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Comparative Analysis of Separation Versus Direct Transport of Solid Waste from Tulkarem District to Zahret Al-Finjan

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Dedication

To the candles that burnt to light the road for us…..my parents

To my soul mate……. My husband.

To my brother, sisters and to my faithful friends

To all the people who support me especially my teachers

Throughout my learning

And education life

Acknowledgment

I would like to express my sincere gratitude to Prof. Dr. Marwan Haddad for his guidance and constructive advice.

Special thanks to my husband for help, encouragements, and patience.

Finally, I am very grateful to all those who helped and encouraged me to make this research possible.

الإقرار

أنا الموقع أدناه مقدم الرسالة التي تحمل العنوان:

Comparative Analysis of Separation Versus Direct Transport of Solid Waste from Tulkarem District to Zahret Al-Finjan

دراسة مقارنة خيارات فصل النفايات الصلبة لمنطقة طولكرم مقابل النقل المباشر إلى زهرة الفنجان

اقر بأن ما اشتملت عليه هذه الرسالة إنما هو نتاج جهدي الخاص، باستثناء ما تمت الإشارة إليه حيثما ورد، وان هذه الرسالة ككل، أو أي جزء منها لم يقدم من قبل لنيل أية درجة علمية أو بحث علمي أو بحثي لدى أية مؤسسة تعليمية أو 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.

Student's name: …….....…… اسم الطالب:

Signature: ……..……..... التوقيع:

Date: …… التاريخ:

List of abbreviations

ADF	Advance Disposal Fees
Avg	Average
C and D	Construction and demolition
EQA	Environmental Quality Authority
ERM	Environmental Resources Management
JCspd	Joint Councils for services, planning and development
JSC	Joint Service Council
IDA	International Development Association
GDP	Gross Domestic Product
GEO	Global Environment Outlook
LCA	Life Cycle Assessment
LGUs	Local Governments Units
METAP	Mediterranean Environmental Technical Assistance Program
MRFs	Material Recovery Facilities
MSW	Municipal Solid Waste
NIS	New Israeli shekel
OECD	Organization for Economic Co-operation and Development
PCBS	Palestinian Center Bureau of Statistics

PLO	Palestinian Liberation Organization
PNA	Palestinian National Authority
RORO	Run On Run Of
SVDP	Society of st. Vincent De Paul
SW	Solid Waste
TS	Transfer Station
UNEP	United Nations Environment Program
UNRWA	United nations Relief and Works agency
USEPA	United States Environmental Protection Agency
WS	Wadi Shaer
WSJSC	Wadi Shaer Joint Services Council
WS-TS	Wadi Shaer Transfer Station
ZF	Zahret Al-Finjan

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Comparative Analysis of Separation versus Direct Transport of Solid Waste from Tulkarem District to Zahret Al-Finjan

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Abstract

Integrated municipal solid waste management (MSWM) can be defined as the selection and application of suitable techniques, technologies and management programs to achieve waste management objectives and goals. Solid waste management (SWM) is an integral part of the urban environment and planning of the urban infrastructure to ensure a safe and healthy human environment while considering the promotion of sustainable economic growth. In the study area (Tulkarem District), neither MSWM nor SWM is employed: no methods are applied for waste reduction, no recycling and reuse alternatives, and no composting plants exist.

This thesis aims to conduct a comparative analysis of solid waste separation options versus direct transport to Zahret Al-Finjan landfill for Tulkarem district to help future policy decisions, evaluating the existing SWM system and estimating the least cost option for managing solid waste in the study area.

The responsibility of Tulkarem Joint Services Council for solid waste management is administration of the transfer station and transporting the solid waste from the Wadi Shaer transfer station to Zahret Al Finjan landfill, 19 local authorities are individually responsible for solid waste

collection. The members of the council are: Tulkarem city, Wadi Shaer JSC, Al Kafriyat JSC, and Al Sa’biat JSC.

Two field works were applied to achieve the study objective and these are: applying a pilot separation and field survey by applying questionnaires to the study area.

Three types of questionnaires were used, one for households, another for Local Governmental Units Questionnaire and a third for involved people employees in the SW service. The main aim of the questionnaires is to know people's perceptions toward source separation. The result from all questionnaires that prefer the idea of separation but not at source; it is preferable to be at Wadi Shaer transfer station, so there is no need to do a cost analysis for the "source separation.

The main objective of the pilot separation is to determine the solid waste composition in the study area. The average percentage for organic substances is 46% and the other components is 54%. The pilot separation applied depended on ASTM-2008 standard for unprocessed solid waste.

Three options were discussed for the municipal solid waste recycling: Direct transport from WS-Transfer station to ZF landfill, separation at source, and separation at transfer station with two scenarios (manual and mechanical). Solid waste recycling options was evaluated by cost analysis and comparing the results to choose the best option.

Cost analysis for 20 years (up to 2030) for solid waste separation options is evaluated. The analysis included the capital cost, operational costs, revenues, benefit costs and break even point.

Source separation option is cancelled, because the people reflect no perception toward source separation.

Direct transport option has no revenues and a yearly loss is increasing.

The average yearly revenues for manual separation option is **45,488 US$**, but it is not feasible because B/C is negative.

Mechanical separation at WS-transfer station has the highest revenue, average yearly revenue is **1,107,349** US $ however in the first five years, an accumulated loss of around **119,732** US $. It is important for this option to know where is the break event point to avoid loss from first year operation, the transfer station should separate 23tons/day of SW and recycle 6 tons/day to break even. The average B/C ratio for this option is 0.9 (near to 1), this option is the best.

Chapter One

1. Introduction:

1.1 General:

One of the most important issues in the world is the environment and its protection. Today, the progress of human beings and the society is measured by the ability to control the environmental elements. Therefore, the population increases, the industry and agriculture progress, but without following suitable ways for waste collection, transport and treatment. This has resulted in increasing waste quantities and consequently the pollution of the environment including land, water, and air, and exhausting the natural resources in different parts of the world. In most countries, solid waste management has become one of the most vital issues to protect health and public safety (ERM, 2000).

Municipal solid waste is a heterogeneous mixture of paper, plastic, cloth, metal, glass, organic matter, etc. generated from households, commercial establishments, and markets. The proportion of different constituents of waste varies from season to season and place to place, depending on the lifestyle, food habits, standards of living, the extent of industrial and commercial activities in the area, etc (Katju, 2006).

Processing and recovery includes all techniques, equipment, and facilities used basically to recover recyclable materials, or energy from solid wastes. In recovery of materials separation operations have been devised to recover valuable (recyclable) resources from the mixed solid waste delivered to transfer stations. These operations may include manual

separation, mechanical (size) separation, air classifiers, magnetic devices etc. The selection of any material-recovery process is a function of separation cost versus value of the recovered materials.

Municipalities, village councils and village communities are responsible for the solid waste management in their own territory while the UNRWA manages the waste in the refugee camps. Daily generation of domestic waste in the West Bank and the Gaza Strip is 2,600 tons in total. In addition, 450tons are generated by the 350,000 Israeli settlers living in the West Bank. All towns and villages in Gaza Strip have collection services while in the West Bank only 25% of the population has a solid waste collection and the waste is disposed randomly in unsatisfactory manner and even burned in the field (El Hawi, 2002).

The study area produces about 99 tons per day of MSW in 2011 which is about 35,640 ton per year and this value is increasing annually. The individual average daily solid waste generation is 0.83 kg/d in 2011 (Tulkarem, 2010).

This study examines the solid waste separation options in Tulkarem District by studying three different separation options of the solid waste collected from the local communities. Separation options include; zero separation (existing situation/direct transport to Zahret Al Finjan); separation at source and separation at the transfer station. The classification of the reusable and recyclable materials was identified, as well as the percentage of the solid waste that can be separated from the total incoming waste to the Wadi Shaer Transfer station. In addition, the cost analysis for the options has played an important role in evaluating waste disposal

methods and advocating one option over the other. Our goal is to quantify the benefits and costs of the SWM options in the study area in order to help future policy decisions and strategies for solid waste management in the area. The main motivation for preparing this study is that all members in Tulkarem Joint Services Council for solid waste management are suffering from SW- fees, they claimed that it is so high and it is important to find a solution for this problem.

1.2 Significance of the Study:

The results of this research will help in performing new strategy for solid waste management in Tulkarem District and knowing the significance of solid waste recycling and recovery of materials. Tulkarem Governorate in fact lacks for the real data about solid waste composition percentages (in general). And it worth menthioning that the role of Tulkarem Joint Services Council for Solid Waste Management should be wider.

1.3 Goals and Objectives of the Study:

The main goal of this study is to conduct a comparative analysis of solid waste separation options versus direct transport to Zahret Al-Finjan landfill for Tulkarem district. As a secondary objective assessment of the status of solid waste management in the study area was considered.

The specific objectives are to:

- Determine the components and the quantities of solid wastes generated at Tulkarem District and Assess and quantify availability of raw materials that can be recovered.

- Determine the knowledge, attitudes, and perceptions of people for the acceptance for solid waste recycling and reusing it in their houses.
- Identify domestic market possibilities for the solid wastes recovered from the separation process.

1.4 Study Problem

The problem of this study can be summarized as follows:

Earlier contacts with Tulkarem Joint Services Council for solid waste management, revealed that the JSC suffer from problems of persistent financial deficit that leads for imbalancing in management and services.

An additional problem is the lack of information about solid waste composition in Tulkarem district. There is limited knowledge on the importance of solid waste separation for solid waste management and its effects on the revenues for the community that will help in reducing the solid waste transporting tariff.

1.5 Study Motivation:

The main motivation for this study that the Joint Services Council for Solid Waste Management in Tulkarem Governorate has no acceptance for the importance for solid waste recycling, although they transfer around 99 ton/ day to ZF landfilll. Thus this action will reduce the solid waste tariff fees that the authorities should pay.

Chapter Two

2. Background

2.1 Study Area and Characteristics:

Tulkarem is a Palestinian city in the Tulkarem Governorate in the extreme north West Bank. The population density in the Tulkarm District is about 682 person/km². The current population of the Tulkarm district is estimated at 172,793 people, which includes the two refugee camps, Tulkarm and Nur Shams, representing about 7% of the total West Bank population[PCBS, 2006]. The number of people living in the rural areas is estimated at 71,738, representing 41% of the total population of the district. About 21,464 people live in the refugee camps while the rest are residing in the urban areas [HWE, 2008].

2.1.1 Location:

The city is situated on the western part of the north West bank,. It is bordered by the 1948 cease-fire line in the west. Its central location between a plain and a mountain has made it commercially and strategically significant and has had a great effect on its growth. In the past, Tulkarem was a caravan station and a trading center for products from the city's surrounding villages and farms, as well as a point from which armies crossed to Egypt and the Levant.

Tulkarem is at the crossroads of three historically important arteries: A road which runs north from the Latrun area along the edge of the plain to Mount Carmel and the Galilee, a road which winds northward along the outer tier of hills from the Ajlon valley to the Jezreel Valley, and a road

that rises from the Mediterranean Sea to Nablus. In the past it was a junction of the coastal railroad from north of Haifa to Cairo and a branch of the narrow gauge Hejaz railway to Damascus [HWE, 2009].

2.1.2 Climate:

The climate of Tulkarem is subtropical, with rainfall limited to the winter. The average temperature in the winter ranges from 8 to 16 °C, while the average temperature in the summer ranges from 17 to 30 °C. Tulkarem is distinguished by the moderating effect the sea breeze has on its climate. The average temperature is 27 °C in August, while February's average temperature doesn't fall below 13.5 °C. Humidity is moderate in summer, about 40-70%, though it rises in winter to between 70-85%. Tulkarem receives in excess of 550 millimeters of rain yearly, which is dispersed and intermittent, characteristic of the Mediterranean Basin [HWE, 2008].

2.1.3 Topography:

Topography and Drainage:

Tulkarem city lies on the western slopes of the West Bank, which are characterized by gentle slopes. The city is divided into six built up urban areas: Shweikeh, Anabta, Thinnaba, Tulkarem, Faron, and Irtah, as shown in Figure 1. The elevation in the city ranges between 50 to 180 meters above sea level.

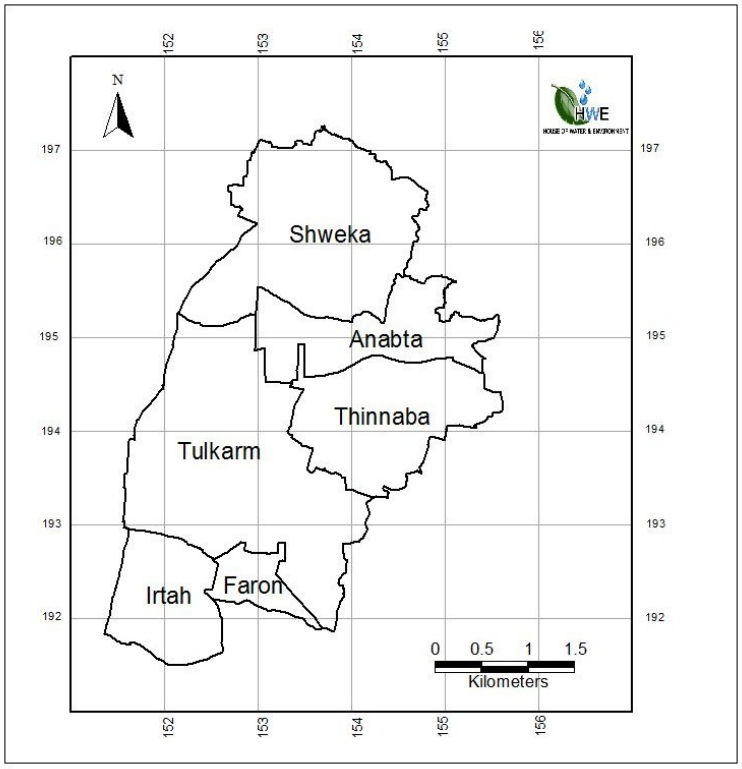

Figure 1: Urban blocks in Tulkarem city [HWE, 2008].

There are many valleys located in the district such as Wadi Abu Nar, Wadi Ammar, Wadi Hawwatut, Wadi AlSham, Wadi Masseen, Wadi Al Teen, and Wadi Zeimar, that drain to the west and ultimately to the Mediterranean Sea. Two valleys are within the municipal boundaries: Wadi Zeimar and Wadi Tin. When Wadi Zeimar crosses into Israel it is called the Alexander Stream, and it runs through Emek Hefer municipality before reaching the Mediterranean Sea [HWE, 2008]. See Figure 2.

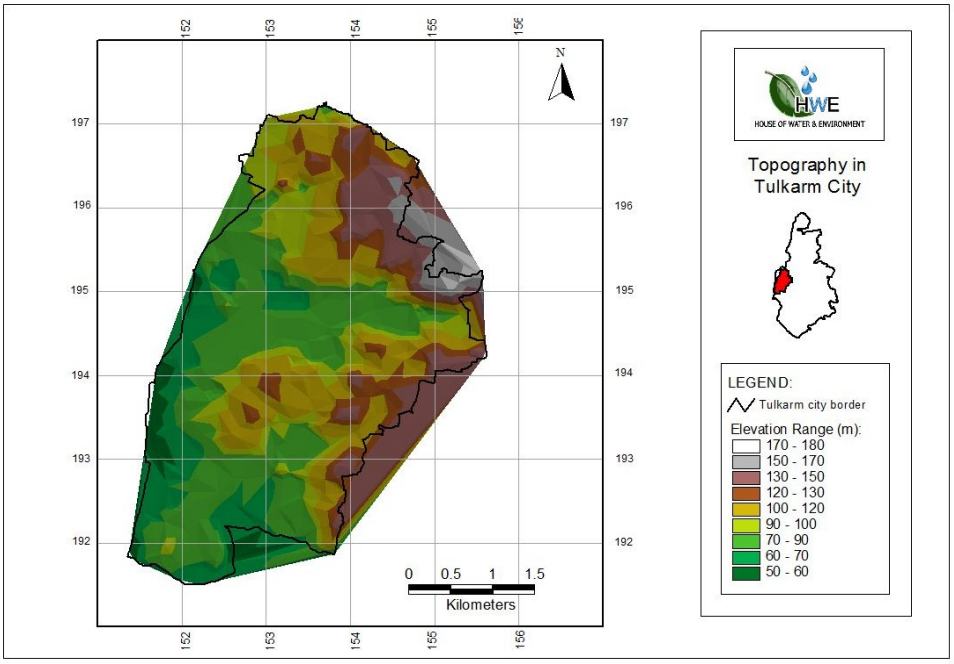

Figure 2: Topography of Tulkarem city [HWE, 2008].

2.1.4 Land use:

Tulkarem was built over a higher area than that surrounding it. The land which was formed as a result of the new fourth epoch consists mostly of creeping sands from the west to the east. The mountainous valleys carry quantities of alluvium and gravel to Tulkarem's lands in seasons of heavy rain and floods, thus creating fertile soil. In addition, an aquifer feeds numerous wells and springs in the area.

Tulkarem's arable land allows the city inhabitants to produce citrus fruits, melons, olives, olive oil, tomatoes, potatoes, wheat, sesame, peanut, eggplant, peppers, green beans, guava, and other products. Land designations in the West Bank are defined by "Oslo II" interim agreement, where Tulkarem proper is located in Area A, or under full Palestinian control.

