Kurdish Studies
Feb 2024
Volume: 12, No: 2, pp.5954-5974
ISSN: 2051-4883 (Print) | ISSN 2051-4891 (Online)
www.KurdishStudies.net

Received: December 2023 Accepted: January 2024
DOI: https://doi.org/10.58262/ks.v12i2.443

Characteristics of Solid Household Waste and the Factors Affecting it in Buraydah City, Saudi Arabia

Mohammed Ibrahim Aldagheiri[1], Ibrahim Saleh Alrebdi[2]

Abstract

Buraydah city witnessed high population growth rates and urbanization in the last two decades, improvements in the standard of living and growing consumerism contributed to generation of high amounts of Municipal Solid Waste (MSW). This study explored the characterization of MSW and investigated factors influencing it. It was also interested in obtaining a real indicator that reflects the per capita output of solid household waste per day in Buraydah. The study followed descriptive and statistical methods to analyze and forecast results. Questionnaires and personal interviews were used throughout the study, where the total sample size was 1205 homes, to which 1221 forms were distributed. The waste characterization study showed 47% 53% ratio for organic to inorganic waste, and 1.15 kgs is the average per capita waste generation/day, while the lowest rate was 0.81 kilograms and the solid water annually increased by 5 percent. In addition, plastic is the main component and has the highest percentage (20 %) among inorganic waste in the study area, and cardboard accounted for 10 %, and came in second place after plastic. The study shown that the production of household waste is affected by many overlapping factors that can negatively or positively, affect the quantity or characteristics of household waste such as: Family size, Type of housing, Educational level, Standard of living, Social behavior and habits, Seasons and occasions. This study recommends the establishment of a database for integrated management of MSW and calls for integrating regulatory bodies and community's efforts to improve MSW management. Finally, this study heightened raising public awareness, training and environmental education for all people.

Key words: *Waste, Municipal Solid Waste, Environmental Impact, Buraydah*

1. Introduction

1.1 Background

Solid waste management has become a major daily challenge for the Kingdom of Saudi Arabia, with a population of nearly 29 million people, as Saudi Arabia produces more than 15 million tons of solid waste annually. At the same time, consumption has increased greatly. The cheapness of raw materials has also contributed to the increase in canned food and ready-to-eat factories, and in unrecyclable plastic and paper utensils, which was a factor that increased the volume of household waste. Therefore, studying the sources of household waste and how to treat it has become a pressing environmental issue in light of the economic boom in many countries of the world, including the Kingdom of Saudi Arabia. It is highly necessary to benefit from this waste in order to achieve sustainable development and reduce the environmental and health risks that could be caused by this waste that threatens the future of life on Earth. The current household waste recycling rate in the Kingdom is estimated at 23.5%, and the components that are used are iron, copper, paper, cardboard and plastic (1).

Experts interested in the waste recycling industry confirm that the Kingdom of Saudi Arabia t

[1] Department of Geography, College of Languages and Humanities, Qassim University, Buraydah 52571, Saudi Arabia, Email: aldagheiri@qu.edu.sa
[2] Email: saudi19801@gmail.com

is still lagging behind in in comparison with developed countries, although there is an encouraging percentage of waste and cheap raw materials. In addition, there are good success opportunities for economic feasibility studies, and consumers need recycling projects (2).

According to the estimates of the Qassim Region Municipality, in the city of Buraydah, the daily average of solid household waste generated in the city of Buraydah for the year 1436 AH exceeded 550 tons, at an annual cost of about 65 million riyals, while in 1427 AH the amount of waste generated was 270 tons at an annual cost of 26 million riyals (3). We find that there is a significant increase in the quantities of waste produced and the costs of collecting and transporting it with a lack of recycling, and this constitutes a financial and administrative burden. Since the government's direction in development plans is to achieve comprehensive development while ensuring sustainability for this development, which requires a rapid and comprehensive scientific, planning and implementation study, it is directed towards collecting waste and making use of it in an ideal way, and devising administrative, technical and economic technical methods, through which the goals of public cleanliness and preservation can be achieved. On the environment and its natural resources, and improving them in a way that ensures the achievement of sustainable development as in developed countries. Accordingly, the problem of the study is to identify the characteristics of household solid waste in the city of Buraydah and the most important factors affecting it.

Therefore, the objectives of this study include:

1. To identify household solid waste in terms of its quantities, components and characteristics in the city of Buraydah.
2. To determine the most important factors affecting household solid waste in the city of Buraydah.
3. To derive a real indicator that reflects the output per capita per day of household solid waste in the city of Buraydah.

1.2 Study Area

The city of Buraydah (Figure 1), the administrative capital of the Qassim Region, is located almost in the center of the Region and is surrounded by a number of governorates, namely: Al-Asyaah Governorate in the north and northeast, Uyun Al-Jawaa Governorate in the northwest, Al-Shamasiyah Governorate in the east and southeast, Unaizah Governorate in the south, and Bukayriyah Governorate in the west. It is located astronomically between latitudes 26̊.10̊.38̊ and 26̊.31̊.20̊ north and longitudes 43̊.43̊.49̊ and 44̊.10̊.56̊ east. The number of neighborhoods in the city is 70, and its area is 572 km^2 (3). Its population is about 470 thousand people, according to the results of the census of 1431 AH (4).

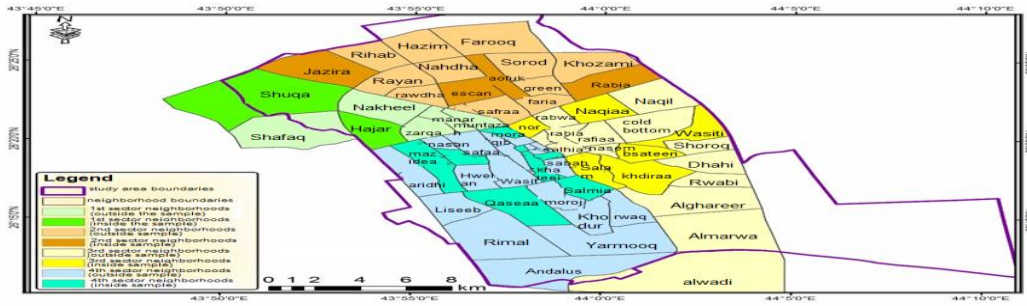

Figure 1: Buraydah City (Study Area).

