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Evaluation of Solid Waste Separation and Recycling in Jenin Area

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This Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Environmental Science, Faculty of Graduate Studies, An-Najah National University, Nablus, Palestine.

2015

Dedication

DEDICATED TO THE SOUL OF MY FATHER, TO MY MOTHER, BROTHERS AND ALL MY FRIENDS

Acknowledgment

First of all, praise be to Allah for helping me in completing this thesis.

I would like to express my sincere gratitude to my supervisor Dr. Hafez Shaheen for his helpful efforts, fruitful guidance, and continual encouragement throughout the entire research. Special thanks go also to Dr. Samer Al-Atout for the help in preparing the proposal of this study.

Special thanks to my mother and brothers for help, encouragements, and patience. I am very grateful to all those who helped and encouraged me to make this research possible. Finally, thank go to all the people who helped me in Jenin-Joint Services Council for Solid Waste (JSC).

Hanan Hijawi

الإقرار

أنا الموقع أدناه مقدم الرسالة التي تحمل عنوان:

Evaluation of Solid Waste Separation and Recycling in Jenin Area

أقر بان ما اشتملت عليه هذه الدراسة انما هو نتاج جهدي الخاص، باستثناء ما تمت الاشارة اليه حيثما ورد، وأن هذه الرسالة ككل، أو أي جزء منها لم يقدم من قبل لنيل أي درجة علمية أو بحث علمي لدى اي مؤسسة تعليمية او بحثية أخرى.

Declaration

The work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

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Date: **التاريخ:** ٢٤/٨/٢٠١٥

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List of Abbreviations

ARIJ	Applied Research Institute Jerusalem
ERM	Environmental Resources Management
GNI	Gross National Income
ISWM	Integrated Solid Waste Management
JSC	Joint Services Council
MSW	Municipal Solid Waste
NGOs	Non-Governmental Organizations
NIS	New Israeli Shekel
NSSWM	National Strategy for Solid Waste Management
PARC	Palestinian Agricultural Relief Council
PCBS	Palestinian Central Bureau of Statistics
PNA	Palestinian National Authority
PWA	Palestinian Water Authority
SW	Solid Waste
SWM	Solid Waste Management
UNEP	United Nation Environmental Program
WHO	World Health Organization
ZF	Zahrat Al-Finjan

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Abstract

Solid waste separation at source in Jenin was evaluated in this thesis through a pilot in Sabah Al-Khair residential complex, north of Jenin city. The subject of solid waste in Jenin area in terms of sources and the current system of management was addressed. In addition, the thesis identified the factors affecting the management of solid waste in Jenin area.

Data collection was mainly based on a questionnaire and other supporting means such as interviews with staff involved in waste management and observations and documentary analysis.

The pilot study which was applied on Sabah Al-Khair suburb measured the degree of people's commitment to the separation of solid waste at source. Special waste containers of sorting were distributed in four different points (gatherings) in the suburb; each point contained two containers; one for wet organic waste and the other for dry waste. Baskets and bags intended for sorting have been distributed to the households. The study estimated the proportion of organic waste from the total household wastes. Daily household generation rates of solid waste in Jenin city were also estimated.

The proportion of organic waste was found at 57.1%, while the proportion of all remaining materials formed 42.9% and the daily household

generation rate of solid waste was 3.03 kg. The percentage of people's commitment for SW separation resulted at 82.8%. This is primarily due to the high degree of awareness and social level of the study sample. The application of such projects requires raising the level of awareness of the target sample, which was an outcome of this study.

Factors affecting the size and management of solid waste were addressed and discussed and classified into human factors and natural factors. These factors vary in their impact on the size and management of solid waste. Human factors were more influential than natural factors because solid waste is the result of human activities in the first place and are, therefore, the driving forces. The natural factors are just complementary. It had been shown that there were variation between the city, refugee camp, and the village regarding the impact of these factors on solid waste management.

There is urgent need to focus on solid waste separation at source and make efforts to raise the citizen's commitment towards this methodology. Attention must be given to community participation; one of the successful tools to develop solid waste separation and recycling sector .More interest and care are required to reach the desired development of this sector among the community.

Chapter One

Introduction

1.1 Overview

One of the most important current issues that concerns humanity is the environment and its protection. Today, the progress of human beings and the society is measured by their ability to control the environmental elements, among which is Solid Waste (SW). Therefore, Solid Waste Management (SWM) has become one of the vital issues to protect health and public safety. Environmental sustainability is among the important targets for every nation since it is linked with the citizens' wellbeing and it is considered as citizenship's right and privilege (Al-Khatib et al., 2015).

Waste is a continually growing problem at global and regional as well as at local levels. As the result of rapid increase in production and consumption, urban society generates solid material regularly which leads to considerable increase in the volume of waste from several sources such as, domestic, commercial, institutional and industrial waste of most diverse categories (Soufan, 2012).

Improper handling of SW can cause environmental pollution, and can create breeding grounds for pathogens and spread of infectious diseases. SW has the potential to pollute all the vital components of living environment (i.e., air, land and water) (Hinde, 2010).

This study calls for reduction of SW by addressing key issues; separation and recycling of SW, to protect the environment and public health. The

separation at-source and recycling of SW in Jenin area was evaluated by applying pilot in Sabah Al-Khair residential complex. It also studied the acceptance of people to separate SW at source.

1.2 Study Objectives

The main objectives of this research are:

1. Study the acceptance of the people in Jenin for separation SW at source; to implement recycling in effective manner.
2. Estimate the proportion of organic waste from the total household waste in Jenin city.
3. Estimate the daily household generation rate of SW in Jenin city.
4. Evaluate the waste separation in Jenin.
5. Identify the factors influencing SWM.
6. Propose recommendations for developing the process of SW separation at source.

1.3 Study Questions

This research attempts to answer the following questions:

1. Would SW separation at source be successful or not in Jenin community?
2. Recycling of SW in Jenin district encouraging or not?
3. What are the human factors (driving forces) and the natural factors affecting the size and management of SW in Jenin?
4. What is the daily household generation rate of SW in Jenin city?

5. What is the proportion of organic waste from the total household waste in Jenin city?

1.4 Hypothesis

Separation of SW at source is accepted by the people in Jenin and can be applied in the West Bank. Residential waste management is affected by human and natural factors. This is the hypothesis behind this master thesis.

1.5 Significance of the Study

Waste separation in the early stages will ease the separation process and increase the quality of the waste transmitted to the recycling or reusing. Separation begins in many cities in the world in the homes of citizens. Data in Jenin indicate that about half of the waste is organic waste which implies the possibility of reduction at least half of the waste that will be landfilled. An effective way of separation at source is separation into two streams: dry waste and organic waste.

Reduction of SW at source has many significant advantages; among which is the increase of the lifetime of sanitary landfills. It is also a better and environmental friendly solution.

In Jenin, SW is dumped at Zahrat Al-Finjan (ZF) landfill which has a capacity of 2.25 million ton of SW. Studies and designs for the ZF landfill were originally made for Jenin and Tubas governorates, where the lifetime of the landfill was estimated at 30 years. The service area of ZF landfill has been extended to include Nablus, Tulkarem, and Qalqiliya governorates. This decreased the potential lifetime of the landfill to 10-15 years. For that,

there is an essential need to reduce the amount of waste that reaches the landfill in order to prolong the lifetime of the landfill. Separation at source will enhance this necessity.

The mixed wet food/organic waste contaminate paper and other recyclables materials, making them unfit for recovery. It also creates barriers to sorting efficiency. Therefore, waste separation into the two streams is necessary.

Reusable and recyclable materials can be sold, which offsets the cost of waste disposal. In addition, natural resources can be conserved by reusing and recycling the separated waste, which is an important step towards integrated solid waste management (ISWM).

1.6 General Outline of the Study

The general structure of the thesis is as follows:

- Chapter one is the introduction.
- Chapter two includes the research methodology covering research methods, study population and area, and the methods of gathering information, studying tools and methodology diagram
- Literature review covering topics related to the study is in chapter three.
- Chapter four includes the background of Jenin district including: location, topography, climate, socio-economic characteristics, infrastructure services, health Service, and education.
- Chapter five is a review of the existing SWM system in Jenin area. Previous related studies and interviews with persons, entities, establishments, municipalities, etc. were considered to explain this system.

- Chapter six explains the set of human and natural factors affecting the SW size and management in Jenin district, through a survey of selected random sample of different communities (city, refugee camp, and town).
- Chapter seven presents the pilot of SW separation at source which was applied in the suburb of Sabah Al-Khair. It measures the degree of people acceptance to separate the SW at source.

  This chapter also covers the socio- economic characteristics of Sabah Al-Khair residents through a questionnaire applied to the population. Then, it presents the application of the pilot for two months (April, and May of 2015), discusses the results and analyses them.
- The final results of this thesis are discussed in chapter nine, and the recommendations are provided.

Chapter Two

Methodology

2.1 Research Methods

Set of research methods have been applied in this study, as follows:

1. Experimental method: represented by the sample and the pilot that was applied at the residential complex “Sabah Al-Khair”.
2. Descriptive method: By describing the social and environmental characteristics of the study area.
3. Analytical method: This is focused on the statistical data available; it was employed in the questionnaire analysis that was distributed to a random sample of households. Excel and SPSS programs were used in the analysis.
4. Comparative method: By Comparison the behavior of population in dealing with SW according to the community type (city, village, and camp).

2.2 Study Area and Population

The study population consisted of the families of Jenin area, 120 families were questioned as follows:

1. Families at Sabah Al-Khair, where pilot solid waste separation at source was applied, which is about 60 families.
2. Families that were chosen for the study of human factors affecting the size and management of SW in Jenin, which counts 60 families

distributed as: 20 families in the Jenin refugee camp, 20 families in the city, and 20 families in Al-Yamoun.

2.3 Limitation Selection of Sample Size

The sample size is supposed to be larger than the size that was used in this study. The reasons for choosing this sample size are:

- The difficulty of control of the area in case of using larger size of sample, in terms of container distribution or taking weights.`
- The financial capabilities do not allow the use of larger sample (increasing the sample size means increasing the number of containers that will be distributed in the street and the number of baskets that will be distributed to households). So, 60 households were selected out of 600 households in Sabah Al-Khair residential Complex (10% of households).
- 60 households were only selected to identify the factors affecting SWM, this was just a comparison method to compare the population behavior according to the community type (increasing the sample size requires staff for questionnaire distribution).

This study can be used as an indicator, to get more representative sample is recommended using a larger sample size.

2.4 Methods of Gathering Information and Studying Tools

The study was based on collection information from two main sources:

1. **Literature Sources**

   This stage was summarized by collecting information from the available literatures and theses in university libraries, local statistical sources, and

data in reports issued by local institutions such as Joint Services Council (JSC), Palestinian Central Bureau of Statistics (PCBS), and the Department of Agriculture in Jenin.

2. **Field Sources**

The process of gathering the field information is the most important phase of this study, which formed the bulk, and can be divided into:

- **Site Visits and Interviews**

  Site visits to many of the institutions working in the field of SW, and conducting personal interviews with stakeholders, like JSC. From which data about the amount of SW scheduled by city, village and camp were collected, other information about the mechanisms used in the current SWM in Jenin.

  In addition to Jenin Municipality, Department of Agriculture, Jenin Hospital, and compost plant in Jalama village, etc. were visited in order to understand the nature of different kinds of waste: construction, agricultural and animal waste, as well as medical waste.

- **Questionnaires Application**

  Two types of questionnaires were distributed to households in the study area; the first questionnaire is about the behavior of the population in dealing with Municipal Solid Waste (MSW) according to the Community type: village, town, and camp (Annex 1).The second questionnaire was distributed to households in Sabah Al-Khair suburb where a pilot SW separation was applied (Annex 2).

  As to make sure that the questionnaires are correctly filled, the researcher herself interviewed the people and filled the questionnaires

during the interview. The interview has been conducted with the housewives, through field visits to homes in Sabah Al-Khair, and women in the women's councils of Jenin refugee camp and Al-Yamoun.

Photos were snapped as another tool for this study, where many of the pictures were captured during the application of the pilot and during the visiting of various sites relevant to the study.

- **Observation**

  The researcher relied on observation and estimation methods in measuring the extent of commitment of the population about SW separation at source.

  This phase was a preliminary stage in the measurement. The researcher relied on accurate measurement, such as using the weigh as a measurement tool, which was employed to measure the extent of commitment.

2.5 Methodology Diagram

The following figure depicts the steps to be applied to conduct the study.

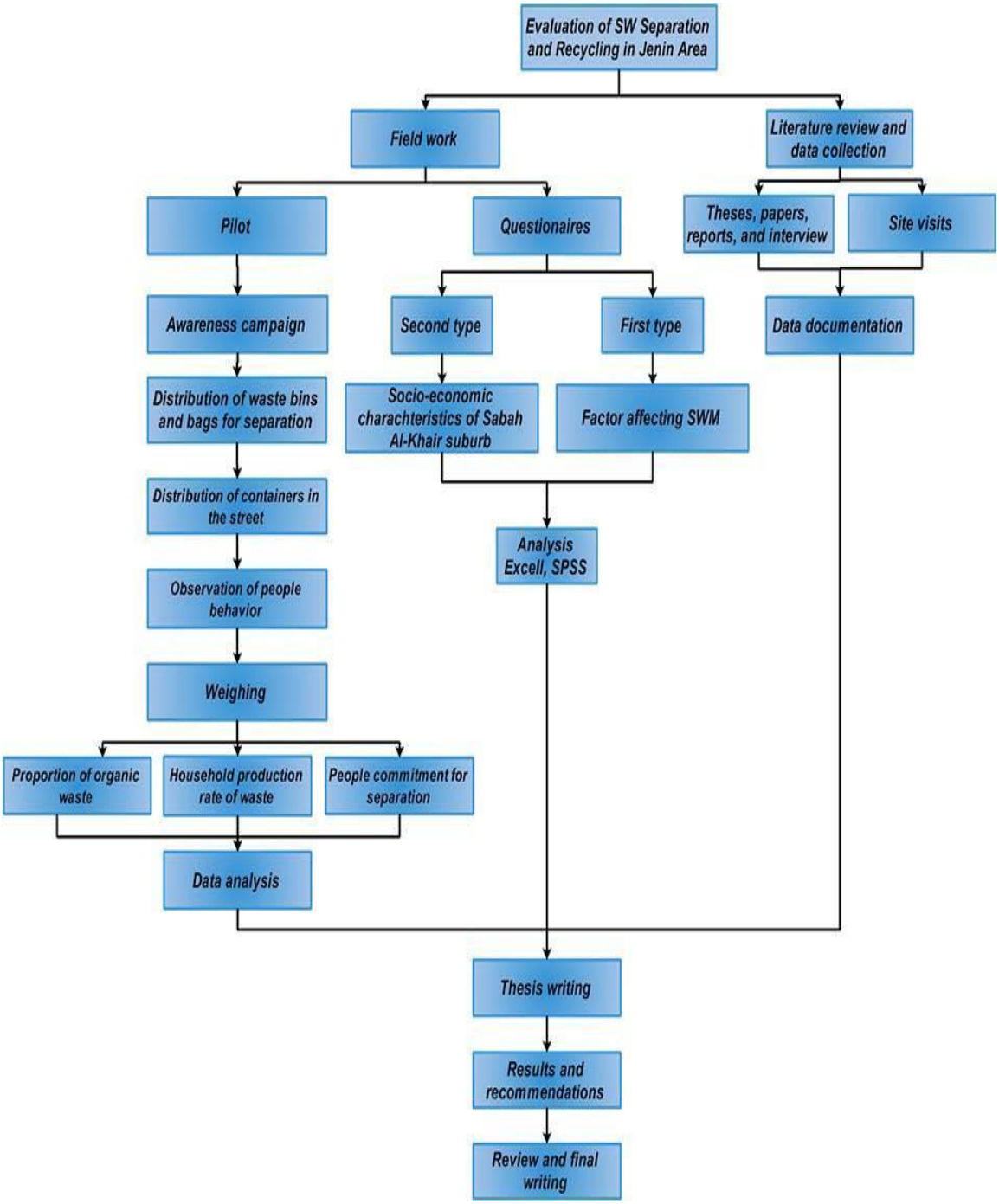


Figure (2.1): Methodology Diagram

Chapter Three

Literature Review

3.1 Introduction

In the early centuries, management of SW was easily dealt with at the household level. The population explosion, economic development and improvement of people's living standards have accelerated the generation rate of MSW; its composition has become more various (Lombrano, 2009).

MSW is a heterogeneous mixture of paper, plastic, cloth, metal, glass, and organic matter, etc. generated from various sources. The proportion of different constituents of waste varies from season to season and place to place, depending on the lifestyle, standards of living, the extent of industrial and commercial activities (Sharholy, 2007).

Global MSW generation is approximately 1.3 billion tons per year. This amount is expected to increase to 2.2 billion tones by 2025 (Hoornweg and Bhada-Tata, 2012). The problem of MSW management has earned increasing attention as a major hindrance to urbanization and economic development all over the world.

MSW contains some valuable material, plastics, metals, glass, cardboards, and leftovers, etc. Fortunately, most of these can be easily recycled; and separation processes have been introduced into the pretreatment of MSW, worldwide.

SW minimization through recovery of recyclables leads to overall reduction of the amount of waste generated by a society, which in turn substitute the dependency on the nonrenewable natural resources, reduces the negative

environmental impacts of disposal, and reduces economic losses (Musleh and Al-Khatib, 2010).

3.2 Solid Waste Management

3.2.1 General

Solid waste management is one of the most challenging issues that are facing developing countries. The generation of large quantities of waste is especially problematic since it is the source of many serious pollution problems. SWM is not only a technical problem but is strongly influenced by political, legal, socio-cultural, environmental and economic factors. Moreover, these factors have interrelationships that are usually complex in waste management systems (Abu Zahra, 2006).

SWM involves control of: generation, storage, separation, collection, transportation, processing, and final disposal of SW (Soufan, 2012). SWM starts with the collection and ends with disposal and/or beneficial use.

Proper SWM requires collection of the different waste separately, called source separated waste collection. Source separated collection is limited by infrastructure, personnel and public awareness (Soufan, 2012).

Source separated collection is common in high income regions of the world where the infrastructure to transport separate waste streams exists. In developing countries SW is collected in a mixed form because separation at source is nonexistent, and its implementation is very difficult due to the economic and social complications (UNEP, 2011).

The integrated solid waste management is a strategic approach to managing all sources of waste; prioritizing waste avoidance and minimization, practicing separation, promoting 3Rs: Reduce, Reuse, and Recycle, implementing safe waste transportation, treatment, and disposal in an integrated manner (UNEP, 2011).

This thesis was to tackle separation at source in context of understanding the social and environmental complications; this was achieved by applying a pilot study.

3.2.2 Waste Management Hierarchy

The waste management hierarchy is considered the most fundamental basis of modern SWM practice. The hierarchy ranks waste management operations according to their environmental or energy benefits (UNEP, 2005). In virtually all countries, the hierarchy is similar to that shown in Figure (3.1).

Hierarchy can be summarized as the following steps:

1. Prevent the generation of waste, or reduce the amount generated.
2. Reduce the toxicity or negative impacts of the waste that is generated.
3. Reuse in their current forms the materials recovered from the waste stream.
4. Recycle, compost, or recover materials for use as direct or indirect inputs to new products.
5. Recover energy by incineration, anaerobic digestion, or similar processes.
6. Dispose of residual SW in an environmentally sound manner, generally in landfills.