2.1.5 Geology:

The outcrop geological formations of the Tulkarem governorate range in age from Upper Cretaceous to Quaternary. The district is mainly covered by sedimentary carbonate rocks such as limestone, dolomite, marl and chalk. The general geology of the Tulkarem area is represented in Figure 3 [HWE, 2008]. A brief description of the lithological formations encountered in the Tulkarem District.

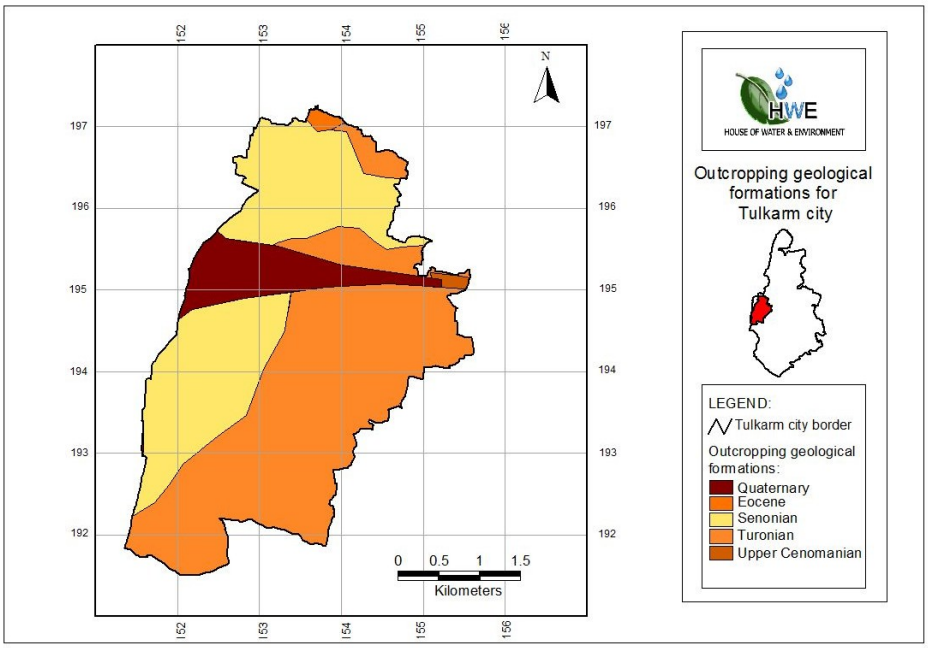

Figure 3: Outcropping geological formations in Tulkarem city [HWE, 2008] .

Upper Cenomanian:

The Upper Cenomanian formation (also known as the Bethlehem formation) consists of limestone, dolomite with chalk, and marl. Outcrops are found mainly on the flank of the A'nabta anticline. The dolomite forms a rugged morphology on gentle slopes.

Turonian:

The Turonian formation (also known as the Jerusalem formation) consists of a series of massive, thick- to- thin bedded limestone to dolomitic limestone and dolomites with a thickness of approximately 70-130m. The lower part of the Turonian formation consists mainly of limestone and dolomite with marl and some chalk, making it sometimes difficult to be distinguished from the underlying Bethlehem formation. Towards the top of this formation, chalk beds with occasional chert bands are common, and the formation is transitional to the overlying chalk facies. The Turonian formation has a well-developed karst feature and is commonly used as a building stone. It is exposed in the A'nabta anticline and is considered a very good aquifer.

Senonian:

The Senonian formation is mainly made up of Cretaceous Rocks, which are composed of chalk. Outcrops exist in the A'nabat anticline and on the western limb of Nablus-Beit Qad syncline. In the A'nabta area, the chalk is thin and consists of marly base and passes upwards through bedded and crystalline limestone that has few marl partings.

Eocene:

The Eocene formation is composed of tertiary rocks, which are exposed in the Anabta area and in the Nablus- Beit Qad syncline. It is mainly composed of chalk and limestone. The exposure area of this sub-series is widespread and covers about one third of the total area of the Northern West Bank. Five facies of this formation have been identified:

chalk with minor chert, chalk with minor interblended nummulitic limestone, limestone with minor interblended chalk, bedded massive nummulitic limestone and reef limestone. The presence of the limestone and the conglomerate lenses form a good aquifer while the chalk and marl act as a good aquiline.

Quaternary:

Quaternary rocks are divided into the following formations:

1. Lisan Formation: these recent sediments are mainly composed of alluvium consisting of limestone, chart and clay.

2. Nari Formation**:** it occurs mainly in high rainfall areas where carbonate rocks are dissolved by percolating water. It forms a thin coating over the limestone with a thickness of about 10-15 m.

2.1.6 Aquifers:

The major aquifers in the area are the Shallow Aquifer and the Upper Cenomanian-Turonian complexes. The Abu Dis acts as an acquired hence, forming a water barrier. The Upper Aquifer is the predominant aquifer in the region. Figure 4 shows available aquifers in Tulkarem [HWE, 2008].

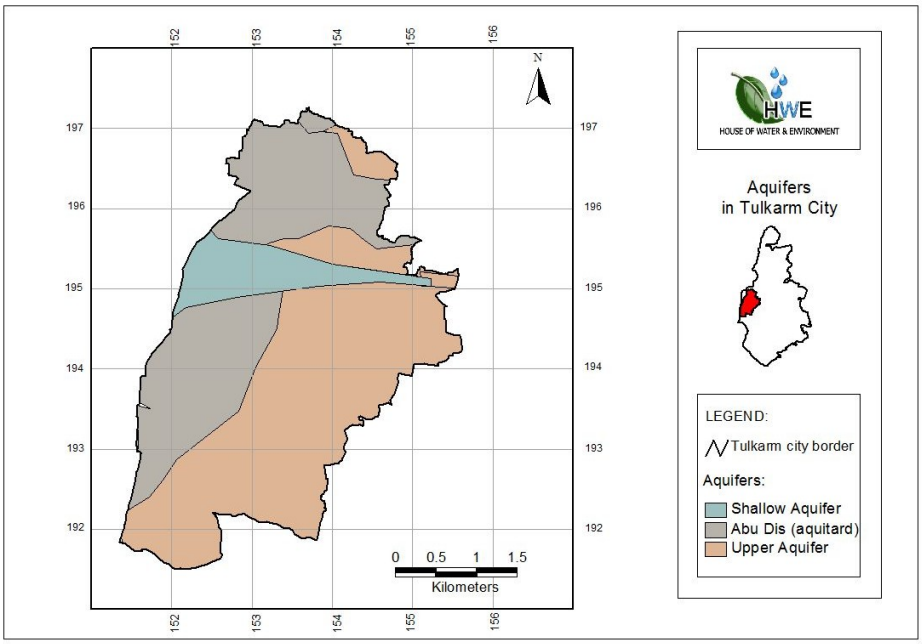

Figure 4: Aquifers in Tulkarem city [HWE, 2008].

The Upper Aquifer System:

The Upper Aquifer is represented by the formations of the age Turonian (Jerusalem formation) and Cenomanian (Bethlehem and Hebron formations).

Turonian Aquifer:

The Turonian aquifer is part of the Upper Aquifer but can be classified as a distinct local aquifer if the formation beneath it acts as an aquitard as is the case in some areas in the eastern and southern parts of the West Bank. The Turonian aquifer is considered a fairly good aquifer especially where the saturation thickness is in tens of meters. This aquifer is of good thickness and extent in the Tulkarm area (approximately 130 m thick). The water quality of this aquifer is generally good but in some areas there is evidence of deterioration because of sewage and agro-chemical pollution.

Cenomanian Aquifer:

The formations of this aquifer are the Bethlehem and Hebron. The aquifer is an important regional source of water supply for domestic use. The Cenomanian Aquifer has high recharge values. It is heavily exploited in the areas near Tulkarm and Qalqilya because the aquifer is at a shallow depth in this area. The depth to water is rarely more than 200 m below ground surface.

2.2 SWM system in Tulkarem District:

2.2.1 Solid waste management responsibility:

The Palestinian Local Authorities Law No. 1 of 1997 assigns the responsibility of SWM services to local authorities. As articulated in article (15), they are responsible for the collection of waste from streets, houses and public stores as well as for the transportation and disposal of the collected waste. Moreover the law provides for Local authorities to establish Joint Services Councils through which they may collaborate in the delivery of services, including waste management [ARIJ, 2009].

Currently, there are 5 Joint Councils for services, planning and development (HCspd) in the Tulkarem Governorate, namely HCspd-Al Kafriyat, the HCspd- Al Sha'rawieh, the HCspd-Al Sa’biat, the JC for services and regional planning-Wadi Al Shaer and the Joint Services Council –Wadi Al Zeimar. Only two of these councils provide the member local authorities with the service of SWM including the HCspd-Al Kafriyat and the HCspd-Al Sa’biat. Accordingly, each of the remaining local authorities is individually responsible for managing the solid waste

generated within jurisdiction (Figure 1). There are 5 village councils that have hired a contractor to collect and dispose of the generated solid waste and two other local authorities, which are Dir Al Ghusun Municipality and Al-Jarushiya village Council, have acquired the SWM service provided by the Joint Services Council for SWM-Jenin. As regards to the two refugee camps in Tulkarem Governorate, it should be noted that the UNRWA is responsible for the collection and transfer of the generated solid waste to Far'oun dumpsite.

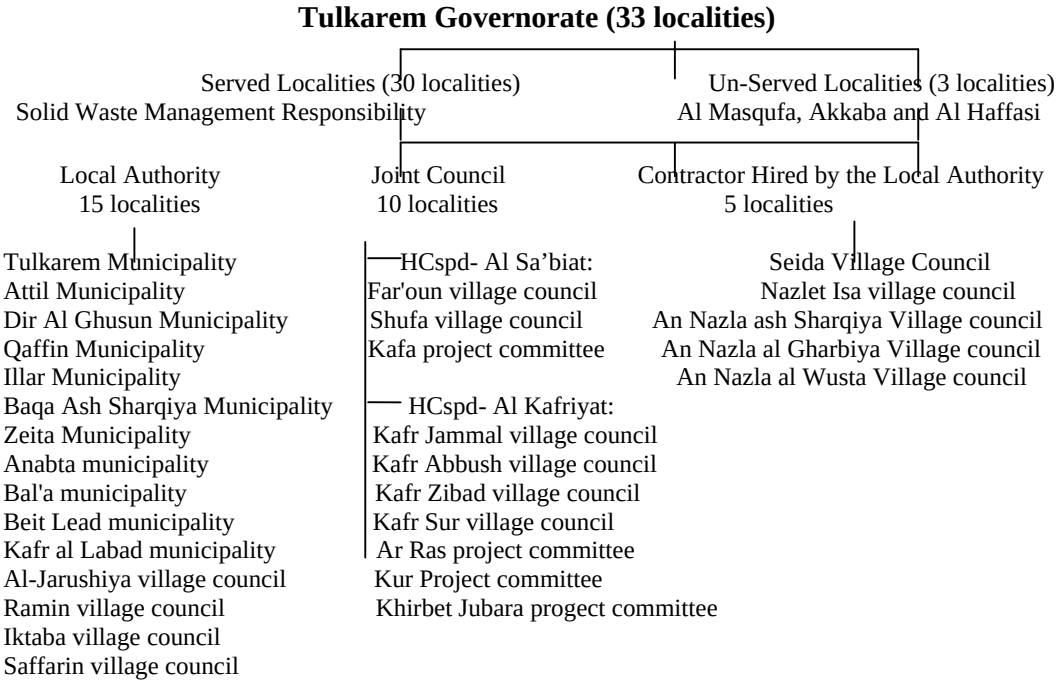

Figure 5: Authorities Responsible for Solid Waste Management [ARIJ, 2009].

For more clarification, Table (1) detail all local authorities in Tulkarem Governorate, type and solid waste management responsibility.

Table (1): Distribution of Solid Waste Management Responsibility [Rafa, 2007]

Locality	Locality Type	Solid waste Management esponsibility
Tulkarem	Urban	Tulkarem Municipality
Attil	Urban	Attil Municipality
Dir Al Ghusun	Urban	Dir Al Ghusun Municipality
Qaffin	Urban	Qaffin Municipality
Illar	Urban	Illar Municipality
Baqa ash Sharqiya	Urban	Baqa ash Sharqiya Municipality
Zeita	Rural	Zeita Municipality
Seida	Rural	Contractor hired by the Village Council
Nazlat Isa	Rural	Contractor hired by the Village Council
An Nazala Ash Sharqiya	Rural	Contractor hired by the Village Council
Al-Jarushiya	Rural	Al-Jarushiya Village Council(1)
An Nazala Al Gharbiya	Rural	Contractor hired by the Village Council
An Nazala Al Wusta	Rural	Contractor hired by the Village Council
Al Masqufa	Rural	No Service is Provided
Akkaba	Rural	No Service is Provided
Anabta	Urban	Anabta Municipality
Bal'a	Urban	Bal'a Municipality
Biet Lid	Urban	Biet Lid Municipality(2)
Kafr al Labad	Rural	Kafr al Labad Municipality
Ramin	Rural	Ramin Village Council(3)
Iktaba	Rural	Iktaba Village Council(3)
Sffarin	Rural	Sffarin Village Council(2)
Al Haffasi	Rural	No Service is Provided
Far'un	Rural	HCspd - Al Sa’biat
Shufa	Rural	
Kafa	Rural	
Kafr Jammal	Rural	HCspd - Al Kafriyat
Kafr Abbush	Rural	
Kafr Zibad	Rural	
Kafr Sur	Rural	
Ar Ras	Rural	
Kur	Rural	
Khirbet Jubara	Rural	

(1) The village council is benefiting from the sevices offered by Dir Al Ghusun Municipality that has signed an agreement with Zahret Al Fonjan to collect and transport the solid wastes.
(2) Beit Lid Municipality and Saffarin village council cooperate with each other in SWm services as they share the same tractor to collect and dispose of the generated SW.
(3) The village Councils of Ramin and Iktaba share the same tractor and workers.

2.2.2 Operational Aspects:

The practices for managing solid waste in Tulkarem Governate until 2010 are limited to the collection of the generated waste, and to the transport and dumping to the collected waste in the disposal sites. Based on the 2007 census data, the total population living in the Tulkarem Governorate, excluding the two refugee camps, was 139,802 inhabitants. Approximately 58.5% of the total population lives in the urban areas and remaining 41.5% of the population is distributed in Tulkarem rural areas [Tulkarem, 2008].

2.2.3 Solid Waste Collection:

The solid waste collection containers and vehicles that are currently used in the localities served vary in number and size.

As regards to the available solid waste collection fleet in the Governorate, there are 5 tractors and 17 compactors of different capacities as follows: 4 compactors of 3-7m^3 capacity, 14 compactors of 8-10m^3 capacity, 8 compactors of 13m^3 capacity and 1 compactor of 20 ton capacity. Accordingly, the average number of solid waste collection vehicles per 1,000 persons 0.158 vehicles. The details regarding the available solid waste collection vehicles in Local Authorities and Joint Councils in Tulkarem Governorate are presented in Table (2) [Tulkarem, 2008].

Table (2): List of Available Solid Waste Collection Vehicles in Local Authorities and Joint Councils [Tulkarem, 2008].

Local Authority / Joint Council	Type	Capacity (m3)
Tulkarem Municipality	Compactor	20 ton
	Compactor	13
	Compactor	13
	Compactor	13
	Compactor	13
	Compactor(1)	15
	Compactor	9
	Compactor	4
	Compactor	13
Attil Municipality	Compactor	8
Qaffin Municipality	Compactor	13
Illar Municipality	Compactor	13
Baqa ash Sharqiya Municipality	Compactor	13
	Tractor	---
Zeita Municipality	Tractor	---
Anabta Municipality	Compactor	6
Bal'a Municipality	Compactor	9
	Tractor (2)	---
Biet Lid Municipality and Sffarin Village(3)	Tractor	---
Kafr al Labad Municipality	Compactor	8
Ramin and Iktaba Village Council(3)	Tractor	---
HCspd - Al Kafriyat	Compactor	5
HCspd - Al Sa'biat	Compactor	5
Dir Al Ghusun, Seida, Nazlat Isa, An Nazala Ash Sharqiya, Al-Jarushiya, An Nazala, Al Gharbiya, An Nazala Al Wusta, Al Masqufa, Akkaba and Al Haffasi	No Compactor	---

Notes:
(1) The compactor is not used any more due its bad condition.
(2) The tractor belongs to the JC spd- Wadi Shaer and is shared with Kafr al Labad Municipality.
(3) The two local authorities share the same tractor that belongs to the JC spd - Wadi Shaer to collect and dispose of generated solid waste.

Currently the collected solid waste in Tulkarem, Far'oun, Shufa, Kafa, Kafr Jammar, Kafr Abbush, Kafr Zibad, Kafr Sur, Ar Ras, Kur and Khirbet Jubara is transferred to Far'oun dumping site that is used as a transfer station before transferring it to Zahret Al Finjan sanitary landfilll in Jenin. Moreover, the solid waste collected in Attil, Dir Al Ghusun and Al-Jarushiya is directly transferred to ZF landfill. In the remaining localities, the collected solid waste is disposed of in 12 dumping sites including Anabta dumping site and 11 random dumping sites. Anabta dumping site is used by municipalities of Anabta, Bal'a, and Beit lead and the village councils of Ramin and Iktaba. Open burning of collected solid waste is practiced in all the uncontrolled dumping sites.

