صحية متوافقة مع الظروف البيئية ، ويجب على البلدية أن تلعب دوراً أكبر وتعطي القطاع الخاص دوراً أكبر في عملية إدارة النفايات الصلبة وتذليل العقبات التي تعيق عمل الشركات الاستثمارية ، بالإضافة إلى توعية المجتمع من خلال عقد ورش عمل تثقيفية. في المدارس والجامعات لنشر الوعي البيئي في المجتمع والتحذير من مخاطر تراكم النفايات في الأحياء السكنية.
الكلمات الدالة : الإدارة ، البلدية ، النفايات الصلبة ، البيئة.

1. INTRODUCTION

Waste results from human and animal activities and that is disposed of useless or undesirable waste can be classified in several ways, based on sources, environmental hazards, facilities, and physical properties; Depending on the source, solid waste is again classified as agricultural, industrial, and municipal waste Okecha S.A. [1]. Solid waste management is not an easy task in developing and developed countries, as it is considered of contemporary environmental problems in urban areas Pattnaik & Reddy [2]. Developing countries lack improper planning associated with population growth, and rapid development leads to increasing traffic congestion; thus, it is difficult for vehicles to collect garbage and reach these places, allowing dirt to accumulate over time Zerbock Olar [3]. ″

Solid waste can mean different things to different people; many people believe that waste is a source of income. On the other hand, the majority of the developed countries see that waste is a problem. Therefore, it must be addressed to solve it; recognizing trash as a problem does not prevent littering of waste; waste management theory is founded on the expectation that waste management is to prevent waste causing harm to human health and the environment [14]. Solid Waste generation and its potential impacts on health, environmental quality, and the urban landscape have become national issues addressed in Iraq today. All stakeholders concerned with the safety and beautification of our environment have recognized the negative impacts of the un-removed solid human waste found in residential neighborhoods, markets, schools, and central business districts in our cities. As a result, urban residents often face a serious impact on their collective health and safety.

The increasing population growth and urban development with poor planning and lack of attention to the waste problem, as well as lack of cooperation and coordination between the public and the municipality, led to the accumulation of tons of waste, Which requires an organizational capacity between the public and private sectors to devise the best solutions for the safe disposal of solid waste or to benefit from it as an economic return.

1.1 The study Problem

The solid waste management process requires great effort; as known, the accumulated waste creates many problems for people, including traffic congestion, health, and environmental risks.

Also, 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. Furthermore, 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; 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 [17].”

The random 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.

Today, local and federal authorities in Iraq are working to remove the stack of waste from their environments. But these attempts are outdone by the chaotic nature of overflowing dumps and piles of solid waste generated from household sources, institutions, markets, malls, and businesses ,that the authorities in Iraq are unable to control the indiscriminate dumping of hazardous commercial and industrial waste, which is a clear violation of laws and environmental sanitation rules and regulations Ahmed [6].”

1.2 Importance of solid waste management

Process of monitoring, collecting, transporting, treating, recycling, or disposing of waste. This term is usually used for waste resulting from human activities, to mitigate the negative effects as the environment, health, and public appearance Also used to obtain resources from the Recycling route ,as developed societies have excessive consumption of various products, which does not depend on the rich countries.

However, the spread of infection 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. Shows Table 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 of responsibility those in charge of these cities, as these wastes must be disposed of every day in the interest of public health Abu Ruwaida and others [4].”

Table 1

Capita production of household waste Khayal [5]."

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

Today, local and federal authorities in Iraq are working to remove a stack of waste from their environments. But these attempts are outdone by the chaotic nature of overflowing dumps and piles of solid waste generated from household sources, institutions, markets, malls, and businesses ;that the authorities in Iraq are unable to control the indiscriminate dumping of hazardous commercial and industrial waste, which is a clear violation of laws and environmental sanitation rules and regulations Ahmed [6].”

2. LITERATURE REVIEW

2.1 The concept of solid waste

Waste results from the daily movement of human activities; a long time ago, waste generation rates and quantities increased, 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 due to the Industrial Revolution and types of waste generated in the cities; Materials such as metals, glass, and plastics are beginning to appear in large quantities in municipal waste.

Lots of people in cities and communities are randomly throwing waste into open dumps. These landfills, in turn,

formed fertile areas for rats and other insects and began to pose major public health risks.

Unhealthy waste management practices led to outbreaks of epidemics that led to large numbers of deaths. Hence, in the nineteenth century, public officials began to dispose of waste in a controlled way in another way to protect public health; most developed countries went through a period when they were developing ecologically.

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 Brunner, Chandler, Vergara, Wilson [7],[8],[9],[10]."

2.2 Review of Theoretical Literature

This section summarises 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."

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.

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, and inorganic waste.

2.3 Waste management in the Iraqi context

2.3.1 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; Baghdad governorate generates large waste estimated at more than 1.5 million tons of solid waste every year. The rapid increase in waste production imposes tremendous pressure on the Iraqi waste treatment infrastructure, severely damaging political instability and bad management.

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 ,National Solid Waste Management Programme (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, Social education was also taken into consideration to ensure the provision of an educational system that supports the participation and awareness of society and individuals in waste management Ashraf Alnajjar [11].”

2.3.2 The problem of waste in Iraq

The problem of waste in Iraq began from the absence of government legislation and instructions that arranges the recovery process's responsibilities between the local population and municipal administrations; It also lacks community awareness of environmental problems because of the unstable security situation and the low educational level.

Solid waste 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 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 follows : [12].”

1. Lack of advanced means to eliminate the stack of waste resulting from daily activities.

2.Lack of financial resources and few capabilities and equipment impede without achieving a standard Service required.

3. The method of managing all kinds of waste is characterized by ineffective partial solutions, resulting in negative economic, health, and environmental impacts.

4. Lack of environmental legislation related to management and its implementation.

5. The accumulation of 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 AL-Qaraghully [13].”

3. MATERIALS and METHODS

3.1 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 [14].Fig. 1 Shows the geographical location of Iraq.

Fig. 1: Map of Iraq

Shows Table 2 total population and population growth rate. 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 Hugh, Majid, and Others [16].”