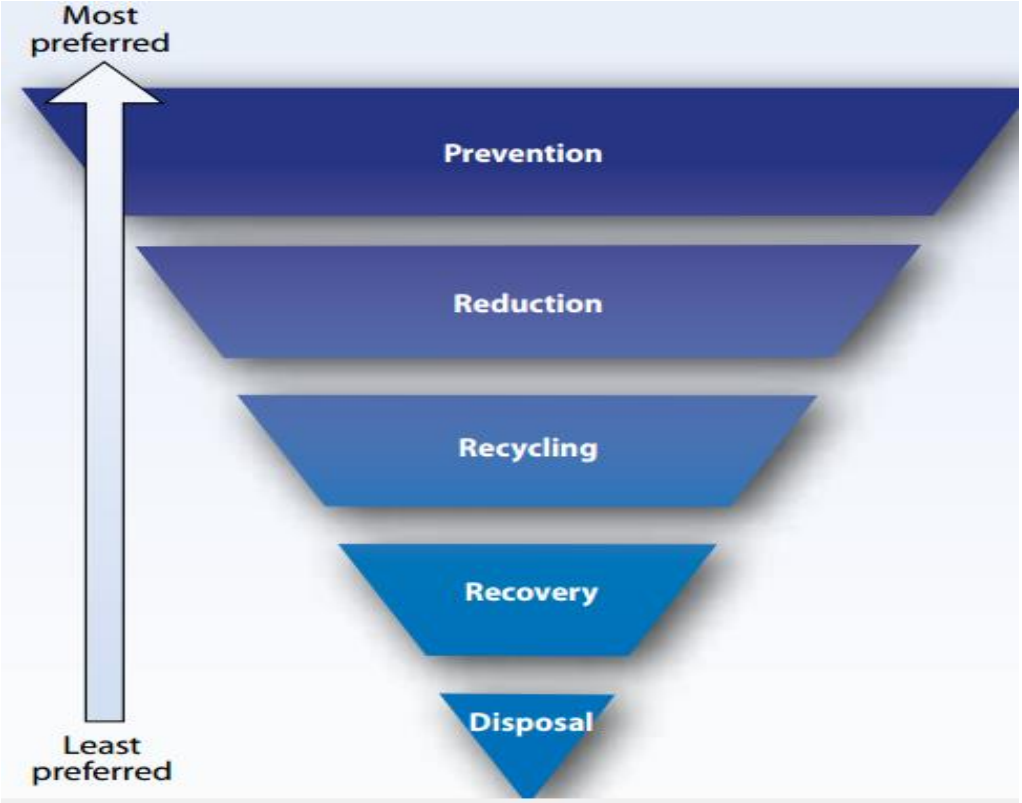


Figure (3.1): The Waste Management Hierarchy (EPA, 2011)

Greening the waste sector refers to a shift from less preferred waste treatment and disposal methods such as incineration (without energy recovery) and different forms of landfilling towards the "three Rs" (UNEP, 2011).

The hierarchy is a useful policy tool for conserving resources, for dealing with landfill shortages, for minimizing air and water pollution, and for protecting public health and safety. At the same time, it should be recognized that all waste management practices have costs, as well as benefits. The thesis is to consider the hierarchy in the sense that separation at source, if successful, will support such policy. The application of the pilot study and the questionnaires of the study take into account social, environmental and economic aspects, which are the factors related to enhancement of these policies.

Waste management practices vary from one country to another according to income level, Table (3.1) is an illustration of these practices.

Table (3.1): SWM Practices by Income Level (Hoornweg and Bhada-Tata, 2012).

Activity	Low Income	Middle Income	High Income
Source Reduction	No organized programs. Reuse and low per capita waste generation rates are common.	Some discussion of source reduction, but rarely incorporated into an organized program.	Organized education programs emphasize the three 'R's. More producer responsibility and focus on product design.
Collection	Sporadic and inefficient. Service is limited to high visibility areas, the wealthy, and businesses willing to pay. Collection rate less than 50%.	Improved service and increased collection from residential areas. Larger vehicle and more mechanization. Collection rate varies between 50 to 80%. Transfer stations are slowly incorporated into the SWM system.	Collection rate greater than 90%. Compactor trucks and highly mechanized vehicles and transfer stations are common. Waste volume a key consideration.
Recycling	Most recycling is through the informal sector and waste picking. Recycling rates tend to be high both for local markets and for international markets. Recycling markets are unregulated.	Informal sector still involved. Some high technology sorting and processing facilities. Recycling rates are still relatively high. Recycling markets are somewhat more regulated.	Recyclable material collection services and high technology sorting and processing facilities are common and regulated. Increasing attention towards long-term markets. Overall recycling rates higher than low and middle income.

Composting	Rarely undertaken formally, even though the waste stream has a high percentage of organic material. Markets for, and awareness of, compost lacking.	Large composting plants are often unsuccessful due to contamination and operating costs (little waste separation); some small-scale composting projects at the community/ neighborhood level are more sustainable.	Becoming more popular at both backyard and large-scale facilities. Waste stream has a smaller portion of compostable than low and middle income countries. More source separation makes composting easier.
Incineration	Not common, and generally not successful because of high capital, technical, operation costs, and high moisture content in the waste.	Incinerators are used, but with experiencing financial and operational difficulties. Air pollution control equipment does not exist, little or no stack emissions monitoring. Governments include incineration as a possible waste disposal option but costs prohibitive.	Prevalent in areas with high land costs and low availability of land (e.g., islands). Most incinerators have some form of environmental controls and some type of energy recovery system. Governments regulate and monitor emissions.
Landfilling/Dumping	Low technology sites usually open dumping of wastes. High polluting to nearby aquifers, water bodies. Often receive medical waste. Health impacts on local residents and workers.	Some controlled and sanitary landfills with some environmental controls. Open dumping is still common.	Sanitary landfills, leachate collection systems, gas collection and treatment systems. Often problematic to open new landfills due to concerns of residents.

Costs	Collection costs represent 80 to 90% of the municipal SWM budget. Waste fees are regulated by some local governments, but the fee collection system is inefficient. Only a small proportion of budget is allocated toward disposal.	Collection costs represent 50% to 80% of the municipal SWM budget. Waste fees are regulated by some local and national governments. More innovation in fee collection, e.g. included in electricity or water bills. Expenditures on disposal are higher than in low income countries.	Collection costs can represent less than 10% of the budget. Large budget allocations to intermediate waste treatment facilities. Community participation reduces costs and increases options available to waste planners (e.g., recycling and composting).

Countries are classified into four income levels according to the World Bank. For the current 2015 fiscal year, low-income economies are defined as those with a GNI per capita, of $1,045 or less; middle-income economies are those with a GNI per capita of more than $1,045 but less than $12,746; high-income economies are those with a GNI per capita of $12,746 or more. Lower-middle-income and upper-middle-income economies are separated at a GNI per capita of $4,125. According to the World Bank classification, West Bank and Gaza Strip are classified as Lower-middle-income economies ($1,046 to $4,125).

3.3 Solid Waste Management in the West Bank

3.3.1 Introduction

The SW generated in 2011 by the Palestinian in the Palestinian territories was around 2,018.6 ton/day, which is divided between 1,274.5ton/day in the West Bank and 744.1 ton/day in the Gaza Strip. Waste generated from the urban areas is about 68% of total waste in the West Bank, while this percentage comes to 25.7% in the rural areas. The remaining percentage is from the refugee camps (PCBS, 2013).

The Palestinian National Strategy for Solid Waste Management (NSSWM) (which is the first cross-sectorial strategy for SW in Palestine) calls for prevention of open burning of SW to protect the environment and public health. Improper landfilling can cause environmental pollution and can create breeding grounds for pathogens and spread of infectious diseases (NSSWM, 2010).

This strategy aims at setting the development path for the Palestinian SWM until 2014. The NSSWM aims at addressing key strategic issues,

developing the legislative, organizational, technical and economical foundation needed to achieve an efficient and effective SWM system, in addition to reducing the negative health and environmental impacts of SW (NSSWM, 2010).

During the last 10 years, two sanitary landfills have been constructed and are under operation in the West Bank: Zahrat Al-finjan and Al-Menya landfills. The first sanitary landfill (ZF) was constructed in Jenin to serve the northern West Bank. The waste is dumped there as mixed municipal waste and is covered with daily soil. The construction of new central landfill projects has reduced random dumpsites. The sanitary landfill contributes to solving or reducing the health impacts of waste as this is an environmental and engineering solution, designed and operated according to acceptable standards (NSSWM, 2010).

3.3.2 Solid Waste Characterization

SW streams should be characterized by their sources, by the types of waste generated, as well as by generation rates and composition. Accurate information in these areas is necessary in order to monitor and control existing waste management systems and to make regulatory, financial, and institutional decisions.

3.3.2.1 Waste Sources

SW is usually divided into a number of categories (domestic, industrial, commercial, and agricultural). Al-Batnij (2013) gives the following sources of waste:

- Domestic waste: Generated from the households and most of this waste is organic.
- Industrial waste (non-hazardous, hazardous, and hospital wastes): Generated from processing and non-processing industries.
- Commercial waste: Generated from offices, restaurants, hotels, and public services, etc.
- Agricultural waste: Generated from the agricultural activities such as leaves, plants, plastic pipes and the hazardous waste that is generated from using fertilizers and pesticides.

All types of SW (household, industrial, commercial and agricultural) consist mostly of the following categories (Al Sa'di, 2009):

- Organic materials such as food waste or weeds,
- Paper and cardboard including newspaper, magazines and cartons,
- Glass,
- Metals, and
- Plastics.

3.3.2.2 Waste Generation

Generation of SW in the West Bank varies from one governorate to another; Table (3.2) presents the amount of SW generated in different governorates. The last column of the table is the calculated per capita generation.

The average per capita generation of SW per day in the governorates of the West Bank is about 0.85 kg. Hebron governorates comprise the highest per capita generation of SW which is about 1.0 Kg/c/d, while Salfit comprises

the least per capita generation of SW which is about 0.82 kg/c/d. This research is focused on Jenin, where the per capita generation is 0.91 kg/c/d.

Table (3.2): SW Generation in the West Bank, (PCBS, 2011)

Governorate	Population (2011)	Total SW generation (ton/day)	Total SW generation (kg/day.capita)
Jenin	**281,156**	**255.5**	**0.91**
Tubas	56,642	54.2	0.96
Tulkarm	168,973	162.9	0.96
Nablus	348,023	319.1	0.92
Qalqilya	100,012	90.2	0.90
Salfit	64,614	53.0	0.82
Ramallah& Al Bireh	310,218	276.1	0.89
Jericho & Jordan valley	46,718	44.8	0.96
Eas Jerusalem	144,740	127.2	0.88
Bethlehem	194,095	186.3	0.96
Hebron	620,418	615.3	0.99
West Bank	**2,580,167**	**2,184.6**	**0.85**

3.3.2.3 Waste Type Composition

As a country develops and becomes wealthier, the composition of its waste stream typically becomes more varied and complex. The organic-rich MSW is the highest proportion in middle and lower income countries, which is about 65%, 43%, and 30% in low income, middle income, and high income countries respectively. While the high-income countries' MSW streams contain a large proportion of paper and plastics (UNEP, 2011).

In Jenin area, the organic-rich MSW is the highest proportion of the total MSW, which is about 53.7%, while the metals form the lowest proportion as it is illustrated in Figure (3.2).

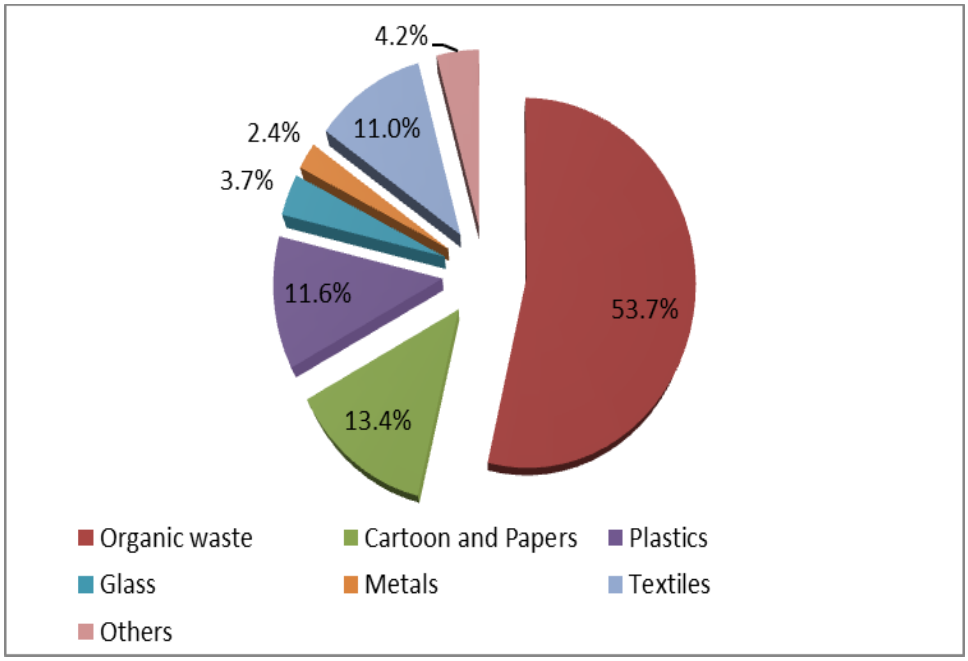


Figure (3.2): Proportion of SW in Jenin District (Al Sa'di, 2009)

3.3.3 Waste Collection

Waste collection is the collection of SW from point of generation to the point of treatment or disposal. MSW is collected in several ways (UNEP, 2011):

1. House-to-House: Waste collectors visit each individual house to collect garbage. The user generally pays a fee for this service.
2. Community Bins: Users bring their garbage to community bins that are placed at fixed points in a neighborhood or locality. MSW is picked up by the municipality, or designate, according to a set schedule.
3. Curbside Pick-Up: Users leave their garbage directly outside their homes according to a garbage pick-up schedule set with the local authorities.

4. Self-Delivered: Generators deliver the waste directly to disposal sites or transfer stations, or hire third-party operators (or the municipality). This is particularly applied to those who generate huge amounts of SW and for construction waste, which are disposed at landfills.
5. Contracted or Delegated Service: Businesses hire firms (or municipality with municipal facilities) who arrange collection schedules and charges with customers. Municipalities often license private operators and may designate collection areas to encourage collection efficiencies.

The collection of SW in the West Bank is managed by the municipalities or the village councils. In Palestine, the number of non-served communities was166 according to the PCBS (2005) census; however, the number decreased to 79 in 2010. Currently, around 85 % and 100% of the households receive SW collection service in the West Bank and Gaza Strip respectively (PCBS, 2011).

The MSW is collected in West Bank in different ways:

- Direct collection: the waste vehicles collect the waste from the 1.1 m^3 containers or barrels. This is found in most of the West Bank local communities.
- Skip lift containers: which are commercial container in size of 5- 6 m^3 collected by skip-lift vehicles.
- Manual door to door collection: The people used the plastic bins to dispose the waste, and then the waste is collected by truck or tractors.

3.3.4 Waste Disposal

Disposal is the last and most important activity in SWM practices, disposal of SW can be carried out in several ways. In managing disposal of SW the following information are important (William, 2013):

- Quantity of waste generated,
- Composition of waste generated,
- Economics of the methods available,
- Environmental impacts due to implementation, and
- Public acceptance of the selected methods.

There are four principal methods of disposal depending on the amount and the quality of the waste (William, 2013):

- Incineration
- Composting
- Land filling
- Waste to energy

Lack of proper management and enforcement of SW disposal in the West Bank in addition to Israeli occupation measures (travel restrictions, curfews, closures and lack of access to proper disposal sites) threaten the environment and public health. This led some municipalities and village councils to apply local emergency solutions represented by waste dumping inside town/village limits. Such random dumpsites have been tremendously reduced and controlled by PNA, especially after the construction of the two sanitary landfills. In addition many of the JSCs for SWM which have been enforced in Palestine managed to control such actions (Soufan, 2012).

3.3.5 Waste Recovery in the West Bank

Many countries are trying to reduce the generation of waste through various policies. Waste minimization through recovery leads to overall reduction of the amount of waste generated, recovery includes energy recovery and material recovery (Annepu, 2012).

The main function of the material recovery process is to maximize the quantity of recyclables processed, while producing materials that will generate the highest possible revenues in the market. Recovery involves using the waste as raw material to make new products, thus offsets the use of raw material. This is achieved by the separation of the waste at source, and/or on site (Annepu, 2012).

Material recovery could be achieved by recycling of recyclables material and composting of organic waste. In the West Bank there are many experiences for Recycling and Composting.

3.3.5.1 Recycling and Composting

Once the waste are generated and collected, the best alternative to handle them would be recycling where the materials generally undergo a chemical transformation (Kui, 2007).

Sale of recyclables from mixed waste provides livelihood for some residents in low and middle income countries. High income countries use machines to do the same but they would need the recyclables to be collected as a separate dry stream without mixing with organic food wastes. In the West Bank, SW is collected in a mixed form. Once the waste is mixed it becomes difficult to separate them. The waste components that are

currently recycled in the West Bank are plastic, scrap metal, cardboard, organic waste, and tires recycling.

First: Plastic sorting and recycling

Plastic is sold to local industries for mechanical processing, and then sold to plastic industries. Sorting, collection, shredding and extrusion of plastics started in Hebron many years before similar activities began in the northern West Bank. The earliest plastic recycling facility started operating in 2002 (Musleh and Al-Khatib, 2010).

Separation of plastics from wastes takes place at:

- Sairafi transfer station in Nablus,
- Yatta Dumpsite in Hebron,
- Zahrat Al Finjan landfill in Jenin, and
- From waste communal containers in Hebron governorate.

Second: Glass recycling

As to Musleh and Al-khatib (2010), minor glass recycling takes place in Hebron by three factories (glass is mainly originating from Israel), where traditional artisan glass workshops purchase beverage bottles and use them as raw material.

The glass workshops depend entirely on the recycled glass and do not use any primarily materials. Glass workshops can only recycle bottles or similar glass containers. Other types of glass, such as mirrors and windows, cannot be recycled. There are three sources of glass bottles and containers:

- Bottles purchased from the informal sector,

- Bottles imported from Israel, and
- Containers from pharmaceutical companies that want to discard glass bottles containing residuals of pharmaceutical chemicals. Since these companies want to dispose of bottles containing hazardous material as cheaply as possible they deliver them to the workshop free of charge.

Each workshop uses 100-200 kg of glass each day. Combined the three workshops utilize about 0.5 tons of glass per day (Musleh and Al-Khatib, 2010).

Third: Cardboard and paper

Cardboard is sold to Israeli industries, Palestinian companies in the West Bank only collect and compact cardboard and paper; there are no cardboard or paper factories in the West Bank. The cardboard and paper is collected from different areas in the West Bank, as follows (Musleh and Al-Khatib, 2010):

- Collection of cardboard and paper from the streets of Jenin City. The waste is collected before it reaches ZF landfill site.
- Sorting of cardboard and paper from the SW stream collected at Sairafi transfer station in Nablus.
- Separate collection of cardboard and paper from steel mesh containers installed by the private sector for cardboard and paper. These containers are located in the commercial areas of Ramallah, Al Bireh, Beitunyia cities, Al Bireh Governorate, and in Nablus.

- Separate collection of paper and used books from public schools as per a contract with the Ministry of Education and Higher Education.

Fourth: Scrap metals

Metal is sold to Israeli industries and to Palestinian exporters. In the West Bank there are several scrap metal sorting and collecting initiatives. Scrap metal collection is carried out by both formal and informal sector from four sources (Musleh and Al-Khatib, 2010):

- Purchase from source (households and industries) by itinerant scrap metal buyers,
- Direct collection from SW containers by informal sector,
- Direct collection from random dumpsites by informal sector,
- Direct collection from Sairafi transfer station in Nablus, and
- Metals acquired from tires by informal sector.

Fifth: Composting

Similar to the recycling of inorganic materials, source separated organic waste can be composted; the compost obtained can be used as an organic fertilizer on agricultural fields. Organic compost is rich in plant macro nutrients like Nitrogen, Phosphorous and Potassium, and other essential micronutrients. United Nations Environment Program (UNEP) defines composting as the biological decomposition of biodegradable SW under predominantly aerobic conditions to a state that is sufficiently stable for nuisance-free storage and handling and is satisfactorily matured for safe use in agriculture.

Experience of recycling agricultural waste is very limited across the West Bank (Musleh and Al-Khatib, 2010):

- Few composting demonstration projects are conducted by agricultural organizations. These demonstrations are part of the extension services provided by these agricultural organizations, therefore they are located in farmers where agricultural organizations are active.
- One composting facility is located in Thinnaba village in Tulkarem governorate - in the north of the West Bank; this project is operated by an agricultural cooperative of 81 farmers since 2008.The production rate in the first 6 months of 2010 was 30 tonnes per month.
- Pilot composting was tested at Sairafi transfer station in Nablus in 2008. It utilized 30 tons of waste.
- Pilot project for waste separation and composting in the village of Al Jalama, Jenin, financed by the Italian institution NEXUS. This project is under operation since 2011.