2. Literature Review

Despite the many geographical studies concerned with the study of the city of Buraydah and the large cities in the Kingdom of Saudi Arabia, none of them dealt with the issue of waste in the city of Buraydah. This study looked at some previous geographical studies in the field of solid waste, the factors affecting it, and methods of disposal and managing it in a sustainable manner, the most important of which are:

The study by (5) dealt with solid waste and the consequences of not treating it, its resultant environmental dangers, methods of treating and classifying solid waste, and methods of treating household waste in Saudi Arabia and the countries of the Gulf Cooperation Council. It discussed the possibility of exploiting this solid industrial waste and of recycling materials of economic value. It concluded that benefiting from industrial and household solid waste is an important factor in treating solid waste and requires in-depth studies in the field of the utilization of the types of solid waste.

(6) dealt with the types, components, and size of solid waste and showed methods of dealing with waste, the environmental and economic effects of solid waste recycling, and the economic evaluation of its various components. It indicated that used aluminum cans are the most profitable component of solid household waste when recycled.

(7) focused on the current solid waste management system in the city of Jeddah in terms of waste collection, transportation and disposal, and identified weaknesses in each process. It discussed the importance of recycling waste in this system, its obstacles, the reasons beyond its failure, and the methods of making it successful. It also examined the methods of sorting solid waste, and how the sorting process is conducted at the source or at the transitional stations. It also estimated the amount of future waste to determine the life expectancy of the new landfill, which has an area of 4.5 million square meters, and found that it will not last for more than 21 years, and that this period is short compared to its area and the population of the city of Jeddah, which will reach 6,411,479 people in the year 1452 AH in comparison with what happens in industrially developed countries; Based on what has been studied, the study recommends waste recycling.

(8) focused on the human factors affecting the volume of waste, current disposal methods, environmental effects, and economic benefits of recycling. One of the most important findings of the study is that the volume of garbage is directly proportional to a number of economic, social and demographic variables.

(9) dealt with the history of waste in Qatar, waste characteristics, and waste management in terms of collection, transportation, and dumping. It depended on the questionnaire tool and was applied to Qatar University students during the year 2003. It showed that there is a relationship between the volume of waste and the type of housing, the type of housing and the level of income, as well as the type of housing and the attitude and civilized behavior towards cleanliness. Its recommendations focused on solving this environmental problem by the method of waste recycling.

(10) sought to study the waste problem and how to deal with it, identify the most important reasons that led to its accumulation, try to find the most appropriate ways to dispose of it and the natural and human factors that influenced it, and determine its components and quantities, in addition to the methods of collecting, transporting and disposing of it.

(11) focused on greenhouse gas emissions and their relationship to wrong practices for household waste management in the Kingdom of Saudi Arabia. With an increase in the total output of solid waste per capita and a decrease in the unemployment rate, the emission of solid waste increases in Methane gas. The research concluded that the best practices in solid waste management and disposal are recycling and converting it into energy and fertilizer while mitigating the negative effects of climate change.

After reviewing the previous studies that dealt with the subject of the research, we find that the current study agrees with them in:

1. Studying the characteristics of the waste.
2. Studying the effects and damages of waste on the environment.
3. Studying the method of waste management in general in a number of cities in the Kingdom.
4. Treating waste by recycling.
5. Using geographic information systems (GIS) in data analysis.

The addition of this study is that it aims to shed light on the geographical dimension in environmental aspects and their impact on development in general and sustainability in particular. Although this study agrees with some previous studies on the subject, it differs in the method of treatment, focusing on points not covered by previous studies, which are as follows:

1. Highlighting the environmental dimension.
2. Highlighting the economic dimension.
3. Highlighting the social dimension.
4. These points, in their entirety, are the components of sustainability.
5. The current study focuses on the following programs:
6. Reducing waste at the source.
7. Highlighting the importance of recycling and making use of the largest amount of waste.
8. Demonstrating the importance of reducing the volume and quantity of waste.
9. Raising the efficiency of the waste collection process by reducing the large costs in the current collection process.
10. Determining the best paths in the waste collection process, using GIS.
11. Determining the appropriate sites for waste collection and the best routes for transporting it to the landfill, according to the GIS data.
12. Highlighting the awareness-raising dimension of the importance and value of economic waste and its role in creating a healthy environment and a profitable economic return.
13. Highlighting the importance of changing consumer habits to reduce waste.

3. Methodology

3.1 Data Collection

The study adopted the analytical descriptive method which is based on analysis, induction, deduction and comparison, and utilized interviews and questionnaires as a means to identify some practices and monitor some of the opinions of residents and workers in waste management, by focusing on household solid waste, its distribution in the study area and its characteristics from a geographical point of view.

The research community is represented in the city of Buraydah, with the boundaries of its urban scope in 1435 AH.3. Due to the large area of the study community, an appropriate multi-stage sample was chosen to represent the community.

- The first stage: Dividing the city into four main sectors, as illustrated in Figure (1).
- The second stage: Selecting a sample of neighborhoods representing 30 % of the neighborhoods of each sector, bringing the total number of neighborhoods to 21 which represent about 30 % of the total Buraydah neighborhoods.
- The third stage: Selecting a random sample of housing, representing 5 % of the houses of each neighborhood. See Table (1).

Table 1: Distribution of the Study Sample in the City of Buraydah

Sector No.	No. of sector neighborhoods	Percentage of city neighborhoods	No. of neighborhoods selected for the sample of 30 % of sector neighborhoods	No.	Sample neighborhood names	Sample number representing 5% of neighborhood houses	Percentage of questionnaire number
1	7	10	2	1	Al-Homr	28	2
				2	Al-Shaqqah	150	12
2	15	21	4	3	Al-Iskan	187	16
				4	Ar-Rabiyah	34	3
				5	Al-Ofoq	65	5
				6	Aj-Jazeera	50	4
3	22	33	7	7	Khudhairaa	22	2
				8	As-Salam	57	5
				9	As-Sadah	72	6
				10	Al-Basateen	33	3
				11	An-Noor	86	7
				12	Al-Wusaytaa	83	7
				13	An-Naq'	21	2
4	26	36	8	14	Al-Qusay'ah	20	2
				15	As-Salimeyyah	84	7
				16	Aj-Janoob	43	4
				17	Al-Khaleej	55	5
				18	Khab Al-Bareedi	20	2
				19	Al-Hilal	55	5
				20	Al-Mareedseyyah	20	2
				21	Al-Marqab	20	2
Total	70	100 %	21	21 representing 30 % of city neighborhoods		1205	100 %

The total sample size was 1221 homes, to which 1221 forms were distributed, 16 of which were excluded due to their invalidity, and the total number of forms used in the analysis was 1205 forms. Due to the nature of the subject of the study, its sources vary, and the following are the most important of these sources:

- Published and unpublished data and records of Qassim Region Municipality.
- Data and records of cleaning companies operating in the city.
- Personal interviews with officials in the authorities related the subject of the study.