Table 2

Iraq's population and overpopulation [15].”

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

The area of Iraq is 435052 square kilometers; the population of Iraq is young. About two-fifths of the population is under 15, while two-thirds are under 30. Its birth rate is high, and it has a low death rate due to its much smaller elderly population; less than one-seventh of Iraqis are over 45, Women have a life expectancy of about 76 years, while men’s life expectancy is 73 Hugh, Majid, and Others [16]. Fig. 2 Shows is the average age of the population in Iraq.

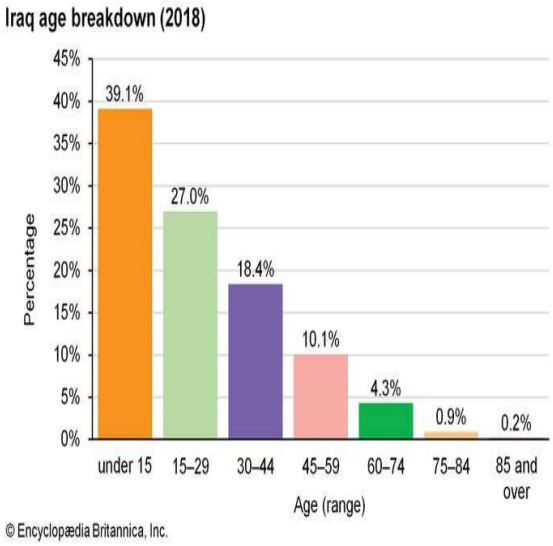


Fig. 2 : Average age of the Iraqi population [16].”

3.1.1 Baghdad Governorate

Baghdad is the Iraqi capital, and the largest city in Iraq, with about 7.6 million people, according to 2013 statistics, and an area of 204.2 square kilometers. Fig. 3 shown in the map of Baghdad and the provinces in it .The city of Baghdad produces about 8-10 thousand tons/day, and it produces more than 2.5 million tons of waste annually [15].

Fig. 3: Map of Baghdad

Baghdad governorate covers an area of 5159 km2, of which 900 km2 area of the city Baghdad is managed by the Baghdad Municipality and is divided into (14) municipalities. Although, in addition, there are administrative units outside the Baghdad Municipality borders (Abu Ghraib, Mahmoudiya, Taji, Rashidiya, and Al-Madaen), Baghdad is about (7) million people, the amount of waste in Baghdad's city reached 34958605

tons/year. In contrast, Baghdad's outskirts amounted to 306016 tons /year [17]."

3.1.2 Kirkuk Governorate

Kirkuk is from 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). As Fig. 4 shown in the map of Kirkuk and the provinces in it.

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 2020 Al-Najjar [18]."

Fig. 4: Map of Kirkuk

3.2 Methodology

This article is based on the data collected during nine months between 2020 and 2021. Data was collected as part of gaining a master's degree. The data were collected in two ways through Interviews with various bodies responsible for waste management in Iraq, including municipalities and academics in universities, six participants, one with a bachelor's degree, and the other with an environmental researcher's degree, two of them with the rank of assistant teacher, and two with a doctorate, or work experience Or a teaching period ranging from 01 to 10 years (1); 11 to 20 years (2); 21 - 30 years old (2) over 40 years old (1).

Also collected data from the questionnaire; the number of respondents to the questionnaire was 320 males and females aged between 18 and over 45, master's and doctoral graduates, university and high school graduates, including government employees, self-employed workers, and homemakers. They were also from all the governorates of Iraq, and their answers to the questionnaire questions varied; 21 respondents were neglected for not answering correctly and accurately from the community groups identified by the researcher.

Initially, the questionnaire design was coded and blended from a given topic based on standardized structures. Thus, the questionnaire produced valuable data

that were required to achieve the objectives of the study, Also, collected data from a review of official government documents and published articles; was used and included in the study's theoretical framework.

The interviews were analyzed, and then the results of the questionnaire were analyzed; it clarified the issues of waste management, the results of which will be presented in the next section.

A combination of qualitative and quantitative research methodologies was used to obtain comprehensive responses; Quantitative data were processed and analyzed with SPSS computer software to produce frequency tables and descriptive statistics. Qualitative data will be analyzed theoretically, and part of it has been copied, processed, and discussed in light of the theoretical framework, The researcher integrated the quantitative and qualitative approaches in analyzing the data, and the reasons are because some results are required for a personal evaluation of the information obtained from the respondents. Simultaneously, some conclusions were reached after simple mathematical calculations such as mean, percentages, and frequency tables.

4. RESULTS and DISCUSSION

This section presents data analysis first as an analysis of qualitative data obtained from structured interviews and an analysis of the quantitative data obtained from the questionnaire.

4.1 Analysis of interview data

Four themes, in particular, emerged from structured interviews, 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 managing solid waste. With an overview and a comparison with the literature, some Responses implicitly indicated that.

mentioned a scientific researcher at the Ministry of Environment:

"*The municipality has a weak role because of lack of adequate logistical support 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."

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, 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, also separating hazardous waste; from municipal waste".*

A representative of the Energy World Company for Training and Development said:

" *Establishing special times and a regular schedule for collecting 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".*

3. Waste disposal methods

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

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

Another respondent from another city, a university professor 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 dumped in random places in most areas".*

4. waste management development

Respondents were asked about how to develop the current situation of waste management and devise radical solutions to issue One respondent, a university Prof at the University of Mosul, 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 a mechanism to motivate and encourage citizens.*

According to (GIS) applications, we are 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."

3.2 Analysis questionnaire of data

To knowledge 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, the following formula calculates it: Percentage = (Number of Respondents * 100) / Total Number of Respondents. The total responses collected were 320 responses; however, 21 responses were considered unengaged after initial data screening and were removed from the study, so accepted 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:

The gender of the respondents' clients to the researcher as Fig.5 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 were asked to fill out the questionnaires.

Half of the respondents have a master's or Ph.D. degree; they represent 50% of the total responses; on the other hand,35% have a bachelor's degree, and 15% are school students shown in Fig.5.