The distance travelled by solid waste collection vehicles to the final disposal sites varies from one locality to another depending on the location of the disposal site and the availability of a transfer and haulage system. In the Tulkarem Governorate, transfer and haulage exist only in Far'oun dumping site as mentioned above with an average transport/travel distance of 32 km to ZF landfill. The travel distance from the localities that are using Far'oun transfer station varies from 2-15 km as illustrated in table (3) furthermore; the distance from the locality to the random dumping site does not exceed 4 km.

Table (3): Travel Distance form Locality to Transfer Station or Final Disposal Site [ARIJ, 2009].

Solid Waste Disposal Site	Local Authority / Joint Council	Travel Distance form Locality to Transfer Station or Final Disposal Site (Km)
Far'un dumping site/transfer station then to Zahret Al Finjan sanitary landfill	Tulkarem Municipality	4.0
	HCspd - Al Sa'biat	
	Far'un Village Council	2.0
	Shufa Village Council	8.0
	Kafa Project Committee	4.0
	HCspd - Al Kafriyat: Village Councils of Kafr Jammal, Kafr Abbush, Kafr Zibad, Kafr Sur and the Project Committees of Ar Ras, Kur and Khirbet Jubara	15.0
Directly to Zahret Al Finjan sanitary landfill	Attil Municipality	21.0
	Dir Al Ghusun Municipality	25.0
	Al-Jarushiya Village Council	20.0
Anabta dumping site	Anabta Municipality	5.0
	Bal'a Municipality	3.5
	Biet Lid Municipality	10.0
	Ramin Village Council	10.0
	Iktaba Village Council	6.0
Random dumping site	Qaffin Municipality	2.0
	Illar Municipality	2.5
	Baqa ash Sharqiya Municipality	3.0
	Zeita Municipality	1.0
	Seida Village Council	4.0
	Nazlat Isa Village Council	1.5
	An Nazala Ash Sharqiya Village Council	1.0
	An Nazala Al Gharbiya Village Council	2.0
	An Nazala Al Wusta Village Council	2.0
	Kafr al Labad Municipality	5.0
	Sffarin Village Council	1.5

2.2.4 Wadi Shaer Project-Transfer station:

Waste transfer stations are facilities where municipal solid waste is unloaded from collection vehicles and briefly held while it is reloaded onto larger long distance transport vehicles for shipment to landfills or other treatment or disposal facilities.

In the context of improving the solid waste management systems in the West Bank and Gaza, the Italian Government has agreed in April 2004 for grant about 1.678 US $ million to assist in financing the improvement methods of solid waste collection and disposal in Wadi Shaer Joint Service Council (WS-JSC). The agreement signed on June 2008 between the Palestinian National Authority (PNA) on behalf the Palestinian Liberation Organization (PLO) and the International Development Association (IDA) on behalf the Italian Government. Meanwhile, the administration of the project is governed by the World Bank. The project aims mainly to improve the methods of waste collection and disposal in WS-JSC area which includes seven local communities in Tulkarem Governorate including Anabta, Bala', Kufur Allabad, Ramin, Beit Lead, Safareen, and Iktaba [WSJSC, 2010].

The new transfer station is simple. Collection trucks can unload directly their waste into a waiting transfer container of 32 m^3. The proposed transfer station is open, not covered, but is surrounded by fences that limit access to the site. All waste collected is brought to the transfer station and downloaded in big containers with 32m^3 capacity. These containers will be then transferred to the Zahret Al-Finjan landfill using a transfer truck with RORO trailer. If such station is built, then the collection trucks can bring

all the collected garbage to the station from where it will be transported to Zahret Al Finjan landfill site which is about 23 km away from the station and along the road of Anabata - Bazaria - Silat Al Dhaher- Sanur to Fahma Al Jadida and down to the Zahret Al Finjan Landfill. In any case this is the nearest route available nowadays to Zahret Al Finjan Landfill. The station has easy entry access and exits for trucks. It has a ramp for tipping, roll-off containers of 32 m^3 capacity, service room, leachate collection tank, washing facilities, truck scale and will be used as a parking lot for the garbage trucks and washing of the collection trucks and cars owned by the JSC regularly.

The side effects for construction the transfer station are the rehabilitation and closure of the uncontrolled dumping sites one located on the road from Anabta to Tulkarem, close to the new proposed transfer station. The area of the dumpsite is about 20,000 m^2, and currently receives 25 tons of mixed waste daily. The bad practice of burning the waste creates heavy smoke, which is a hazard to residents, drivers, visitors on the adjacent road. In addition to the Anabta main dumpsite. also another random dumpsites in Kufur labad town of about 15,000 m^2 are closed, rehabilitated, and returned back for agricultural use. All bad practices of burning the waste that creates heavy smoke, which forms a sever hazard to residents, drivers, visitors on the adjacent road is terminated, and this major environmental problem comes to its end. It is important to mention that after starting construction of Wadi Shaer transfer station encouraged to start rehabilitation and closing Far'oun dump site, which is located in the south-east side of Tulkarem City outside the municipality boarder and spreads over an area of 10,000 m^2.

The second effect is the improvement of the solid waste collection and management by provision of supplementary solid waste equipment including supply of new solid waste collection trucks with compactors, and a transfer truck with trailer truck of a total capacity of 40 ton in order to improve the collection and transportation systems for the council member villages. The management services shall be also improved by the supply of other needed equipment such as containers in different sizes, trashes, bins, bags and other solid waste tools.

2.2.5 The existing SWM system in Tulkarem District:

2.2.5.1 SW collection and responsibility:

After construction Wadi Shaer transfer station, the council signed agreement with Solid Waste Management Council to administrate the transfer station and transporting the solid waste from T.S to Zahret Al Finjan landfilll which is about 23 km away from the station. The member ships of SWM JSC are listed below:

1) Tulkarem Municipality: acts its city and suburbs.
2) Wadi Shaer JSC: acts 7 local authority.
3) Al Kafriyat JSC: acts 7 local authority.
4) Al Sa’biat JSC: acts 5 local authority.

Figure below shows the structure of solid waste management for the local authorities after construction Wadi Shaer transfer station.

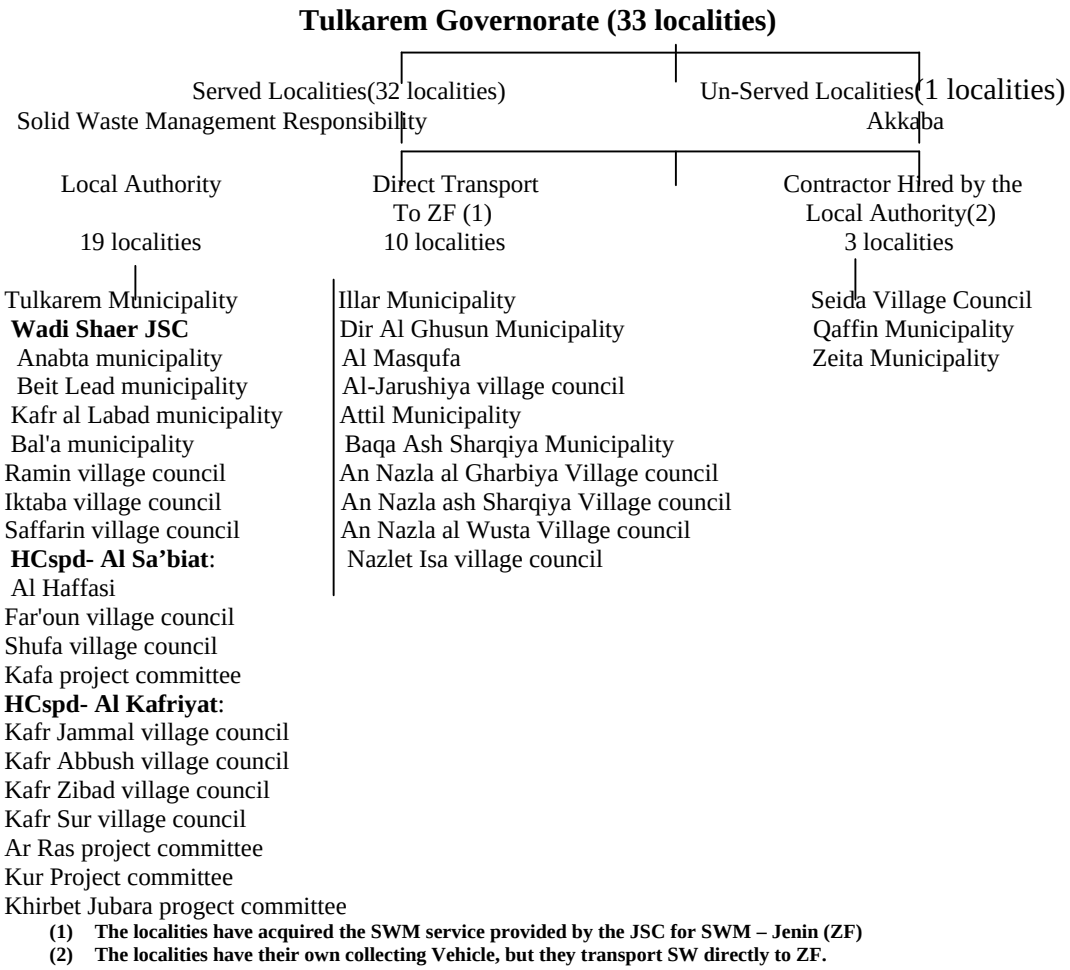

Figure 6: Authorities Responsible for Solid Waste Management after construction WS-TF.

The actual role for Joint Services Council for Solid Waste Management is the administration of the transfer station (Wadi Shaer Transfer station) and transporting the solid waste from TS to Zahret Al Finjan landfill, and the other 19 localities are individually responsible for the collection of waste from streets, houses and public stores as well as for the transportation of the collected waste to the transfer station.

Table (4): SWM responsibility, population and collection frequency.

Locality	Solid waste Management Responsibility		Population 2007 PCBS, 2007	Collection Frequency (days/week)
Tulkarem Camp	UNRWA		10,545	6
Nur Shams Camp	UNRWA		6,421	6
Tulkarem	Tulkarem Municipality		50,838	7
Attil	Attil Municipality		8,957	6
Dir Al Ghusun	Dir Al Ghusun Municipality		8,168	6
Qaffin	Contractor hired by the Village Council		8,312	6
Illar	Illar Municipality		6,134	6
Baqa ash Sharqiya	Baqa ash Sharqiya Municipality		4,064	6
Zeita	Contractor hired by the Village Council		2,826	6
Seida	Contractor hired by the Village Council		2,903	6
Nazlat Isa	Nazlat Isa Village Council		2,313	6
An Nazala Ash Sharqiya	An Nazala Ash Sharqiya council		1,500	6
Al-Jarushiya	Al-Jarushiya Village Council		924	6
An Nazala Al Gharbiya	An Nazala Al Gharbiya council		929	6
An Nazala Al Wusta	An Nazala Al Wusta council		337	6
Al Masqufa	Dir Al Ghusun Municipality		258	6
Akkaba	No Service is Provided		252	6
Anabta	Anabta Municipality	Wadi Shaer JSC	7,263	6
Bal'a	Bal'a Municipality		6,545	6
Biet Lid	Biet Lid Municipality		4,949	6
Kafr al Labad	Kafr al Labad Municipality		4,037	6

Ramin	Ramin Village Council	1,790	6
Iktaba	Bal'a Municipality	2,641	6
Sffarin	Biet Lid Municipality	753	6
Al Haffasi	Kafr al Labad Municipality	156	6
Far'un	HCspd - Al Sa’biat	3,072	6
Shufa		2,174	6
Kafa		400	6
Kafr Jammal	HCspd - Al Kafriyat (called now Al Kafriyat Municipality)	2,402	6
Kafr Abbush		1,444	6
Kafr Zibad		1,068	6
Kafr Sur		1,107	6
Ar Ras		535	6
Kur		260	6
Khirbet Jubara		290	6

2.2.5.2 SWM Joint services council Employees:

According to SWM council, 11 employees and workers divided into two parts, 3 are administrators and 8 are transfer station workers. As summarized in table 5, 2 drivers (from Wadi Shaer transfer station to ZF landfill), 1 cleaner man (responsible for cleaning TS), 1 worker works on bagger to transport the SW in the 32m³ containers after the compactors loading the waste, 1 worker is responsible for monitoring the Balance and recording the SW weights, 1 admin to administrate and monitoring the works inert the TS, 1 mechanical engineer is responsible for the vehicles maintenance, his work is part time just for the need.

Table (5): SWM Staff in Joint Services Council.

	Item	Frequency	Notes
1	Executive manager	1	Administrators
2	Accountant	1	
3	Secretary	1	
4	Drivers	2	TS employees
5	Cleaner Man	1	
6	Loader "Bager" laborer	1	
7	Balance Monitor	1	
8	Guard	1	
9	Mechanical Engineer	1	Part time
10	Admin	1	TS employees
	Total	11	

2.2.5.3 Sources of MSW:

Report from Tulkarem Municipality estimated that household waste accounts for 50% of the total solid waste, with the construction and industrial sectors together constituting 25%, and remaining types (e.g. commercial, institutional) about 25%. Hazardous material is to some extent present in all these waste types, although such material is only a significant component of industrial and hospital waste.

2.2.5.4 Solid Waste Generation:

The generated solid waste per capita per day in Tulkarem governorate for the year 2005 is 0.8kg and expected to increase to 0.85 in the year 2010. In the year 2015 the estimated generated solid waste per capita per day is 0.9 (HWE, 2009).

2.2.5.5 Solid Waste composition:

For the estimation of the required capacity of the solid waste transfer station over a 20-year period, the available data on the waste composition

has to be considered, mainly with respect to the (feasible) options for separation and recycling. Unfortunately until the preparation of this report, no reliable data exist except that carried out by Municipality of Tulkarem. Table 6, show the solid waste composition measured at various places in Tulkarem city, Alkafriyat and Wadi Shaer JSC respectively.

Table (6): Solid Waste composition in Tulkarem city, Al-Kafriyat JSCand Wadi Shaer JSC.

	%organic	%Metal	%Paper	%Glass	%Plastic	% Others
Tulkarem City [HWE, 2009]	43	16	19	9	10	3
Al-Kafriyat JSC [HWE, 2009]	50	10	12	3	11	14
Wadi Shaer JSC [Polse, A. and Hamzeh, T., 2001]	74	2	9	2	10	3
Average	**55.6**	**9.3**	**13.3**	**4.6**	**10.3**	**6.9**

By giving this relatively high organic component, the option of composting should be considered in the near future as a serious alternative, not only to reduce the waste volumes to be disposed at the landfilll, but also with respect to a possible use as an alternative for soil improver or fertilizer. Also the high composition of metal and paper, encourage performing separation stage at the transfer station.

2.3 Solid Waste Separation:

2.3.1 Introduction:

It is known that the management of solid waste from the point of generation to final disposal can be grouped into six functional steps as follows: Waste generation; Storage (in the containers); Collection; Transfer and transport; Processing and recovery; and Final disposal.

Processing and recovery includes all techniques, equipment, and facilities used basically to recover recyclable materials, or energy from solid wastes. In recovery of materials; separation operations have been devised to recover valuable (recyclable) resources from the mixed solid waste delivered to transfer stations. These operations may include manual separation, mechanical (size) separation, air classifiers, magnetic devices etc. The selection of any material-recovery process is a function of separation cost versus value of the recovered materials.

The separation of solid waste components including papers, cardboard, aluminum, plastic,….etc is one of the most positive and effective ways to achieve the recovery and reuse materials and some of waste component is separated and then are soled for special companies.

Recycling is a series of activities, which includes separation, collection, transferring, transporting, sorting and processing. Materials disposed after use are recycled from the municipal waste stream and used as raw materials to manufacture products. Recycling is considered as an effective method for sustainable waste management.

Recycling has increasingly been adopted by communities as a method of managing municipal solid waste. It is the process used to convert certain waste materials to new materials or products. This achieved by the separation of the waste at the source (point of generation) by the residents, waste pickers, and waste collectors, and/or separation by recycling plant at the site (transfer stations and/or landfills). Some recycled materials have high percentage of organic waste such as leaves, grass, food waste, etc which can be used for soil improvement due to controlled decomposition of organic materials. The conversion of waste materials into soil additives is called composting.

2.3.2 Solid Waste separation Options:

Separation is a necessary operation in the recovery of reusable and recyclable materials from municipal solid waste. Separation can be accomplished at the source of generation MRFs depending on the separation objectives, variety of MRFs or MR/TFs can be developed. The reuse and recycling opportunities and the options available for the separation of materials will affect the type of waste management program implemented by a community.

2.3.2.1 Waste separation at the source of generation:

Waste separation at the source is usually accomplished by manual means. The number and types of components separated will depend on the waste diversion goals established for the program. Even though waste materials have been separated at the source, additional separation and processing will usually be required before these materials can be reused or recycled.