3.3.5.2 Energy Recovery

Energy recovery is a method of recovering the chemical energy from SW. Chemical energy stored in waste is a fraction of input energy expended in making those materials, due to the difference in resources (materials/energy) that can be recovered, energy recovery falls below material recovery on the hierarchy of waste management (Gendebien, 2003).

The main Parameters, which determine the potential of energy recovery from SW, are (Ramachandra and Bachamanda, 2007):

- Quantity of waste, and
- Physical and chemical characteristics (quality) of the waste.

The important physical parameters requiring consideration include (Ramachandra and Bachamanda, 2007):

- Size of constituents,
- Density, and
- Moisture content.

Smaller size aids in faster decomposition of the waste. Waste of high density reflects a high proportion of biodegradable organic matter and moisture. Low-density waste, on the other hand, indicates a high proportion of paper, plastic and other combustibles.

High moisture content causes biodegradable waste fraction to decompose more rapidly than in dry conditions. It also makes the waste rather unsuitable for thermo-chemical conversion (incineration, pyrolysis / gasification) for energy recovery, as heat must first be supplied to remove moisture.

3.4 Waste Separation

When it comes to waste separation, two different processes are included in this term, namely, at-source waste separation and on-site waste separation. At-source waste separation refers to the separation of waste streams where they are generated before they are mixed. On-site waste separation refers to the separation of the mixed waste stream, usually taking place at a material

recovery facility, transfer stations, and/or disposal sites etc. (Xiaolong, 2011).

There are various stages of sorting (Ramachandra and Bachamanda, 2007):

- At the source or house hold level,
- At the municipal bin,
- At transfer station or sorting facility,
- At waste processing site, and
- At the landfill site.

The source is the best place to separate waste materials for reuse and recycling. Households must be more aware of the importance of separation recyclable materials. From this point, this thesis is working in the improvement of separation options in Jenin by applying a pilot study, which is to focus on the social awareness and the acceptance of residents to separate SW at the household level.

Sorting operations can be carried out in three ways (Ramachandra and Bachamanda, 2007):

- Manual sorting,
- Semi-mechanized sorting, and
- Fully mechanized sorting.

3.4.1 Separation at Source

Sorting at source is driven by the existing markets for recyclable materials and the link between the household and the waste collector. Normally each household equipped with different bins or containers for different waste; such as glasses, papers, organics, and packaging etc.

There are many advantages for applying separation at source (Al Sa'di, 2009):

- Achieving high separation rates,
- Promotes clean, marketable materials,
- Limiting levels of contamination,
- Not disposing of recyclable materials as SW, and
- Proper documentation which is difficult when recyclables are mixed with SW.

Many environmental issues should be considered for the evaluation of the SW separation at source (Al Sa'di, 2009):

- Odors and air pollution,
- Land use and visual,
- Traffic, and
- Health impacts.

The following are the social impacts that are considered for SW separation at source taking into consideration improving the SW collection schemes (Al Sa'di, 2009):

- Convenience and accessibility impacts,
- Participation and awareness impacts,
- Health impacts, and
- Local Employment.

3.4.2 Separation on Site

Sorting of the mixed waste includes separation of bulky items, separation of waste components by size using screens, manual separation, and

separation of ferrous and non-ferrous metals. Manual separation is extensively adopted in several countries, while mechanized sorting are used in developed countries. Such mechanized sorting facilities are usually expensive in comparison to manual sorting (Ramachandra and Bachamanda, 2007).

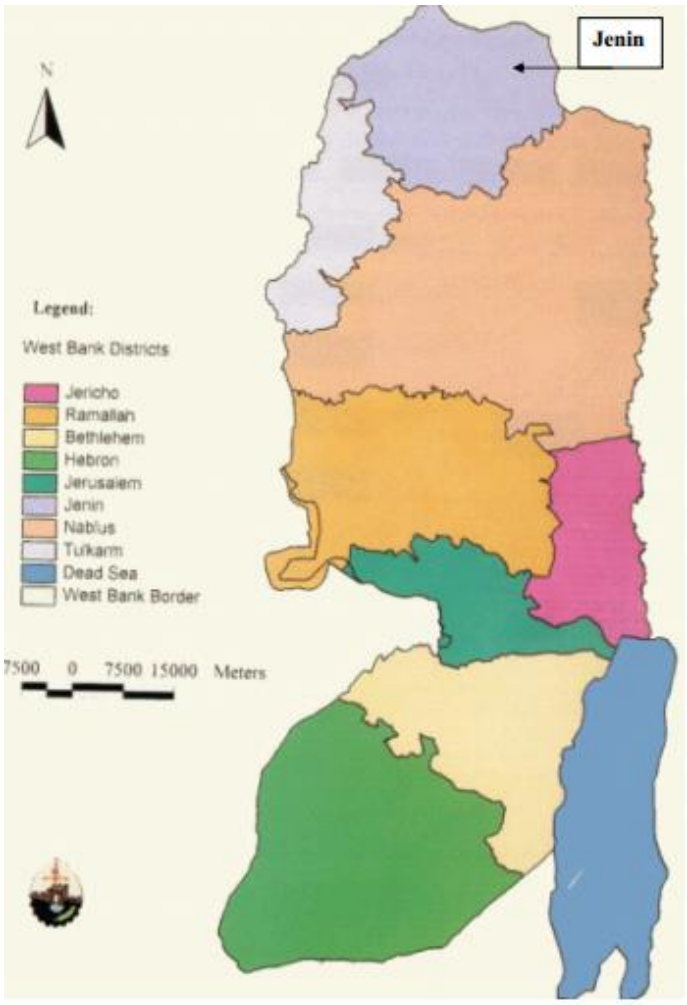
To achieve the goal of efficient and effective waste separations, the application and implementation of sound and appropriate technologies are extremely necessary. For separations at source, no cutting-edge technologies but different bins for separations are necessaries. The key issue is how to properly manage and implement this separation bin system. However, when it comes to on-site waste separation, expensive and complex machineries are needed for dealing with the mixed waste to have the separation waste streams. This will lead to material or energy recovery (Xiaolong, 2011).

Chapter Four

Study Area

4.1 Location

Jenin is located in the northern part of the West Bank in Palestine as shown in Figure (4.1). It is abounded by Nablus and Tulkarem districts from the south and south east and by the 1948 cease-fire line from other directions of the district. The area of Jenin district is 592 km^2 located between 100-750 m above sea level (زكارنه، 2012).



[wibsite:www.theodora.com/maps]

Figure (4.1): Location of Jenin in the West Bank

4.2 Topography

The highest point in Jenin area is Jabel Hureish, 3.5 Km east of the Jaba'a village, its height is 750 m above sea level. While the lowest elevation is 90m above sea level at El Mukhabba area, south of Muqebila village at the Israeli border (زكارنه، 2012).

4.3 Climate

The climate of Jenin area is governed by its position on the eastern Mediterranean. Winter is moderate and rainy, summer is hot and dry.

- **Temperature**

  In the summer, the temperature is moderate as a result of the influence of the Mediterranean winds that reach Jenin district due to the absence of the highlands between Jenin district and Mediterranean Sea. The average maximum temperature is 27.8 ^{o}C; recorded in the summer months especially in July and August. The average minimum temperature is 15.9 ^{o}C; recorded in December (PCBS, 2013).

- **Wind**

  Wind direction above Jenin area is between southwest and northwest, more northerly during the summer, with daily speed about 9.2 km / h (PCBS, 2013).

- **Precipitation**

  The mean annual rain-fall in Jenin area is 545 mm. The rainy season in Jenin district starts in the middle of October to the end of April (PCBS, 2013).

4.4 Socio-Economic Characteristics

This section presents demographic and socioeconomic characteristics of people living in Jenin. This is important because these social and economic factors affect greatly the awareness of individuals.

4.4.1 Demography and Population

Population size is important factor in estimating majority of municipal services. MSW total generations are mainly dependent on per capita generation. For proper SWM plan and sustainability, it is mandatory to predict in some manner the future population based on statistics. Table (4.1) shows the population projections for Jenin area.

Table (4.1): Estimated Population at Mid-Year of Jenin Governorate (PCBS, 2014)

Year	Population Number
1997	192743
2007	253558
2008	260216
2009	267027
2010	274001
2011	281156
2012	288511
2013	295985
2014	303565
2015	311231

The total population of the Jenin area is estimated at 303565 at the end of 2014, 154222 of them are males, and 149343 of them are females, with population density of 508 person/ km ^{2} (PCBS, 2014). The projected population of the Jenin area at 2015 is about 311 231, with annual growth rate of 2.6% during the period (2007-2015).

In Jenin area about 93.8% of families live in their own houses, this percentage decreases to 81.8 % in the West Bank (PCBS, 2011).

In the year 2007, a detailed survey of the population and demographic characteristics was made. It is the second survey in the era of the Palestinian National Authority, where the first survey was in 1997. It is expected to conduct a third survey in 2017.

Table (4.2): Population in Jenin Governorate by Age Group and gender (PCBS, 2007)

Age Group	Both Genders %	Gender %	
		Males	Females
0-4	13.48	6.90	6.58
5-9	13.34	6.80	6.53
10-14	13.16	5.56	6.40
15-19	11.53	5.89	5.63
20-24	8.88	4.62	4.25
25-29	7.40	3.82	3.58
30-34	6.80	3.42	3.37
35-39	5.68	2.90	2.77
40-44	4.91	2.58	2.32
45-49	3.80	1.96	1.83
50-54	2.52	1.22	1.29
55-59	1.94	0.98	0.96
60-64	1.59	0.72	0.86
+ 65	4.97	1.48	2.14
unknown	1.31	------	------
total	100	50.78	49.21

4.4.2 Economy

The dominant economic activity in the Jenin area is the agriculture, particularly in the historically fertile Marj Ibn Aamer and the plains around Jenin city where irrigated agriculture predominates. Because of the soil fertility and availability of water in the area, the Jenin area is considered one of the best agricultural areas in Palestine.

The unemployment rate in the Jenin district is 15.4%. Around 73.3% of the employed have permanent jobs, 11.3% have limited jobs (PCPS, 2011).

With the advent of the Palestinian National Authority, the nature of economic activity has changed where it began shifting from agriculture to commercial and service activity. For example in 2010, the trade and vehicles repairing sector forms 50.6% of the total number of establishments operating in other economic activities, While the agriculture sector accounted 18% at the same year, as can be seen in Table (4.3).

Table (4.3): Number of Establishments in Operation in the Jenin Governorate by Main Economic Activity (PCBS, 2011).

No.	Economic Activity	No. of Facilities	Percentage %
1	Agriculture and livestock	1994	18.1
2	Mining and quarrying	18	0.2
3	Processing industry	1192	10.9
4	Electricity and water supply	53	0.5
5	Construction	17	0.15
6	Wholesale and retail trade and repair of vehicles	5562	50.6
7	Hotels and restaurants	477	4.3
8	Transportation, storage and communications	74	0.67
9	Financial Intermediation	54	0.5
10	Real estate and business activities	291	2.65
11	Education	177	1.6
12	Health and social work	369	3.4
13	Other personal activities	704	6.4
Total		10982	100

4.4.3 Infrastructure Services

4.4.3.1 Water Resources

Groundwater is the main source of water in Jenin area, it is represented by both springs and wells (Al-Batnij, 2013).

- Springs

There are 42 springs in Jenin area; these springs are mostly used for low-scale agricultural and domestic purposes.

- Wells

There are 63 wells in Jenin area; they are used for both irrigation and domestic purposes.

There are 80 residential communities in Jenin area; they are distributed according to water resources, 58 of them where public water network is available, while 22 of them where public water network is not available.

The water sources in the district vary; some of them are controlled by the Israeli Water Company (Mekorot), the other is controlled by Palestinian Water Authority (PWA) (PCBS, 2014).

4.4.3.2 Roads and Transportation

Roads networks have not develop in Jenin area in line with the large population growth, which led to a defect in the transportation system both of planning level or organization of streets, or with regard to infrastructure for roads (زكارنه، 2012).

Roads' planning is considered one of the most important factors affecting the SWM especially in transportation mechanism from the generation sources to treatment facilities. The type of roads in terms of being paved or unpaved, its extension, its kind, its trends and the movement of cars affect SW collection, where the alleys hinder the movement of combining cars (سالم، 2004).

Paved roads can be classified in Jenin area on basis of their length to three types (الخطيب، 2011):

- **Main Roads**

  Main roads inside Jenin area represent part of the main road network at the level of the West Bank. This is facing the modifications and

improvements until today. The main roads are the best paved roads in Jenin area in terms of construction and flexibility of movement. Main roads are responsive to the heavy and rapid transit at the same time. However, it does not accommodate the passage of more than one car in one direction except at the main entrances of Jenin city (الخطيب، 2011).

- **Secondary roads**

  Secondary roads are the roads that branch to reach between several towns and villages to link them with the main road network; usually less extensive and less efficient than the main roads (الخطيب، 2011).

- **Feeder roads**

  Feeder roads are paved roads that link between neighborhoods within cities or villages; link villages with public transport network and link agricultural land with secondary roads. These roads are less quality from a technical hand compared with the main and secondary roads (الخطيب، 2011).

4.5 Health Services

The health services in the Jenin district, as well as those in the other districts in Palestine, have been provided by many uncoordinated bodies:

1. Private Palestinian sector,
2. Charitable and Non-Governmental Organization (NGOs), and
3. UNRWA, which is responsible for refugee camps.

The following are the health services available to residents in Jenin area:

1. Primary health care clinic and private clinics.

2. Hospitals: There are three hospitals in Jenin area; one is government, and the others are private, with 180 beds. The number of beds per inhabitants is about 1:1666 (PCBS, 2014).

4.6 Education

There are 257 schools (148 are basic and 109 are secondary) in Jenin area from the total of 2058 schools in the West Bank; 229 of these schools are governmental, 18 are private schools, and 10 are UNRWA schools. The total number of students in Jenin area is around 76991 (PCBS, 2014).

Table (4.5): Percentage Distribution of Population (15 Years and Above) in Jenin Governorate and the West Bank by Educational Attainment (PCBS, 2013).

Educational Level	Jenin Area %	West Bank %
Illiterate	3.9	4.0
Can Read and Write	5.5	6.4
Elementary	15.5	15.4
Preparatory	39.4	38.6
Secondary	21.7	20.3
Associate Diploma	3.8	4.5
Bachelor and Above	10.0	10.8
Total	100	100

The highest percentage of the educational level in Jenin area is preparatory, followed by secondary level. As regards to the number of illiteracy are back primarily to the elderly who are not lucky enough to receive an education degree.

According to statistics of 2010, the illiteracy rate in Jenin was 5.4% (PCBS, 2011), in contrast, this percentage dropped to 3.9 in 2013.

Chapter Five

Solid Waste in Jenin Area

5.1 The reality of Solid Waste in Jenin

SW in Jenin is one of the daily challenges that face those who are working in the cleanliness sector.

The amount of SW generation is affected by many factors, such as human factors including the number of population and income level and by other social and political factors. It is also influenced by natural factors such as the climate (أبو العجين، 2011).

It is important to know the components of SW, because if they are known, the necessary tools and devices required to deal with the waste can be determined. Consequently, the necessary plans to reduce the waste can be put. For example, the high proportion of paper waste requires a machine for cutting and compacting the paper to reduce its size and to recycle it. The high proportion of organic waste requires a special collection system to prevent its fermentation and then use them in the production of compost (أبو العجين، 2011).

5.2 Solid Waste Sources in Jenin

SW is considered one of the most important daily outputs resulting from human activities of different kinds, domestic, industrial and commercial. It also results from hospitals, constructions and the agricultural sector (Al-Batnij, 2013).

5.2.1 Household Solid Waste

Household waste is the most important and the largest SW component. It is composed primarily of organic waste such as leftovers food, as well as the inorganic such as paper, plastic, glass, iron, scrap and clothing worn components (Al Sa'di, 2009).

The household waste forms 50% of the total SW in Jenin district (Figure (5.1)). This percentage is similar to the results of a study referred to which was conducted by the Applied Research Institute (ARIJ) for the SW management in Palestine in 2009. The study affirmed that household waste accounts for about 45-50% of the SW components in Palestine.

Because the household SW is composed mostly of organic waste, its accumulation poses a risk to public health. So, there is urgent to speed up its transport to prevent the spread of diseases and odors, especially in summer time.

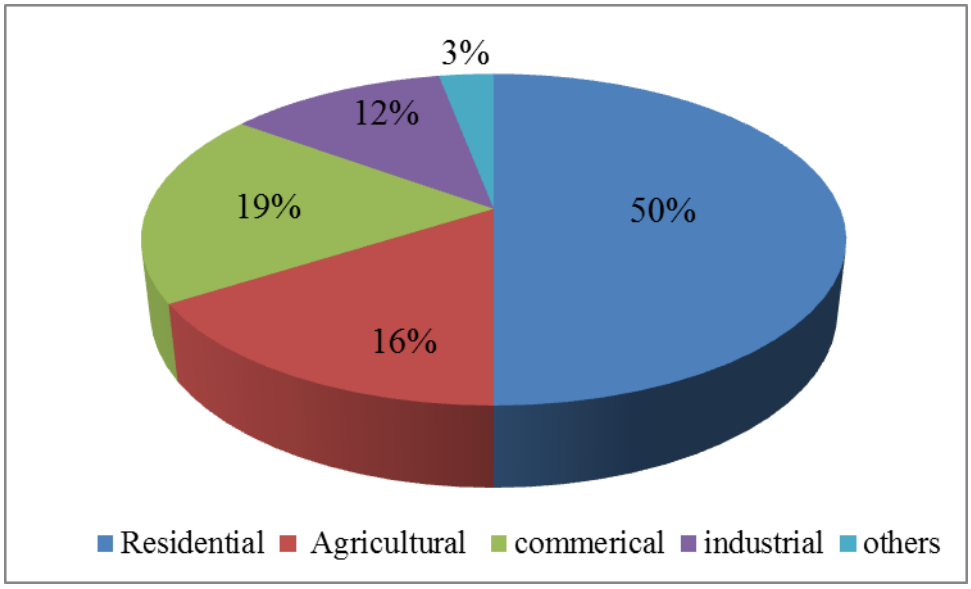


Figure (5.1): Municipal waste sources at Jenin governorates

Source: prepared by the researcher, data sourced from ERM (1998)

5.2.2 Agricultural waste

Agriculture is the most significant economic activity practiced by the inhabitants of Jenin, and usually results in many forms of waste: organic; like the residues of crops and animal dung, or SW; like the containers of pesticides and chemical fertilizers, and remnants of greenhouses.

Regarding the livestock waste; dung varies in the amount according to the kinds and weight of animals, for example cows produce about 1.4 to 5 kg of dung (calculated as dry dung) per head per day, meanwhile goats and sheep produce 0.3 to 0.6 kg per head per day (عبد الظاهر، 2011).

In Jenin, especially in rural areas, there are many farms for livestock breeding. The amounts of waste generated by livestock in Jenin area can be estimated as Table (5.1) lists.

Table (5.1): Number of Livestock in Jenin Area by Type of Livestock

Type	Cows	Sheep	Goats
*No.	5269	81189	19692
Annual waste (tons)	6154.2	13335.3	3234.4

***Palestinian Central Bureau of Statistics, 2013**

It is calculated that dry residues from livestock in Jenin area is about 22724 tons per year, which is a large amount and can be of great economic and environmental benefit due to the ease of recycling a large part of it and then using it in agriculture as an organic fertilizer. This is an opportunity to get rid of them safely.

In addition to crop residues and dung, there are large numbers of private slaughterhouses in Jenin area, which generate many of solid and liquid

waste. It is noted that most of this SW is thrown in the containers used for the household waste. This means that a special kind of environmental management is required to deal with this waste.

5.2.3 Medical Waste

Solid medical waste is made up of two main elements: medical waste that is similar to household waste, which consists of paper, cardboard, packaging waste, glass, and food waste. The other part is hazardous waste which contains toxic, harmful, infectious and cancer-causing substances (Al- Khatib, 2013).

In Jenin, there are many health centers; whether governmental, private, or those which are supervised by the International Relief Agency. These centers generate large quantities of solid and liquid waste containing hazardous components that may harm the health and the environment.

Abu-Awwad (2008) conduced that the generation of the health centers of medical waste is 0.83 kg per each health care primary center per day, while the generation of medical waste from private health clinics is amounted to 0.4 kg/ health clinic/ day.

The rate of generation of medical waste in the primary health care centers and private clinics in Jenin is about 62 tons per year as (Table (5.2)). It is importance to have appropriate management of medical waste in Jenin.