3.2. Data Processing and Analysis

The data has been processed, analyzed and presented in a scientific way that achieves the objectives of the study, including: statistical tables, cartographic representation of maps, illustrations and graphs, and photographs. To achieve this, appropriate computer,

mathematical and statistical programs were used, such as EXCEL, SPSS and mathematical equations, as follows:

Calculating population growth rate using the exponential equation:

It is one of the accurate methods for calculating the population growth rate, and it takes the following formula:

p2=p1 e r x t

Where p2 = the population in the second census, p1 = the population in the first census, r = the annual growth rate, t = the time interval between the two censuses, e = the exponential powers of the growth rate and time and their constant value is = 2.71828 (16).

Calculating the weight of household solid waste in kilograms per person per year:

w = tw/p x 100 (kg/person/year).

Where w = the weight of household solid waste in kilograms per person per year, tw = the weight of total waste in tons per year, p = the population of the region (12).

Calculating the density of waste using the following equation:

$$d = \frac{pXsh}{A}$$

Where d = waste density in grams, p = population of the sample, sh = per capita waste in grams per day, a = area occupied by the sample lands (9).

4. Discussion

4.1 Characteristics of Household Waste

Household waste is the waste resulting from the activities of residents in homes that is thrown away or disposed of and is of no benefit to its producers. It usually consists of non-hazardous materials, which are leftovers, remains of packing materials, household consumables, and other stuff used by residents, in addition to the waste resulting from food processing.

Household waste is classified as either organic or inorganic waste. Organic waste is the waste that can be fermented and decomposed, such as food leftovers, leftovers of food processing, and garden waste while inorganic wast is the materials that are not subject to fermentation or decomposition, such as glass, plastic, cardboard, paper, textiles, and various metals such as iron, aluminum, copper, etc (13)

Studying the characteristics of household waste aims to identify the components of waste elements, their distribution proportions and quantities. After converting these characteristics into data and numbers, they are used in preparing and directing programs aimed at managing this waste, starting with reducing the proportions of materials and their consumption through consumption rationalization programs, and reducing the rates of the production of a particular type or types of waste items. Reusing or repeatedly using some materials is a waste management option which is helped by the identification of waste characteristics. In addition, the now numerous and developed methods of recycling enable the recycling and transformation of waste into other products, or producing other materials out of waste. Thus, the principle of sustainable development is achieved by recycling materials, preserving unused materials, the environment and natural resources for future generations. The recycling process also helps to create an additional source of income from waste. (14).

4.2 Selection of the Waste Characteristics Sample

Waste characteristics constitute an important factor in the waste management process environmentally, economically, and socially. To identify these characteristics, a field survey was necessary to reach numbers that help in making appropriate decisions for the integrated waste management process. Therefore, the researchers selected a random stratified sample. The six neighborhoods included in the original study sample were selected out of twenty-one neighborhoods, namely: As-Safraa, Al-Iskan, Al-Fayziyyah, Al-Khabib, Ar-Rabieh, and Ar-Rayyan, representing approximately 30 % of the neighborhoods of the study sample. Three houses were selected from each neighborhood, so that the total sample becomes eighteen houses, but one of the houses was excluded for lack of seriousness in providing information. Then the weights of the waste were measured for ten different days. The study of the characteristics of the waste included the following materials:

4.3. Basic Components and Proportions of Waste

The weights of different household waste components in the city of Buraydah showed a slightly higher percentage of inorganic waste, reaching 53 % compared to organic waste, which reached 47 %, as shown in Table (2). It is known that many families appreciate their articles and do not throw away food leftovers which they give to the needy through charities such as Itaam, Hifz Al-Ne'ma, Az-Zeyy Al-Khayri, and other charities. Some families dry bread leftovers and use them to feed livestock.

Table (2) shows the details of the different weights of the components and organic items of household waste, which are distributed among four components: foods, mixed materials, liquids, and other materials.

Table 2: Weights of Organic Household Waste Compared to Inorganic Household Waste in Buraydah in 2017 (in Kilograms).

Sample No.	Total weight of organic waste (kg)	Total weight of inorganic waste (kg)	Overall weight (kg)
1	55.35	59.80	115.15
2	21.30	49.05	70.35
3	42.00	51.80	93.80
4	58.20	48.00	106.20
5	24.45	48.15	72.60
6	22.20	57.70	79.90
7	36.70	45.30	82.00
8	36.80	48.45	85.25
9	52.35	48.55	100.90
10	25.75	51.49	77.24
11	79.15	34.45	113.60
12	46.59	45.35	91.94
13	41.40	40.55	81.95
14	57.15	46.44	103.59
15	56.80	48.35	105.15
16	46.40	61.31	107.71
17	46.75	60.30	107.05
Total	749.34	845.04	1594.38
Percentage	47 %	53 %	100 %

Leftovers of cooked foods had a large percentage of 68 % of total organic materials which represent 32 % of total household waste. It is noted that the leftovers of rice and bread constitutes a large percentage of food leftovers. This corresponds to the data contained in the report of the World Food and Agriculture Organization (15) on food waste in the world. The report indicated that a third of cooked foods is wasted, along with abundant amounts of fresh water that was used in the production of these materials.

Mixed organic materials are the second highest component of organic waste, with a percentage of 26 % of organic waste and 12 % of the total components of household waste. They are a mixture consisting of many different types and are subject to fermentation and decomposition.

Organic waste contained liquids, which are leftovers of drinks and juices, in addition to water leftovers in water bottles, moisture and liquids present as part of foods, and sometimes liquid leftovers of detergents and chemicals used for household purposes. The percentage of these liquids was 1 % of the total volume of waste.

Organic waste contains other materials which was 1% of household waste. It was expired foodstuffs such as dairy products and other materials used in the preparation and processing of foods.

Table 3: Components and Weights (Kg) of Various Inorganic Materials of the Study Sample in Buraydah in 2017.