2.3.2.2 Waste separation at MRFs and MR/TFs:

MRFs and MR/TFs are used for the further processing of source – separated wastes obtained from curbside collection programs and drop-off and buy-back centers without processing facilities, the separation and recovery of reusable and recyclable materials from commingled MSW, and improvements in the quality (specifications) of the recovered waste materials. In the simplest terms, a MRF can function as a centralized facility for the separation, cleaning, packaging, and shipping of large volumes of materials recovered from MSW.

Manual versus mechanical separation:

From MSW can be accomplished manually or mechanically. Manual separation is used almost exclusively for the separation of wastes at the source of generation. Many of early MRFs built in the 1970s were designed to separate the waste components mechanically. Unfortunately, none of these early facilities is currently in operation, primarily because of mechanical problems. The current trend is to design MRFs based on the integration of both manual and mechanical separation functions.

MRFs for source separated wastes:

The types of source separated materials that are separated further at MRFs may include paper and cardboard from mixed paper and cardboard, aluminum from commingled aluminum and tin cans, plastics by class from commingled plastics, aluminum cans, tin cans, plastics, and glass from mixture of these materials, glass by color (clear amber, and green).

MRFs for commingled MSW:

All types of waste components can be separated from commingled MSW. Wastes are typically separated both manually and mechanically. The sophistication of the MRF will depend on the number and types of components to be separated, the waste diversion goals established for the waste recovery program, and the specifications to which the separated product must conform.

2.4 Solid Waste Impacts:

2.4.1 Impact on Human Health:

All dumping sites in Palestine are not fenced; adults and children frequently search the garbage there. All kind of collected solid wastes are mixed and dumped together, including hazardous medical wastes generated at the health centers located in the target area (including nearby houses in dumping sites). These wastes are collected and treated in the same way as any other solid waste. It is of our interest not to have any accident like the one occurred in Yatta/ Hebron dumping site where several children were injured in an explosion caused by unknown factors.

The relationship between solid waste and human diseases is intuitively obvious, but difficult to prove. There are many human diseases associated with solid waste. These diseases are supported by the growth of insects and rodents which ultimately transfer these diseases to human beings.

2.4.2 Impacts on Air:

Solid waste that is randomly dumped, and waste in dumping sites is continuously burned. This may have a great impact on the health of the nearby population. There are 4 houses 20 meters far from the dump site. Others houses are 200 meters away from the dump site. The methane gas produced from the fermentation of organic generates fire, leading to open burning of the accumulated solid waste. All sorts of heavy meals, dioxins and organic pollutants are released to air. A continuous polluting fume is created from burning of solid waste is 85-90% ash while 15-10% is fly ash which plays a role in air pollution. The nearby residents are the most likely to be impacted by air pollution, pollution of groundwater, scavengers, insects and odors [HWE, 2009].

2.4.3 Impacts on Groundwater:

Water is a valuable recourse in this arid area and may be impacted by the high number of scattered dumping sites over the West Bank. The existing dumping sites are not covered or lined from the bottom to protect the groundwater and surface water. Runoff passes through the waste. This contaminated water then flows to the nearby valley, or seeps into the ground, where it is eventually causes pollution to the groundwater. Pollution of water resources is particularly likely where there is heavy Rainfall and rapid percolation through the soil.

Also, for Feroun dump site the nearest wadi to it is Wadi Alteen. This makes the situation more dangerous as the methane gas and contaminants coming from the leachate of solid waste pollutes the surface water and the springs of Wadi Alteen. This water constitutes a major

drinking water resource for Tulkarem and the surrounding towns and villages. Any contamination to this water source can affect people in the target area [HWE, 2009].

2.4.4 Impact on Landscape and Land use:

The solid waste dumped is spread over than large areas. The accumulated solid waste form a pyramid of solid waste which is always under burn either by human or as a result of methane gas resulted from the biodegradation of materials dumped. These quantities are above the street level and should be removed. Due to the expansion of the dump site the nearby lands were badly affected and are not of good use for agriculture. The overall sight view is very bad and not acceptable.

Chapter Three
Solid Waste Management in Different Regions

3.1 Local Studies:

The Ministry of Local Government is the main coordinating agency for solid waste management within the Occupied Palestinian Territories, having overall responsibility for the relevant functions of local authorities. The Regional Solid Waste Councils are responsible for the construction of solid waste plants, under the supervision of the Ministry of Local Government. The Ministry of Planning and International Cooperation is responsible for the overall planning and fund raising, while the Environmental Quality Authority is responsible for licensing of sites, environmental monitoring, provision of expertise and ensuring environmental protection. However, as a result of the current crisis and related Israeli occupation measures such as closures and curfews, these central responsibilities are largely inactive.

Most of the day-to-day processing of solid waste (collection, transportation and disposal of waste, and operation and maintenance of facilities) is the responsibility of the local authorities. In larger towns and cities, this is usually the local municipality, while in smaller localities the village councils play a key role, often with coordination provided by the district authorities.

Since the outbreak of the Second Intifada, the access of municipal maintenance staff to solid waste dumps has, at various times, been difficult or impossible, as a result of curfews, partial or full closures, and overall

worker safety and security considerations. Israeli occupation measures have also created difficulties in obtaining spare parts.

Though subject to severe constraint under the prevailing conditions, local authorities continue to perform solid waste management functions. Most recycling, as far as it exists, continues to be carried out by the private sector.

In the refugee camps, most solid waste collection and transport is carried out by the United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA), using its own equipment and management procedures.

UNRWA normally uses disposal sites operated by local authorities. In recent years, several regional solid waste management councils have een established, for example in northern and central Gaza, Bethlehem, Hebron, and Jenin, grouping together all municipalities, villages and rural areas in a given region into a single entity. These councils have focused mainly on developing proposals for regional waste management solutions [ARIJ, 2009].

3.1.1 Solid waste types, composition and generation:

Local surveys and estimates indicate that household waste accounts for 45-50 % of the total solid waste, with the construction and industrial sectors together constituting 20-25%, and remaining types (e.g. commercial, institutional) 25-30 % (Al-Khateeb, 2008).

Hazardous material is to some extent present in all these waste types, although such material is only a significant component of industrial and

hospital waste. There is virtually no separation of hazardous waste, except for some limited treatment of infectious waste, for example in Jericho, Nablus, Gaza and Khan Yunis cities, and disposal of old medicines (Gaza city). Hazardous waste is mixed with municipal solid waste during both collection and disposal. There are few available data on quantities of hazardous waste.

Several studies in the Occupied Palestinian Territories over the last decade have included pilot surveys and/or professional estimates of solid waste generation and composition, like:

A study conducted by Al Sa'di (2009) focused on Reuse-recycling and solid waste separation options for municipal solid waste at Zahrat A-Finjan (ZF) landfill. The options that the study used are separation at source through curbside collection and drop-off centers, separation at transfer station; and separation at ZF landfill. The solid waste composition has been examined via pilot separation and the compositions are organic and food wastes, cartoon and paper, plastic, glass, metals, textile, and others. The average percentage of the organic fraction from the total waste in the different zones is 53.73%, whereas the percent of the other different components is 46.27%. These options have been managed taking into consideration the available solid waste collection, transfer and disposal systems.

cost analysis for 11 years (up to 2020) for all solid waste options. The analysis included the capital and operational costs, revenues and B/C ratio has been estimated assuming the JSC approved fees; based on this study estimated fees and/or zero benefits.

The results show that if the percentage of the separated waste is 41%, the life time of ZF landfill will be prolonged nine years. The total lifetime of ZF landfill will be then 22 years, taking into consideration the annual increase of the population and the solid waste production.

Abu Zahra (2006), conducted a study about the current solid waste management system in Nablus district, it covers the issue from three aspects. These are the management system, awareness of citizens, and solid waste composition. Around 97% of the population in Nablus district are located within areas that have a solid waste collection system. There are great variations in the management system between the city and villages, and among different villages. The collection systems in villages vary from one to another by equipment used. Insufficiency of existing labor and equipments, improper disposal of waste in dumping sites, and low fee collection rates, are the main problems in the existing management system. There is no separation of hazardous and medical waste in all localities. These practices increase threat to citizens and the environment. Different citizens' attitudes toward solid waste management were revealed. Like, readiness of citizens to pay more for better collection system as their income increases, and the readiness of citizens living in separate houses to walk further to container than citizens living in apartments. There is a good indication about readiness of citizens to separate solid waste into five components for recycling purpose. On the other hand, there is a need to increase citizens awareness and care about solid waste management issues. The weight composition percentage of the solid waste in Nablus district is 63% organic material, 8% plastics, 3% metals, 3% glass, 10% paper and cardboard, 3% textiles 10% others and inert materials. It is clear that the

high portion of solid waste is organic material, as expected in developing countries. The variation in the composition between village and city is minor. The organic content is a bit higher in villages while the paper content is higher in the city.

Musleh (2002), has studied the of biological treatment in the West Bank, This project highlights the major factors determining solid waste policy making in a socio-political system in transition. The case study of the West Bank focuses on the biological treatment of solid waste disposal within the solid waste policy making process.

The research investigates technical, economic, and socio-institutional factors that determine biological treatment internationally. The research identifies the agencies involved in waste management, but the complexity of the internal and external forces and networks for the different actors and links for decision makers will be left for future research.

Mayyaleh (2008), focused on the assessment of Household Hazardous Waste Management, a comparative study for Nablus city and its refugee camps, the study aims at studying household hazardous waste (HHW) to determine the type and the quantity of hazardous materials most commonly used at homes, the level of awareness of household heads concerning the disposal of these substances, the extent of hazardous substance-related accidents and injuries occurring at homes. It also suggests an integrated management plan for HHW taking into consideration different engineering measures for managing the HHW from the point of generation to final disposal.

The study dependent on questionnaire was distributed among 1300 households. Findings indicate that home products and personal care products most commonly consumed hazardous substances at homes and 17.9% of the study households have injuries, poisons and burns from accidents resulted from the use of these substances. The study also found that the level of households' awareness of hazardous substances is generally low and is in need of continuous improvement.

Al Khateeb (2009), produced a study on municipal solid waste management in Jericho and Ramallah cities in the West Bank. This study assesses the technical and economic status of existing system. Two types of questionnaires were used, the first for institutional and the second for household survey. It is found that the solid waste management in the study area is not self sustaining since the overall all cost recovery from actual expenditures is 67% and 15% for Jericho and Ramallah respectively, suffering from lack of coordination, primary collection methodology is different, in Jericho it is the curb side collection, while in Ramallah it is community bin collection. A waste physical composition study was performed at two municipal solid waste disposal sites throughout the province with varying demographic and socioeconomic attributes. The results of the municipal solid waste composition survey showed the following results: the organics 40.15 % and 41.63 %, plastics 20.44% and 30.19% paper and cardboard 21.12% and 10.58%, glass 4.39% and 2.02% and metals 2.43% and 3.23% for Ramallah and Jericho respectively.

Cost analysis of solid waste management for the city of Qalqilia is prepared by Hinde (2010). This study aims at quantifying the benefits and costs of the solid waste management options in Qalqilia city. Four options

were discussed for the municipal solid waste (MSW) disposal in Qalqilia city and these are: Maintaining the existing situation (The do-nothing option); constructing a transfer station and transport MSW to Zahrat Al-Finjan Sanitary Landfill in Jenin District, constructing a sanitary landfill for Qalqilia City operated by the Municipality, making partial recycling to separate the recyclable materials and partial compost generation and then transfer the remaining part of the solid waste to Zahrat Al-Finjan sanitary landfill. Solid waste disposal options for Qalqilia City were evaluated based on cost analysis, where it was found that the first option which is maintaining the existing situation (the do-nothing option) has the largest cost which is 71.1$/ton, The second option; constructing a transfer station and transport the MSW to Zahrat Al-Finjan sanitary landfill, is more economic than the first option where the cost of Municipal Solid Waste Management (MSWM) is 58.7 $/ton. Making partial recycling for recyclables material and compost and transferring the remaining solid waste to Zahrat Al-Finjan sanitary landfill. The cost of MSWM can be from 45.9$/ton to 52.3$/ton. This option provides more jobs and reduces the vulnerability of groundwater and air pollution. Construction of sanitary landfill for Qalqilia City is the highest capital cost in addition to lack of the required land.

3.1.2 Solid waste service fees:

Currently, the provision of solid waste collection and disposal services consumes a large portion of the budgets of the municipalities and village councils. However, the contribution through fees from the people served in general is marginal and varies from one city or village to another; many have no fees at all. Collection fee coverage in a non-conflict situation

is in the range of 10- 20% of the real municipal solid waste management costs. There are no disposal fees collected in the Occupied Palestinian Territories [ARIJ, 2009].

3.1.3 Existing systems and technical status:

The urban collection system is based on three systems:

(a) Compacting trucks and 800-1,000 liter steel containers (mostly in the city centers).

(b) Larger 5-6 m^3 communal containers collected by skip-lift or roll-on trucks.

(c) 800-1,000 liter steel containers emptied by tipper crane trucks. There is currently no urban door-to door collection. Smaller communities and villages normally use manual door-to-door collection combined with truck transport.

Many of the trucks have been provided through various donor programs over a period of some years. As a consequence, the model of equipment varies quite widely, causing challenges for maintenance. However, the receptacle system (containers and bins) appears to have been standardized in a way that allows most trucks to collect the various containers used. In the refugee camps, the United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA) uses 800-1,000 liter steel containers and 5-6 m^3 containers collected by trucks.

3.1.4 Solid waste assembly, collection, transfer and transport:

The existing procedures seem to be based largely on international or local professional planning, resulting in systems and equipment that are appropriate and quite modern. With a focus on serving adequately as large portion of the population as possible, while keeping costs low, key elements would usually be:

- To minimize the number of truck trips to disposal sites.
- To optimize the collection routing, thus minimizing the travelling distance and time.
- To maximize the number of fully loaded trips to the disposal site (two trips per day should be an average minimum for trucks collecting small containers, but three or more trips would be preferable).
- To utilize to the maximum extent possible the available equipment.
- To provide a suitable and accessible receptacle system for the population served.

With the present composition and high density of municipal solid waste, the need for compaction may be limited when the transport distance to the disposal site is short.

In the short term, the existing combination of equipment will remain relevant. However, the use of small 5-6 m^3 communal containers and skip-lift or roll-on trucks is not the most efficient, resulting in a high number of trips with small loads. A system of medium or large back loading

compacting trucks for unloading a number of containers during each trip may be more efficient. For planning purposes, one truck for every 10,000 to 20,000 inhabitants served (depending on the container system and vehicle size) would be appropriate.

When gross domestic product (GDP) per capita increases, the density of the waste is reduced due to the lower content of heavy organic matter and increased content of lighter paper, plastics, and other packaging material. Consequently, as a long-term solution, compacting collection systems must be more or less the standard.

Door-to-door systems, or at least additional more dispersed manual collection, could still be a relevant solution in a situation with a large unemployed workforce. This system is active (using donkeys- and hand-carts) within some town areas and where vehicle access is limited. To introduce this system in more high-income suburban areas would be dependent on the people in such areas paying fees that would fully cover the costs.

The location of larger containers must take into consideration the walking distance involved. International experience indicates that this should not exceed approximately 100 m if uncontrolled local disposal is to be avoided. Furthermore, planning should be based on a collection of containers two or three times a week, depending on the season [Arij, 2009].

3.1.5 Transfer and haulage systems:

When a network of fewer disposal sites is established, the travel distances will increase, particularly in the West Bank. This will make a

transfer and haulage system financially and technically viable in many regions. Transfer and haulage will be increasingly viable as the number of people in the collection area increases. With the existing rather high density, compacting before haulage may not be necessary, but this must be introduced in long-term transport systems. State-of-the-art systems are already in extensive use in Israel, so regional experience is available.

It is questionable whether transfer and haulage is appropriate with the short transport distances in Gaza under a non-conflict situation. Normally, transfer and haulage is not viable with average transport distances less than approximately 15 km one way.

3.1.6 Solid waste recycling:

In municipal solid waste management, a principal priority is to reduce in waste generation and promote reuse, recycling, and resource recovery. Waste reduction is mainly an educational and awareness challenge and can be encouraged in most societies. In the present crisis situation, there are very few incentives for recycling in the Occupied Palestinian Territories, except for components having a potential net value through recycling. The almost complete absence of disposal fees fails to take advantage of the most common rationale for recycling, namely saving on disposal costs. The Occupied Palestinian Territories constitute a relatively small community and the industrial sector is very limited. Thus, the domestic potential is limited for industrial processing of many fractions that can potentially be recycled, and will probably continue to be so at least in the short and medium term.

The rationale for recycling could be pollution reduction, volume reduction, commercial use or substitution of virgin raw material. Another important aspect of recycling is that the specific costs for this go up with the increasing degree of recycling. In the Occupied Palestinian Territories, the best way to start recycling is with the fractions having a net value (metals), or those that supply a local demand (soils/compost), solve a particular problem (debris) or correspond to a domestic processing capability (metals and glass).

One low-cost approach is to focus on voluntary schemes based on incentives and education. This could bring the recycling rate up to 10-12%. To be able to achieve more, mandatory schemes and higher costs must be introduced. In the Occupied Palestinian Territories, such measures will be mainly applicable to the long term.