Table (5.2): Generated Medical Waste in Jenin District (Abu-Awwad, 2008)

	PHC	Pr. C
Weight of medical waste in kg/health unit/day	0.83	0.4
Number of health units in Jenin district	140	254
Number of working days per year	260	312
Total weight in kg /year	30248	31619
Subtotal weight	**61.867 Tons/year**	

Regarding the generation of healthcare waste in all hospitals of medical waste; the results indicated that the average hazardous healthcare waste generation rate ranges from 0.54 to 1.82 kg/bed/day with a weighted average of 0.78 kg/bed/day (Khalaf, 2009).

The separation of the medical waste is the best way of managing it. The Statistical Environment Survey to Health Facilities for the 2014 showed that 45.7% of the governmental and private health centers in Palestine collect their SW inside the building of the facility. 18.5% of them collect their SW in the health care yards and 35.8% collect the SW outside the facility. While 73% of them collect waste in an open container and 27% use special closed containers (PCBS, 2014).

Through the field visit to Jenin governmental hospital, it was found that medical waste is managed and handled well inside the hospital. Medical waste is separated from other types of waste and is put in a sealed container placed in the hospital yard (Figure (5.2)). When it is full, it is coordinated with the JSC to collect it.

Figure (5.2): Medical Waste in Jenin Governmental Hospital (3 | 2015)

Although the medical waste in the hospital is separated from other types of waste, it is collected and mixed with other waste and transported to the landfill where it is handled just like any other type of waste. This requires a special administrative action to impose special instructions for dealing with medical waste.

5.2.4 Industrial and Commercial Waste

Industrial waste varies in quantity and composition according to the type and size of the industry. Extractive industries (especially the extraction of different raw materials) are famous for the magnitude of the amount of SW in comparison with the manufacturing industries. There is a lot of industrial

waste that is very hazardous and thus requires specific procedures in handling and disposal (2011 ،عبد الظاهر).

The commercial waste is that which results from trade, business and entertainment centers. In Jenin, there are many enterprises operating in the industrial and commercial sector.

5.2.5 Construction Waste

Construction waste is all the waste results from the process of building and demolition. The danger of this waste lies in case it contains asbestos resulting from the remnants of asbestos used in the old building which can be decomposed and then reach the groundwater and may contaminate it. Construction waste can cause chest, stomach, lung cancer, especially among smokers.

Over the last decade, the occupied Palestinian territory has been subject to intense construction activity, mainly a result of extensive damage to private and public buildings suffered in the context of the ongoing conflict.

Construction of new buildings in the West Bank of the occupied Palestinian territory accounted for 85% of the total new surface area licensed for construction activities in 1999 (United Nations, 2004).

This cycle of destruction and upgrading activities produces large amounts of construction waste. However, no sanitary landfills currently exist in the occupied Palestinian territory, construction waste is not subject to a specific regulatory framework and no published research has looked into construction waste management in this region (Al-Sari et al., 2012).

In Jenin, construction waste increased during the period of the Israeli invasion of Jenin refugee camp in 2002, where the number of destroyed buildings was estimated to reach 1,400 buildings. Some were totally demolished, and others were partially destroyed (طاهر، 2011).

Behavior of the population is the most important factor contributing to the accumulation of construction waste. A lot of people dispose of it along the way on the roads, or in open areas. The lack of awareness and the absence of environmental control are the primary reasons for such behaviors.

Municipalities in Jenin do not have specific mechanisms to deal with or get rid of construction waste. ZF landfill does not receive it except in a few rare cases, such as using part of this waste to level up areas in the landfill (JSC, 2015).

5. 3 Current System of SWM in Jenin Area

5.3.1 Introduction

In 2014, when the population of Jenin city was 59 176 persons, a total of 22,552.539 tons of waste was generated. The daily average of waste generation was 1.05 kg/ capita. All types of waste in Jenin city, except the construction waste, are disposed of by the JSC, which is responsible for the first and second collection. In Jenin villages and towns, JSC is responsible for the second collection only; whereas the first collection is the responsibility of their municipalities. First and second collections are described later.

5.3.2 Solid Waste Collection and transporting

The JSC provides workers to collect the waste in different regions of the city; those workers are supervised by observers with experience. JSC also provides vehicles of different sizes to collect the waste from the containers and the collection points and transferred it to the landfill. Table (5.3) lists the type of vehicles available at the JSC serving Jenin. The number of workers in the cleanliness sector is 98 (Table (5.4)).

Table (5.3): Vehicles Used for Waste Transport in Jenin City (JSC, 2015)

No.	Vehicle Type	Capacity (m^3)	Rate of weight (ton/ day)
1	Volvo (waste compactor)	12 m^3	9.0
2	Volvo (waste compactor)	18 m^3	13.3
3	Isuzo	5 m^3	2.3
4	Man	21 m^3	12.7
5	Man	20 m^3	12.3
6	IFFCO Rmesh	17 m^3	5.9
7	IFFCO Rmesh	25m^3	12.2

Table (5.4) Workers in the Cleanliness Sector in Jenin City (JSC, 2015)

Task	No.
First Collection Workers (sweepers)	70
Second Collection workers (vehicles workers)	16
vehicles drivers	8
Supervisors	6
Total	98

SW collection in Jenin city goes in two different stages:

5.3.2.1 Initial collection

The initial stage involves sweeping the streets, whether main ones or those in the neighborhoods of the city. This includes collecting waste in the areas

and neighborhoods that cannot be reached by vehicles. The collection is done by trained workers to collect the waste and transfer it to containers or assembly points where vehicles can reach. In this stage certain tools and equipments are used, such as street sweepers which sweeps the main streets, or small bulldozers that collect waste from some areas such as the vegetable market and the Industrial Zone. Other equipments used to get the job are: brooms, dustpans and wheelbarrows.

The city is divided into specific areas in which workers are distributed. Observers make sure that the course of daily work goes well. Workers are provided with special clothing and safe tools like gloves, uniforms, and masks.

5.3.2.2 Second Collection

This stage is done via the vehicles that are equipped with different sizes of compressors that suit the amount of waste generated. Vehicles collect the waste from the containers, which are of different types and sizes, from the assembly points and from those areas where there are no containers. Each vehicle has a driver and two workers who unload the waste inside the vehicle.

Each vehicle has its defined route within the city. The routes are drawn based on criteria that are: the daily working time, vehicle capacity, the amount of waste produced in this path, the area, the nature of the waste, the distance traveled for the collection, and the distance from and to the landfill.

5.3.3 Solid Waste transfer

SW transfer station is a facility constructed to gather and later transport the waste. This is normally for the communities that are far from the landfill. The SW is collected by the collection vehicles and is transported, unloaded at transfer stations to be reloaded by vehicle trailers, which transport the waste to the landfill.

The transfer station site must be large enough to provide space for the collection vehicles that enter the transfer station, unload its wastes and also provide place for separation; if it exists (Thompson, 2007).

There are two SW transfer stations in Jenin, one serving the villages west of Jenin and the other in Tubas Governorate. Both of these transfer stations are supervised by the JSC (ZF).

5.3.4 Solid Waste Separation

Separation of SW which is applied in Jenin area is only for paper and cardboard separation at source. There is no separation at transfer station or at landfill site.

The Separation at source in Jenin area is mainly managed by the JSC and for the following communities:

1. Jenin city
2. Al-Yamun
3. Silat al-Harithiya
4. Kafr Dan
5. Burqin
6. Yabad
7. Silat al- Dhahr

8. Arranah
9. Ajjah
10. Anzah

This is done through putting cages in the markets and commercial areas that produce paper and cardboard (Figure (5.3)).

Figure (5.3): Cages for Cardboard in Jenin City

The generation average of separated paper and Cardboard in Jenin area is equal to 126.64 tons monthly (Table (5.5)). The sale price of one ton of separated paper is about 50-100 dollars.

Table (5.5): Quantities of Separated Cardboard in Jenin Area during the Period of (January- April, 2015) (JSC, 2015)

Month	Quantity (tons)
January	99.10
February	97.66
March	180.45
April	129.37

5.3.4 Final Disposal

Disposal of SW is the last step in SWM activities; it can be carried out in several ways. The most common method to dispose of SW in Jenin area is landfilling; it is an effective and low cost method of disposal.

There is one sanitary landfill in Jenin district, which is Zahrit A-Finjan landfill and is located in Jenin governorate in Wadi Ali between Arrabeh and A'jja. It is 18 km south of Jenin City, 26 km west of Tubas, 23 km north of Nablus through Jenin-Nablus road, 24 km east of Tulkarem and 50 km northeast of Qalqilyia. Figure (5.4) shows the location of ZF landfill within Jenin district.

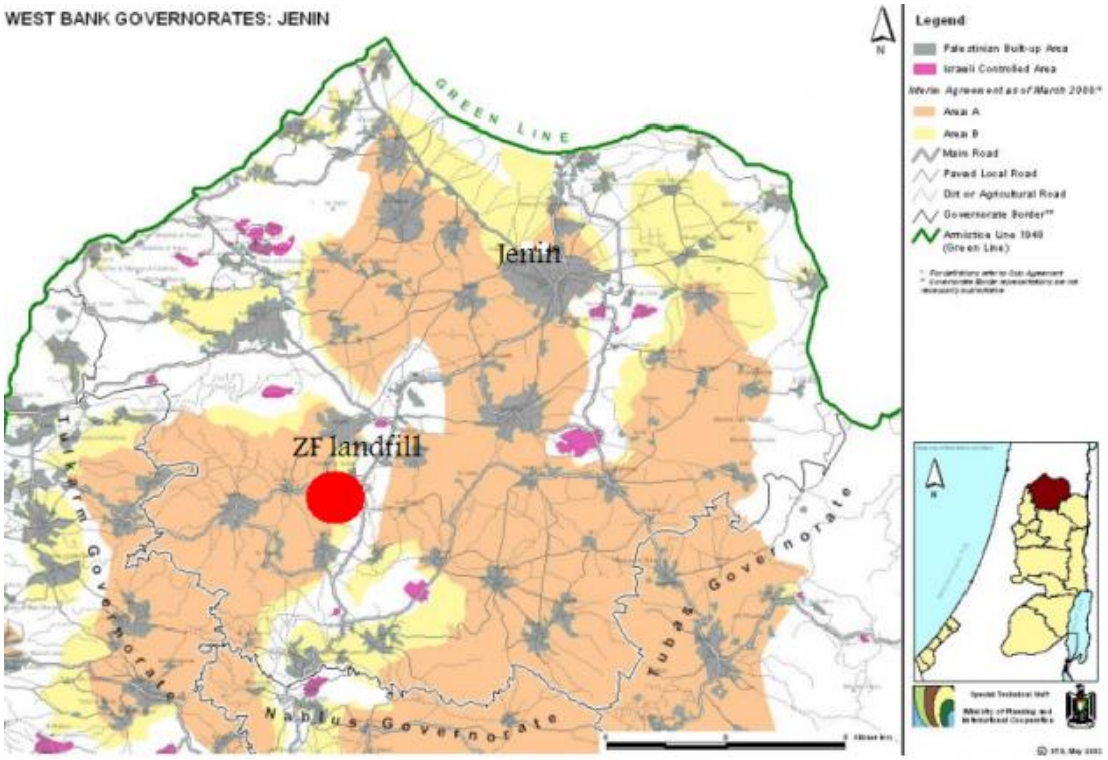


Figure (5.4): Location of ZF landfill in Jenin governorate (JSC, 215)

Chapter Six

Factors Affecting Solid Waste Management in Jenin Area

6.1 Human Factors Influencing SWM “Driving Forces"

The factors affecting the size and management of SW are various, including natural factors and human factors. These factors vary in their impact on the size and management of SW. The human factors are more influential than the natural factors, due to the fact that SW is primarily the result of human activities (أبو العجين، 2011).

The human factors are the main driving forces of the SWM. These factors affecting the generation of SW are many, including: population growth, behavioral factors of the population, lifestyles, environmental awareness, and the political conditions. These can be clarified as follows:

6.1.1 Population

The population factors vary in their impact on the generation and management of SW. This important population factors include: population size, income level, and the behavior of the population. In this part of the study, these factors and their impact on SWM were discussed through the field study of the different communities in Jenin area.

6.1.1.1 Population Size

Population growth is the most important factor affecting the increase of SW where it goes in direct proportion with it. The population growth is usually accompanied by many changes in the urban and economic activities,

consumption and production. Ultimately, SW generation increases, which implies an urgent need for an effective management to get rid of it and to deal with it in a scientific and proper manner (Hoornweg and Bhada-Tata, 2012).

When comparing the number of population with the amount of SW that arrived to the ZF landfill in Jenin (Table (6.1)), it is noticed how the amount of SW that is collected annually goes up, depending on the increasing numbers of the population. SW in Jenin city increased from 19188 tons in 2011 to reach to about 21403 tons in 2012, as well the numbers of the population has increased in the same period by about 1287 capita.

Table (6.1): The Relationship between Population and the Quantity of SW

Year	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
***Population No.**	40444	41657	42907	44194	45520	59176
****Quantity (tons)**	13863	16487	19188	21403	21823	22523
(kg/capita/day)	0.94	1.08	1.23	1.33	1.31	1.04

***Palestinian Central Bureau of Statistics, 2015**

****Joint Services Council, 2015**

It is also noticed that the individual production of SW increased in the period (2009-2012). In contrast, the daily generation rate dropped in 2014. The decline in the individual generation of waste is a positive sign in the process of SWM. The decline shows that citizens start to have environmental awareness about the need to reduce the amount of waste at source. This is consistent with the national strategy for SWM, which

stresses the need to reduce the amount of waste as a first step in the process of effective management of SW. The strategy adopted the application of a number of practical effective methods that can be used to reduce waste amounts, such as encouraging the separation of reusable and recyclable waste. This was the goal of this study.

6.1.1.2 Income level

Quality and quantity of SW are affected by the level of income, and the rate of consumption, which varies from one family to another. The waste generation rate decreased as the family's income decreased (Pirani et al., 2014).

To determine the relationship between income and the amount of daily SW, the population sample had been divided into different income levels that are: (2000 NIS, 3000 NIS, and more than 3,000 NIS) per month. Table (6.2) lists the percentages of the population that generated different amounts of SW (2, 3, 4, 5, and more than 5) kg\ household\ day as a function of the level of income.

Table (6.2) shows that there is variation in the relationship between income level and the size of the daily waste. The average daily waste for the majority of households ranges from 3-5 kg. This can be clarified as follows:

- When the income is 2000 NIS, 50% of the families generate about 3 kg of waste daily; while 41.6% of them generate waste amounts of 4 kg, and 8.4% of them have about 5 kg of waste.

- When the income is 3,000 NIS, 35.9% of the families generate daily waste of about 3 kg, and 33.7% of them 4 kg. It can be observed the percentage of those whose waste reaches 5 kg is increasing to reach 12%, while it reached only 8.4% in the previous category of income.
- When the income is more than 3,000 NIS, about 36% of the families generate waste at about 5 kg per day, where this is 12% when the income is 3,000 NIS. The proportion of families whose waste is more than 5 kg per day increased to about 31% in this category, while in the former category it is only 4%.

Table (6.2): Income Levels and Daily Household production of SW

Income (NIS)	2 Kg	3 Kg	4 Kg	5 Kg	More than 5 Kg
	In percentage				
2000	----	50	41.6	8.4	----
3000	14.5	35.9	33.7	12	3.9
More than 3000	6.7	13.5	12.8	36.2	30.8

We can conclude from the above that there is an increase for waste generated by high-income families (more than 3,000 NIS), where 67% of them generate up to 5 kg daily. The percentage went down in the low-income families.

Financial success affects waste generation by causing more consumer activity on the residential scale. In addition, it may very well be that with higher income, people do not feel the need to be frugal in their management of the resources at their disposal. This leads to greater amounts of waste generated for those who are more affluent (Pirani et al., 2014).

However, getting to a clear relationship between income level and the amount of waste generated must be accompanied with the knowledge of the number of family members, because the number of family members affects the amount of daily waste more clearly.

6.1.1.3 Behavioral Factors

The behavior of the population primarily affects the effectiveness of SW collection. These behaviors vary from one family to another, some of which is related to the behavior of the family in waste transporting. Others are linked to the time when the waste is removed from the house and some are linked to the means used in transporting the waste.

Through the field study in Jenin area, it had been confirmed that there were differences between the city, the town and the refugee camp in the behavioral factors. This could be clarified as follows:

First: Person Responsible for SW Outing

The transfer of household SW out the house is one of the most important factors affecting waste management. Families vary in the way they deal with SW transfer from the house. In some areas, the father is in charge of the waste transfer, while the mother or the eldest son or children are responsible of doing so in other families.

The person responsible for SW transfer affect in different ways, some would put it inside the containers, others would throw it beside them, and some would throw it away at the nearest free place. The last behavior contributes to the accumulation of waste in the streets, and consequently it

hampers its collection and its disposal processes. The person responsible for the transfer of the SW to the container varies as Table (6.3) shows.

Table (6.3): Person responsible for SW Transfer per Community Type

	Father	Mother	Eldest son	Children
	In percentage			
Jenin City	35	25	15	25
Town	15	50	5	30
Camp	25	35	15	25

There are variations when it comes to the person in charge of SW transferring from one community to another. This variation could be clarified as follows:

- 35% of the families in Jenin city depend on the father to transfer the household SW from home; while 25% of them rely on the mother.
- In the towns, the vast majority of the families rely on the mother in the disposal of SW. This is due to social values in the villages and the willingness of women to transfer SW. Also the percentage of families who depend on the children to transfer SW is high compared to the cities as it has reached 30% in towns.
- In refugee camp, the percentage of families who rely on the father equals the percentage of those families who depend on the children to get rid of the daily household waste. Moreover, the percentage of those who depend on the mother is really high in comparison with the city as it reached 35% in the camp. This percentage is considered low when compared to the villages where it is about 50%.

The problem in relying on the children in the disposal of SW is that they often get rid of it by putting it near and not inside the containers, thereby

hindering the process of collection, transportation. This leads to accumulation and causes environmental problems.

Second: SW Separation at Source

The process of SWM is affected by citizens sorting and separating of the household waste. This is the most important step to reduce the size of the household SW. It is considered a preliminary step to SW recycling (Musleh and Al-Khatib, 2010).

The field study has shown that the entire population does not separate medical waste from household SW putting the lives of workers of SW collection at risk.

Milhem (2004) investigates the health risks facing the cleaning staff in Bethlehem and Hebron cities. It was found that the cleaning staff is susceptible to various symptoms of diseases. As to the study 55.3% of the cleaners are suffering from sore throat, cough, high temperature, and that 27.9% suffer from diarrhea or blood in the stool. In addition 25% of the cleaners suffer from breathing problems, and 20.2% of them suffer from skin diseases. The study showed that the cleaners who have low levels of education are more likely to these dangerous risks. In this study, the behavior of the people in sorting and reusing the household waste could be illustrated by Table (6.4).

Table (6.4): Sorting and Reusing Household Waste

	Solid Waste Sorting %		Medical Waste Sorting %		Reuse %	
	Yes	**No**	**Yes**	**No**	**Yes**	**No**
Jenin City	20	80	0	100	35	65
Town	60	40	0	100	85	15
Camp	20	80	0	100	15	85

The above table demonstrates the following:

- The majority of the families in the city do not separate the organic waste (leftovers and remnants of cooking). The percentage of those who do is only 20%. Concerning reusing the materials before throwing them, it was found that 35% of families reuse some materials before throwing them, and the rest do not. In the city the majority of people do not separate the organic waste, neither reuses the SW.
- In the camp about 20% of the families separate the organic household waste, while only about 15% of them reuse household waste.
- In the towns, approximately 60% separate the organic household waste and about 85% of them reuse the remnants of organic materials of food to feed birds and domestic animals. In the villages and towns there are large areas available around the houses compared to the city and the camp. The camp has narrow streets and its houses are very close from each other. In the village, people also separate other materials such as iron and damaged metal and sell them to street vendors.

- All families in the communities do not separate medical waste from the rest of the waste.

Third: Means Used in Household Waste Outing

SWM process is affected by the means that citizens use in getting it out the house. Using nylon transparent bags that are torn easily in transferring the waste leads to disperse it on the ground. It will be difficult to collect it, especially if its collection is delayed to the next day and animals like cats and rats will play with it. This problem occurs also in the case of using plastic bags, but to a less extent from the nylon bags. When using the plastic baskets, they are kept in front of the house with a cover in most cases to ensure that it does not fly over and animals can eat approach.