Sample No.	Cardboard	Paper	Plastic	Textiles	Metals	Glass	Other	Total
1	7.15	5.80	21.00	8.50	3.80	6.35	7.20	59.80
2	10.25	5.95	18.90	2.05	2.30	3.60	6.00	49.05
3	7.65	8.80	19.65	3.80	3.00	2.60	6.30	51.80
4	8.05	3.70	19.00	1.25	3.70	6.40	5.90	48.00
5	6.65	6.15	18.35	2.60	4.85	3.75	5.80	48.15
6	9.70	10.15	19.65	2.65	4.15	4.30	7.10	57.70
7	7.55	3.45	19.20	3.55	3.80	2.25	5.50	45.30
8	8.75	5.90	17.45	2.80	4.55	3.20	5.80	48.45
9	7.10	10.55	18.05	0.50	2.30	4.15	5.90	48.55
10	7.00	8.79	21.45	1.95	2.60	3.40	6.30	51.49
11	8.00	1.45	14.45	0.50	3.70	2.15	4.20	34.45
12	14.45	0.00	17.15	1.65	2.40	4.20	5.50	45.35
13	14.00	1.10	13.60	1.00	4.70	1.25	4.90	40.55
14	8.65	2.14	19.20	1.65	3.15	5.25	6.40	46.44
15	10.60	2.10	19.15	2.95	4.35	3.40	5.80	48.35
16	12.20	2.30	17.70	2.86	9.60	9.25	7.40	61.31
17	18.85	2.20	19.50	2.15	6.00	4.20	7.40	60.30
Total	166.6	80.53	313.4	42.40	68.95	69.70	103.4	845.0

The weights of the inorganic components of household waste amounted to 53 % of the total weights of the waste, consisting of many types. These items differ according to seasons and occasions. Their percentage and weights (kg) according to the results of the study of waste characteristics in the city of Buraydah were as shown in Table (3).

Plastic is the main component and has the highest percentage (20 %) among inorganic waste in the study area. It was noted that plastic had moisture or residues of some food items; which

increased its weight. There were wide spectrums of plastic items, which varied with the diversity of life and luxury in cities, and the nature of the population's consumption of many diverse commodities that depend on plastic in packaging, packing, and loading instead of the natural materials that were previously used, such as the palm-frond baskets, cloth bags, or paper.

Cardboard accounted for 10 %, and came in second place after plastic. It represents the largest volume among waste components. The abundance of cardboard quantities in household waste is due to packaging preparations for marketing population needs of all goods and services. The quantities of cardboard waste are directly proportional to increased consumption. Compared with the results of studies of waste characteristics in other Saudi cities, usually cardboard is the highest component of household waste, while its low percentage in the study area is likely due to that it had been picked up and collected in advance by informal waste collectors. A number of private sector factories in the Kingdom of Saudi Arabia are working to recycle cardboard and convert it into new products that have economic value and stable prices.

Metals accounted for 4 % of household waste, and they consist of iron, aluminum, and copper. Iron mostly comes from packages of canned food, powdered milk, etc. Aluminum consists of heat-preserving dishes and soft drink cans. As for copper, its quantity is very small and is associated with some old tools, kitchen utensils, some old trinkets, electrical appliances, and etc.

Glass accounted for 4 % of household waste, which is a low percentage, as plastic materials have recently appeared to replace glass, but there are materials still available in glass containers, most of which relate to beverages, juices and some food containers, in addition to glass that is found in other household materials and appliances. Glass recycling is not widely practiced in the Kingdom because the glassware industry is still not widespread in the region, raw materials are available, and the economic viability of recycling is not encouraging.

Table 4: Percentages of Different Materials in Waste and Average per Capita Production per Day in the City of Buraydah.

Sample No.	Percentage of inorganic materials	Percentage of organic materials	Per capita waste (10 days)	Per capita production of waste per day
1	51.93	48.07	12.79	1.28
2	69.72	30.28	8.79	0.88
3	55.22	44.78	10.42	1.04
4	45.20	54.80	11.80	1.18
5	66.32	33.68	8.07	0.81
6	72.22	27.78	9.99	1.00
7	55.24	44.76	11.71	1.17
8	56.83	43.17	14.21	1.42
9	48.12	51.88	11.21	1.12
10	66.66	33.34	8.58	0.86
11	30.33	69.67	14.20	1.42
12	49.33	50.67	11.49	1.15
13	49.48	50.52	9.11	0.91
14	44.83	55.17	12.95	1.29
15	45.98	54.02	15.02	1.50
16	56.92	43.08	13.46	1.35
17	56.33	43.67	13.38	1.34
Total	53.00	47.00	11.47	1.15

Other materials in inorganic household waste amounted to 7 % of the waste. They have many categories, including electronic waste (mobile phones, computer parts, batteries, children's toys, etc.), medicines, medical supplies, and other semi-hazardous materials that are available in solid chemical forms. Waste, such as detergents, disinfectants, and dry sanitary ware, may lead to pollution and cause some health risks for workers collecting and treating household waste.

4.4. Per Capita Production of Household Waste

Calculating the per capita production rate of household waste per day is one of the most important criteria that a waste management specialist cares about because this rate is associated with many mathematical, planning and demographic operations.

Table 5: Average per Capita Household Solid Waste Production in Some Arab and Foreign Countries.

Country	Per capita production (Kg per day)	Country	Per capita production (Kg per day)
Sultanate of Oman	0.6 – 0.9	Lebanon	0.6
Saudi Arabia	1.3	Syria	0.5
Jordan	0.9	The United States	2.0
Qatar	1.3	Australia	1.9
Tunisia	0.8	Germany	1.1
Sweden	0.8	France	0.7

It can be seen from the above table that the highest rate of per capita production of household waste was 1.5 kilograms per day in the study sample, while the lowest rate was 0.81 kilograms. The entire study sample average of per capita production per day was 1.15 kilograms. Many studies are concerned about such rate because it is used to calculate the volume of waste produced by the residents of a specific city in order to select the technical services necessary to accommodate this waste, starting from collection, transportation, treatment, and ending with safe disposal. The per capita production rates of waste vary annually in terms of the increase or decrease in its volume, an issue which should be taken into account when preparing future plans.

The rates of per capita production of waste in the study area differ from the average per capita production in the Kingdom of Saudi Arabia and the State of Qatar, which amounted to 1.3 kilograms (1). Moreover, the Ministry of Municipal and Rural Affairs indicated in its annual report that the average per capita production of municipal waste is 1.28 kilograms per day, rising to 1.4 kilograms in major cities compared to 1.1 kilograms in medium-sized cities.

The study area recorded a manifestly lesser amount of waste production, which may be due to the study area members' culture and religiosity in dealing with leftovers. This is also due to the fact that non-regular workers engaged in the process of collecting recyclable materials sort some waste components such as cardboard.