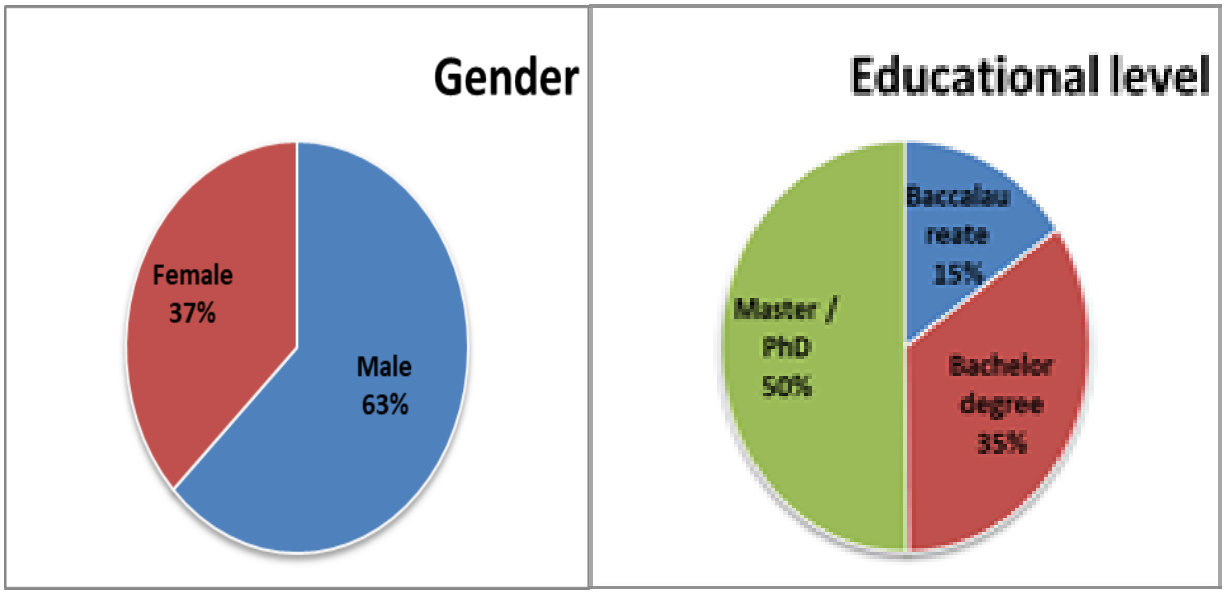


Fig. 5: Demographics Gender and Educational Level.

Fig. 6 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.

Half of the respondents are employees; they represent 55%, the other half are either free businessmen, or housewives, or students shown in Fig.6.

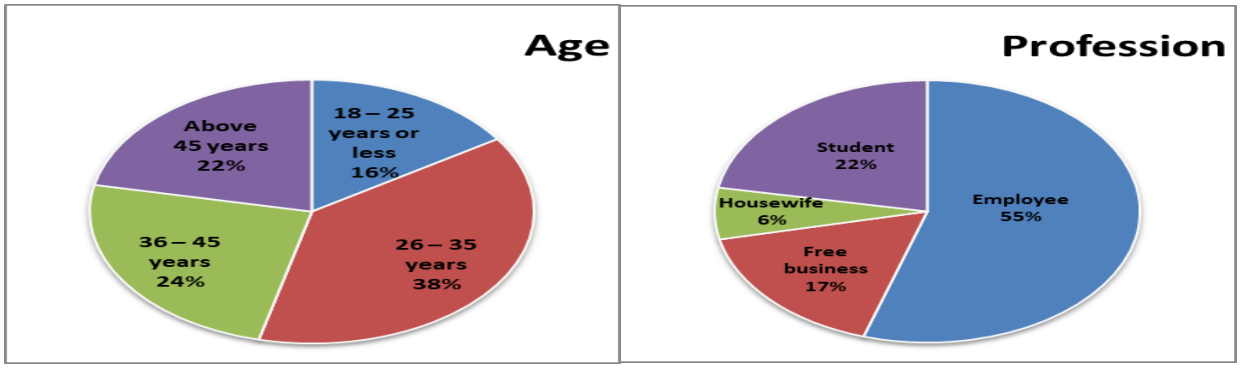


Fig. 6 : Demographic Age and Profession.

The second part:

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

Table 3

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 3 shows that almost all of the respondents have waste bins in their homes/stores/stalls; they represent 90%.

Table 4

General information Q2, Are you sorting the waste 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 shows that more than half of the respondents do not sort their waste in their homes or stores, representing 64%.

Fig. 7 Shows Q3 General information Q3, How is the waste collected inside the home or neighborhood?

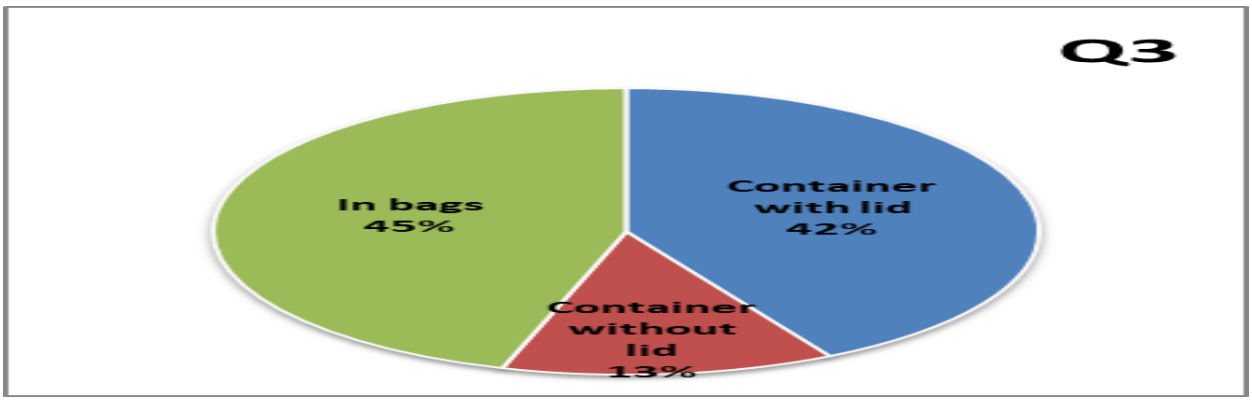


Fig. 7: General information Q3

Fig.7 shows that almost half of the respondents collect their waste in bags; they represent 45%, the other half

collect their waste using a lidded container, representing 41%.