Through the field study as Table (6.5) shows, it is clear that people in Jenin area differ from one community to another in the means used to take out the household waste and bring it to the container.

Table (6.5): Means Used for Outing the Household Waste per Community Type

	Plastic basket	**Plastic bag**	**Nylon bag**
	In percentage		
Jenin City	20	70	10
Town	5	70	25
Camp	30	55	15

We can benefit from the above results in the evaluation of the possibility of domestic separation of SW based on the attitude of the family in dealing with the disposal of waste. It is clear that separation will be very difficult in the case of using plastic baskets which are placed in front of the house. The waste is thrown away once and is put in the basket instead of moving it

directly to the container. This hinders the possibility of application the domestic separation which requires maintaining the waste in more than one basket and transporting them directly to containers for separation.

Fourth: Time of SW Outing from the Household

SW collection is affected by the time of discarding the waste. Whenever the time complies with the collection period, the process will be more efficient. According to the field study there was a variation among people in the time of bringing the waste outside the household.

Table (6.6): Variation among the families in the Time of Discarding the Waste

	Morning	Afternoon	Evening
	In percentage		
Jenin City	75	5	20
Town	35	20	45
Camp	90	5	5

These figures can be illustrated as follows:

- In the camp the percentage of families who get the waste out in the early morning is very high at 90%. This is due to the process of manual collection done by the UNRWA workers who collect the waste in the early morning. A lot of families in the camp put the waste in front of their houses. UNRWA workers collect it from the alleys of the camp and transfer it to a large container that is placed at the entrance of the camp.
- In Jenin city, the percentage of families who get the waste out in the morning is 75%. A large proportion of people working as employees

are keen to get rid of their waste daily in the morning when they are going work.

- In the towns and villages there is a clear difference in the time of discarding the waste from the house; 35% of them in the morning, 20% at noon, and the highest percentage refers to those who do this in the evening,45%.

In towns and villages there is less manual collection of SW because of the width of the streets and spaces compared to the camp. Therefore, the collection is primarily done from the containers.

The problem of discarding the waste at noon is that it stays until the morning of the next day; there is a big chance of fermentation and rotting and then unpleasant odors, especially in the summer. It is really important to know the exact time when the cleaners or the waste trucks arrive as to reduce the chance of accumulation of SW in the street.

Some countries have fixed time tables which show the exact times of cleaners or waste trucks appointments. In these countries the citizens have to abide by these appointments and are never allowed to bring out the waste into the street after these times. For example, in Brazil the citizens are informed about the exact appointments of waste trucks and are asked to bring the waste out 30 minutes before. When anyone violates the rules, they pay a fine (Li et al., 2008).

Fifth: The Way to Get Rid of Household Waste

People vary in the way they get rid of their household waste. Some of them get rid of it by leaving it in front of the house, especially in areas that rely

on manual collection like the camp. Others get rid of it by transferring directly to the container. Some leave it in front of the house or at the street entrance.

Table (6.7) shows that there is considerable variation in the way of getting rid of household waste. This can be illustrated as follows:

- In Jenin city about 45% of the families get rid of the household waste by putting it in front of the house because the municipal containers are far away from the house. 50% of the families dispose their waste by transferring it directly to the container. There is no burning of SW in the city.
- In Jenin camp 60% of the families dispose of the household waste by placing it in front of the house, 10% of them get rid of the waste by placing it in the street entrance. The cleaning worker using a small vehicle put the SW it in the large container which is found at the entrance of the camp; containers are not available inside the camp.25% of the people transfer the waste directly to the large container at the entrance of the camp because it is not far away from their houses.
- In the town, the majority of the population disposes of the SW by transferring it to the container; those are about 80% of the people. Approximately 10 % of people get rid of their waste by placing it in the street entrance because the containers are far away from their houses .And 10% of them burn the waste. It is rare to find one who gets rid of the waste by putting it in front of the house.

Table (6.7): Variation in the Way of Getting Rid of Household Waste

	Front of the house	Street entrance	Burning	Container
	In percentage			
Jenin City	45	5	0	50
Town	0	10	10	80
Camp	60	10	5	25

Sixth: How often the waste is discarded per week

Waste collection process is affected by the number of times when it is discarded from the house during the week. According to the field study there was variation among the population in the number of times they get rid of the household waste (Table (6.8)).

It could be noticed from Table (6.8) the following:

- 50% of Jenin families bring out their waste every day, 40% of them every two days, the rest each three days or more. This percentage may refer to those people who do not have containers close to their houses and/ or the service of daily collection is not available to them. These are forced to collect and remove the waste every three days or every week.
- The vast majority of the families in the towns and villages bring out their household waste every day. Their percentage reached about 75%; while 10% of them bring out the waste every two days and 15% of them every three days.
- In Jenin refugee camp about 55% of the families bring out the household waste each day. This is linked to the manual collection

service in the camp, 20% get rid of it every two days and 25% every three days.

Table (6.8): Contrast among the People in Discarding the Household Waste

	Daily	Every two days	Every three days	Weekly
	In percentage			
Jenin City	50	40	5	5
Town	75	10	15	0
Camp	55	20	25	0

6.1.2 Social Factors

6.1.2.1 Lifestyles

Social factors are considered important factors affecting the household SW generation. Social factors vary; some are related to annual events like Eid and Ramadan, or Fridays; local markets; weddings and others are related to social occasions. All result in much solid and liquid waste.

Waste increases on Friday in particular since it is a holiday and the family members gather for lunch. In Jenin city, about 55% of the families believe that the SW is high on Friday. In the village 70% of them think the same. In the camp 50% of them think that their SW is high on Saturday, which is the holiday for those working inside the 1948 Occupied Palestine (Table (6.9)).

Table (6.9): Waste Variation on Weekdays

	Saturday	Monday	Thursday	Friday
	In percentage			
Jenin City	25	0	20	55
Town	5	5	20	70
Camp	50	5	15	30

6.1.2.2 Environmental Awareness

Education and environmental awareness help in the reduction of waste generation via promoting the idea of separation and reusing it. In the absence of serious environmental educational programs in schools, universities and in the media channels, people tend to consume twice as much and not to reuse the waste, neither to recycle it. In addition there is an extravagance in using the canned goods and the non-recyclable materials, which all ends in the landfill.

Therefore, there is an urgent need for environmental education in which the importance of preserving the environment is taught. It is really important to work on increasing the awareness of humans' environmental rights in line with the social, economic and technical development. It is essential also to protect the environment from the human himself, which requires the need to strengthen legislation and laws regarding the environment (Soufan, 2012).

6.1.3 Political Factors

The application of sound and integrated management of SW in the Palestinian territories faces barriers and multiple challenges on the legislative, regulatory, technical, environmental and financial levels. The situation gets worse because of the lack of accurate statistical data that could constitute the inputs necessary for the planning and control of decision-making related to the sector. The complexities of the current political situation in Palestine add other challenges; as the Palestinians do not have full control over the land and the resources. In addition to the

Israeli occupation practices which is considered as a war against the Palestinian environment.

The Israeli environmental war against Palestinians is characterized in two aspects: The first is breaking the agreements related to the protection of the environment and the sustainable use of natural resources. 84 of the Palestinian communities' areas are used randomly and illegally by the Israeli settlements as landfills. The second aspect is represented by the Israeli obstructing of the implementation of projects related to waste management in the Palestine which might help in reducing the environmental problems (طعمه، 2010).

Since the start of the second Palestinian uprising (Al-Aqsa Intifada), and due to the Israeli activities, curfews, closures, and military checkpoints imposed since 2000. SWM in West Bank was badly affected by these conditions, and this situation is negatively affecting health and damaging the environment. Most of these cases were due to reasons beyond the capability of the municipalities with its limited resources (Arafat et al., 2006).

The Palestinian government was able to get a number of achievements on the legislative level related to the SW sector. The main achievement was represented in acknowledgment (statement) of a number of relevant laws, notably Law No. (1) On the local bodies for the year 1997, and Environment Law No. (7) of 1999 and the Public Health Act of 2004 (NSSWM, 2010).

Having a law on SW in the Palestine is essential, and more important is the need for activate the role of the executive authority which can follow up this matter, and punish the offenders. Law is drawing of regulations that

need implementing and instructions. Therefore, the current legal situation should be subject to development and modification to fit in with the NSSWM, and to achieve its objectives.

6.2 Natural Factors Affecting SWM

The natural factors have less impact on the SW than the human factors. Sometimes the impact of natural factors is a sub-sequent to human factors. A good example is when collecting the SW is delayed in summer time when the temperature is high; this leads to problems like rotting of organic material and the spread of odors.

The effect of natural factors could be presented in many elements; the most important and basic factor is the climate, which affects the SW indirectly.

The monthly variation of SW in 2011 and its high quantities during the summer can be illustrated by Figure (6.1). The figure plots the tonnage of wastes delivered to ZF landfill in 2011. The amount of waste in July and August is higher compared to the rest of the year. If such a rise occurs in other months of the year, it will be interpreted by linking it to social occasions. For example, the high amount of waste in October 2011 was linked to Eid al-Adha which came in that month. Such examples confirm what was said previously about the impact of social factors on the generation of household waste.

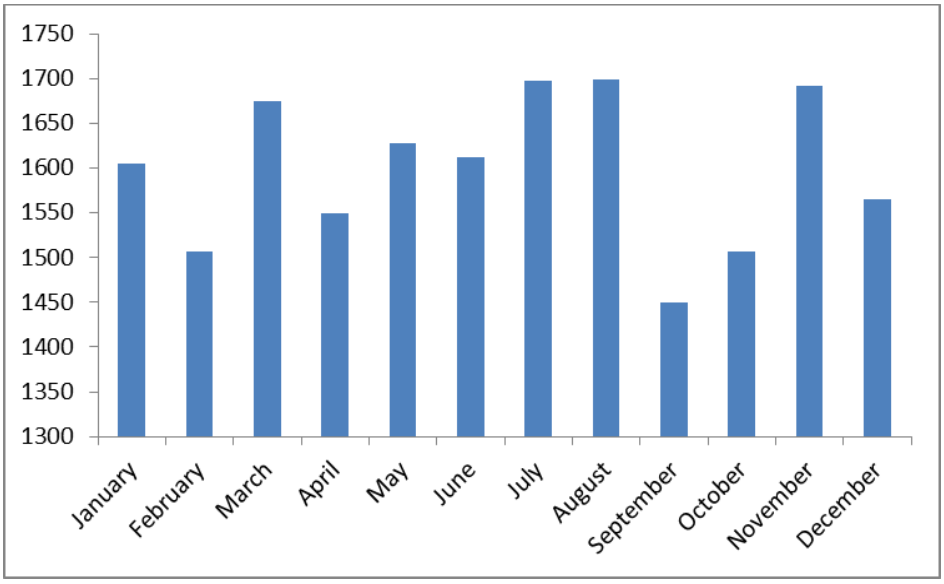


Figure (6.1): Tonnage of SW received at ZF landfill in 2011

Chapter Seven

Pilot Study of SW Separation at Source

7.1 Introduction

Sabah Al-Khair residential complex is selected for the pilot study of SW separation at source. It is a community located at the north of Jenin city. Figure (7.1) clarifies the selected area of the suburb where the pilot study of SW separation at source was conducted. The study was applied on 60 households of 600 households, where the number of families in the suburb is about 600 families (PCBS, 2015).

Figure (7.1): Sabah Al -Khair Suburb (Jenin Municipality, 2015)

7.2 Study Area

7.2.1 Population

The number of people who actually have been counted by the General Census of Population, Housing and Establishments 2007 in the Sabah Al-Khair suburb is about 3,078 capita.

The age structure of the population of the suburb is listed in Table (7.1). The population in the suburb is young; where young people count higher than the older. Those in the age group (0-14 years) represent about 37.4%, while the percentage of those in the age group (15-64) is 52.8%. The rest were those who are 65 years and above. The study of the qualitative composition of the population shows that the number of the males and female is very close, where the number of males was 1568, and the number of females was 1510.

Table (7.1): Population in Sabah Al-Khair Suburb by Age Group and Gender, 2007

Age group	Both Gender %	Gender	
		Male %	Female %
0- 4	12.3	6.1	6.2
5- 9	12.7	6.6	6.1
10- 14	12.4	5.8	6.6
15- 19	10.8	5.3	5.5
20- 24	8.1	4.0	4.1
25- 29	6.7	3.4	3.3
30- 34	6.2	3.1	3.1
35- 39	5.6	3.0	2.6
40- 44	5.4	3.0	2.4
45- 49	3.8	2.0	1.8
50- 54	2.6	1.2	1.4
55- 59	1.9	1.0	0.9
60- 64	1.7	1.0	0.7
+ 65	2.7	1.2	1.5
Unknown	7.1	3.8	3.3
Total	100	50.5	49.5

Source: Palestinian Central Bureau of Statistics, General Census of Population, Housing and Establishments 2007, unpublished data.

7.2.2 Education

The preparatory level got the highest score among other education levels in the suburb of "Sabah Al-Khair", as shown in Table (7.2); it reached 27%, followed by elementary and secondary levels at 18.7%, 17.4% respectively. Reference to Table (4.5), the average of people who has university degree in Sabah Al-Khair suburb reached about 20.3%, which is higher than the average in Jenin which reached about 13.8%.

Table (7.2): Population in Sabah Al-Khair suburb by Educational level and Gender

Educational level	Both Gender %	Gender	
		Male %	Female %
Illiterate	2.7	0.5	2.2
Can Read and Write	9.9	4.2	5.7
Elementary	18.7	9.1	9.6
Preparatory	27.1	13.6	13.5
Secondary	17.4	9.2	8.2
Associate Diploma	6.3	3.4	2.9
Bachelor and Above	14.0	7.9	6.1
Unknown	3.9	2.4	1.5
Total	100	50.3	49.7

Source: Palestinian Central Bureau of Statistics, General Census of Population, Housing and Establishments 2007, unpublished data.

7.3 Methodology

SW separation at source depends primarily on citizens' participation and acceptance of the idea of separation. The methodology of the pilot study was based initially on the social dimension and then on the technical dimension.

7.3.1 Social Dimension

The main category for social criteria that affect the success of the SW separation at source is the community that plays the main role in succeeding for the separation system. The following is a discussion of this dimension.

Convenience and Accessibility

The convenience and accessibility is essential in applying separation system at source in all stages including waste storage, collection, and distribution of the waste containers. The convenience and accessibility for residents will be through identifying the time of waste collection and disposal, which can be identified through the designed pilot and program, which includes: town name; collection time; collection ways and collection point locations (Schouw, 2003).

The collection point locations that include container must be chosen and prepared in ways to achieve the convenience for the resident and worker such as the short distance, odors and safety control. The convenience for the workers will be through improving their working conditions and facilities, increase their earning capacity, and improve their social security, including access to housing, health and educational facilities. Proper equipments and protective clothing can reduce the health risk (Schouw, 2003).

Residents participation and awareness

One of the important key in applying the separation at source is the cooperation and participation of the residents that can be achieved by many

ways, such as coordination with municipalities and councils, establishing committees, and implementing educational and awareness programs. The major barrier that is considered a challenge for separation process is the lack of awareness among the residents, practices of the separation, waste compositions, identifying the recyclable materials, etc. Huge efforts must be done to raise general public awareness and educate the residents how to separate their waste according to the required categories. This can be done via education courses, school programs, teaching and learning materials (Nigbur et al., 2005).

The directed training and motivational programs for institutions and leaders are considered as an effective means for improving awareness and participation in SW separation system (Nigbur et al., 2005).

To provide a social description of the sample where the study was conducted and to determine the extent of the contribution of members of the community in the success of the project, 60 questionnaires were applied on the sample households of Sabah Al-Khair suburb. Personal interviews were made with the housewives in the suburb. The questionnaire was simple in order to save the time in understanding and filling out of the questions.

The questionnaire includes several aspects starting from personal information about family members in order to understand the nature of the families. Then discussing some of the environmental pollution issues down to the most important section of the questionnaire which talks about reuse

and the separation of household SW. The questionnaire includes also discussion of awareness programs in the field of environment.

To strengthen the social dimension of the study and before the actual application in the field, leaflets that are issued officially by Jenin municipality have been distributed to all the families in the region to support the project and to encourage participation and credibility of the SW separation among the citizens.

During the actual application in the field, the importance of supporting the social dimension was confirmed and the importance of raising awareness among the population was emphasized. Explanatory brochures on how SW is separated at source were distributed. They include information about the exact definition of SW and its risks on health and environment. Furthermore they inform people of the importance of separation at source and the benefits to citizens and environment. The brochures also show the role of the citizen and the responsibility of preservation the environment, in addition to explaining the most important objectives of recycling household waste.

7.3.2 Technical Dimension

Knowing the components of waste that is generated daily in the study area is considered the first step. They were known through separating them and knowing the percentages.

Based on the knowledge of the components of the waste in Jenin through previous studies, the mechanism of action was executed in the following steps:

1. Because the wet organic waste constitutes about 53% of the total waste and the rest is dry waste (which forms about 47%), two types of containers were chosen; one for the wet organic waste and one for the dry waste.
2. Determine: what is the organic wet waste? What is the dry waste which will be separated?

   The organic wet waste components are: leftovers, remnants of cooking, peel and residue of vegetables and fruits, eggshells, fish scales, residue of home garden crops (leaves, grass, weeds, and straw) and sawdust.

   The dry waste components are: metal cans, empty beverage cans, plastic cans, hairdresser's hair, nylon and plastic bags, residue of clothes, scrap, glass, paper and cardboard.
3. Determine the detailed information about the suburb in which the project will be applied and identify the number of houses and the number of people in each family to estimate the daily SW generation rate of the family in the study area.

The houses on which the study will be applied have been identified at 60 houses. The total number of inhabitants is 290 capita.

4. Choosing the plastic containers of 240 liter capacity for the separation process.
5. Determine the number of containers required for the implementation of the project. 8 containers are required, taking into account the following:

- The number of houses in the study area is 60. According to the previous studies it was found that the Palestinian family daily production rate of SW is about 4 kg, thus:

  60 * 4 = 240 kg\ day
- Through the study of the current situation of SWM in Sabah Al-Khair suburb, waste is collected day after day, so:

  240 * 2 = 480 kg
- The capacity of the container used in the experiment is about 65 kg. So eight containers are required; 4 containers for the organic wet waste and 4 others for the wet waste.

6. Distribution of bags and baskets with explanatory posters to all the families in the study area to separate organic waste from the rest of the waste types. Figure (7.2) is a photo of the type of baskets used for organic waste, tightly closed.
7. Choosing 8 containers and numbering them. The containers are distributed at 4 points, each point contains two containers. For example, in point No.1 two containers are placed; one container for wet waste and another container for dry waste. In point No. 2 two containers are placed; one container for wet waste and one for dry waste, and so on.
8. Distribute the containers that are devoted to the study and use writing to distinguish the dry waste containers from the wet waste containers and placing them in specific points (Figure (7.3)).

9. Measuring the weights of the containers three times a week according to the days of waste collection. Figure (7.4) illustrate the weighing process applied in the study.

The total weight of all the containers at a time represents the amount of production of all families in two consecutive days.

10. Taking the weight of each container separately. After measuring its weight emptying the container on the ground to judge the degree of commitment. The following two methods were applied:
    - Take pictures of the container when discharged and assess commitment through pictures based on observation and appreciation.
    - When the container of organic wet material is emptied, a type of non-organic waste is taken and weighed to determine the efficiency of the separation.
    - When the container of the dry waste is emptied, any type of organic waste is taken and weighed to determine the efficiency separation the dry material.

Figure (7.2): Baskets used for Organic Waste

Figure (7.3): Containers used in the study

Figure (7.4): Weighing of the Containers

The total weight of the waste generated in this day and the weight of wet organic and dry materials were determined separately. The degree of the commitment towards separation was also determined.

The experiment is repeated for two months (April and May, 2015). The month is divided into four periods, each period 3 days (Saturday, Tuesdays, and Thursday of each week). The readings are recorded in a form that is filled three times per week. Table (7.3) is the form applied.