The per capita production rate is high when compared to the per capita production in some Gulf and Arab countries, such as the Sultanate of Oman, Jordan, Tunisia, and some European countries, as follows:

The big difference in the increase in waste production in the Arab Gulf countries in comparison with the rest of the Arab countries may be due to several factors, including:

- They are the largest importers of goods in the world.

- Habits of excess generosity lead to extravagance and overspending in terms of food consumption.
- Consumerism and high family income.

4.5 Factors affecting the Quantity and Characteristics of Household Waste

The production of household waste is affected by many overlapping factors that can negatively or positively, affect the quantity or characteristics of household waste and the distribution of the various components of recovered and recyclable materials of household waste. It is difficult to rely on solely one factor of the factors that are expected to affect the quantity and characteristics of household waste. These factors overlap to produce an effect on the quantity and characteristics of waste. Table (14) below includes some of the social and economic characteristics that the study deduced from the study sample in Buraydah.

Table 14: Quantities of Recyclable Materials in Household Waste in Buraydah in Terms of The Characteristics - The Population of 550,000 People Produce 632.5 Tons per Day.

No.	Materials recyclable from waste	Their percentage in waste according to the results of the study	Quantity in tons / day	Price per ton of materials in riyals
1	Plastic	20 %	126.0	500
2	Cardboard	10 %	63.0	450
3	Paper	4 %	25	400
4	Metals/aluminum/ iron	4 %	25	4000 500
5	Food leftovers	38 %	240	_
6	Total		416.0 tons/ day	

Analysis results showed that the factors below have an impact on the quantity and characteristics of household waste, as follows:

1. Family Size

Family size and the number of its members are one of the variables used to calculate the amount of household waste produced in the city of Buraydah, and it is calculated by multiplying the population of the city by the per capita production rate of waste per day (the population of Buraydah equals 550,000 people x 1.15 kilograms per day = 632.5 tons per day). It is expected that the size of the family and the number of its members will affect the amount of waste produced, and the size of the family contributes to constituting the characteristics of the waste produced. The family with a large number of members is expected to produce waste of different characteristics, due to the disparity and differences in individuals' needs in terms of their age. For example, the needs of the elderly differ from those of young people or children. Thus, the quality of waste produced varies in size.

Family size and the number of its members is one of the most important factors affecting the amount of produced waste. We sometimes find models that refute this hypothesis. For example, families of 8 members produced the least weights of waste, which are 70.44 kg, as shown in the table above for sample 2 in No. 8, The per capita production rate was low at 0.88 kilograms per day.

Table 7: Weights of Produced Waste in Terms of the Number of Family Members in the City of Buraydah, 2017.

No.	Sample number	Number of family members	Total weight (kg)	Per capita production (kg)
1	5	9	72.60	0.81
2	10	9	77.24	0.86
3	13	9	81.95	0.91
4	3	9	93.80	1.04
5	9	9	100.90	1.12
6	4	9	106.20	1.18
7	1	9	115.15	1.28
8	2	8	70.35	0.88
9	6	8	79.90	1.00
10	12	8	91.94	1.15
11	14	8	103.59	1.29
12	17	8	107.08	1.34
13	16	8	107.71	1.35
14	11	8	113.60	1.42
15	7	7	82.00	1.17
16	15	7	105.15	1.50
17	8	6	85.25	1.42

Sample 5 in No. 1, which refers to families of 9 members, produced an amount of waste lesser than that of the same category, amounting to 72.60 kg, and the per capita share amounted to 0.81 kg / day, which is the lowest production per capita despite the high number of family members (9). We note that another family (sample 1 in No. 7) has the same number of family members (9), and the total weight of its waste production was 115.15 kg, with an increase of 40.55 kg above the family in No. 1, while the per capita production increased from 0.81 kg to 1.28 kg, i.e., a difference of 0.47 kg.

As for families with 8 members, we find a large discrepancy in the quantity of produced materials, as shown in No. 8 and sample 2. The total weight of family waste production was 70.35 kg and the per capita share was 0.88 kg, compared to another family with the same number of individuals in No. 14, where the weight of the produced waste was 113.60 kg, and the per capita share was 1.42 kg. We find that a family in No. 8, with 8 members produced 70.35 kg of waste, which is the lowest among the study sample, and the per capita production rate was 0.88 kg / day.

The weights of the materials produced in the 7-member family of sample 15 in No. 16 amounted to 105.15 kg, and the per capita share was 1.5 kg / day. On the other hand, we find that a 7-member family in No. 15 produced a total waste weight of 82.0 kg, and the per capita production rate was 1.17 kg.

The 6-member family in sample 8 produced waste weight of 85.25 kg, and the per capita share was high, i.e., 1.42 kg / day.

2. Type of Housing

The type of housing reflects the level of income, and luxury housing, such as a villa and a floor in a villa, is associated with people with high incomes. Home equipment is influenced by the

type of housing. For example, traditional houses have simple equipment in comparison with other types of housing. As for waste production and its relation to the type of housing, the results of the study showed differences in waste volume and average waste production between high and low-income people. These results also indicated that some residents of traditional houses and of small apartments produce more waste than those living in luxury housing.

Table 8: Type of Housing of the Sample and Produced Waste in Buraydah, 2017.

No.	Sample	Type of housing	Total weight (kg)	Per capita production (kg)
1	5	Villa	72.60	0.81
2	10	Villa	77.24	0.86
3	13	Villa	81.95	0.91
4	6	Villa	79.90	1.00
5	3	Villa	93.86	1.04
6	12	Villa	91.94	1.15
7	7	Villa	82.00	1.17
8	4	Villa	106.20	1.18
9	1	Villa	115.15	1.28
10	8	Villa	58.25	1.42
11	11	Villa	113.60	1.42
12	2	Floor in a villa	70.35	0.88
13	15	Floor in a villa	105.15	1.50
14	14	Ground floor	103.59	1.29
15	9	Traditional house	100.90	1.12
16	17	Traditional house	107.05	1.34
17	16	Traditional house	107.71	1.35

References: Field Study, 2017.

Table (8) presents data about the type of housing of the study sample and the amount of produced waste. We can identify the extent of differences in the amount of waste produced compared to the type of housing.

The following conclusions can be drawn from the above table:

The waste production of residents who live in villas ranged between 72.60 kg in sample 5, No. 1 and 115.15 kg in sample 1, No. 9, and the per capita production rate ranged between 0.81 and 1.28 kg/ day. The least waste weight was 70.35 kg in sample 2, No. 12 who live in a floor in a villa, and the per capita production rate was 0.88 kg/ day.