Shows Q4, What is the average waste disposal time?

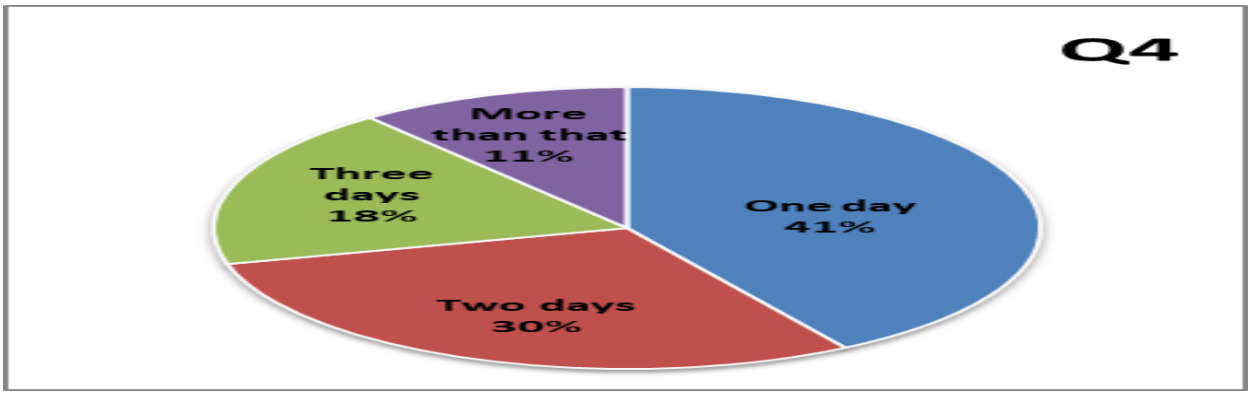


Fig. 8: General information Q4

Fig.8 shows that almost half of the respondents confirmed that the average waste disposal time is one day, representing 41%.

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

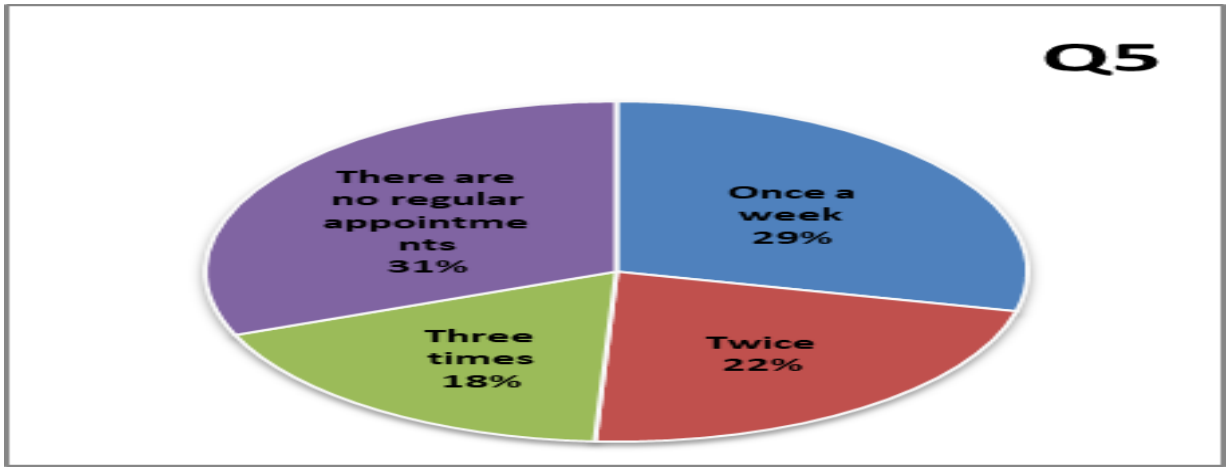


Fig. 9: General information Q5

Fig. 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.

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

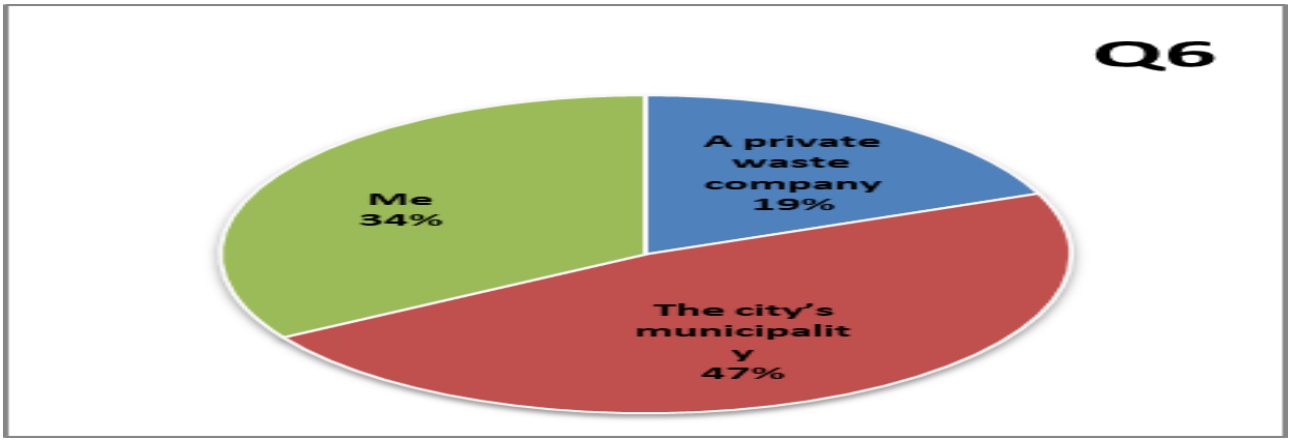


Fig. 10: General information Q6

Fig. 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.