Table (7.3): The Form for One Day

Point No.	Wet Organic Waste Container				Dry Waste Container			
	Total weight	Organic Weight	Dry weight	*Container efficiency	Total weight	Dry weight	Organic Weight	Container efficiency
1								
2								
3								
4								
Total								
Note	1. Total waste weighted = Total weight in organic waste containers+ Total weight in dry waste containers 2. Household generation rate (for Saturday and Thursday)= (total waste weighted in that day/60/2) kg/day 3. Household generation rate (for Tuesday) = (total waste weighted in that day/60/3) kg/day 4. Total organic weight = Organic weight in wet organic waste container+ Organic weight in dry waste container 5. Total dry weight = Dry weight in wet organic waste container+ Dry weight in dry waste container 6. Container efficiency for wet organic waste container = (Organic weight in this container/ total weight in this container) *100% 7. Container efficiency of dry waste container = (dry weight in this container/ total weight in this container) *100% 8. Degree of commitment towards SW separation= (Container efficiency for wet organic waste containers + Container efficiency of dry waste containers) / 2							

*** Efficiency**

Container efficiency means: the weight of the waste that are supposed to exist in this container. If we were dealing with the container of organic

waste, the efficiency of this container is the weight of the organic materials only. This represents the commitment of people to the separation process in this container, which is measured by converting this organic weight to a percentage.

Example:

If the total weight of the waste in a particular container (wet organic container) is equal to 60 kg and the weight of wet organic material is 45 kg, and the rest of the weight (15 kg) is the weight of other dry waste. The proportion of people's commitment to separation in this container is:

(Weight of organic materials/ weight of all the waste inside the container) *100%

= (45/ 60) * 100% = 75%

Instruments used in the measurement

1. A scale.
2. Means of protection: gloves, hats, masks.
3. Brooms and dustpans.
4. Reading’s model.

Actions that have been carried out during the measurement of weights

1. Wearing the means of protection (gloves, hats, and masks) (Figure (7.5)).
2. Emptying the container and the bags in an empty area.
3. Removing the sharps waste was the first step, such as needles, broken glass, and others.
4. Sorting the waste components of each container

5. Taking weights using the scale and recording them in the model.

(Wearing the means of protection)

(Emptying the container in an empty area)

(Sorting the waste components)

(Taking weights)

Figure (7.5): Actions that have been carried out during the measurement of weights

7.4 Analysis of Results

7.4.1 Questionnaire results

First: Results related to personal information

1: Age

By analyzing the results of the questionnaire, it was observed that there is diversity in the age of the respondents. Table (7.4) lists the age results of the study sample. The questionnaire was not applied on members whose age is less than 20 years. This suggests a relatively high level of awareness of those surveyed.

Table (7.4): Percentage of Age Groups in the Study Population

* Age groups	Percentage %
20- 24	5
25- 29	16
30- 34	15
35- 39	16
40- 44	8
45- 49	5
50- 54	5
55-59	5
60 or more	25

*** Refers to the age of the housewife**

2: Educational level of housewife

With respect to the educational level of the housewife, the proportion of those who obtain university degree formed the highest rate at 57%. The percentage of those who finished secondary and elementary school degree reached 36%, and 7% respectively.

The proportion of female labour decreased in the study population, estimated at 20% and distributed between government jobs and private

sector. The vast majority of them, estimated at about 80%, were housewives.

3: Average number of family members

The total amount of individuals in the study population was 290 individuals. Table (7.5) lists the average number of individuals in the family surveyed including the parents. The percentage of families in which the number of members ranges between (1-2), (3-5), (6-8), and more than 8 is 25%, 50%, 20% and 5% respectively.

Table (7.5): Average Number of Family Members

Average number of members	1- 2	3- 5	6- 8	More than 8
Percentage %	25	50	20	5

With regard to the number of males, the percentage of families in which the number of males ranges between (3-5) is about 47.5%, while the percentage of families in which the number of males ranges between (1-2) is about 46%. The largest percentage refers to those families in which the number of females ranges between (1-2), and is 77% (Table (7.6)).

Table (7.6): Average Number of Family Members

Average number of members	1- 2	3- 5	6- 8
Male %	46	47.5	6.5
Female %	77	23	0

4: Type of dwelling

The Social status of the population in the study area was relatively high in line with this study. This can be concluded from the nature of the area dealt with. All the residents of the region own their houses. The percentage of those is 96% of the total surveyed.

The questions about environmental pollution issues intended to find out how much awareness the housewife has with regard to environmental issues. They are summarized in Table (7.7). The table provides analysis of the part of the questionnaire which discussed the subject of waste separation and reuse. The table includes the results of part four which concerns to the issues of environmental awareness programs.

Table (7.7): Issues related to environmental pollution, reuse and separation of SW and environmental awareness programs

No.	Subject of the question	Yes	No	Notes
Second: Environmental Pollution				
1-	Level of knowledge about SW recycling.	90%	10%	
2-	Level of knowledge about environment pollution	98%	2%	
3-	Level of knowledge about the relationship between SW and environmental pollution.	88%	12%	
4-	Reasons of environmental problems.			All the reasons mentioned in the questionnaire (members of the community, industry, occupation, agriculture, not dealing properly with SW) play an integral role in the existence of the environmental problem. They focus on the main reason which is the responsibility of people and communities.
5-	Major role in preserving the environment			17% of the sample size thinks that the role is the responsibility of members of the community; 18% the responsibility of the municipalities; 66% think that it is both the responsibility of the members of the community and the state equally.
Third: Reuse and separation of SW				
6-	Reuse of materials before throwing them away in the trash pin.	48%	52%	This attitude focuses on re-using the shopping bags, and then reusing the plastic and glass containers.

7-	Sorting some of the components of SW instead of collecting them together.	22%	78%	The separation process focuses primarily on the leftovers of food, so that they are collected and fed to birds and pets that are bred in the home garden. Often the mother in the family does this, while the rest of the family members do not pay attention to it.
8-	Contribute in future to the project of SW separation at source.	90%	10%	
9-	With regard to those who accepted the project of separation. The possibility of transferring the separated waste to containers far away from the house.	56%	34%	
10-	With regard to those who disagree with the project. The possibility of participating if the containers placed in front of the house	20%	80%	
11-	With regard to those who disagree with the project: The reason behind their refusal?			The main reason for not participating in the project is due primarily to the lack of an appropriate place in the kitchen to put more waste basket. In addition to the lack of interest in this subject by the housewife.
12-	The need for a moral (not money) reward to motivate people to participate in the project of SW separation.	37%	63%	
13-	Prediction of the possibility of the success	58%	42%	

	of the project by the population.			
14-	To the participants in the project: The main motivation for participation.			Concern about the environment and religious morals are the main motivation for participation.
Fourth: Environmental awareness programs				
15-	The existence of media programs oriented toward guiding the community on environmental issues.	3%	97%	
16-	The success of awareness programs, if any, to the success of the projects of: re-use, separation, and recycling of SW.	85%	15%	
17-	Aspects that are required to be covered by the awareness programs.			The vast majority of the sample size emphasized that the environmental awareness programs must focus on: The importance of preserving the environment, reminding people of the role of religion in preserving the environment, reminding participant of the material and moral reward.
18-	Appropriate methods that can contribute to increasing the environmental awareness.			Primarily: media, women's councils, special awareness lessons for school students.

Discussing the results of the questionnaire

1. With regard to the age of the housewife, the study did not include ages under twenty years old; this indicates the high level of awareness of those in the study. That was observed from the analysis of the questions related to environmental pollution issues. The vast majority has prior knowledge on the subject of recycling of SW and environmental pollution. In addition, there are a percentage of respondents who separate the SW components.
2. Regarding the nature of housing, more than 96% of the total families in the survey own the houses they live in. This indicates that the study population enjoys good financial statuses.
3. With regard to the educational level, there is diversity in the educational level of the housewives. The majority of them have a university degree while the other has either secondary or elementary school degree.
4. All the previous findings suggestive to high-level social status for the study population. This is a clear indication why they accept the idea of categorizing solid waste.
5. There is an initial indicator of people's willingness to contribute to the project of SW separation.
6. There is general enthusiasm and acceptance for the idea of the project which has been observed through discussions and positive reactions with the population.

7. People agreed that there are no media programs or campaigns geared towards guiding the community to the environmental issues. This is considered a negative indicator as public institutions neglect the importance of media programs that influence the community.

7.4.2 Pilot Results

SW separation in Jenin city was verified by applying the pilot separation at source. The study was applied for two months, 20 data forms were recorded. The pilot was to achieve the following objectives:

1. Evaluation of SW separation at source and determine the degree of commitment to separation.
2. Identify the household generation rate of SW (kg/ household / day).
3. Identify the proportion of wet organic waste generated.

Table (7.8) is the forms of the 2 months of (April and May) of 2015. It presents the results related to the objectives.

Table (7.8): Data and Forms of the Pilot Study

Day1 (Sa, 11-4-2015)								
Point No.	**Wet Organic Waste Container**				**Dry Waste Container**			
	Total weight	**Organic Weight**	**Dry weight**	**Container efficiency**	**Total weight**	**Dry weight**	**Organic Weight**	**Container efficiency**
1	71.9	57.1	14.4	80%	50	41	9	82%
2	61	50.3	10.7	83%	41.5	35	6.5	84%
3	68	60.5	7.5	89%	36.7	33.1	3.6	90%
4	58	45.4	12.6	78.3%	40	32.2	7.8	80.5%
Total	258.6	213.3	45.2	82.6%	168.2	141.3	26.9	84.1%
Note	1. Total waste weighted = 426.8 kg 2. Household generation rate = 3.5 kg/ day 3. Total organic weight = 240.2 kg = 56.3% 4. Total dry wright = 186.5 kg = 43.6% 5. Degree of commitment towards SW separation = 83.3%							
Day 2 (Tu, 14-4-2015)								
Point No.	**Wet Organic Waste Container**				**Dry Waste Container**			
	Total weight	**Organic Weight**	**Dry weight**	**Container efficiency**	**Total weight**	**Dry weight**	**Organic Weight**	**Container efficiency**

1	72	58	14	80.5%	42	36	6	85.7%
2	70.3	57.3	13	81.5%	39	33.5	5.5	85.8%
3	69.9	59.4	10.5	85%	32.5	28.5	4	87.7%
4	56	46	10	82.1%	37	30	7	81.1%
Total	268.2	220.7	47.5	82.3%	150.5	128	22.5	85.1%
Note	1. Total waste weighted = 418.7 kg 2. Household generation rate = 2.33 kg/ day 3. Total organic weight = 243.2 kg = 58.1% 4. Total dry wright = 175.5 kg = 41.9% 5. Degree of commitment towards SW separation = 83.7%							

Day 3 (Th, 16-4-2015)

Point No.	Wet Organic Waste Container				Dry Waste Container			
	Total weight	**Organic Weight**	**Dry weight**	**Container efficiency**	**Total weight**	**Dry weight**	**Organic Weight**	**Container efficiency**
1	62	50	12	80.6%	41.4	34.2	7.2	82.6%
2	58.5	48.7	9.8	83.2%	40	32	8	80%
3	50.5	43	7.5	85.1%	39.5	33.5	6	84.8%
4	43	33.6	9.4	78.1%	29.5	22.5	7	77.6%
Total	214	175.3	38.7	81.75%	150.4	122.2	28.2	81.25%
Note	1. Total waste weighted in that day = 364.4 kg 2. Household generation rate = 3.04 kg/ day 3. Total organic weight= 203.5 kg= 55.8% 4. Total dry wright = 160.9 kg= 44.2% 5. Degree of commitment towards SW separation = 81.5%							

Day 4 (Sa, 18-4-2015)

Point No.	Wet Organic Waste Container				Dry Waste Container			
	Total weight	**Organic Weight**	**Dry weight**	**Container efficiency**	**Total weight**	**Dry weight**	**Organic Weight**	**Container efficiency**
1	73	58.5	14.5	80.1%	41	33.8	7.2	82.4%
2	69.5	53.7	15.8	77.2%	38	30.3	7.7	79.7%
3	70	61	7	87.1%	37	33.6	3.4	90.8%
4	68	55	13	80.9%	35.4	29.4	6	83%
Total	278.5	228.2	50.3	81.3%	151.4	127.1	24.3	83.9%
Note	1. Total waste weighted in that day = 429.9 kg 2. Household generation rate = 3.6 kg/ day 3. Total organic weight= 252.5 kg = 58.7% 4. Total dry wright = 177.4 kg = 41.3% 5. Degree of commitment towards SW separation = 82.6%							

Day 5 (Tu, 21-4-2015)

Point No.	Wet Organic Waste Container				Dry Waste Container			
	Total weight	**Organic Weight**	**Dry weight**	**Container efficiency**	**Total weight**	**Dry weight**	**Organic Weight**	**Container efficiency**
1	83.3	72	11.3	86.4%	51	40.7	10.3	79.8%
2	82.5	68.8	13.7	83.4%	59	49.5	9.5	83.9%
3	80.4	71.7	8.7	89.1%	51.7	44	7.7	85.1%
4	78.8	64.7	14.1	82.1%	55.8	43.5	12.3	77.9%
Total	325	277.2	47.8	85.3%	217.5	177.7	39.8	81.7%
Note	1. Total waste weighted in that day = 542.5 kg 2. Household generation rate = 3.01 kg/ day 3. Total organic weight = 317 kg = 58.4%							

	4. Total dry wright = 225.5 kg = 41.6% 5. Degree of commitment towards SW separation = 83.5%

Day 6 (Th, 23-4-2015)

Point No.	Wet Organic Waste Container				Dry Waste Container			
	Total weight (kg)	Organic Weight (kg)	Dry weight (kg)	Container efficiency	Total weight (kg)	Dry weight (kg)	Organic Weight (kg)	Container efficiency
1	72	59	13	82%	45	36	9	80%
2	66.5	54.5	12	81.9%	43.2	36.2	7.5	83.7%
3	65.9	57.4	8.5	87%	43	37	6	86%
4	61.9	49.8	11.8	80.8%	42.8	35	7.5	81.8%
Total	266	220.7	45.3	82.9%	174	143.7	30.3	82.8%

Note

1. Total waste weighted in that day = 440 kg
2. Household generation rate = 3.6 kg/ day
3. Total organic weight = 250.7 kg = 57%
4. Total dry wright = 186.3 kg = 43%
5. Degree of commitment towards SW separation = 82.8%

Day 7 (Sa, 25-4-2015)

Point No.	Wet Organic Waste Container				Dry Waste Container			
	Total weight	Organic Weight	Dry weight	Container efficiency	Total weight	Dry weight	Organic Weight	Container efficiency
1	69	54.8	14.2	79.4%	39.5	32.3	7.2	81.7%
2	65	53	12	81.5%	37	29.1	7.9	78.6%
3	58	51	7	87.9%	35.5	31.5	4	88.7%
4	49.5	40	9.5	80.8%	30	24.7	5.3	82.3%
Total	241.5	198.8	42.7	82.4%	142	117.6	24.4	82.8%

Note

1. Total waste weighted in that day = 383.5 kg
2. Household generation rate = 3.2 kg/ day
3. Total organic weigh t= 223.2 kg = 58.2%
4. Total dry wright = 160.3 kg = 41.8%
5. Degree of commitment towards SW separation = 82.6%

Day 8 (Tu, 28-4-2015)

Point No.	Wet Organic Waste Container				Dry Waste Container			
	Total weight	Organic Weight	Dry weight	Container efficiency	Total weight	Dry weight	Organic Weight	Container efficiency
1	70	56.5	13.5	80.7%	49.5	40	9.5	80.8%
2	51.2	41.6	9.6	81.3%	41	33.8	7.2	82.4%
3	50.2	44.8	5.4	89.2%	32.8	29.8	3	90.8%
4	69	54.1	14.9	78.4%	38.5	30	8.5	77.9%
Total	240.4	197	43.4	82.4%	161.8	133.6	28.2	82.9%

Note

1. Total waste weighted in that day = 402.2 kg
2. Household generation rate = 2.23 kg/ day
3. Total organic weight = 225.2 kg = 56%
4. Total dry wright = 177 kg= 44%
5. Degree of commitment towards SW separation = 82.6%

Day 9 (Th, 30-4-2015)

Point No.	Wet Organic Waste Container				Dry Waste Container			
	Total weight	Organic Weight	Dry weight	Container efficiency	Total weight	Dry weight	Organic Weight	Container efficiency

1	65.5	54	11.5	82.4%	43.2	35.2	8	81.4%
2	59	49	10	83%	39.5	33.5	6	84.8%
3	55.5	49.5	6	89.2%	30	26	4	86%
4	49	39	10	79.5%	27	22	5	81.5%
Total	229	191.5	37.5	83.5%	139.7	116.7	23	83.4%
Note	1. Total waste weighted in that day = 368.7 kg 2. Household generation rate = 3.07 kg/ day 3. Total organic weight= 214.5 kg= 58.2% 4. Total dry wright = 154.2 kg = 41.8% 5. Degree of commitment towards SW separation = 83.4%							

Day 10 (Sa, 2-5-2015)

Point No.	Wet Organic Waste Container				Dry Waste Container			
	Total weight	**Organic Weight**	**Dry weight**	**Container efficiency**	**Total weight**	**Dry weight**	**Organic Weight**	**Container efficiency**
1	73	60	13	82.2%	50	40.5	9.5	81%
2	69	55.5	13.5	80.4%	46.5	38.9	7.6	83.6%
3	62.5	56.5	6	90.4%	49.7	44.7	5	91.2%
4	59	46.7	12.3	79.1%	34.5	27	7.5	78.2%
Total	263.5	218.7	44.8	83%	180.7	151.1	29.6	83.5%
Note	1. Total waste weighted in that day = 444.2 kg 2. Household generation rate = 3.7 kg/ day 3. Total organic weigh t= 248.3 kg= 55.9 % 4. Total dry wright = 195.9 kg = 44.1% 5. Degree of commitment towards SW separation = 83%							

Day 11(Tu, 5-5-2011)

Point No.	Wet Organic Waste Container				Dry Waste Container			
	Total weight	**Organic Weight**	**Dry weight**	**Container efficiency**	**Total weight**	**Dry weight**	**Organic Weight**	**Container efficiency**
1	83	69	14	83.1%	59	46	13	78%
2	80	67	13	83.7%	56.7	44.7	12	78.8%
3	76	70.5	5.5	92.7%	59.3	49	10.3	82.6%
4	68	54	14	79.4%	59.8	45.5	14.3	76.1%
Total	307	260.5	46.5	84.7%	234.8	185.2	49.6	78.9%
Note	1. Total waste weighted in that day = 541.8 kg 2. Household generation rate = 3.01 kg/ day 3. Total organic weight = 310.1 kg = 57.2% 4. Total dry wright = 231.7 kg = 42.8% 5. Degree of commitment towards SW separation = 81.8%							

Day 12 (Th, 7-5-2015)

Point No.	Wet Organic Waste Container				Dry Waste Container			
	Total weight	**Organic Weight**	**Dry weight**	**Container efficiency**	**Total weight**	**Dry weight**	**Organic Weight**	**Container efficiency**
1	67	57	10	85%	43.2	36.2	7	83.8%
2	57	47.2	9.8	82.8%	37.5	30	7.5	80 %
3	64.3	58.3	6	90.7%	48.8	44.8	4	91.8%
4	45	35.5	8	78.8%	29	22.5	6.5	77.6%
Total	233.3	199.5	33.8	84.3%	158.5	133.5	25	83.3%
Note	1. Total waste weighted in that day = 391.8 kg 2. Household generation rate = 3.26 kg/ day 3. Total organic weight = 224.5 kg = 57.3%							

	4. Total dry wright = 167.3 kg = 42.7% 5. Degree of commitment towards SW separation = 83.8%

Day 13 (Sa, 9-5-2015)

Point No.	Wet Organic Waste Container				Dry Waste Container			
	Total weight	Organic Weight	Dry weight	Container efficiency	Total weight	Dry weight	Organic Weight	Container efficiency
1	69	55.5	13.5	80.4%	49.3	39	10.3	79.1%
2	57.5	47.3	10.2	82.2%	37.7	30.7	7	81.4%
3	72.3	65.3	7	90.3%	48.7	44.8	3.9	92%
4	59.7	50.7	9	84.9%	38	31.3	6.7	82.3%
Total	258.5	218.8	39.7	84.4%	173.7	145.8	27.9	83.7%

Note

1. Total waste weighted in that day = 432.2 kg
2. Household generation rate = 3.6 kg/ day
3. Total organic weight = 246.7 kg= 57%
4. Total dry wright = 185.5 kg = 43%
5. Degree of commitment towards SW separation = 84%