Families living in traditional houses have relatively lower incomes, and hence, their production of waste is less, ranging between 100.90 and 107.71 kg, as shown in samples 9 and 14. These weights are higher than those of sample 2 No. 12) whose waste weight was 70.35 kg, with an increase of approximately 50 %. The per capita daily waste production rate of residents of traditional houses ranged between 1.12 and 1.35 kg, as shown in samples 9 and 16.

The quality of housing showed high rates of household waste production by the residents of traditional houses, as in samples 16 and 17 whose rates exceeded those of villa owners who have expectedly high standard of living and monthly income. This also proves that the quality of housing is not necessarily the only factor affecting the quantity and characteristics of household produced waste.

3. Educational Level

The good educational level of the family is one of the factors that are expected to contribute positively to pushing the family to rationalize consumption and produce less household waste. Observations and mixing with other cultures contribute to raising the awareness of individuals and families, especially in following waste management instructions. The families that have had opportunities to live in Western countries for the purposes of work or study, or those who spend their annual vacations there, tend to interact with the municipality's guidelines and sort materials at the source, etc.

The educational qualification has a different effect on the decrease or increase in the per capita waste production rate. The study sample has five cases of both heads of the family and housewives having higher education, as in samples Nos. 1-5. A discrepancy was observed between the samples in the amount of produced waste of families with higher education, as we find among them the least and the highest rates of waste production.

The material weights of literate heads of families in the sample were high, and the per capita waste production rate per day ranged between 1.2-1.43 kilograms, indicating that the educational level was not a major and decisive factor in per capita waste production.

The highest per capita consumption rate was in sample 15, amounting to 1.5 kilograms / per capita / day. The educational level was higher education for the head of the family and secondary school for the housewife. This refutes the hypothesis that the higher qualification of the head of the family reduces consumption; rather, it increased consumption.

Table 6: Social, Economic, and Educational Data of the Sample of the Study of Waste Characteristics in Buraydah, 2017.

No.	Sample	Number of family members	Nationality	Age	Educational level		Employment status		Housing type	Monthly income in riyals	Total weight in kg	Per capita production
					Head of the family	Housewife	Head of the family	Housewife				
1	5	9	Saudi	41-50	Higher education	Secondary school	Self-employed	Housewife	Villa	12000+	72.60	0.81
2	10	9	Saudi	51-60	Secondary school	Secondary school	Government employee	Housewife	Villa	6001-9000	77.24	0.86
3	2	8	Saudi	41-50	Higher education	Higher education	Government employee	Government employee	Floor in a villa	12000+	70.35	0.88
4	13	9	Saudi	51-60	Secondary school	Primary school	Government employee	Housewife	Villa	12000+	81.95	0.91
5	6	8	Saudi	51-60	Secondary school	Secondary school	Private sector employee	Retired	Villa	6001-9000	79.90	1.00
6	3	9	Saudi	41-50	Secondary school	Secondary school	Government employee	Housewife	Villa	12000+	93.80	1.04
7	9	9	Saudi	60+	Literate	Illiterate	Retired	Housewife	Traditional house	3001-6000	100.90	1.12
8	12	8	Saudi	31-40	Secondary school	Middle school	Self-employed	Housewife	Villa	12000+	91.94	1.15
9	7	7	Saudi	31-40	Higher education	Higher education	Government employee	Housewife	Villa	12000+	82.00	1.17

No.	Sample	Number of family members	Nationality	Age	Educational level		Employment status		Housing type	Monthly income in riyals	Total weight in kg	Per capita production
					Head of the family	Housewife	Head of the family	Housewife				
10	4	9	Saudi	51-60	Secondary school	Secondary school	Government employee	Housewife	Villa	12000+	106.20	1.18
11	0	9	Saudi	41-50	Higher education	Higher education	Government employee	Government employee	Villa	12000+	115.15	1.28
12	14	8	Saudi	41-50	Middle school	Literate	Private sector employee	Housewife	Ground floor	6001-9000	103.59	1.29
13	17	8	Non-Saudi	51-60	Literate	Illiterate	Retired	Housewife	Traditional house	6001-9000	107.05	1.34
14	16	8	Saudi	41-50	Secondary school	Primary school	Government employee	Housewife	Traditional house	9001-12000	107.71	1.35
15	8	6	Saudi	31-40	Higher education	Higher education	Government employee	Government employee	Villa	12000+	85.25	1.42
16	11	8	Saudi	41-50	Higher education	Higher education	Government employee	Housewife	Villa	12000+	113.60	1.42
17	15	7	Saudi	41-50	Higher education	Secondary school	Private sector employee	Housewife	Floor in a villa	9001-12000	105.15	1.50

Table 9: The Educational Status of the Selected Sample.

No.	Sample	Educational level		Total weight (kg)	Per capita production (kg)
		Head of the family	Housewife		
1	2	Higher education	Higher education	70.35	0.88
2	7	Higher education	Higher education	82.00	1.17
3	1	Higher education	Higher education	115.15	1.28
4	8	Higher education	Higher education	85.25	1.42
5	11	Higher education	Higher education	113.60	1.42
6	5	Higher education	Secondary school	72.60	0.81
7	15	Higher education	Secondary school	105.15	1.50
8	10	Secondary school	Secondary school	77.24	0.86
9	6	Secondary school	Secondary school	79.90	1
10	3	Secondary school	Secondary school	93.80	1.04
11	4	Secondary school	Secondary school	106.20	1.08
12	12	Secondary school	Middle school	91.94	1.15
13	13	Secondary school	Primary school	81.95	0.91
14	16	Secondary school	Primary school	107.71	1.35
15	14	Middle school	Literate	103.59	1.29
16	9	Literate	Illiterate	100.90	1.12
17	17	Literate	Illiterate	107.05	1.34

4. Standard of Living

The level of income is a factor that has a direct effect on waste production. With an increase in the level of income, an increase in consumption rates is expected, thus increasing waste

production. Sometimes, the low level of income is a reason for producing more waste because of the purchase of low-quality and cheap commodities that have a short lifespan and are expected to turn into waste quickly.

The high-income category (9001-12000 riyals per month) recorded the highest per capita waste production rate of 1.50 kilograms/ day, in Sample 15, No. 12.

The high-income category (12000+ riyals per month) also recorded the lowest daily per capita waste production rate sample 5, No. 1, amounting to 0.81 kilograms. The same high-income category (12000+ riyals per month) witnessed an increase in per capita waste production rate in samples No. 9 and No. 10, reaching 1.42 kg. As for the highest rate, which is 1.5 kilograms, it was for the family with monthly income level of 9001-12000 riyals.