Shows Q7, Where is the waste taken for disposal?

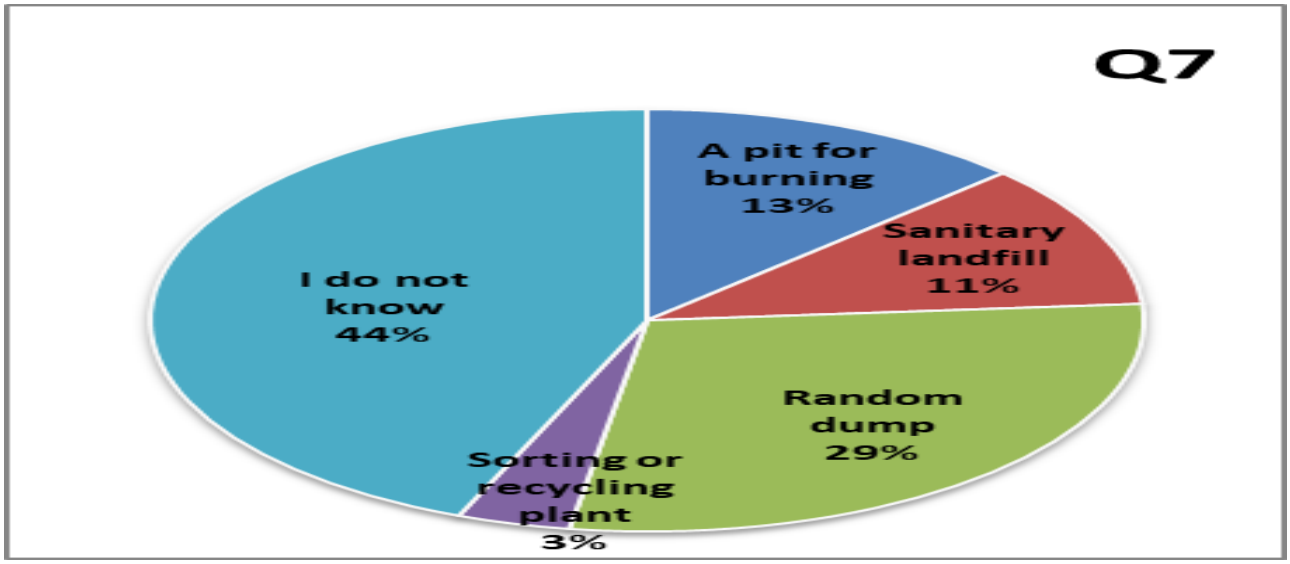


Fig. 11: General information Q7

Fig. 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 it is taken to a random dump.

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

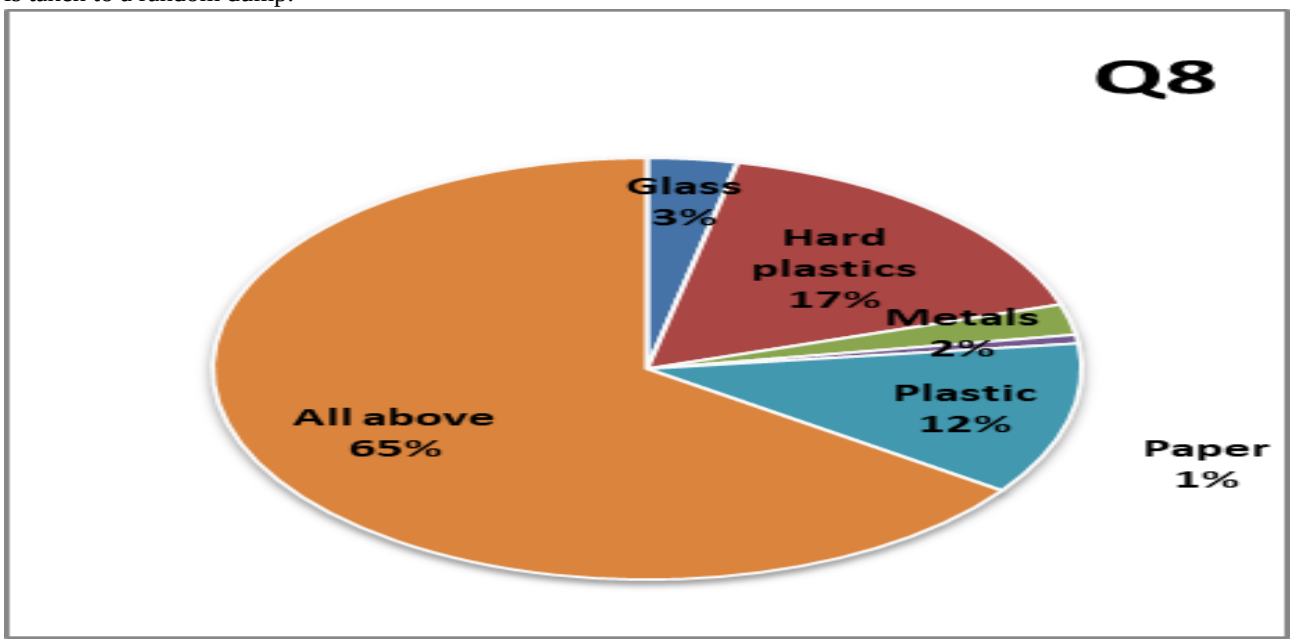


Fig. 12: General information Q6

Fig. 12 shows that more than half of the respondents prefer to recycle glass, hard plastic, metal, paper, and plastic, which accounts for 65%.

of this analysis represents the attitude toward waste management. These questions are analyzed using the simple percentage analysis and T-test, and ANOVA test to compare the demographic groups' attitudes toward waste management