Some recycling activities previously took place in the Occupied Palestinian Territories, mainly in the private sector, and focusing on metals, glass and to some extent paper. Metals and glass were handled in Nablus and Hebron, respectively, while other fractions were brought to Israel. Car wrecks were recycled in Nablus [HWE, 2009].

In the region, the recycling industry is extensive in Israel, with some 1,100,000 tons recycled domestically in 2001, equating to a national rate of approximately 16%. In a non conflict situation, cooperation with this industry would be a natural option. There are currently some possibilities for financially viable export of certain fractions (e.g. cardboard, high-quality paper etc.) to Turkey. Egypt also has a very extensive recycling activity and it could be another option for export [HWE, 2009].

One particular fraction – debris – has become a major problem in many areas owing to the destruction of buildings and infrastructure. Most of the debris is in fact inert material (concrete, bricks, plaster etc.), which could be seen as recyclable and not as waste. Such material can be used in road-building, construction foundations and landscaping, or be crushed to gravel. The challenge is to extract minor problem fractions such as reinforcement, wood etc. This may be achieved through using special cutting equipment designed for environmentally-friendly demolition. Such equipment is inexpensive and can be fitted on existing excavators.

3.2 Regional Studies:

Municipal Solid Waste Management (MSWM) is one of the most serious environmental concerns in the Mashreq and Maghreb countries (the Region), especially because of its adverse effects on the quality of life, human health, natural resources, and on economic development. Population growth and increased development activities have resulted in an increased level of waste generation. All Mashreq and Maghreb countries have identified solid waste management as a national priority within their National Environmental Action Plans. Furthermore, many national solid waste strategies and programs are currently being prepared by all countries that are expressing a strong interest in furthering their efforts in tackling solid waste management in a more comprehensive and cost effective way [METAP, 2003].

Despite the considerable efforts by many countries to address the existing situation, much work is still needed to meet the challenges of improving the current management conditions. As a result.

Launched in January 2002, the RSWM Project, a three year initiative, aims particularly for the Mediterranean Region at:

a) Providing tools to national and sub-national (i.e. regional and/or municipal) institutions to plan, design, implement, operate, and manage ISWM systems, through the preparation of development capacity modules, development of operational guidelines, and the organization of national and regional training courses.

b) Promoting the exchange of information and experiences within the region in the field of solid waste management.

c) Strengthening the national, municipal, and NGOs capacities and expertise.

3.2.1 SW in regional countries:

A study was conducted by Mediterranean Environmental Technical Assistance Program (METAP). (2003) regional solid waste management project. Throughout the region, it is estimated that more than 45 million tons of municipal solid waste were generated in 2010. The following table shows the wide variations in the generated waste quantities within the region. There are very significant differences in quantity depending on many factors, such as:

- The size of the population living in the area.
- The type of sources of the area (commercial, residential, touristic, industrial, etc.).
- The quantity of public or private gardens.

- Whether the families living in the area are predominantly poor or rich.
- The season of the year.
- The cultural aspects of the area affecting the composition, quantity and peak-days of the solid waste produced.

Table (7): Solid Waste Generation for South and East Mediterranean countries [METAP, 2003].

Region	MSW Generation (million tons/year)
Algeria	7.4
Egypt	20.1
Jordan	2
Lebanon	1.8
Morocco	8.8
Palestinian Authority	1.7
Syria	5.7
Tunisia	2.3

Some typical waste generation rates for low-income, middle-income and high income countries Organic waste comprises by far the highest proportion of municipal solid waste, ranging from 55-70% by weight. Plastic comprises approximately 7-10% and paper and paperboard waste comprise approximately 11-14% by weight. A wide variety of other materials is generated at lower quantities. All specified in Table (8).

Table (8): Solid Waste Composition for South and East Mediterranean countries [METAP, 2003].

Component	**Typical of Region (%)**	**Countries outside typical region (%)**
Paper/ Cardboard	11-14	Lebanon 17% Israel 22%
Glass	2-7	Lebanon 9%
Plastic	7-10	Jordan 16% Israel 14%
Metal	2-6	
Component	**Typical of Region (%)**	**Countries outside typical region (%)**
Organics	55-70	Israel 43%
Fabric/ Textiles	3-5	
Unspecified	2-5	Egypt 13% Israel 8%

Knowing the composition of waste is important for deciding the treatment systems. Numerous factors have an influence on the composition and characteristics of solid waste:

- The area: residential, commercial ,etc.
- The season and weather (differences in the amount of population during the year, tourist places).
- The economic level (differences between high and low-income areas). High-income areas usually produce more inorganic materials such as plastics and paper, while low-income areas produce relatively more organic waste.
- The cultural aspects of the zone.

Urban waste is normally divided into three major groups:

- Inert waste: metals, glass, soil, slags and ashes.
- Putrescibles: food waste and yard trimmings.

- Combustibles: paper, cardboard, plastics, wood, tyres, leather and textiles.

The status of solid waste shows two main solid waste generation trends in the region:

- Waste generation in the region might increase by up to 50% between 1998 and 2012.
- The composition of waste is changing: Global experience indicates that as economies develop, the proportion of organic materials in the waste stream decreases as packaging-related waste increase

3.2.2 Cost analysis of MSWM:

A study was prepared by Abu Qdais (2006), discusses the various practices and challenges of solid waste management in Jordan from both a technical and economic perspective. An overview of the current practices and their environmental implications in three major cities of the country, which generate more than 70% of the country's solid waste, is presented. Recent literature on solid waste management in Jordan has been reviewed; and data on the total amount of municipal solid waste generated, compositional variations over the last two decades, and future projections are presented.

The necessity, importance and needs of solid waste recovery and reuse are identified. The review of the legal frameworks indicated that there is a need for detailed and clear regulations dealing specifically with solid waste. The service cost analysis revealed that none of the municipalities in Jordan sufficiently recover the cost of the services, with more than 50%

being subsidized from the municipalities' budgets. The allocation of the available resources was analyzed and service performance indicators assessed. Factors that should be taken into consideration when making the decision to move from a traditional SWM approach to a more integrated approach are highlighted and suggestions for a more smooth transition are recommended.

Recovery for solid waste management in Lebanon. This study talks about project financed from World Bank, the project is to promote the adoption of integrated solid waste management in the selected Mediterranean countries, among which Lebanon. The project will provide the necessary tools for designing, developing, and implementing the main elements of ISWM while promoting exchange of information and experiences within the Region in the field of solid waste management.

The objectives of the project were to:

1) Develop a legal framework that supports the adoption of ISWM.

2) Implement training modules at the national and municipal level for the application and enforcement of the legal framework with focus on capacity development in supervision and monitoring contracts.

3) Develop an economic model with relevant implementing tools that assist municipal and national entities in selecting preferred SWM.

4) Assist concerned institutions in selecting and applying two of the World Bank Regional Guidelines for Solid Waste Management in METAP countries.

A study prepared by ELARD (2005). The costs of waste

management in Lebanon like capital, operational and management costs and predicted trend of growth of revenues were estimated.

Revenues from the municipal charge on the rental value of property, as well as that from the municipal charge on utility bills both fall below the minimum cost of a SWM system. Therefore, each of these two sources would not be sufficient to fulfill the cost requirements of implementing a SWM system in Lebanon.

Policy and institutional assessment of solid waste management in five countries Cyprus, Egypt, Lebanon, Syria, Tunisia by El Jor. (2002). This study reflects the current practices, problems and planned solutions for Lebanon's Municipal Solid Waste Management. Although industrial and hospital waste represent an important element in the country's Solid Waste situation, they shall not be covered by this study.

The aim of this study is to assess the policy and institutional frameworks for MSW management in five countries of the region, namely Egypt, Syria, Lebanon, Tunisia and Cyprus. The objectives are to identify appropriate strategies and solutions for improvement based on each country's needs and the broader political and social changes going on within that country by estimating the cost values for strategies.

The outputs of this study are:

1) Resources deemed necessary to carry out the tasks of MSW management are various but are here mostly designated as both Human and Financial and neither are available to the authorities mandated to manage MSW.

2) The Beirut Emergency Program that is currently carried out by the Sukkar Group is running into financial problems due to the high costs incurred for the purpose of running an operation by international standards. The local governments' sources of revenues that would be partly used to finance the MSW management are the municipal revenues consisting of:
   a) 11% municipal tax on rental values, and proceeds from land sales and construction permits that are collected directly by the municipalities (direct taxes).
   b) A share of the revenues collected by the Central Government (10% surcharge on telephone, electricity and water bills, and duties on imports, liquor and fuel) and distributed to the municipalities on the basis of their registered population and size of the spent previous year's budget.

However, the flow of these revenues was severely affected during the civil strives years leaving the municipalities with an eroded resource base. Currently, due to governmental budgetary constraints, municipalities cannot depend on transfers from the Independent Municipal Fund, but rather on ad-hos advances from the Central Government just to meet priority needs.

3.3 Worldwide Studies:

Managing solid waste is one of biggest challenges of the urban areas of all sizes, from mega-cities to the small towns and large villages, which are the home to the majority of humankind. It is almost always in the top five of the most challenging problems for city managers. It is somewhat

strange that it receives so little attention compared to other urban management issues. The quality of waste management services is a good indicator of a city's governance. The way in which waste is produced and discarded gives us a key insight into how people live. In fact if a city is dirty, the local administration may be considered ineffective or its residents may be accused of littering (UN-HABITAT, 2010).

Good solid waste management system is like good health: if you are lucky to have it, you don't notice it; it is just how things are, and you take it for granted. On the other hand, if things go wrong, it is a big and urgent problem and everything else seems less important (UN-HABITAT, 2010).

Managing solid waste well and affordably is one of the key challenges of the 21st century, and one of the key responsibilities of a city government. It may not be the biggest vote-winner, but it has the capacity to become a full-scale crisis, and a definite vote-loser, if things go wrong.

3.3.1 Solid Waste Management Techniques

A Sustainable Waste Management Techniques were studied by Taiwo, (2010). Attaining sustainability in waste management requires an option that employs environmental friendliness. Such a technique must be effective, efficient and less costly than many options. The techniques are: landfill (open dumping sites, sanitary landfills and secured landfills), incineration, pyrolysis and gasification, composting and anaerobic digestion. He shows the environmental effects and benefits of these techniques and the costs considerations. The study shows that the composting technique is more suitable option of solid waste management because it is cheap, environmentally friendly, wealth creating and

sustainable. This action will lead to waste reduction at landfill, job creation and production of organically produced food crops. Organic agriculture has continued to gain more ground all over the world for its sustainability and safety of the farm produce.

The economic and environmental evaluation of waste treatment and disposal technologies for municipal solid waste were studied by Daskalopoulos et al. (1998). This study reviews the main economic costs and the environmental impacts of the widely- accepted waste treatment and disposal methods. Three basic alternatives for MSW disposal were discussed: direct dumping of unprocessed waste in sanitary landfills, processing of the waste before final disposal and processing of the waste to recover resources "material and/or energy" with subsequent disposal of the residues. The process, environmental impacts, operational factors, examples of successful waste management schemes were presented and future trends were assessed. Municipal solid waste (domestic and commercial) options are discussed, these options are landfilling of the waste, waste incineration with or without energy recovery and recycling or composting the relevant fractions of the waste streams. The factors that influencing recycling programs are: technical limitations, level of public participations, markets for recycled products and economic viability of recycling operation. Municipal solid waste management was defined as the discipline associated with the control of generation, storage, collection, transfer, processing and disposal of MSW, in a way which is governed by the best principles of public health, economics, engineering, aesthetics, and other environmental considerations.

Renkow and Rubin (1998) investigated if municipal solid waste composting make economic sense. The article claims that there is little information on the costs of MSW composting and how those costs compare with the costs of alternative forms of waste disposal (especially traditional land disposal). The article reported the results of a survey of 19 MSW composting facilities around the United States. Results indicated that MSW composting generally costs around $50 per ton, and that very few facilities receive any revenues from the sale of compost to offset operating costs.

Additional economic analysis indicates that, at present, MSW composting cannot be justified on financial grounds in most parts of the US, but may be competitive with land disposal where the cost of landfillling is high (such as the north-east). Municipal solid waste composting technologies, surveys results, compost uses, costs of MSW composting, and comparison between the MSW composting and the land disposal were discussed in this paper.

Emery (2007) prepared an environmental and economic modeling for a case study of municipal solid waste management scenarios in Wales. A case study area in a typical South Wales valley location was selected to model the environmental and economic impacts of a number of waste disposal scenarios. The environmental impacts of a number of waste management scenarios were compared using a life cycle assessment (LCA) computer model.

The studied scenarios are:

- A 'Do Nothing' scenario which 100% of MSW recovered being disposed of in landfilll site.

- Meet 2009/2010 recovery targets through a combination of recycling and composting
- Meet 2020 landfill directive targets through a combination of recycling , composting and incineration.
- A ' Burn All' scenario. 100% of municipal solid wastes are to be sent to an incinerator.

An interactive Microsoft excel spreadsheet model was also developed to examine the costs, employment and recovery rates achieved using various waste recovery methods including curbside recycling and incineration. The LCA analysis showed the incineration option to be more favorable than the landfill and recycling/composting options. However, the economic modeling results showed higher running costs and lower associated jobs when compared to the other options such as recycling. The paper concludes by suggesting that integrated waste management will ultimately be the most efficient approach in terms of both economics and also environment benefits.

3.3.2 Public awareness and willingness for recycling:

Mohammad Aljaradin. (2011) prepared a study for public awareness and willingness for recycling in Jordan. This paper examines the level of willingness and awareness of recycling of Municipal Solid Waste (MSW) among residential, with specific focus on university students. A total of 1,000 residents were surveyed using 3 types of questionnaires designed to pattern their views on recycling of MSW and to test their willing for recycling, but also to examine their knowledge and awareness of recycling befits on a social, economical and environmental basis. In total 28

questions have been asked in a computer based survey to the students. The result clear that the recycling knowledge between respondents is very low. However, they were hold a positive attitude toward the willing for learning more. Respondents also aware of the environmental and economical benefits from recycling, whereas they have negative attitude toward walking more distance and for paying more for better recycling.

In this study the females feel more responsible for recycling more than men, but their knowledge for recycling appears less than them.

Finally, no expectation that the people will do recycling in their school, university home and work, if you did not provide them with the basic facilities needed and without teaching them how to recycle. Many agreed that awareness program should be started to teach them about recycling benefits and to teach them how to recycle.

Somehow the government in some point could need to enforce the source separation at generation point.

El Hawi et. al. (2002) has studies the recycling of municipal solid waste in the Gaza Strip. This paper aims at evaluating the willingness of the public to participate in recycling activities, and assess recycling from the strategic disposal point of view as an alternative to land filling in the Gaza Strip. The objectives of the study are to:

- Review, understand and analyze recycling in the Gaza strip.
- Assess public concern on recycling and if the public are willing to use recycled products.
- Assess willingness to start source separation.

- Assess how decision-makers are evaluating recycling from the disposal strategy point of view.
- Analysis of respondents/target group and interpretations regarding recycling.

The results of this study is high willingness of public to use recycled products However, public health was the main concern of respondents followed by religious and cultural aspects. Respondents could be motivated to start source separation. However, awareness programs on source separation and incentives from municipalities to encourage the public to start separation are not available.

McDonald (1998) prepared a paper of public participation in plastics recycling schemes. This paper presents the results of a structured survey of 500 members of the public served by schemes to collect plastics waste for recycling. Data were gathered on the characteristics, behaviors and motivations of recyclers. The author also sought to discover how the public perceive plastics compared to other materials, and as a recyclable material. Responses were collected in such a way that the awareness of the recyclability of materials could be compared with the recycling behavior of respondents. An element of comparison was introduced between those served by a system of bottle banks (bring scheme) and those covered by a household collection (collect scheme). The survey results are reported and their implications for the management of post-consumer plastics waste collection schemes are discussed.

3.3.3 Financial analysis of solid waste management:

In a paper which is prepared by Palmer (1996), on the Cost of Reducing Municipal Solid Waste. This paper explores public policies for reduction of municipal solid waste. A simple model of waste disposal was parameterize using supply and demand elasticities from the economics literature and 1990 prices and quantities of recyclable and recycled materials. Using this model, the waste reduction was calculated in response to three public policies:

1) Deposit/refunds.
2) Advance disposal fees.
3) Recycling subsidies.

The results illustrate the effects of the three policies on source reduction and recycling of five recyclable materials that comprise 56% of municipal solid waste: aluminum, glass, paper, plastic, and steel. The calculated responses provide information about the cost of reducing municipal solid waste through various policies.

This analysis found that a deposit/refund is significantly less costly than either a recycling subsidy or an ADF. However, high administrative costs might alter this conclusion, making an ADF appear more attractive.

The analysis also suggests that a modest reduction in municipal solid waste would be efficient if it could be accomplished without large administrative and transactions costs. The marginal social benefits of waste reduction was considered to result from avoided disposal and transportation costs. These avoided social costs currently amount to approximately $33

per ton, although the costs vary substantially by region. This marginal benefit implies that a 7.5% reduction in the wastes in our model would have been optimal in 1990 from a benefit-cost perspective if the reduction were accomplished by a deposit/refund.