Middle-income categories (6001-9000 riyals per month) witnessed variation in their per capita waste production which ranges from 0.86 kilograms per day as the lowest rate, and 1.34 kilograms per day as the highest rate.

The low-income category (3001-6000 riyals per month) also had relatively high rates, with waste production weights reaching 100.9 kg in sample 9, No. 17, with a per capita production rate of 1.12 kg per day.

Table 10: Income Levels of the Selected Sample.

No.	Sample	Monthly income in riyals	Total weight (kg)	Per capita production (kg)
1	5	12000+	72.60	0.81
2	2	12000+	70.35	0.88
3	13	12000+	81.95	0.91
4	3	12000+	93.80	1.04
5	12	12000+	91.94	1.15
6	7	12000+	82.00	1.17
7	4	12000+	106.20	1.18
8	1	12000+	115.15	1.28
9	8	12000+	85.25	1.42
10	11	12000+	113.60	1.42
11	16	12000+	107.71	1.35
12	15	9001-12000	105.15	1.50
13	10	6001-9000	77.24	0.86
14	6	6001-9000	79.90	1.00
15	14	6001-9000	103.59	1.29
16	17	6001-9000	107.05	1.34
17	9	3001-6000	100.90	1.12

The green color indicates the lowest per capita rate of waste production, the yellow color the medium rate, and the red color the highest rate.

People with limited income and education levels sometimes make inaccurate choices in terms of their purchases and management of resources, resulting in more waste, as they race for promotion offers and buying cheap and poor-quality goods and commodities that turn into waste quickly.

5. Social Behavior and Habits

The process of waste production is linked to the behavior and habits of societies, especially those known for generosity and hospitality, as is the case in Arab culture. Social customs, culture, and societal behaviors are factors that affect the consumption of goods and services, which affects the volume and characteristics of waste production.

6. Seasons and Occasions and their Impact on Waste Quantity and Characteristics

Do the size, quantity, and quality of household waste change from a season to another, such as the summer or winter seasons, Ramadan occasions, feasts, holidays, etc.? To answer this question, the frequencies and percentages of the study sample were calculated, and shown in Table (11):

Table 11: The Opinions of the Population about the Change in the Amount of Waste in Different Seasons in the City of Buraydah, 2017.

Answer	Frequency	Percentage %
Yes	1020	95
No	185	15
Total	1205	100

The above table indicates that those who answered "yes" had a frequency of 1020, with a percentage of 85 %. As for those who answered "no," their frequency was 185, with a percentage of 15 %.

The study population who answered (yes) were asked about the seasons and occasions that are the most waste-producing from their point of view, and Table (12) and Table (13) show the percentages and distribution of frequencies over seasons and occasions.

Table 12: Study Population's Opinions about the most Waste-Producing Seasons in the City of Buraydah, 2017.

Season	Frequency	Percentage %
Summer	763	74
Winter	200	20
Autumn	26	3
Spring	31	3
Total	1020	100

Table 13: Study Population's Opinions about the most Waste-Producing Occasions in the City of Buraydah, 2017.

Occasion	Frequency	Percentage %
Ramadan	728	71
Feasts	168	17
Holidays	101	10
Other	23	2
Total	1020	100

The above tables indicate that the most waste-producing season in the year is summer with the highest rate of 74 %, while the least waste-producing seasons are autumn and spring with 3 % each. As for winter, its waste production rate is 20 %. This is due to the fact that temperatures are very high in summer in the Kingdom of Saudi Arabia, and drinks are consumed more,

producing waste of bottles, glassware, cans of drinks and ice creams in large numbers. In addition, other kinds of waste increase in the summer, such as food leftovers from weddings and household events.

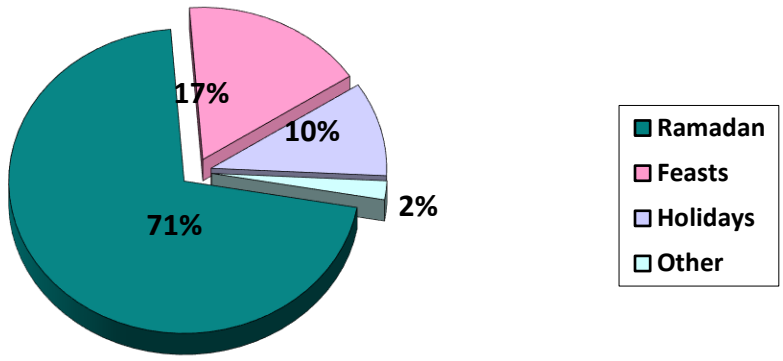

Figure 2: The Study of the Population's Opinions about the most Waste-Producing Events. [Reference: Field Study, 2017].

The results in Figure (2) above show that Ramadan is the occasion that produces the most amount of waste, as its percentage in this month reached 71 %. This blessed month is associated among all Muslims with special preparations. In the Kingdom of Saudi Arabia, iftar tables are decorated with ready-made meals, which are distributed to fasting people. The need for drinks and liquids that are prepared for fasting people contributes to waste production in large quantities, such as plastic containers, water bottles, etc. There is an increase in organic waste in Ramadan, due to food preparations. It is also noted that food waste also increases in this holy month. As for the increase in waste production in holidays, it reached 10 %, while that in feasts reached 10 % and that in other occasions 2 %.

5. Conclusion and Recommendations

The waste characterization study showed 47% 53% ratio for organic to inorganic waste, and 1.15 kgs is the average per capita waste generation/day, while the lowest rate was 0.81 kilograms and the solid water annually increased by 5 percent. In addition, plastic is the main component and has the highest percentage (20 %) among inorganic waste in the study area, and cardboard accounted for 10 %, and came in second place after plastic.

The study revealed the difficulty of relying on a single factor to determine the effect on the quantity and characteristics of household waste, and that many factors interact to produce that effect. It showed that there was no clear influence on the characteristics of waste from the following influences:

A. Family size: The results of the study showed that the family with 9 members recorded the lowest production per capita, amounting to 0.81 kg, while the highest amount of production per person per day was 1.50 kg for a family with 7 members.
B. Type of housing: The highest per capita waste production for a family living in a villa was 1.50 kg, while the lowest per capita production for a family living in a villa was 0.81 kg. According to the analysis, residents of popular homes produce high rates of waste. Their rates exceeded those of villa owners, whose standard of living and monthly income are expected to rise. This also provides evidence that the quality of housing is not necessarily the only influence on the quantity and characteristics of household waste produced.