.**The Third part:**

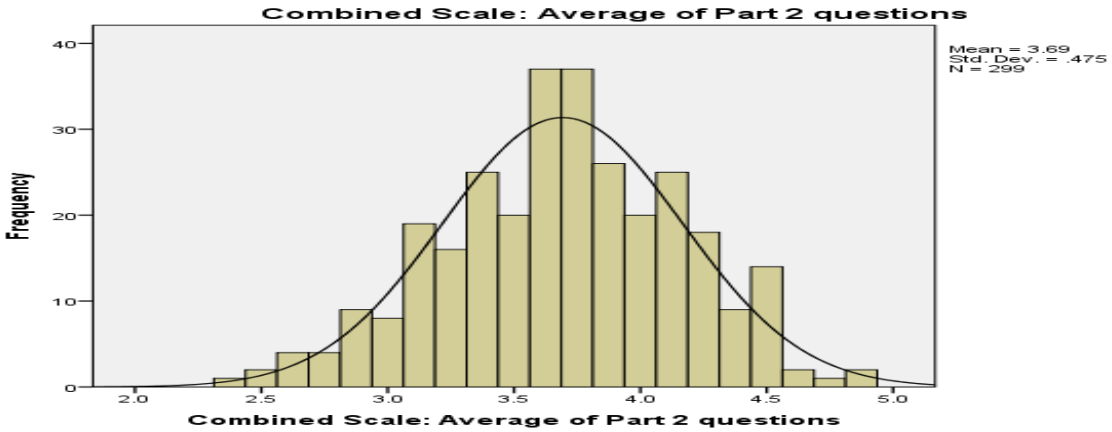


Fig. 13: Normality assessment

Fig. 13 shows Part of Normality assessment is making sure 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 compared to normal distribution" for not having a Kurtosis, the kurtosis analysis must be between 8 and -8. the results are shown below table, it can be concluded no Skew and Kurtosis.

The below Table 5 also includes the mean and standard deviation of each question.

Table 5
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 waste management?	3.45	1.256	-.419	-.952	
Q6: If containers are provided for waste sorting, are you prepared to commit to throwing waste 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 workforce and vehicles to transport waste?	2.97	1.197	.011	-.958	

According to Fig. 14:

- Half of the respondents agreed that they are ready to compost your garden waste; they represent 56%.
- Comparing gender groups using the T-test, a P-value of 0.854 shows no difference between gender attitudes related to this question.
- Comparing educational level groups using the ANOVA test, the P-value of 0.873 shows no difference between education level attitude and this question.
- Comparing between age groups using the

ANOVA test, the P-value of 0.383 shows no difference between age attitudes related to this question.

- Comparing between professional groups using the ANOVA test, the P-value of 0.628 shows no difference between professional attitudes related to this question.

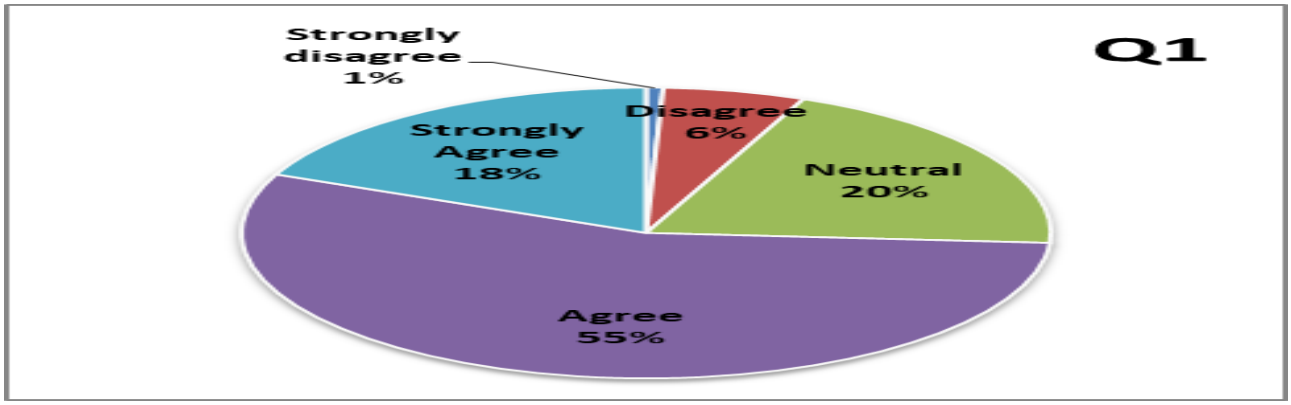


Fig. 14: Attitude questions Q1.

According to Fig.15:

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

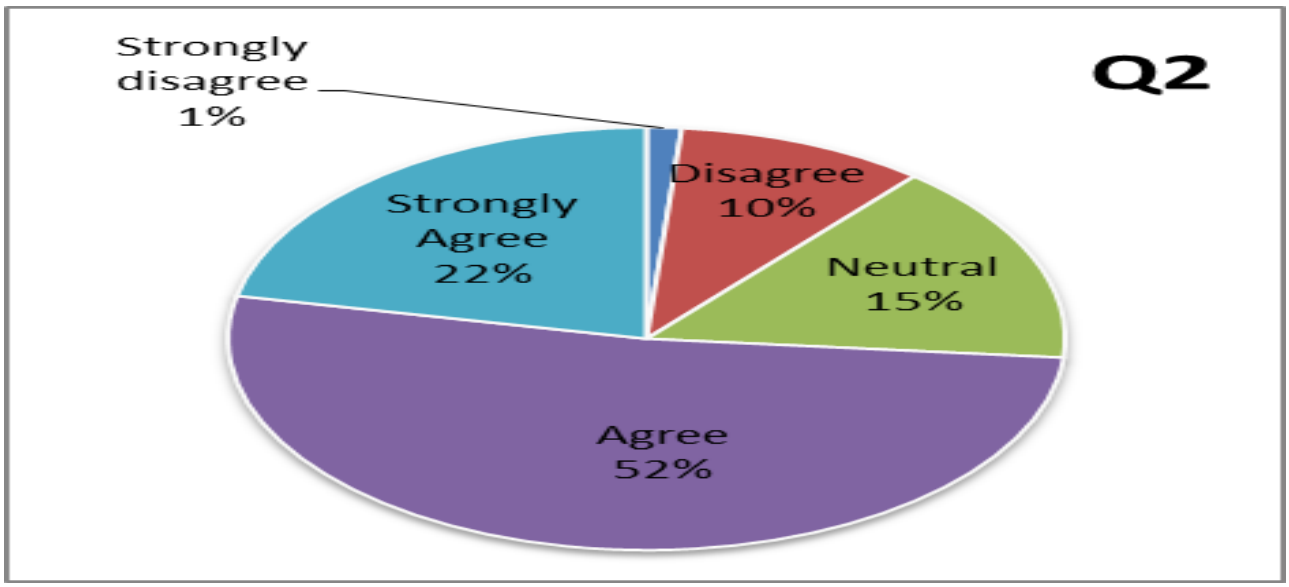
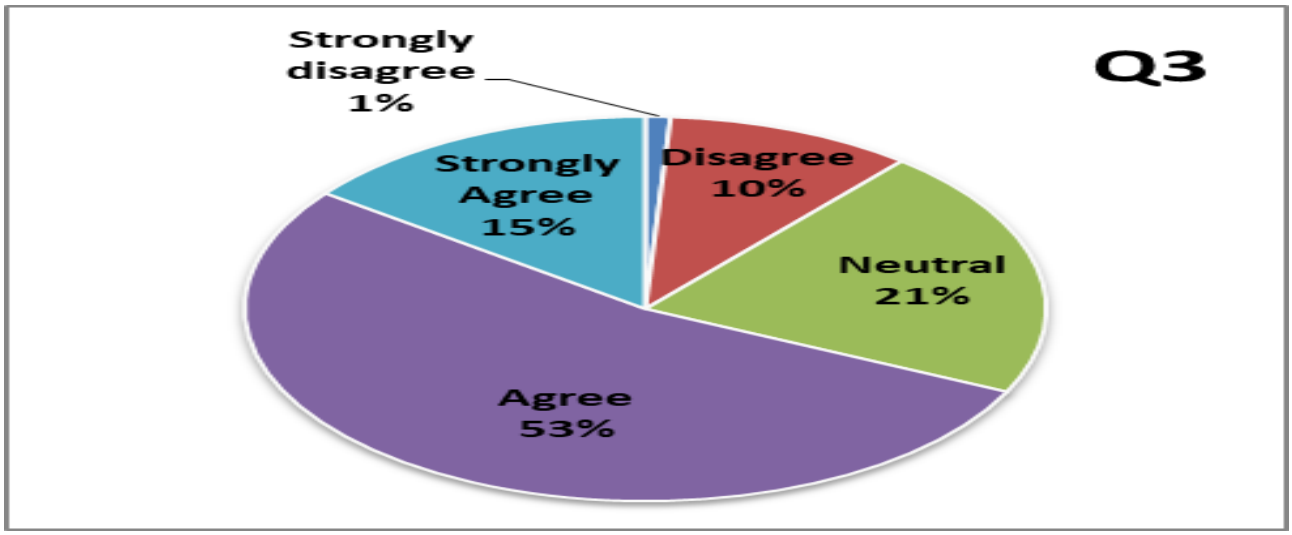


Fig. 15: Attitude questions Q2.

According to Figure 16 :

- 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, a P-value of 0.796 shows no difference between gender attitudes related to this question.

- Comparing educational level groups using the ANOVA test, a P-value of 0.419 shows no difference between education level attitudes related to this question.
- Comparing between age groups using the ANOVA test, a P-value of 0.562 shows no difference between age attitudes related to this question.



- Comparing between professional groups using ANOVA test, P-value of 0.429 shows no difference between professional attitude related to this question.

Fig. 16: Attitude questions Q3.

According to Fig. 17:

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

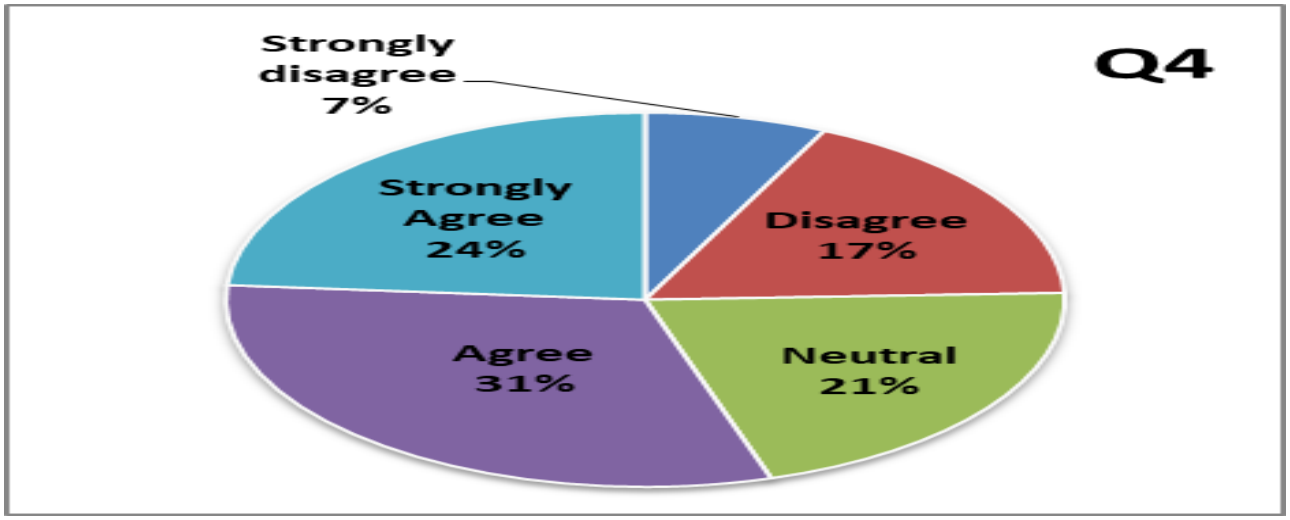


Fig. 17: Attitude questions Q4

Table 6

Attitude Q5, 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%	

Table 6 shows:

-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, a P-value of 0.266 shows no difference between gender attitudes related to this question.