Other paper in 2005 was hold by DSM Environmental Services, Inc. about the price of solid waste management services in Vermont. The objective of this paper is to determine current prices charged for collection and disposal of residential and commercial municipal solid waste (MSW), residential and commercial recycling services, and collection and disposal of construction and demolition (C and D) debris.

This report compares current prices to baseline prices identified in 1999 where appropriate. As another point of comparison, current prices for solid waste management services in Vermont are compared to prices in neighboring states. To the extent possible, DSM followed the same methodology and has reported the data in the same way as in 1999. However, in some cases it has been necessary to change the method of reporting the data. These changes have been noted where they impact on the comparison of results.

As in 1999, DSM focused its survey for the curbside residential, commercial, and C and D analysis on four representative regions of the state: Bennington County, Chittenden County, the Vermont side of the Connecticut River upper valley (Upper Valley) and the Northeast Kingdom. For information on drop-off services and surcharges, DSM evaluated information from other regions of the state as well. The survey and analysis methodology is similar to that used in 1999, with the

exception of greater emphasis on the commercial sector in 2005. Information on solid waste prices in other states is new to the 2005 report.

Results show that Vermont prices are roughly 25% higher for drop-off and curbside service and tip fees than most of those in comparison states. One likely reason for this higher amount is the surcharges placed on solid waste in Vermont, and the other is that Vermont waste is transported out of state in larger volume than some other rural states, and thus increased transportation charges are included.

In the study prepared by Golder Associates Inc. (2004) cost analysis of the archuleta county solid waste management system. This study was conducted due to the inadequate funds being set aside for future capital expenditures at the County-owned and operated Archuleta County Landfill (ACL), such as that for equipment replacement, cell development and closure/post-closure financial assurance, as well as to gain a better understanding of the financial stability of the Solid Waste Fund, the County requires an analysis of their solid waste disposal system from an engineering economics perspective.

The study analysis focuses on the tipping fees required to operate the system in a self-sustaining manner under the current conditions as well as under other viable options such as either partial or complete transfer of waste to other disposal facilities. Another option that could be considered, but is outside the scope of this analysis, is privatization of the ACL operation.

The scope of the project consisted of:

1. Current System: Providing a current system cost breakdown of the operations “as is,” including landfill operating costs, transfer station operating costs, system administration, and hauling costs (for the County-operated transfer stations). The appropriate tipping fee was determined for the self-sustaining operation of current system (base tip fee), along with recommendations for appropriate additional tip fee increments to allow set aside of funds for future capital expenditures including equipment, staffing, and cell construction.
2. Transfer Option: A cost breakdown was prepared to determine whether a potential economic benefit would exist if the Archuleta County Landfill were utilized only for bulky wastes, such as construction and demolition waste, and for the remaining municipal solid waste (residential and commercial) to be transferred to other landfills. Three landfills within a 100-mile radius were evaluated.
3. Based on the economics of Items 1 and 2 above, recommendations are made at the conclusion of the analysis for the best option and the associated tipping fee requirements for implementation of the recommended option.

To plan for the financial means to support the County’s solid waste landfill and transfer station operations, Archuleta County has requested that Golder evaluate future disposal options. Utilizing financial estimates and assumptions provided by the County, as well as estimates of available airspace at the landfill facility, Golder performed basic financial modeling for the solid waste system for the following options:

• Option 1: Operation of site using 2004 budget information without the addition of cell development costs of Phase 3 and 4 or any new equipment.

This is the current situation. Adjust tipping fees to adequately reflect the current “baseline” expenditures.

• Option 2: Operation of the site using 2004 budget information with the addition of cell development costs estimates for Phase 3 and 4. Adjust tipping fees to offset expenditures and improve funding for future capital outlays.

• Option 3: Operation of the site, using selected 2004 budget information with the addition of cell development cost estimates for Phases 3 and 4, new equipment, and restructured staffing of landfill personnel.

• Option 4: Consider a larger transfer station (constructed either by the County or by a Contract Operator) and transfer all commercial, residential, and industrial solid waste to a third-party landfill. Continue to operate the ACL only for bulky wastes such as construction waste, demolition waste, tires, appliances, and yard waste to offset costs for closure, post-closure, equipment, cell development, and monitoring.

• Option 5: Transferring all waste to a third-party landfill, and closing the Archuleta County Landfill.

Analysis of system revenues and expenditures from the year 2001 to the year 2004, personnel/staffing costs, and equipment operation and maintenance costs and other costs and benefits and revenues were also discussed in the report.

The benefit cost analysis of recycling programs for the Eugene Saint Vincent de Paul was studied by Jackson and Strauss (2007). This study aims to conduct a benefit-cost analysis of the recycling programs of the St.

Vincent de Paul Organization. It begins by examining the costs of landfill use, including operating costs, external costs, and the issue of scarcity rent as it relates to landfills.

The benefits created from the recycling activities of St. Vincent de Paul are also examined. These benefits arise from the sale of recycled and reconditioned materials, as well as from the job opportunities the recycling program creates. The study attempts to quantify the benefits from the vocational service programs provided by St. Vincent de Paul. The study concluded that the external costs of having and using a landfill are higher than the tipping fee, which causes an inefficiently high amount of waste to be disposed at the landfill.

The study argued that the external costs of the landfill justify higher tipping fees (perhaps by imposing a tax on the landfill), a subsidy for alternative methods of waste disposal, or increased payments to SVDP for diverting waste from the landfill.

3.3.4 Worldwide studies summary:

The main points are summarized below:

1) The main solid waste management techniques are: landfill (open dumping sites, sanitary landfills and secured landfills), incineration, pyrolysis and gasification, composting and recycling.
2) When we choose an option for SW management, it should be more suitable option: cheap, environmental friendly, wealth creating and sustainable.

3) The factors that influence recycling programs are: technical limitations, level of public participations, markets for recycled products and economic viability of recycling operation.
4) The most important matter in SWM is people participations by questionnaires or meetings to know public awareness and willingness for it.
5) Recycling is the most suitable technique for municipal solid waste reduction.
6) It is important to know the solid waste composition percentages in cost analysis operations.
7) Before starting SW separation and recycling, be sure of the selling price for SW components in local markets.
8) The main elements of financial analysis for solid waste management are:
    a) Capital cost.
    b) Administration and operation costs.
    c) Benefit cost ratios.
    d) Revenues.

3.4 Comparative analysis:

Ayalon (2000) conducted a study of application of a comparative multidimensional life cycle analysis in solid waste management policy: the case of soft drink containers. This paper described the application of a multidimensional life cycle analysis (LCA) for packaging soft drinks in Israel. The suggested an approach that combines the conventional product LCA, vertical summation of all environmental burdens along the chain of production, use and disposal activities, and horizontal comparison of

different products and disposal options, such as recycling, incineration or land filling. The paper attempts to show that the most effective, as well as transparent, means of comparing packaging alternatives, is to place them on a commensurate basis, the most appropriate one being a monetary basis. Taking into account limitations and drawbacks of monetary valuation of non-market assets (namely, environmental assets), the study derived estimates of environmental benefits and damages associated with each alternative. The production of soft drinks containers in Israel, used here as an example for the above mentioned considerations, is based mainly on imported materials, since natural resources such as oil or bauxite do not exist in Israel. Locally, only direct production and pollution abatement costs are incorporated in the final bill, while global environmental burdens are excluded. Countries extracting and producing raw material for the packaging industry, in effect, grant an environmental subsidy to the final users, in this case the Israeli user. The paper suggests that only by globalization of externalities and fully internalizing environmental costs into the price of the final product (the packaging material or the packaged product), an equitable full environmental accounting can be designed. This mechanism can be even accompanied by global trading in the relevant environmental credits. Decisions will, consequently, follow a sustainable path, in both importing and exporting countries.

Other study carried out by Koufodimos and Samaras. (2002) on waste management options in southern Europe using field and experimental data, shows that the waste generation profile that determines the appropriateness of different waste management options was created after a 1-year municipal waste sampling investigation conducted in the

Municipality of Pilea in Northern Greece. The paper described the results of:

1) The sampling method, which was conducted four times during 1 year (once per season) in selected areas of the city.
2) The qualitative analysis of the collected samples.
3) The waste treatment, which consisted of drying, grinding, calorific value measurement, incineration and chemical analysis of the collected samples.

Comparative analysis between the above mentioned data and on past data derived from investigations conducted in other Greek regions with similar characteristics to those of Pilea were used to identify and discuss future trends in the composition of generated waste over time. An analysis of the current waste management status in Greece as well as the feasibility of implementing a comprehensive management approach is assessed taking into account guidelines set worldwide to promote renewable energy sources use. It is concluded that recycling, perhaps the most positively received of all waste management practices, is going to be an essential part of contemporary waste management strategies, composting can play an important role, while incineration seems to be a conditionally feasible solution.

Lasaridi et al. (2006), presents the results from a comparative study of municipal solid waste (MSW) costs and respective management practices of the municipal authorities in Attica, Greece. Data on MSW collection, transport and disposal as well as their costs, from 33 municipalities of the largest region of the country were collected through a

questionnaire survey. The annual waste production of the municipalities examined ranged from 50 (Antikithira) to 511,000 ton/yr (municipality of Athens), while the total waste management cost ranged from 41 (Helioupolis) to 184 €/ton (Amarousio). The MSW management costs are determined by a number of factors, including their quantity and composition, collection and transportation systems, treatment and final disposal methods, etc. A number of efficiency indicators are also estimated for each municipality in terms of solid waste disposal policy. Finally, an attempt to identify the causal factors for the differentiation of municipal costs is made, without underestimating the restrictions of the current analysis originating from the lack of reliable waste production data and full cost accounting systems.

Visvanathan and Trankler (2003) presented scenario of municipal solid waste management (MSWM) in four study countries of Asia – namely China, India, Sri Lanka and Thailand comparing technical, economic, legal and, health issues. An overview of various aspects of the municipal solid waste (MSW) is provided comprising all domestic and non-hazardous wastes in the urban areas of the above countries with emphasis on the generation and composition of MSW, management needs, collection systems practiced, transportation and disposal systems used. The collection systems and their lacunae, the recycling practiced with respect to the involvement of the government and the private sectors are underlined. Disposal methods in India and Thailand find mention in particular for landfill and incineration. Other issues taken up are the effects on MSW due to cultural aspects and climatic variations. Moreover, it reflected the public awareness and participation of the community in MSWM as well as the

involvement of the NGOs and the private sector. Finally, the emerging trends with respect to the integrated solid waste management (ISWM) have been discussed.

Chapter Four

4. Methodology

4.1 Experimental Program:

This study depends mainly on an experimental program, that enhances the study results, the two experimental programs depend on applying pilot separation for manual separation of solid waste for Tulkarem District. The other one is a field survey which depends on applying a questionnaire for the study which aims at recognizing the people's point of view about the idea of source and transfer station separation and how will their participation for this idea will be. A detailed program and methodology are clarified below. In this study, the components of experimental program are:

1. Solid waste sorting.
2. Field questionnaire.
3. Cost analysis and comparative analysis.
4. Data management and statistical analysis.

4.1.1 Solid Waste Sorting:

The solid waste composition and sorting at Wadi Shaer transfer station was verified via pilot separation to identify the percentage of the different waste components. Pilot separation has a high significance and use: waste composition information has widespread applications and can be used for activities such as solid waste planning, designing waste management facilities, and establishing a reference waste composition for use as a base line standard in both facility contracts and acceptance test

plans. The method can be used to define and report the composition of municipal solid waste through the selection and manual sorting of waste samples. Where it can be applicable, care should be taken to consider the source and seasonal variation of waste. After performing a waste composition analysis, laboratory analysis may be performed on representative samples of waste components, or mixtures of waste components, for purposes related to the planning, management, design, testing, and operation of resource recovery facilities.

This study used standard test method for determination of the composition of unprocessed municipal solid waste (ASTM D5231). This test method describes procedures for measuring the composition of unprocessed municipal solid waste by employing manual sorting. This test method applies to determination of mean composition of MSW based on the collection and manual sorting of a number of representative sorting samples of waste over a selected time period covering a minimum of one week.

4.1.1.1 Solid Waste Sampling Precautions:

1. Review of the hazards and procedures with the operating and sorting personnel prior to conduct the field activities.
2. Sharp objects, such as razor blades, needles, and pieces of glass, are present in solid waste and they are removed carefully and put a side.
3. Personnel handling and sorting solid waste were appropriate protection clothes, such as heavy safety clothes, heavy leather gloves, dust masks, hats, safety glasses, and safety boots.
4. Containers of liquids or other potentially dangerous wastes are put aside and handled by SW crew.

4.1.1.2 Procedure:

1. Select a location for the discharge of designated loads, manual sorting activities, and weighing operations that is flat, level, and away from the normal waste handling and processing areas.
2. After unloading solid waste, random samples were taken.
3. All waste are mixed.
4. Segregation the wastes into nine categories.
5. Weigh the categories, the results have been recorded and compared accordingly.
6. Waste sampling was conducting during one month, a daily sampling except Fridays.
7. The total number of samples is 26 samples starting on 20/3/2011 till 18/4/2011, total weight is 17,661 kg.

4.1.1.3 Calculation:

1. Number of 91 to 136kg Samples:
2. The number of sorting samples (that is vehicle loads) (n) required to achieve a desired level of measurement precision is a function of the component(s) under consideration and the confidence level. The governing equation for n is as follows:

$$n = (t^* \, s/e \cdot \bar{x})^2$$

…… (ASTM, 2008)**.**

where:

t* = student t statistic corresponding to the desired level of confidence

s = estimated standard deviation, e = desired level of precision

$\bar{x}$ = estimated mean.

All numerical values for the symbols are in decimal notation. For example, a precision value (e) of 20 % is represented as 0.2.

Table (9): Values of mean (x) and standard deviation (s) for within-weak sampling to determine MSW component composition (ASTM, 2008).

Component	Standard deviation (s)	Mean (x)
Newsprint	0.07	0.10
Corrugated	0.06	0.14
Plastic	0.03	0.09
Yard waste	0.05	0.04
Food waste	0.03	0.10
Wood	0.06	0.06
Other organics	0.06	0.05
Ferrous	0.03	0.05
Aluminum	0.004	0.01
Glass	0.05	0.08
Other inorganic	0.03	0.06

Table (10): Values of t statistics (*t) as a function of number of samples and confidence interval (ASTM, 2008).**

No. of samples, n	90%	95%	No. of samples, n	90%	95%
2	6.314	12.706	24	1.714	2.069
3	2.920	4.303	25	1.711	2.064
4	2.353	3.182	26	1.708	2.060
5	2.132	2.776	27	1.706	2.056
6	2.015	2.571	28	1.703	2.052
7	1.943	2.447	29	1.701	2.048
8	1.895	2.365	30	1.699	2.045
9	1.860	2.306	31	1.697	2.042
10	1.833	2.262	36	1.690	2.030
11	1.812	2.228	41	1.684	2.021
12	1.796	2.201	46	1.679	2.014
13	1.782	2.179	51	1.676	2.009
14	1.771	2.160	61	1.671	2.000
15	1.761	2.145	71	1.667	1.994
16	1.753	2.131	81	1.664	1.990
17	1.746	2.120	91	1.662	1.987
18	1.740	2.110	101	1.660	1.984
No. of samples, n	**90%**	**95%**	**No. of samples, n**	**90%**	**95%**
19	1.734	2.101	121	1.658	1.980
20	1.729	2.093	141	1.656	1.977
21	1.725	2.086	161	1.654	1.975
22	1.721	2.080	189	1.653	1.973
23	1.717	2.074	201	1.653	1.972
			∞	1.645	1.960

For applying the equation, plastic is selected as the governing component the period is not less than one weak (5-7 days).

Each sorting sample weighed 91-136 kg.

Using equation:

$$n = (t^* \, s/e \cdot \bar{x})^2$$

e = 10% = 0.1.

$\bar{x}$ = 0.09 (Table 9)

s = 0.03 (Table 9)

t* = 90% confidence interval.

First we used n = ∞ ➔ ***n*** = (1.645 * 0.03 /0.1 * 0.09)² = 30

New ***n*** = (1.699 * 0.03 / 0.1 * 0.09)² = 32 sample.

The equation was applied for all categories to calculate the samples, then, estimated the average samples. Table 14 summarizes the results.

Table (11): Number of samples for each category of solid waste components

No.	Category	Number of samples (n)
1	News print	134.5
2	Corrugated	52
3	Plastic	32
4	Yard waste	422.8
5	Food waste	26.4
6	Wood	270.6
7	Other organic	389.7
No.	Category	Number of samples (n)
8	Ferrous	99.3
9	Aluminum	45.3
10	Glass	107.6
11	Other organic	69.6
	Total	1,649.8
	Avg	150

For each sample we need 91- 136 kg ➔ 150* 91 - 150* 136

= 13,650 kg - 20,400 kg

For four weaks (26 days) = 13, 650/26 – 20,400/26

= 525 kg/day – 785 kg/day.

4.1.1.4 Apparatus:

1- Separation table covered by steel mesh (2 * 2 cm).

2- Waste buckets (50 liter) that are labeled with each component.

3- Balance.