C. Educational level: The study showed that the lowest amount of per capita production, which amounted to 0.81 kilograms/day, and the highest amount of per capita production, which amounted to 1.5 kilograms/day, were all from families where the head of the house and the housewife held a high qualification.

D. Standard of living: The study showed that the income level of a family is not an indicator of individual production, as the smallest amount of per capita production, which amounted to 0.81 kg, was for a family whose income level was more than 12,000 riyals, while the largest amount of per capita production was 1.50 kg for a family whose income was less than 12,000 riyals. The study showed that owners with limited income and education, their purchases and management of resources are sometimes based on inaccurate choices, which results in more waste, such as racing after commercial offers and purchasing cheap, poor-quality goods and goods that quickly turn into waste.

E. The study revealed that there is a change in the amount of waste production from one season to another, as 85% of the study sample confirms that. This sample believes that the summer season is the most, with a percentage of 74%, and the month of Ramadan represents the occasion that produces the most waste among the occasions, with a percentage of 71%. % based on the opinions of residents, and this is due to the privacy of this holy month and the accompanying customs of preparing special types of foods, increasing spending and charity, and providing assistance to the needy, a large portion of which sometimes turns into waste.

Recommendations

The following recommendations are suggested based on the outcome of this study:

1. To build a database and an electronic system for household waste management in the study area in all sectors of the city to monitor the weights, components and characteristics of waste, thus providing comprehensive data that enable taking appropriate decisions to manage these waste materials.
2. To monitor and study consumption patterns and identify consumer behaviors. Encouragement should be given to research that aim to control consumption, reduce household waste production, develop technologies for environmentally friendly processing and packaging, enhance product quality, sponsor and support environmental innovations, exchange experiences, and benefit from global experiences, including in a way suitable for the culture and customs of the kingdom and the study area.
3. To integrate the roles of the competent authorities in the region and at the national level, to work together with the aim of reaching a society that has balanced consumption, preserves the kingdom's wealth of depleted natural resources, and is socially affluent, economically active, and reconciled with the environment, through exchanging experiences, strengthening partnerships with local, regional and global community associations and organizations, and learning about successful models to be emulated in facing local and national challenges.
4. To achieve effective community partnership between the components of society and all its institutions to activate the environmental work system.
5. To conduct environmental, social and economic studies of household waste to identify family and community behaviors, and manage them through the waste footprint which is one of the keys to decoding and identifying information.

6. To create environmental awareness, strengthen the role of environmental and educational media, implement awareness-raising and environmental education programs with all partners, direct media messages to improve household waste management, encourage the sorting process at the source, and involve residents of neighborhoods, schools, universities, and residential and commercial complexes in awareness-raising and educational programs to develop the concept of integrated household waste management.
7. To support the role of charitable societies that collect surplus food and are interested in linking charitable donors (producers) of surplus food with people with limited income who need it because these charities contribute to reducing wasted quantities.
8. To train housemaids who prepare the waste to sort waste at the source and put waste materials in more than one container or dustbin to make the most utilization of their various components, and take these materials out of the house at a time that is commensurate with the timing of the movement of waste-carrying vehicles to increase the efficiency of the collection and sorting work.

Acknowledgments

Firstly: Researchers would like to thank the Deanship of Scientific Research, Qassim University for funding publication of this project. Secondly, the authors would like to express cordial thanks to Department of Geography, Qassim University for providing opportunity in conducting the research work.

6. References

1. General Secretariat of the Cooperation Council for the Arab States of the Gulf, Human and Environment Sector (2013 AH). *Guidelines for Municipal Solid Waste Management in the Cooperation Council for the Arab States of the Gulf*. Riyadh. (1)
2. Hawamdeh, Malik Hussein (2014). *Economic Dimensions of Environmental Problems and the Impact of Sustainable Development*. Amman, Jordan: Dar Degla.
3. Qassim Region Municipality (1436 AH), Information Center, unpublished information, Qassim Region Municipality.
4. Department of General Statistics and Information. *Detailed results of the general population and housing census for the year 1431 AH*.
5. Zahed, Adnan Hamza, et al. (1991). "Solid waste: The problem and the solution." *King Abdulaziz University Engineering Sciences Journal*, Vol. 3, pp. 23-40.
6. An-Nuwaihi, Abdul-Bari (2004). "The economic feasibility of recycling solid municipal waste: A case study of the city of Jeddah." An unpublished master's thesis, King Abdulaziz University, Kingdom of Saudi Arabia.
7. As-Seba'ie, Abdullah Faisal (2006). *Evaluation of Municipal Solid Waste Management in Jeddah*. King Abdulaziz University Press.
8. Al-Harbi, Sabah Braik (2009). *Human factors affecting the volume of household waste in the city of Jeddah*. A published master thesis, King Abdulaziz University, Jeddah.
9. Qasim, Sayed Ahmad Salem (2004). "Household solid waste (household rubbish) in the city of Assiut: A study in applied geography." *The Arab Geographical Journal*, The Egyptian Geographical Society, Faculty of Arts, Assiut University, Issue 44, p. 37.
10. Al-Harbi, Dalal Muhammad (2015). *Characteristics of Solid Household Waste in the City of Ar-Rass: A Study in Applied Geography*. Unpublished master thesis. Qassim University, Buraydah, College of Arabic Language and Social Studies, Department of Geography.

11. Al-Kuwari, Noura Youssef Mubarak & Az-Zaman, Sarah Muhammad Abdul-Rahman (2010) "Household solid waste in the State of Qatar: A geographical study." *Annals of Arts and Social Sciences*, Issue 31.
12. Al-Bireh, Ibtisam Abdel-Salam (2007). *Spatial analysis of household solid waste pollution in the two conferences of Misurata, Al-Madina and Al-Zarooq*. A published master's thesis, Faculty of Arts, Misurata.
13. Al-Labadi, Nizar Awni (2015). *Environmental Security and Environmental Waste Management*. First edition. Amman, Jordan: Dar Degla.
14. Abu Ghali, Khaled (2011). "Definition, classification and properties of waste in detail." *Noqtah Mgazine of the Arab Scientific Community*.
15. Food and Agriculture Organization (FAO) (2012) The State of Food Insecurity in the World Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition, United Nations.
16. David, A. P. and Rogerson, P. A. (1994). *The Geographical Analysis of Population with Applications to Planning and Business*. John Wiley & Sons. Inc. New York. P.59.

Fig List

Table List