-Comparing between educational level groups using the ANOVA test, the P-value of 0.834 shows that there is no difference between education level attitude related to this question.

-Comparing age groups using the ANOVA test, the P-value of 0.613 shows no difference between age attitudes related to this question.

-Comparing between professional groups using the ANOVA test, a P-value of 0.103 shows no difference between professional attitudes related to this question.

Table 7

Attitude Q6, The municipality does not have enough human resources 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%	

Table 7 shows:

-The percentages of this question are almost equal; 26% agreed that The municipality does not have enough human resources and vehicles to transport waste, 26% disagreed, and 25% are neutral.

-Comparing gender groups using the T-test, a P-value of 0.340 shows no difference between gender attitudes related to this question.

-Comparing educational level groups using the ANOVA test, a P-value of 0.465 shows no difference between education level attitude and this question.

-Comparing between age groups using ANOVA test, a P-value of 0.443 shows no difference between age attitudes related to this question.

-Comparing between professional groups using the ANOVA test, a P-value of 0.727 shows no difference between professional attitudes related to this question.

5. DISCUSSION AND CONCLUSIONS

The project's main objective was to study solid waste in Iraq and suggest ways to develop this system. The data were collected by interviews and questionnaires, and the Statistical Package for the Social Sciences (SPSS) program was used as a tool to analyze the questionnaire results; the two methodologies were used and combined to reach the largest possible amount of qualitative and quantitative information that may be absent from the researcher and to reach good results and outputs for the research, for reasons including obtaining more and deeper information to reach the largest segment of society and to achieve the goals of the study and obtain accurate results by integrating the two methodologies.

5.1 Summary of findings

The interview data were obtained from various cities in Iraq. The respondents agreed on the municipality's weak role, which is represented by lack of logistical support, such as human resources and advanced mechanisms for waste collection, weakness of fixed timetables for waste collection, absence of waste sorting from the source as well as lack of regular sites compatible with the environmental conditions for the safe 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 waste management program, which includes collecting 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), also continuing, to develop a waste management program by returning some recyclable solid waste or converting organic waste into organic fertilizer, or converting it into thermal and electrical energy, also continuous awareness of citizens about the need to cooperate with municipalities.

The study discovered 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 responses emphasized that no regular municipal waste collection appointments.

3. The respondents emphasized that the municipality collects 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 of the sample prefers to recycle glass, cardboard, paper, and plastic, through the establishment of recycling laboratories; the most commonly recycled plastics are, Polyethylene Terephthalate (PET) – water bottles and plastic trays, High-Density Polyethylene (HDPE) – milk cartons and shampoo bottles.

6. The study showed that the largest percentage of the sample agreed to compost their food and garden trimmings.

7. The study showed that residents are willing to pay for collecting waste from their homes or stores.

8. The respondents most emphasized that the municipalities do not have healthy and environmentally safe dumps for waste disposal

9. The largest sample emphasized that no appropriate policies and laws enhance the effectiveness of solid waste management.

10. Most of the responses emphasized that residents are ready to sort waste in the designated place if the municipality provides containers.

11. The study discovered that the respondents had their opinions divided between agreeing and disagreeing that the municipality does not have enough human resources and vehicles necessary for waste management in their cities.

The waste problem is one of the main problems in Iraq, and day after day, the problem is getting more and more complicated due to the accumulation of waste piles.

Therefore, if the government authorities do not take radical solutions for waste management, they will be unable to deal with the quantities of waste produced daily.

5.2 Conclusions

To this end, The study discovered that Iraq needs stations for the transfer of waste and stations for recycling plastic, paper, and metals; also, there is a need for healthy landfills that comply with environmental conditions. The municipality has a great responsibility to create a waste management program, which includes collecting 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). Additionally, continuing to develop a waste management program by returning some recyclable solid waste or converting organic waste into organic fertilizer, or converting it into thermal and electrical energy. Furthermore to continuous awareness of citizens about the need to cooperate with municipalities.

The weakness of the municipality role in waste management, lack of fixed timetables for waste collection, and 64% agreed that no sorting of waste from the source, 33% strongly agreed that there are no appropriate policies and laws that enhance the effectiveness of waste management , 49% strongly agreed that residents are ready to sort the waste in the designated place in case the municipality provides the containers, 53% agreed that residents are willing to pay for collecting waste from their homes or stores.

The waste management system in Iraq is inadequate and has not been modernized according to the rapid changes in infrastructure, rapid growth, and changes in Population in Iraq since 2003 ,the main issue, in this case, waste accumulation In landfills, waste generation in Iraq is 1.4 kg/person/day; It is estimated that Iraq generates 31,000 tons/day of solid waste, the difficulty of waste management in developing countries, as well as Iraq's daily production of waste and the unsafe disposal of waste.

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

In summary, the research paper attempts to clarify current solid waste management procedures in Iraq and to turn to ways to develop this system; 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. Hopes to stimulate more research on this topic, which represents a real challenge in Iraq.

5.3 Recommendations

Given the above conclusion, the following recommendations/suggestions are as a result of this made:

1. Establishing an appropriate program to separate waste from the source before transferring it to the landfill by providing multiple containers in residential neighborhoods.

2. Utilizing (GIS) applications to identify suitable places and sites for dumping waste.

3. The municipality should play a bigger role and allow investing and Give the private sector a greater role in the waste management process and overcome obstacles that hinder investment companies' work.

4. Establishing plants for recycling and making use of it economically.

5. Planning for 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. Educate the audience by holding educational workshops in schools and universities to spread

environmental awareness in the audience and warn about solid waste accumulation in residential neighborhoods.

8. Encouraging people to compost Organic waste and establish factories to produce fertilizers and use them in agriculture.

9. Activating appropriate legal policies and legislation that enhances waste management effectiveness 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 generated, then transporting it to the sorting plant, and then to the final disposal sites (sanitary landfill).

11. Establish sites to receive waste from people, pay a fee for that, and encourage them to separate waste from the source.

12. Distribute garbage bags to residential homes and place 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, developing 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 to sort, collect and transport waste to places of use and transport organic waste to composting plants, which must be near sanitary landfill sites.

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

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