Day 14 (Tu, 12-5-2015)

Point No.	Wet Organic Waste Container				Dry Waste Container			
	Total weight	Organic Weight	Dry weight	Container efficiency	Total weight	Dry weight	Organic Weight	Container efficiency
1	60	50	10	83.3%	40	32	8	80%
2	56.9	45.9	11	80.6%	38.5	31	7.5	80.5%
3	55.5	45.7	9.8	82.3%	37.9	30.4	7.5	80.2%
4	49.5	40.5	9	81.8%	34.6	27.6	7	79.8%
Total	221.9	182.1	39.8	82%	151	121	30	80.1%

Note

1. Total waste weighted in that day = 372.9 kg
2. Household generation rate = 2.07 kg/day
3. Total organic weight = 212.1 kg = 56.9%
4. Total dry wright = 160.8 kg = 43.1%
5. Degree of commitment towards SW separation = 81%

Day 15 (Th, 14-5-2015)

Point No.	Wet Organic Waste Container				Dry Waste Container			
	Total weight	Organic Weight	Dry weight	Container efficiency	Total weight	Dry weight	Organic Weight	Container efficiency
1	69	57.7	11.3	83.6%	41	34.7	6.3	84.6%
2	60.5	48.5	12	80.2%	39.8	32.8	7	82.4%
3	59.3	48.3	11	81.5%	40.5	35.5	7	82.7%
4	55.2	43.7	11.5	79.1%	37.7	29.2	8.5	77.4%
Total	244	198.2	45.8	81.6%	159	133	26	82%

Note

1. Total waste weighted in that day = 403 kg
2. Household generation rate = 3.35 kg/ day
3. Total organic weight= 224.2 kg= 55.6%
4. Total dry wright = 178.8 kg = 44.4%
5. Degree of commitment towards SW separation = 81.8%

Day 16 (Sa, 16-5-2015)

Point No.	Wet Organic Waste Container				Dry Waste Container			
	Total weight	Organic Weight	Dry weight	Container efficiency	Total weight	Dry weight	Organic Weight	Container efficiency
1	62	51	11	82.2%	43.5	34.5	9	79.3%

2	58.8	48.9	9.9	83.1%	40.9	32.9	8	80.4%
3	53.7	46.7	7	86.9%	42.8	34.9	7.9	81.5%
4	60.5	49	11.5	81%	41.6	32.7	8.9	78.6%
Total	235	195.6	39.4	83.3%	168.8	135	33.8	80%
Note	1. Total waste weighted in that day = 403.8 kg 2. Household generation rate = 3.36 kg/ day 3. Total organic weigh t= 229.4 kg = 56.8% 4. Total dry wright = 174.4 kg = 43.2% 5. Degree of commitment towards SW separation = 81.6%							

Day 17 (Tu, 19-5-2015)

Point No.	Wet Organic Waste Container				Dry Waste Container			
	Total weight	**Organic Weight**	**Dry weight**	**Container efficiency**	**Total weight**	**Dry weight**	**Organic Weight**	**Container efficiency**
1	70.5	59.5	11	84.4%	45	37	8	82.2%
2	62.5	52	10.5	83.2%	42.9	35.1	7.8	81.8%
3	66	60	6	91%	49	43	6	87.7%
4	51.5	42.3	9.2	82%	39.5	32	7.5	81%
Total	250.5	213.8	36.7	85.1%	176.4	147.1	29.3	83.2%
Note	1. Total waste weighted in that day = 426.9 kg 2. Household generation rate = 2.37 kg/ day 3. Total organic weight = 243.1 kg= 56.9% 4. Total dry wright = 184.1 kg= 43.1% 5. Degree of commitment towards SW separation = 84.1%							

Day 18 (Th, 21-5-2015)

Point No.	Wet Organic Waste Container				Dry Waste Container			
	Total weight	**Organic Weight**	**Dry weight**	**Container efficiency**	**Total weight**	**Dry weight**	**Organic Weight**	**Container efficiency**
1	68	58	10	85.3%	43	37	6	86%
2	62	52.5	9.5	84.7%	40	33	7	82.5%
3	50	44	6	88%	39.5	33.5	6	84.8%
4	40.7	32.4	8.3	79.6%	30	23.5	6.5	78.3%
Total	220.7	188.9	31.8	84.4%	152.5	127	25.5	82.9%
Note	1. Total waste weighted in that day = 373.2 kg 2. Household generation rate = 3.1 kg/ day 3. Total organic weight = 214.4 kg= 57.4% 4. Total dry wright = 158.8 kg = 42.6% 5. Degree of commitment towards SW separation = 83.6%							

Day 19 (Sa, 23-5-2015)

Point No.	Wet Organic Waste Container				Dry Waste Container			
	Total weight	**Organic Weight**	**Dry weight**	**Container efficiency**	**Total weight**	**Dry weight**	**Organic Weight**	**Container efficiency**
1	**69**	**55**	**14**	**79.7%**	**40**	**33**	**7**	**82.5%**
2	**57**	**47.5**	**9.5**	**83.3%**	**38**	**32.1**	**5.9**	**84.5%**
3	**52**	**45**	**7**	**86.5%**	**30.8**	**27.3**	**3.5**	**88.6%**
4	**49**	**39**	**10**	**79.5%**	**28**	**22.5**	**5.5**	**80.3%**
Total	**227**	**186.5**	**40.5**	**82.2%**	**136.8**	**114.9**	**21.9**	**83.9%**
Note	1. Total waste weighted in that day = 363.8 kg 2. Household generation rate = 3.03 kg/ day 3. Total organic weight = 208.4 kg = 57.3%							

	4. Total dry wright = 155.4 kg = 42.7% 5. Degree of commitment towards SW separation = 83%							
Day 20 (Tu, 26-5-2015)								
Point No.	**Wet Organic Waste Container**				**Dry Waste Container**			
	Total weight	**Organic Weight**	**Dry weight**	**Container efficiency**	**Total weight**	**Dry weight**	**Organic Weight**	**Container efficiency**
1	**73**	**58**	**15**	**79.4%**	**43**	**33.5**	**9.5**	**77.9%**
2	**62**	**51**	**11**	**82.3%**	**40.9**	**34.4**	**6.5**	**84.1%**
3	**59.5**	**50.5**	**9**	**84.9%**	**39.5**	**35.5**	**4**	**89.9%**
4	**50.3**	**40.3**	**10**	**80.1%**	**30.7**	**24.7**	**6**	**80.5%**
Total	**244.8**	**199.8**	**45**	**81.6%**	**154.1**	**128.1**	**26**	**83.1%**
Note	1. Total waste weighted in that day = 398.9 kg 2. Household generation rate = 2.22 kg/ day 3. Total organic weight = 225.8 kg = 56.6% 4. Total dry wright = 173.1 kg = 43.4% 5. Degree of commitment towards SW separation = 82.3%							

First: People commitment to separation at source

The success of separation at source is the cooperation and participation of the resident, which was achieved by many ways, such as:

1. Coordination with municipality and Joint Services Council
2. Implementing educational and awareness plan
3. Providing material incentives for residents. This was represented by providing good quality baskets to separate waste, in addition to plastic bags.

The study achieved high level of participation. The degree of commitment for SW separation in Jenin city was 82.8%. This high percentage refers to the possibility of success the project when applied on a large scale such as Jenin governorate or even the entire West Bank. In this case, there is a need for efforts to raise the level of awareness of the people and select a sample have the required level of awareness.

Second: Proportion of wet organic waste

The organic waste was the most important and the largest SW component. The wet organic waste forms 57.1% of the total SW. This percentage is higher than the results of JSC for the SW components in ZF, which stated that organic waste is 53.7%.

The variation in these results is due to:

1. In the study of JSC, waste components were estimated from different sources such as residential, commercial, industrial, and agricultural. The variation in the life style between the urban and rural areas affects the proportion of SW components. The proportion of organic waste in ZF was estimated through random samples that are received at the landfill. These samples coming from different communities. This pilot study was applied only on a residential area totally.
2. The study was applied in the beginning of the summer where the proportion of organic waste in household waste is high.

Third: Daily household generation rate of SW

The household generation rate in the study area was estimated at 3.03 Kg/ household/day, which ranges from 2.07 kg/ household/ day to 3.7 kg/household/day.

Fourth: Recycling of SW in Jenin area

SW recycling experience in the Jenin area will be successful in terms of recycling wet organic waste. For the following reasons:

1. The high proportion of wet organic waste, up to about 57%

2. The commitment of people to separate the wet organic materials.
3. Recycling of organic waste to produce compost, can then be used as a natural fertilizer which is a great benefit to health and environment and relieve a significant burden on ZF landfill.

In this case, when using organic waste for compost manufacturing it should be taken into account that not all amount of organic waste is ready for composting:

- Part of wet organic waste which was calculated in this study (57.1%) will evaporate, so it is necessary to measure the moisture content in this waste.
- Some residue of cooking (bones, residue meat) is not valid to use in compost manufacturing, where it is difficult to be decomposed and it forms suitable environment to attract mice and rodents. For that there is a need to be addressed in advance.

7.5 Case Study

(SW Separation at Source: A Case Study of Suzhou, China)

China, the world's second largest generator of MSW, has not experienced successful SW separation at source in any cities (Tai, 2011). Though the Ministry of Construction launched a pilot program in eight major cities (i.e., Beijing, Shanghai, Shenzhen, Guangzhou, Guilin, Hangzhou, Nanjing and Xiamen) in 2000 to explore SW separation at source, all of the pilot cities have experienced very slow progress toward improving their SW

source separation systems. However, the Chinese government has not given up attempts on SW source separation (Deng, 2013).

The Suzhou government has implemented a series of measures for promoting people to do SW source separation, focusing on carrying out pilot programs in residential communities. In 2012 and 2013, the government carried out SW source separation pilot programs (Zhang and Wen, 2014).

Five community groups that already existed in Suzhou were determined as following (Zhang and Wen, 2014):

- Community Group 1: Communities that have not carried out SW separation at source by the government in 2013.
- Community Group 2: Communities that have carried out SW separation at source pilot programs in 2013, but the programs have not been evaluated.
- Community Group 3: Communities that were acknowledged as a "source separation pilot community" at the end of 2012 by the government and that have implemented SW source separation better than Group 1 and Group 2.
- Community Group 4: Communities that have been chosen by the government as a food waste source separation pilot community and

that have implemented SW source separation better than Group 1, Group 2 and Group 3.

- Community Group 5: Communities that were lauded as an “SW source separation demonstration community” at the end of 2012 by the government and that have implemented SW source separation better than all of the other four groups.

In all the communities with pilot programs (i.e., Group 2 to Group 5), the government has done the same with “install SW source separation kiosks” and “layout SW separate collect trash bins”, but has done differently with “carry out SW source separation campaigns”, “give separation bins to residents for free” and “give separation bags to residents for free”. The government has not done any SW source separation activities for the \\\\\

SWM in the communities with pilot programs is the same: the waste collection frequency is 1–2 times per week for recyclable, 1–2 times per month for hazardous waste and 2–3 times every day for food waste and other waste. The collection frequency for the mixed SW in community \\\\\\

Three kinds of waste should be separated out from the SW: recyclable, food waste and hazardous waste. Residents are required to separate the three kinds of waste with different procedures. For recyclables, residents first store them at home and then sell them to waste buyers or throw them into the community separated garbage bins. For food waste, residents

separate this out at home and throw it into the community separated bins. For hazardous waste, residents first store this at home and then throw it into the community separated garbage bins (Zhang and Wen, 2014).

Results and Discussion:

1. People have a very positive attitude about the SW source separation; the ratio of who want to do SW source separation is nearly 90%.
2. The separated ratio of recyclable is the highest because of the economic benefits, but still only 65%. The ratio for food waste and hazardous waste is less than 50%.
3. Nearly 50% of all of the residents in community Group 3 to Group 5 separated out three kinds of waste, while the ratio in Group 1 is as low as 13%.
4. Concurrent with the implementation of SW source separation programs, the residents' SW source separation behavior improved. Residents in community Group 5 have done the best at separating SW, and residents in Group 4 have done the best at separating food waste. Community Group 1 has the highest proportion of people who mixed all of the SW (29%). This implies this SW source separation pilot program in Suzhou is useful in improving residents' source separation behavior and can be spread to more communities.
5. Installing SW source separation kiosks and garbage bins in the community has a strong positive impact on residents' SW source separation behavior. Distributing SW separation bins freely to

residents is useful for improving residents' separation behavior at the very beginning.

Reasons for SW Source Separation or Not

The main reasons that residents separate SW at home are almost the same among different community groups and different age groups. According to importance, the four main reasons are:

1. To decrease the pollution of the environment (68%),
2. To earn money by selling recyclables (60%),
3. To avoid dirty SW from polluting clean SW (45%),
4. It is a good quality for residents (40%).

This implies that most of the respondents have a high awareness of the environmental problems caused by SW and willing to work to resolve these problems.

The reasons why residents do not source separate SW are significantly different among the five community groups. These reasons, according to importance, are as follows:

1. SW source separation is too troublesome (48%),
2. The waste that will be classified will be mixed later (40%),
3. Do not have a place to put the classification trash bins at home (38%).

Chapter Eight

Conclusion and Recommendations

8.1 Results and Conclusion

8.1.1 Current System of SWM in Jenin

The current MSW management in Jenin area is illustrated by the flow chart and is explained in detail in chapter 5.

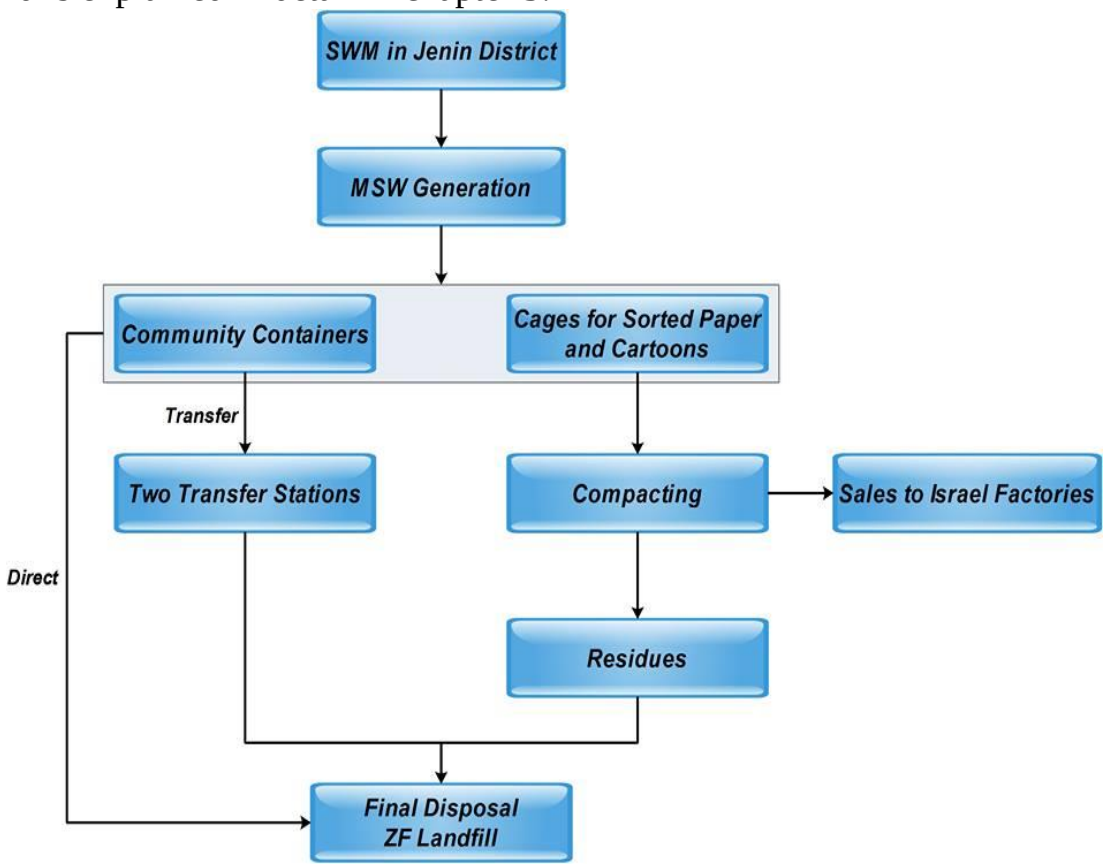


Figure (8.1): SWM in Jenin Area

8.1.2 Factors Affecting SWM in Jenin

Human factors affecting the size and management of SW in Jenin communities are summarized in Table (8.1). The table lists these factors and explains their effects on SWM, illustrating the results of this study.

Table (8.1): Human Factors affecting SWM in Jenin area

Factor	Effect	Results of study
Population		
1. Population size	The population growth is usually accompanied by many changes in the urban and economic activities, consumption and production. Ultimately, SW generation increases.	The amount of SW that annually arrived at ZF landfill goes up, depending on the increasing numbers of the population.
2. Income level	Quality and quantity of SW and the rate of consumption are affected by the level of income.	There is variation in the relationship between income level and the size of the daily waste. The average daily waste ranges from 3-5 kg.
Behavioral factors		
1. Person responsible for SW transferring	Children often get rid of the waste around the containers, thereby hindering the process of collection, transportation. This leads to accumulation and causes a lot of environmental problems.	• 35% of the families in Jenin city depend on the father to transfer the household SW from home, 25% rely on the mother, 25% rely on the children and 15% rely on the eldest son. • The vast majority of the families in the towns rely on the mother. • In Jenin refugee camp: 35%, 25%, 25% and 15% rely on mother, father, children and eldest son respectively.
2. SW separation	This is very important to reduce the size of the household SW. It is considered to be a preliminary	• In Jenin city, only 25% of the families separate some SW components. • In Jenin camp only 20% of the families separate SW.

	step to the stage of SW recycling.	• In the towns and villages, about 60% separate their waste. • All families do not separate solid medical waste from household SW.
3. Means used in waste transfer	Using nylon bags and plastic bags that are torn easily leads to disperse the waste on the ground and then. It is difficult to collect it, and animals like cats and rats will tear with it. The using of plastic baskets is safer.	People in Jenin area differ from one community to another in the means used to take out the household waste and transport it to the container. Most of them use plastic bags.
4. Time of SW discard from the house	When the discarding time complies with the collection period of SW, the process of collection will be more successful.	• In Jenin camp, people who discard the waste in the early morning are very high and reached 90%. • In Jenin city, people who discard their waste in the morning are 75%. • In the towns and villages there is a clear difference in the time of discarding the waste; 35% of them in the morning, 20% at noon, and 45% in the evening.
5. The way to get rid of household waste.	Putting Waste inside container facilitates the collection and transfer process. Disposal of waste by burning lead to many bad effects to humans and the environment	• In Jenin camp, most people dispose of their waste by placing it in front of the house. • In the town, the majority of the families dispose of the SW by transferring it to the container. • In Jenin city, about 45% of the families get rid of the household waste by putting it in front of the house, 50%

		by transferring it directly to the container and 5% by putting it at street entrance. There is no burning of SW.
6. How often the waste is discarded per week.	Waste collection process is affected by the number of times waste is discarded from the house during the week.	• In Jenin camp about 55% of the families bring out the waste each day, 20% every two days, and 25% every three days. • 50% of Jenin city's families bring out their waste every day, 40% every two days, and the rest each three days or more. • The vast majority of the families in the towns and villages bring out their waste every day.
Social Factors		
1. Lifestyles	Social factors result in more solid and liquid waste.	In the city and town, waste increases on Friday in particular. Whereas SW is more on Saturday in the camp.
2. Environmental Awareness	Environmental awareness helps in the reduction of waste production via promoting the idea of separation and reusing.	There is an absence of environmental educational programs in schools, universities and in the media channels.
Political Factors		
	Having a law on SW in the Palestinian. More important is the need for an executive authority which can follow up this matter and punish the offenders.	• The application of sound and integrated management of SW faces multiple challenges on the legislative, regulatory, technical, environmental and financial levels. • Lack of accurate statistical data in SW sector. • The Israeli practices.