4- Personnel handling and sorting solid waste wore appropriate protection clothes, such as heavy safety clothes, heavy leather gloves, dust masks, hats, safety glasses, and safety boots.

5- Brooms and labels.

6- Small axe.

Figure 7: Solid waste recycling apparatus.

Figure 8: Solid waste recycling operation.

4.1.1.5 Solid waste component categories:

The following are the main items that have been separated through the pilot:

1- Organic: all food wastes resulting from kitchens, fruits and vegetables from supermarkets, ….etc.

2- Papers: Office paper, computer paper, newspaper, magazines, waxed paper, books and notebooks.

3- Cartoons: packaging cartoons and all cartoons.

4- Wood: lumber and wood products.

5- Plastic: all plastics.

6- Glass: all glass.

7- Metals: Iron, steel, tin cans, and bi-metal cans, Aluminum, aluminum cans, and aluminum foil, …. etc.

8- Textiles: clothes, carpets, sewing products, curtain, ….all textiles.

9- Others: anything except hazardous wastes, bulky wastes, asbestos, car tires, green wastes (trees), Rock, sand, dirt, ceramics, plaster ,…etc.

4.1.2 Field questionnaire:

The questionnaire is designed for three categories: households, Local Governmental Units and Involved people employees in the SW service.

4.1.2.1 Design of household questionnaire:

As generators of MSW, the public must be aware of the hazards posed by ineffective management of the refuse. Hence the government, environmental organizations and other groups are required to play a key role in bringing about this awareness through role play in the MSWM programs which in turn creates a sense of ownership among the individuals thus developing keen interest for shouldering responsibilities. Unless the public are involved throughout the MSWM programs by the implementing agencies, awareness cannot be achieved. Once the public comprehend and acknowledge the main constraints and challenges in the system, perceptions can be noticed in forms like:

- Voluntary involvement in MSWM campaigns.
- Following of rules and regulations concerning waste disposal.
- Willingness to pay adequate fees and charges.
- Source separation and effective use of the facilities.
- Voicing any environmentally unethical behavior on the part of the public or the government.

This questionnaire was designed to examine households' satisfaction about the solid waste reuse and recycling, meaning of solid waste, recycling and composting, awareness and attitude toward willingness to incorporate in the solid waste management, especially, waste recycling, source separation, keenness to pay for the solid waste services, questions about solid waste generation weight, percentages of solid waste

composition as well as the information about the gender, marital status, family size, type of house (separate or apartment), educational level, social habit of who throw the garbage and occupation were assessed.

The samples of questionnaires were distributed to all authorities that loaded their solid waste in Wadi Shaer transfer station (Tulkarem city, Wadi Shaer, Alsa'biat and Al Kafriyat beneficiaries), that is called the study area. The detailed questionnaire is illustrated in Appendix (E).

Local Governmental Units Questionnaire:

In most countries, the municipality is the designated waste management authority. This has resulted in national policy and legislation designating municipal authorities as the implementers of national recycling strategies, either by formulating local ones or setting up organized recycling schemes. Municipal officials' perceptions and attitudes as stakeholders are critical to fulfill this role. There is a wide range of stakeholders - individuals, organizations and groups both in the formal and informal sector - involved and concerned with MSWM as generators, regulators and legislators. Waste management strategies can only be effective if all the stakeholders work in tandem for a successful venture. The gradual changes in the environmental policies and guidelines with increase in human resources in the field through education and training have initiated the process of effective management. However, the main barriers are lack of financial resources for the MSWM sector, regulations and their enforcement, and community awareness, involvement and participation. Community participation is of utmost importance as generators of the solid waste.

The local government questionnaire was designed to measure and evaluate the technical, operational and financial capacities of the institutions involved in the solid waste handling in the study area. This questionnaire included data on institutions itself and their functionality, number of employees and their classification, equipments owned and contracted by local authorities for solid waste collection, served areas by solid waste collection service, maintenance of solid waste equipments, solid waste collection fees, their willing to solid waste recycling and their prediction for people responses for applying solid waste recycling. The detailed questionnaire is illustrated in Appendix (E).

Involved people in the SW service employee's Questionnaire:

It is so important to design a special questionnaire to the solid waste employees for their direct conduct to the solid waste administration, regardless to the nature of work.

The questionnaire included different aspects such as educational level, monthly income for the family and location of residence, type of locality (city or village camp), nature of work, the average monthly income, number of house residents, sources of income. Questions about solid waste and recycling definitions, solid waste generation and composition, their perceptions and convinces toward solid waste recycling at houses. The detailed questionnaire is illustrated in Appendix (E).

4.1.2.2 Estimation of sample size and distribution:

The household survey as aforementioned has assessed the satisfaction of community towards existing solid waste management

service and examined their attitudes and cooperation in the view of integrated solid waste management. Measured variables are two categories, binary-dichotomous, or more than two categories, nominal or ordinal. The survey was assumed to be normal distribution, while the confidence level is 96%. The sample size has been estimated as per the following formula:

$$Ss = Z^2 * P* (1-P)/ C^2 \text{…….(Kachigan, 1986)}$$

Ss: sample size

Z: Z value (e.g. 1.96 for 95% confidence level)

P: percentage picking a choice, expressed as decimal (use 0.5)

C: confidence interval (margin of error), expressed as decimal (e.g., 0.04 = ±4)

Correction for finite (small) population:

Corrected Ss = Ss / (1+ (Ss-1/ pop))

Where: pop = population

This equation was used since the community, sampling frame is known and population is estimated. As per PCBS census 2010 the households of the study area ((Tulkarem city, Wadi Shaer, Alsa'biat and Al Kafriyat beneficiaries) is about 20642.

$$Ss = 1.96*1.96*0.5\ (1-0.5)/\ 0.04^2$$

Ss = 600.25

Corrected Ss = 600.25 / (1+ (600.25 -1 / 20642))

Corrected Ss = 583 sample.

4.1.3 Cost analysis and comparative analysis:

Cost analysis is an important component of all economic evaluation techniques. It is a useful tool for planning and self-assessment.

To determine the best option for solid waste separation, it is important to do a cost analysis for each option like capital costs, operating and administrative costs, revenues, benefit cost analysis, cash flow diagram and break event point.

It is worth mentioning that before cost analysis, solid waste components and percentages should be identified by applying pilot separation, the results will be used in the analysis of feasibility of manual and mechanical separation by knowing the selling price of the composting and recyclable material in the local market, recyclable materials quantities for the next 10 years, this helped calculating the revenues.

Capital costs is fixed like, construction and purchasing equipments.

Operating costs is variable costs depending on salaries, fuel consumption, depreciations, maintenance and utilities.

Benefit cost analysis is a technique used to compare the various costs associated with an investment with the benefits that it proposes to return. This method determines the annual gain or loss for the SW recycling options.

Break point event is a mechanism which is calculated to estimate the SW quantities that would achieve zero profit. This means that the total revenues will equal total cost at this point.

For comparative analysis, the method is listed below:

1. Determining the solid waste management options.

2. Collecting data by:

- Site visits.
- Questionnaires.
- Books, studies, papers, ….
- Pilot separation for SW.

3. Analyzing the collected data.
4. Calculating and analyzing the different cost components of the SW options, like: Capital costs, operation and administration costs, revenues and benefit costs.
5. Comparing between the options depending on cost analysis results. The comparison will be tabulated.
6. Choosing the best and more economic option.

4.1.4 Data Management and Statistical Analysis:

Data management is a broad field of study, but essentially is the process of managing data as a resource that is valuable to study. One of the largest organizations that deal with data management, DAMA (Data Management Association), states that data management is the process of developing data architectures, practices and procedures dealing with data and then executing these aspects on a regular basis. In this study, data management consists of data presentation, statistical analysis and cost analysis.

4.1.4.1 Data Presentation:

Selling Price of the Composting and Recyclable Material in the Local Market:

The selling prices of the recyclable materials in the local market are quite important in cost analysis and financial feasibility of the SW separation process. For example, sometimes the recyclable materials maybe considerable but their selling prices do not cover the financial expenses on separation process. The plastic recyclable materials may have two prices depending on it will receive treatment such grinding, washing and drying or not. Table 12 presents the selling prices in NIS per ton of such recyclable materials in the local market in 2011 (ZF, 2011).

Table (12): Selling prices of the recyclable materials in the local market (ZF, 2011).

No.	recyclable materials	Price (NIS/ton)
1	Organic (compost)	100
2	Paper and Carton	270
3	Plastic without treatment*	800
4	Plastic with treatment (crushing)	1800
5	Metals (Iron, Cupper, Aluminum)	500
6	Glass	120
7	Textile	-
8	Other	-

Solid Waste Projections:

To evaluate the recycling options for the foreseen planning time, the SW quantities in Tulkarem governorate should be identified. The SW generation rates are increasing for both; the population growth and the increase in SW generation per capita with time. Therefore, to predict the future SW quantities in Tulkarem area, the population growth rate for this area is considered as 2.5% and SW generation increase at 1% (PCBS,

2007) per year. Accordingly, the population is expected to be 149,829 and 191793 in 2020 and 2030 respectively.

The generation rate is expected to be 0.86 and 0.91 kg/capita, day in 2015 and 2020 respectively. As a result, the SW quantities are expected to increase from about 99.36 ton/day in 2011 to about 135.71 and 191.90 ton/day in 2020 and 2030 respectively. Table (13) illustrates projected; population, SW generation rate per capita and therefore the SW quantities for the years 2011to 2030 in Tulkarem District. (108689 capita in 2007 with yearly increase 2.5%).

Table (13): Projected; population, SW generation per capita and SW quantities in Tulkarem District.

Planning Horizon	Population WS-JSC	SW generation kg/capita.day	SW quantities ton/day
2011	119972	0.83	99.36
2012	122971	0.84	102.86
2013	126046	0.84	106.49
2014	129197	0.85	110.24
2015	132427	0.86	114.13
2016	135737	0.87	118.15
2017	139131	0.88	122.32
2018	142609	0.89	126.63
2019	146174	0.90	131.09
2020	149829	0.91	135.71
2021	153574	0.91	140.50
2022	157414	0.92	145.45
2023	161349	0.93	150.58
2024	165383	0.94	155.88
2025	169518	0.95	161.38
2026	173755	0.96	167.07
2027	178099	0.97	172.96
2028	182552	0.98	179.05
2029	187116	0.99	185.37
2030	191793	1.00	191.90

4.1.4.2 Statistical Analysis:

The questionnaires are distributed to a representative sample of 583 households. Each locality received a number of questionnaires in proportion to its population to the total population of the district as clarified in Table (14) below. These questionnaires were collected and analyzed using SPSS program (Statistical Package for Social Science).

Table (14): Distribution of households surveyed according to locality type.

Locality Type	# of House holds	% Percent	# of Questionnaires
City	9,799	47.47	277
Villages	7,689	37.25	217
Refugee Camps	3,154	15.28	89
Total	20,642	100	583

In addition to the households questionnaires (583), twenty questionnaires were distributed for involved people in the SW service employees randomly for different localities, on the other hand, ten questionnaires were distributed for Local Governmental Units.

Chapter Five

Results and Discussions

5.1 Results:

5.1.1 Field Questionnaire:

1- Involved people in the SW service employee's Questionnaire:

According to the involved people in the SW service (employees) about 20% of the respondents live in city while 55% and 25% live in villages and camps respectively. Table (15) summarize the personal information for the respondents.

Table (15): Personal information-SW service employee's Questionnaire

	Respondents					**% Total**
Locality	city	village	camp			**100**
	20	55	25			
Gender	Male	female				**100**
	90	10				
Age	< 25	26-35	36-45	> 46		**100**
	5	35	50	10		
Educational level	primary	Secondary	university	High studies	other	**100**
	25	55	15	5	0	
Housing	Houses	apartment				**100**
	85	15				
# of family members	2-4	5-7	8-10	> 10		**100**
	5	50	40	5		
Occupation	driver	SW collector	Street cleaner	Money collector		**100**
	55	10	10	5		
	accountant	admin	other			
	5	3	12			
	Respondents					**% Total**
Years of work	1-4	5-9	10-14	> 15		**100**
	50	5	30	15		
Sources of income	SW	agriculture	business	other		**----**
	100	30	20	50		
Income (NIS/month)	1000-1500	1501-2000	2001-2500			**100**
	35	25	10			
	2501-3000	> 3000				
	25	5				
SW generation (kg/capita/day)	0.5	0.6	0.7			**100**
	55	25	20			
	0.8	0.9 – more				
	0	0				

The average family size was 5-7 members. About 90% of the respondents were males and 10 % were females. The most common occupations are drivers and 10% are street cleaners and SW collectors. The average monthly income was varying along the study area, but this is mainly due to unreliability of the income data in this case due to reluctance of respondents to answer this survey question, about 35% has a very low income (1000-1500 NIS/month). More than 85% of the respondents own their houses, while about 15 % are renting for living. Besides, more than 20 % of them have university high degree, while only about 55 % of them have only completed their secondary education. About 55% of the respondents expect that SW generation is 0.5 kg/capita/day, while 25% and 5% their answers are 0.6 and 0.7 kg/capita/day respectively.

Table (16): Response for the definition of SW and SW recycling - SW service employee's Questionnaire

Solid waste meaning	% Percent	SW recycling	% Percent
Yes	95	Yes	85
No	5	No	15
	100		100

The table shows that about 95% and 85% of the SW service employees know the definition solid waste and solid waste recycling respectively, while about 5% and 15% do not know the definition of solid waste and solid waste recycling respectively.

Table (17): Response for Arrangement of the generated SW-SW service employee's Questionnaire

Category	Rank (average.)
Organic	1
Papers	6
Plastic	2
Cartoon	7
Wood	8
Glass	4
Metals	3
Textiles	5

The table (17) explain that most of the respondents ranked the SW generation from the highest rate to the lowest rate as organic, plastic, metals, glass, textiles, papers, cartoon and wood.

Table (18): Response for SW separation-SW service employee's Questionnaire

Question	% Percent
Yes	95
No	5
	100

The table shows the willingness of the SW employees toward SW separation in general. It was concluded that about 95 % said that they will separate and 5% will not. The reasons for yes answer are 40% is preservation of the environment, 30% is the benefit of recycled material and cost benefit for municipality and households. The table below clarified the reasons.

If the answer is yes, mention the reasons:

Reason	% Percent
Preservation of the environment	40
The benefit of recycled material	30
Cost benefit for municipality and households	30
	100

The respondents showed high objection towards source separation and they think and prefer that the separation should be held at Wadi Shaer Transfer Station (about 65% of the respondents).

Table (19): Response for best separation option-SW service employee's Questionnaire

Answer	% Percent
By citizens	35
At WS-TS	65
	100

Local Governmental Units Questionnaire:

According to LGUs survey, about 83.3% of the respondents are municipalities and 16.7% are village councils. About 95% of the population covered by the solid waste service by the local authority (high percentage).

Table (20): General information- LGUs Questionnaire

	Respondents			% Total
Locality type	Municipality	Village council		**100**
	83.3	16.7		
Percent of Committed to pay the fees for SW service	80%	35%		-----
Proportion of the population covered by the solid waste service by the local authority	95%			-----
The percent that the local authority added to cover the expenditures of SW services	25% - 45%			-----
Waste collection fees per family	12 – 16 NIS/family			-----
Method of collecting fees for SW collection services	With electricity bill	With water bill	Other	**100**
	50/ pre-paid	33.3	16.7	
Availability of internal laws governing the SW management	Yes	No		**100**
	50	50		
If the previous question is yes, how it is applied	Totally	Partially		**100**
	16.7	83.3		

Table (20) shows that the waste collection fees per family varies from 12-16 NIS/ family and the percentage that the local authority added to cover the expenditures of SW services varies from 25%-45%. Most of the local authorities use pre-paid system (with electricity bill) while 33.3% and 16.7% uses with water bill and others respectively. 50% of the local authorities use internal laws governing the SW management but just 16.7% of the authorities apply them totally, while 83.3% are partially.

Table (21): Employees information - LGUs Questionnaire

	Respondents				% Total
Occupation	occupation	# NO.	Full time	Part time	-----
	admin	1-7	50%	50%	
	inspector	1-4	50%	50%	
	SW collectors	2-10	66.7%	33.3%	
	Street cleaners	2-95	66%	34%	
	drivers	1-8	83.3%	16.7%	
Easily to find workers to work in the SW -Section when you need	Yes		No		**100**
	83.3		16.7		
Average wages of SW workers (NIS / month)	1200 - 1980				-----

According to the local authorities, some questions are directed concerning the employees, Table (21) shows that street cleaners have the highest numbers in the municipalities, but 66% of them work full time and 34% work part time. Most the drivers work full time around 83% of them and around 17% work part time. 50% of the administrators and inspectors work full time.

When we asked the authorities if they find workers to work in the SW easily, the answer is 83% yes, it is easy while 16.7% it is difficult to find.

The average wages for the solid waste workers ranges from 1200-1980 NIS/month depending on the type of work.

Table (22): Municipality orientation towards source separation - LGUs Questionnaire

Question	% Percent
Separation by citizens	0
Separation by local authority	16.7
No separation	83.3
	100

Table (22) shows that the municipalities have no orientation towards separation by the citizens, 16.7% of the municipality respondents have orientation toward separation by the local authority. But the biggest percentage is due to no separation.