8.1.3 Pilot SW Separation at Source

The following are the key results and conclusions for the pilot study:

1. Degree of commitment towards SW separation at source was about 82.8%
2. The success of the project required primarily raising the level of awareness of the population. The possibility of generalization the project of SW separation at source in the West Bank is possible, but needs considerable efforts.
3. Household generation rate in Jenin city is about 3.03 kg/ household day
4. The organic waste is about 57.1% and the dry weight about 42.9%.
5. The high proportion of organic waste, in addition to the commitment of people to separate organic materials encourages recycling of organic waste to manufacture compost. This will be of great benefit to health and environment and relieve a significant burden on ZF landfill.

8.2 Recommendations

There are several elements that are necessary and important for enhancing waste separation at source in the West Bank.

First: Environmental Awareness and Education

In the West Bank, the environmental education has been insufficiently provided. This case is completely the opposite in the countries where waste separation has been successfully conducted. The following

recommendations are for raising environmental awareness by education in the West Bank:

1. Offering Environmental Education at Schools

Schools are major choices for receiving formal education in the West Bank. The best way is to integrate the environmental awareness education into the curriculum. Teaching even from the elementary school level, the advantages of doing waste separation, environmental protection related matters. For the kids, they probably will not fully understand the profound meanings for those teachings, but they can gradually accept this habit and understand with their growth. For higher institutions like colleges or universities, students should be offered courses regarding the waste separation and be models for transferring these ideas into reality.

2. Public Awareness Campaigns

For the majority of people, a more effective means for raising their environmental awareness is though public campaigns. Through mass media like TV, radio, Ads, social activities, programs etc. to spread the idea of doing waste separations. More importantly, seeing other people doing it, there will be more and more people who would join the “main stream”.

Second: Legal Frameworks for Implementation of Waste Separation

Even though there are already existing regulations and laws concerning the environment in the West Bank, but when it comes to real life implementation or enforcement, there is still a great need for improvement, which can be:

1. Waste Classifications and Statistics

For MSW in the West Bank, there is lack of accurate statistical data that could constitute the inputs necessary for the planning and control of decision-making related to the SW sector. There should be a clear definitions and specific classifications according to the nature of the wastes. What shall be defined as recyclable waste, organic waste or electronic waste? What must be properly disposed like electronic waste, which contains toxic metals?

2. Punitive Measures for Failing Implementations

One important reason for the failing of protection the environment despite the existence of regulations and laws are the lack of punitive measures. For example, taxes should be imposed on the landfills or incinerations are not to the environmental standard. However, it might be difficult for regulation bodies to come up with such measures, since this falls more into ethical codes.

Third: Improving Waste Separation Infrastructures and Increase Technological Investment

In the West Bank, there is no technology and infrastructures for the application of waste separation system. On the opposite bad quality containers for collecting in public areas and private or resident sites are hindering this.

To apply separation of SW at source, high quality containers to collect the separated waste is needed. For on-site separations, more funds should be invested on the technological solutions. This is expensive especially for the

initial investment, but on a longer term, by applying high-tech solutions for waste separation and treatment it will become efficient and effective. There will be recovery both for materials and energy from waste; saving eventually outweighs the inputs.

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3. Mr. Mohammed Jaradat, Manager for Palestinian Agricultural Relief Council; 5 April 2015.
4. Mr. Khaled Abu Farha, Mayor of Jalama Municipality; 4 January 2015.
5. Mrs. Bassima Abu Tabikh, Director of Women's center in Jenin Refugee Camp; 7 March 2015.

Site Visits

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   29 January 2015, 3 March 2015, 9 April 2015, 6 May 2015 and 1June 2015.

2. Tubas transfer station, Tubas. Site visit:

   11 May 2015, a station for transfer the waste from Tubas governorate to Zahret A-Finjan Landfill.

3. Compost 2011 Plant, Jalama village. Site visit:

   4 January 2015, a plant for recycling the organic waste for compost.

4. Jenin Governmental Hospital. Site visit:

   8 March 2015, storage site for sorted medical waste.

5. Jalama Municipality, north of Jenin city:

   4 January 2015, discussion the project of waste separation in Jalama village.

6. Jenin Municipality: 5 January 2015.
7. Women's council in Jenin city: 1 March 2015.
8. Women's council in Al-Yamoun town: 7 March 2015.
9. Woman’s council in Jenin Refugee Camp: 10 March 2015.
10. Balawi factory, Industrial Zone in Jenin city. Site visit:

    25 June 2014, a site for Cardboard compression.

Appendix

ملحق (1)

بسم الله الرحمن الرحيم

جامعة النجاح الوطنية

كلية الدراسات العليا

أخي المواطن \ أختي المواطنة.....

تعتبر هذه الاستبانة أداة تجريها الطالبة "حنان هيجاوي" لنيل درجة الماجستير في جامعة النجاح الوطنية في تخصص العلوم البيئة تحت عنوان " تقييم فصل النفايات الصلبة واعادة تدويرها في منطقة جنين" باشراف الدكتور "حافظ شاهين" والدكتور "سامر العطعوط"

تعتبئة هذه الاستبانة بدقة تعتبر مساهمة في إنجاح هذه الدراسة بإذن الله للوصول إلى الفائدة المرجوة.

أشكرك سلفاً على تمضية بعض من وقتك في قراءة وتعبئة هذه الاستبانة التي تم توخي البساطة فيها لاختصار الوقت في قرائتها وتعبئتها.

نوع التجمع السكني

❑ مخيم ❑ مدينة ❑ بلدة\ قرية

1. **عدد الأفراد المقيمين في البيت**

❑2 ❑5-3 ❑ 8-6 ❑ 9

2. **المؤهل العلمي لربَ الأسرة**

❑ أميً ❑ أساسي ❑ ثانوي ❑ بكالوريوس

3. **المؤهل العلمي لربة الأسرة**

❑ أميً ❑ أساسي ❑ ثانوي ❑ بكالوريوس

4. نوع المسكن

❑ ملك ❑ إيجار

5. طبيعة المسكن

❑ شقة في بناية ❑ بيت عادي منفصل

6. مقدار الدخل الشهري للأسرة

❑ حتى 2000 ❑ حتى 3000 ❑ أكثر من 3000 شيقل

7. طبيعة العمل لرب الأسرة

❑ موظف حكومي ❑ موظف خاص ❑ مزارع ❑ أعمال تجارية حرة ❑لا يعمل ❑غير ذلك

8. وزن النفايات المقدره الناتجة عن الأسرة يومياً(كغم)

❑2 كغم ❑ 3 كغم ❑4 كغم ❑5 كغم ❑ اكثر من 5 كغم

9. أكثر يوم في الأسبوع تكثر فيه النفايات

❑السبت ❑الاحد ❑الاثنين ❑الثلاثاء ❑الاربعاء ❑الخميس ❑الجمعة

ما أهم مكوانات النفايات في هذا اليوم

❑ بقايا الطعام ❑ ورقية ❑ بلاستيكية ❑ مواد زجاجية ❑ حديد وخردة

10. ما هو بعد أقرب حاوية نفايات عن منزلك

❑ 20م ❑ 50 ❑ 70 ❑100 فأكثر

11. الشخص المسؤول عن نقل النفايات المنزلية

❑ الأب ❑ الأم ❑ الابن الأكبر ❑ الابن الأصغر

12. وقت إخراج النفايات من المنزل؟

❑ الصباح ❑ الظهر ❑ العصر

13. الوسيلة المستخدمة لنقل النفايات الصلبة المنزلية؟

❑ سلة بلاستيكية(توضع أمام المنزل) ❑ كيس بلاستيك ❑ كيس نايلون شفاف

14. ما هي الطريقة التي تتخلص بها من النفايات المنزلية؟

❑ التجميع أمام المنزل ❑ التجميع مدخل الشارع ❑ الحرق ❑ نقلها الى الحاوية

15. حالة الحاوية كما تجدها؟

❑ مملوءة ❑ فارغة ❑ مملوءة نوعاً ما

16. سبب تراكم النفايات حول الحاوية؟

❑ صغر الحاوية ❑ تأخر تفريغها من قبل البلدية ❑ سلوك السكان

17. عدد مرات التخلص من النفايات المنزلية؟

❑ كل يوم ❑ كل يومين ❑ كل ثلاثة ايام ❑ كل أسوع

18. هل تقوم بإعادة استخدام بعض المواد قبل رميها؟

❑ نعم ❑ لا

19. هل تقوم بفرز بعض المواد قبل رميها؟

❑ نعم ❑ لا

20. هل تقوم بفرز النفايات الطبية عن النفايات العادية؟

❑ نعم ❑ لا

21. هل أنت راض عن الخدمات التي تقدمها البلدية في جمع النفايات من أمام بيتك؟

❑ راضي ❑ غير راضي

22. ما هي مشاكل جمع النفايات في منطقتك؟

❑ تراكم النفايات بسبب عدم كفاءة الحاويات ❑ عدم الانتظام في تفريغ الحاويات ❑ الروائح الكريهة
❑ الحشرات والقوارض

23. هل تعانون من انتشار الذباب والبعوض في فصل الصيف بسبب النفايات؟

❑ نعم ❑ لا

ملحق (2)

بسم الله الرحمن الرحيم

جامعة النجاح الوطنية **كلية الدراسات العليا**

أخي المواطن \ أختي المواطنة في ضاحية صباح الخير.....

تعتبر هذه الاستبانة أداة تجريها الطالبة "حنان هيجاوي" لنيل درجة الماجستير في جامعة النجاح الوطنية في تخصص العلوم البيئة تحت عنوان " تقييم فصل النفايات الصلبة واعادة تدويرها في منطقة جنين" باشراف الدكتور "حافظ شاهين" والدكتور "سامر العطعوط"

يرجى من حضرتكم توخي الصدق والدقة في الاجابة على بنود الاستبانة علما بأن هذه الدراسة سوف تقتصر نتائجها على أغراض البحث العلمي فقط

رقم الاستمارة ( )

أولاً: معلومات شخصية

1. عمر ربَة الأسرة:

❑ 24-20 ❑ 29-25 ❑ 34-30 ❑ 39-35 ❑ 44-40

❑ 49-45 ❑ 54-50 ❑ 59-55 ❑ 60 فاكثر

2. عمر ربَ الأسرة:

❑ 24-20 ❑ 29-25 ❑ 34-30 ❑ 39-35 ❑ 44-40

❑ 49-45 ❑ 54-50 ❑ 59-55 ❑ 60 فاكثر

3. **نوع المسكن:**
❑ إيجار ❑ ملك

4. **متوسط عدد افراد الاسرة (يشمل الوالدين):**
❑ 2-0 ❑ 5-3 ❑ 8-6 ❑ 8 فأكثر

- **متوسط عدد الأبناء الذكور في الاسرة:**

❑ 2-0 ❑ 5-3 ❑ 8-6 ❑ 8 فأكثر

- **متوسط عدد الابناء الاناث في الاسرة:**

❑ 2-0 ❑ 5-3 ❑ 8-6 ❑ 8 فأكثر

5. **المستوى التعليمي لربة الأسرة:**
❑ أساسي ❑ ثانوي ❑ بكالوريوس ❑ درسات عليا

6. **مهنة الام:**
❑ ربة منزل ❑ عاملة

7. **المستوى اتعليمي لرّب الأسرة:**
❑ أساسي ❑ ثانوي ❑ بكالوريوس ❑ دراسات عليا

ثانياً: تلوث البيئة

1. **هل تعرف أو سمعت عن تدوير النفايات سابقاً؟**
❑ نعم ❑ لا

2. **هل تعلم بوجود تلوث للبيئة ؟**
❑ نعم ❑ لا

3. **هل تعلم أن هناك علاقة مباشرة بين النفايات الصلبة وبين تلوث البيئة ؟**
❑ نعم ❑ لا

4. **من وجهة نظرك, المشكلة البيئية بسبب (يمكن اختيار أكثر من إجابة):**

❑ أفراد المجتمع ❑ الصناعة ❑ الاحتلال ❑ الزراعة ❑ عدم التعامل مع النفايات الصلبة بطريقة سليمة

5. **الدور الأكبر في المساهمة في الحفاظ على البيئة يعود على؟**

❑ افراد المجتمع ❑ البلدية ❑ كلاهما

ثالثاً: إعادة استخدام وفرز النفايات الصلبة

6. **هل تعيد استخدم بعض المواد قبل رميها في برميل النفايات الموجود في منزلك (مثل إعادة استخدام أكياس البقالة كأكياس خاصة بالسلال)؟**

❑ نعم ❑ لا

7. **هل تساهم حاليا بفرز بعض مكونات النفايات الصلبة مثل الزجاج والورق والعلب المعدنية وخلافها وجمعهم في أكياس مستقلة في منزلك بدلا من وضعها مع برميل النفايات الموجود في منزلك ؟**

❑ نعم ❑ لا

8. **هل أنت مستعد للمشاركة مستقبلاً في مشروع فصل بعض مكونات النفايات المنزلية؟**

❑ نعم ❑ لا

9. **في حالة قيامك بفرز النفايات فهل يمكن أن تقوم بنقلها إلى حاويات خاصة بعيدة عن منزلك؟**

❑ نعم ❑ لا

10. **إذا كان الجواب "لا", فهل يمكن أن تنقلها إلى حاويات خاصة موجودة أمام منزلك ؟**

❑ نعم ❑ لا

11. **إذا كنت لا تساهم ولا تنوي المساهمة في مشروع فرز النفايات الصلبة, فذلك بسبب (يمكن اختيار أكثر من إجابة):**

❑ عدم وجود مكان مناسب في المنزل لحفظ النفايات التي سيتم فصلها

❑ عدم اهتمامك بذلك ❑ لاجدوى من ذلك

❑ تكاسل ❑ عدم إلمامك بأهمية فرز النفايات

❑ عدم وجود مردود مادي يعود اليك

12. هل ترى أن هناك مردود مادي (مبلغ من المال) للذين يمارسون مهنة فرز النفايات الصلبة واعادة تدويرها ؟

❑ نعم ❑ لا

13. هل ترى أن وجود مردود معنوي بدلا من المردود المادي(مثل منح شهادات شكر وتقدير أو إدراج أسماء المشاركين في فرز النفايات في إعلانات خاصة لشكرهم) يمكن ان يحفز الناس على المشاركة بمشروع فصل النفايات الصلبة؟

❑ نعم ❑ لا

14. إذا كنت تساهم حاليا أو سوف تساهم مستقبلا بإعادة استخدام وفصل بعض مكونات النفايات قبل رميها فهل ذلك ناجم من : (يمكن اختيار أكثر من إجابة)

❑ اهتمامك بالبيئة ❑ وازع ديني (مثل النظافة وعدم الإسراف) ❑ وجود مردود مادي

❑ وجود مردود معنوي

15. **في المجتمع الذي تعيش به, هل تتوقع أن يكون لأفراد المجتمع دور في إنجاح برامج إعادة استخدام وتدوير النفايات الصلبة ؟**

❑ نعم ❑ لا

<u>رابعاً: برامج التوعية البيئية</u>

16. هل ترى أن هناك برامج إعلامية موجهة نحو إرشاد المجتمع بأهمية فرز و إعادة استخدام وتدوير النفايات وتشجيعهم على ذلك ؟

❑ نعم ❑ لا

17. هل تتوقع أن يكون لبرامج التوعية بالأهمية الاقتصادية والبيئية لفصل واعادة تدوير النفايات الصلبة دور في إنجاح برامج إعادة الاستخدام والتدوير ؟

❑ نعم ❑ لا

18. على أي من التالي ترى أن تعتمد برامج التوعية البيئية: (يمكن اختيار أكثر من إجابة)

❑ أهمية المحافظة على البيئة ومنها الموارد الطبيعية

❑ التذكير بالوازع الديني حيال المحافظة على البيئة

- ❑ التذكير بوجود مردود مادي أو معنوي

30. ماهي الطرق المناسبة والأفضل التي يمكن أن تسهم في زيادة الوعي البيئي ؟ (يمكن اختيار أكثر من إجابة)

- ❑ وسائل الإعلام (مثل التلفاز، إذاعة، صحف، انترنت، منشورات)
- ❑ حملات تثقيفية في بعض المواقع
- ❑ حصص خاصة لطلاب المدارس
- ❑ التحدث مع الرجال في خطبة الجمعه
- ❑ التحدث مع النساء في المجالس النسوية
- ❑ تحديد يوم خاص سنوي للتذكير بأهمية فرز النفايات

ختاما أشكرك على مساهمتك واهتمامك في توخي الدقة في تعبئة هذا الاستبيان.

إذا كنت ترغب إضافة بعض الملاحظات أو الاقتراحات أرجو إدراجها في الفراغ التالي:

.....
.....
.....
.....
.....

جامعة النجاح الوطنية

كلية الدراسات العليا

تقييم فصل النفايات الصلبة واعادة تدويرها في منطقة جنين

اعداد

حنان محمد علي سليمان هيجاوي

اشراف

د. حافظ شاهين

د. سامر العطعوط

قدمت هذه الأطروحة استكمالا لمتطلبات الحصول على درجة الماجستير في العلوم البيئية بكلية الدراسات العليا في جامعة النجاح الوطنية في نابلس، فلسطين

2015

تقييم فصل النفايات الصلبة واعادة تدويرها في منطقة جنين

اعداد

حنان محمد علي سليمان هيجاوي

اشراف

د. حافظ شاهين

د. سامر العطعوط

الملخص

تناولت هذه الدراسة تقييم فصل النفايات الصلبة في مدينة جنين من خلال دراسة تجريبية طبقت في ضاحية صباح الخير– شمال المدينة؛ وكذلك تطرقت الدراسة إلى واقع النفايات الصلبة في منطقة الدراسة من حيث المصادر والنظام الحالي لادارتها؛ اضافة الى تحديد العوامل المؤثرة في ادارة النفايات الصلبة في جنين.

واعتمدت الدراسة على التجربة والقياس، كما استخدمت الاستبانة في جمع البيانات اضافة الى عدد من الأدوات الداعمة والتي شملت عقد مقابلات مع الموظفين العاملين في قطاع النفايات الصلبة والمشاهدات وتحليل الوثائق ذات العلاقة.

وقد حددت الدراسة التجريبية التي طبقت على ضاحية صباح الخير درجة التزام الناس بفصل النفايات الصلبة من المصدر، حيث تم توزيع حاويات خاصة للفرز في (4) نقاط (تجمعات) مختلفة في الضاحية؛ احتوت كل نقطة منهم على حاويتين، واحدة للنفايات العضوية الرطبة وأخرى للنفايات الأخرى الجافة. كما تم توزيع السلال والأكياس المخصصة للفرز على المبحوثين.

وقد خلصت الدراسة الى حساب نسبة النفايات العضوية من مجموع النفايات المنزلية، وتقدير معدل الانتاج اليومي للأسرة من النفايات المنزلية والتي أشارت الى أن نسبة النفايات العضوية حوالي (57.1%) من مجموع النفايات المنزلية، بينما كانت نسبة جميع المواد الأخرى (42.9%)، وكان معدل إنتاج الأسرة (3.03) كغم\ يوم.

وأظهرت النتائج أن نسبة التزام الناس بفصل النفايات الصلبة بلغ (82.8 %)، ويعود ارتفاع هذه النسبة بالدرجة الأولى الى درجة الوعي والمستوى الاجتماعي لهذه العينة؛ حيث أن تطبيق مثل هذه المشاريع يتطلب بذل الجهود في رفع مستوى وعي العينة المستهدفة، وقد كان ذلك احدى نتائج الدراسة.

وناقشت الدراسة مجموعة من العوامل المؤثرة في حجم وادارة النفايات الصلبة والتي صنفت الى عوامل بشرية وعوامل طبيعية، وتباينت هذه العوامل في تأثيرها على حجم وادارة النفايات الصلبة؛ حيث كانت العوامل البشرية أكثر تأثيرا من العوامل الطبيعية لأن النفايات الصلبة هي نتاج الأنشطة البشرية بالدرجة الاولى أما العوامل الطبيعية فهي مكمل للعوامل البشرية وذات تأثير أقل. وكذلك بينت الدراسة الميدانية أن هناك فروقات بين المدينة والمخيم والقرية في أثر هذه العوامل على ادارة النفايات الصلبة.

وأوصت الدراسة بضرورة التركيز على أسلوب فصل النفايات الصلبة من المصدر وبذل الجهود لرفع درجة التزام المواطن بذلك.

وأكدت على ضرورة الاهتمام بالمشاركة المجتمعية باعتبارها احدى أهم الأدوات الناجحة لتطوير قطاع ادارة النفايات الصلبة والذي يحتاج الى مزيد من الاهتمام والعناية للوصول الى التنمية المجتمعية المنشودة.