Table (23): Response for SW source separation - LGUs Questionnaire

Answer	% Percent
Yes	66.7
No	33.3
	100

According to the response for SW source separation, the municipalities sense that they are not sure that the people will accept this idea (66.7%).

Table (24): Response for SW separation options - LGUs Questionnaire

Answer	% Percent
At homes	16.7
At WS- TS	16.7
No attitude	66.7
	100

According to the municipality, if it decides to apply separation operation, the table shows that 66.7% will not separate the SW and 16.7% preferred the separation to be at homes and the same percent at Wadi Shaer transfer station.

2- Household Questionnaire

According to the household survey, about 47.5% of the respondents live in a city while 37.3% and 15.2% live in villages and camps respectively. The average family size was 5-7 members and about 57.8% of the respondents were males and 42.2 % were females. Table (25) shows the personal information for households questionnaire.

Table (25): Personal information- Households Questionnaire

	Respondents					**% Total**
Locality	City	Village	Camp			**100**
	47.5	37.3	15.2			
Gender	Male	Female				**100**
	57.8	42.2				
Age	< 25	26-35	36-45	> 46		**100**
	25.9	33.3	23	17.8		
Educational level	Primary	Secondary	University	High studies	Other	**100**
	11.8	29	49.6	5.5	4.1	
Housing	Housing	Apartment				**100**
	64.8	35.2				
# of family members	2-4	5-7	8-10	> 10		**100**
	31.9	49.2	15.8	3.1		

It was obviously noticed that around 55% of the surveyed have high certificates (university and high studies) and this percent is considered to be good. More than 64% of the respondents own their houses, while about 35% live in apartments (renting for living). More than 33% of the respondents are youth 26-35 years old.

Table (26): General information- Households Questionnaire

	Respondents						% Total
Knowing the definition of SW	Yes			No			**100**
	90.1			9.9			
Way of SW disposal	In the container		Front of the house		Other		**100**
	65.2		30.2		4.6		
Who is responsible house waste disposal	Father	Mother		Adults	Children		**100**
	34.5	17		33.3	15.3		
Knowledge what happened for SW after collection by municipality	Yes			No			**100**
	69.3			30.7			
Daily SW generation for one family (kg/day)	1-2	3-4	5-6	7-9	10-11	> 11	**100**
	31.6	37.6	19.9	7.5	2.9	0.5	
Knowledge of SW accumulated hazards on environment and public health	Yes			No			**100**
	86.4			13.6			

The table describes the households culture of solid waste. Around 90% of them know the definition of SW and 10% do not know. 65.2 % of the respondents get rid of the SW by throwing it in the containers while 30.2% throw it in front of the houses and 4.6% use other ways to get rid 0f the SW. The questionnaire asked the households about who is responsible for SW disposal at the house, the answers are varied, 34.5% are the fathers and 33.3% are the adults, while 17% and 15.3% are the mothers and children respectively. About 69% of the questioned people know what is happening for the solid waste after being collected by the municipality, but about 31% do not know. On the other hand about 86% of the households

are aware of the hazards of SW accumulation on environment and public health, while 13.6% are not aware of it.

Table (27): Solid waste composition (according to people opinion)- Households Questionnaire

Category	% Percent (Average.)
Organic	19.38
Paper + cartoon	12.01
Wood	10.81
Plastic	11.66
Metals	9.34
Textiles	11.15
Others	16.47
Total	**100**

It is important to know the households expectations about the percentages of solid waste composition. Most answers are listed as follow: 19.38% organic, 12.01% paper and cartoon, 10.81 wood, 11.66% plastic, 9.34% metals, 11.15% textiles and 16.47 others.

Table (28): Solid waste reuse- Households Questionnaire

<table>
<tr><td rowspan="2"></td><td colspan="4">Respondents</td><td rowspan="2">% Total</td></tr>
<tr><td colspan="2">Yes</td><td colspan="2">No</td></tr>
<tr><td rowspan="2">Knowledge of how to reuse SW</td><td colspan="2">56.9</td><td colspan="2">43.1</td><td rowspan="2">100</td></tr>
<tr><td colspan="2">Yes</td><td colspan="2">No</td></tr>
<tr><td rowspan="2">Convince of feasibility of SW reuse operation</td><td colspan="2">69.3</td><td colspan="2">30.7</td><td rowspan="2">100</td></tr>
<tr><td colspan="2">Yes</td><td colspan="2">No</td></tr>
<tr><td rowspan="2">Are you throwing things that you do not need, but could benefit others like clothes and some tools</td><td colspan="2">45.3</td><td colspan="2">54.7</td><td rowspan="2">100</td></tr>
<tr><td>With waste</td><td>Use as compost</td><td>Feed for animals</td><td>Others</td></tr>
<tr><td>Way of getting rid of Leftovers</td><td>74</td><td>8.7</td><td>16.6</td><td>0.7</td><td>100</td></tr>
</table>

To know the experiences of people towards the solid waste reuse at houses, it is found that 57% of households have the knowledge of how to

reuse solid waste, on the contrary of the 43% of the respondents. 69.3% of the respondents have full satisfactory of the feasibility of SW reuse operation, while 30.7% have no conviction, but 45.3% of the questioned people throw things that they do not need, but could make use of other things like clothes and some tools, while 54.7% do not throw any beneficial things. When the question is about leftovers, I found that 74% of the respondents get rid of them with waste, 8.7% use it as a compost, 16.6% use it as food for animals and 0.7% use it in other ways.

Table (29): Solid waste separation- Households Questionnaire

	Respondents		**% Total**
Knowledge of definition of SW separation	Yes	No	**100**
	75.3	24.7	
Knowledge of the importance of SW separation	Yes	No	**100**
	61.7	38.3	
Knowledge of what happen after separation of SW	Yes	No	**100**
	56.8	43.2	
Knowledge of definition of compost	Yes	No	**100**
	38.4	61.6	
After teach you on the compost operation, will you apply this operation in your guard	Yes	No	**100**
	43.6	56.4	

According to the solid waste separation, 75.3% know the definition of SW separation and 38.4% have the knowledge of compost definition. Unlike for the others who have no idea. Also 61.7% of the respondents are aware of the SW separation importance, but 38.3% have no awareness. The question about peoples' willingness toward applying the compost operation in the houses is directed to the households, 56.4% rejected, while 43.6% accepted.

Table (30): Response of Willingness to start source separation - Households Questionnaire

Answer	% Percent
Yes	37
No	63
	100

If the answer is Yes, mention the reasons

Reason	% Percent
Environment preservation	12.3
Benefits for municipality	17.5
Ability for separation	5.8
Other	1.7

If the answer is No, mention the reasons

Reason	% Percent
No convince	12.9
Inability of the housewife to do so	13.7
No place for this operation	15.8
No time to do so	20.4

The questionnaire was designed to measure the willingness of residents toward source separation. It is concluded that 63% of the households rejected to start source separation, they explained the rejection reasons which are: 20.4% of the respondents have no time to separate, 15.8% have no place for this operation, 13.7% of the housewives are unable to separate and 12.9% no conviction at all.

On the other hand, it is concluded that 37% of the respondents agree to start source separation, they explained their agreement reasons which are: 17.5% said that it refers to benefits for the municipality, 12.3% due to environment preservation, 5.8% said they have the ability for separation and 1.7% have other reasons.

Table (31): Attitude to SW separation at the transfer station-Households Questionnaire

Answer	% Percent
Yes	81.8
No	18.2
	100

If the answer is Yes, mention the reasons

Reason	% Percent
Environment preservation	25.9
Benefits for municipality	37
Cost benefit	16.8
Other	2.6

If the answer is No, mention the reasons

Reason	% Percent
The recycled materials are low	3.1
Need for time and effort	8.2
Health risks to workers in SW separation	5.5
Other	0.9

From other side the questionnaire measures people attitude towards separation at Wadi Shaer transfer station, the result was 81.8% of the respondents prefer applying the SW separation at the transfer station, while 18.2% not prefer that.

The respondents explained their conviction by: 37% of the respondents say that this operation refers to benefits for municipality, around 26% is environment preservation, 16.8% refers of cost benefits and 2.6% have other reasons.

The respondents who refused the idea of separation at transfer station explained their reasons as: The recycled materials are low, the need for

time and effort, Health risks to workers in SW separation and other reasons.

Table (32): Response for people cooperation with the authority on source separation - Households Questionnaire

Answer	% Percent
No commitment	12.4
Commitment at the level of home	71
Warning of no commitments people of the significance of commitment	12.3
Inform the local authority on offenders	4.3
Total	100

According to the response for people cooperation with the authority on source separation, the answers are varied, 71% of the respondents will commit at the level of home, around 12% won't commit in source separation and other people will convince the other to be uncommitted. 4.3% will inform the local authority on offenders.

Table (33): Attitude for giving recycling operation to private company not to the municipality - Households Questionnaire

Answer	% Percent
Yes	66.9
No	33.1
	100

The above table shows that around 67% of the respondents prefer recycling operation to private company rather than the municipality, while 33% prefer giving it for the municipality.

Main findings of the questionnaires

1. According to the households survey, awareness of the SW definition (90.1%), the hazards of accumulated SW hazards on environment and public health (86.4%) and definition of SW separation (75.3%).

This indicates a good awareness and culture of the respondents, this may be due to the good percent of high studies (55%).

2. According to the solid waste reuse, 69.3% of the respondents are convinced of its, feasibility and 54.7% of the respondents are applying this method in a simple way, SW reuse somehow has an effect on reducing the wastes. On the other hand, high percentage of the respondents don't know what is the compost and how it must be applied, but around 56% of them are ready to apply it after teaching them the operation. This way will reduce the organic waste amounts.

3. Source separation: the households have no willingness to start source separation, about 63% of the respondents rejected the idea, they support their rejection by: no conviction, unability of the housewives to do so, no place for this operation and no time to do so.

When the question is directed to the SW employees, they liked the idea of separation but thought that it shouldn't be applied by citizens.

The LGUs opinion was that they don't have any orientation towards the idea of the separation at all (83.3% rejected the idea).

All the previous opinions indicate that the solid waste separation option in this study will fail (separation at source).

4- Separation at Wadi Shaer transfer station: the households accepted this idea, about 82% of the questioned employees accepted the idea, they support their agreement by: it is a way for preservation of the environment, the benefits of the recycled material and the cost benefits for the municipality and the households.

When the question is directed to the SW employees, they liked the idea of separation at Wadi Shaer transfer station (65%) for the same reasons of the households.

The LGUs opinion was they don't have any orientation towards the idea of the separation at all (83.3% rejected the idea).

All the previous opinions indicate that the solid waste separation option in the study deserve to be dependable (separation at WS-transfer station).

5.1.2 Pilot separation

Solid waste characterization took place in Zahret Al-Finjan landfill for the study area, a daily separation is applied since 20/3/2011 till 18/4/2011 (one month). The following table (34) and the figure (9) illustrated the results of the municipal solid waste fractions in the study area.

Table (34): Solid waste composition for Tulkarem District

Items	% Percent (Average)
Organic	46.0
Plastic	11.7
Cartoon	11.0
Paper	4.0
Wood	4.4
Glass	4.3
Metals	5.5
Textile	9.0
Others	4.0
Sum	**100.0**

As shown in the table above the area had high organic percent of wastes, it is more than 45%, while it is noticed above the recyclable

fractions (metals, glass, paper, cartoon and plastics) are representing about 37 % of solid waste stream, the high percentage is coming from plastics and cartoon, while metals and glass are representing only 10%, this is coming from the fact that due to high potential value of metals, many scavengers are collecting the cans and other metals from the containers and homes. Valuable concerns shall be given to cartoon, paper and plastic fractions as well as the organic and food wastes as a source for composting and soil, in spite of the cartoon is collecting directly from commercial places by private sector in Bal'a village.

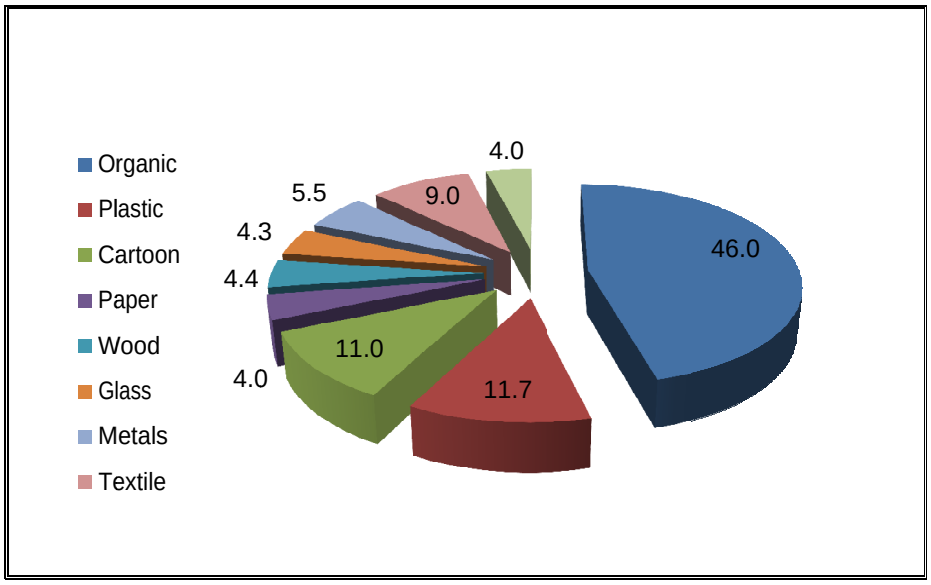

Figure 9: Solid waste composition for Tulkarem District

5.2 Recyclable Materials Quantities:

The SW composition depends on the development level of the community; therefore, the SW composition in Tulkarem area is expected to parallel the expected improvement in the life quality for the inhabitants. This parallelism will decrease the organic content percentage at the SW

composition. It is assumed that the organic content percentage will decrease at a rate of 2% by year (Al Sa'di, 2009). It is assumed that this decrease will be distributed as an increase to the other SW composition categories as follows; 30% plastic, 30% cartoon, 5% paper, 5% wood, 10% glass, 10% metals, 5% textiles and 5% other components(Al Sa'di, 2009). Table (35) illustrates the expected SW component quantities in Tulkarem area in the horizon of 2011, 2020 and 2030 years based on the assumed change on the SW composition.

Table (35): Expected total recyclable materials quantities in Tulkarem area in the horizon of 2010, 2015 and 2020 years

No.	Type of Waste	2011		2020		2030	
		% of SW	Ton/day	% of SW	Ton/day	% of SW	Ton/day
1	Organic	46.0	45.71	37.7	51.16	28.5	54.69
2	Plastics	11.7	11.63	14.2	19.26	17	32.57
3	cartoon	11.0	10.93	13.5	18.31	16.3	31.22
4	Paper	4.0	3.97	4.4	5.99	4.8	9.30
5	Wood	4.4	4.37	4.8	6.53	5.2	10.07
6	Glass	4.3	4.27	5.1	6.96	6.1	11.69
7	Metals	5.5	5.46	6.3	8.59	7.3	13.99
8	Textiles	9.0	8.94	9.4	12.78	9.9	18.89
9	Others	4.1	4.07	4.5	6.13	4.9	9.49
	Total	**100.0**	**99.36**	**100.00**	**135.71**	**100.00**	**191.90**

It is worth mentioning, that the quantities of the recyclable materials are grand and theoretical. Since not all of the recyclable materials could be separated. Also, not all of the recyclable materials can be recycled. Worth mentioning, that cartoon is collected from the commercial places before

transferring to WS-TS by a special sector. So the real percentage of cartoon is too much higher than this result.

5.3 Solid waste Separation Options:

There are many SW separation schemes that are being applied around the world. In this study, the SW separation at Tulkarem Governorate is investigated in the separation at source and the separation at WS-JSC transfer station with two scenarios and the direct transport from WS-TS to ZF landfilll. This section will discuss these options.

5.3.1 Direct transport from WS-Transfer station to ZF landfilll (existing situation/Zero Separation):

This option maybe the best one if the total SW separation expenses exceed the total benefits from selling the recyclable materials. Such transfer station, would only receive the unloaded SW from tractors and compactors of Tulkarem beneficiaries and later transport it to ZF landfill by RORO trailers. Therefore, the SW separation will be at ZF landfill since ZF-JSC having signed an agreement with the private sector for the SW separation at ZF landfill. Such separation project will save dozens of work opportunities, prolong the life time of ZF landfill and therefore less SW tariff for the beneficiaries.

Adopting this option would enhance ZF landfill separation project as a regional SW separation project. Moreover, zero separation will minimize any potential of bad aesthetic view or odor emissions nearby the transfer station which maybe produced through spreading the SW at the transfer station space floor.

5.3.2 Separation at Source:

This option implies the costs of the required vehicles and containers through the curb side and drop-off centers (capital costs), costs of collection and transferring the waste to the transfer stations and/or landfill. The salaries cost is estimated for the staff considered to work through the separation at source and collection, which are: drivers, foremen, and laborers. The fuel consumption costs are estimated for all waste vehicles that are considered to collect the separated waste at the source. The fuel consumption was estimated per distance for each vehicle through the working days, taking into consideration the vehicles types and capacity and the price of fuel for each liter. The maintenance costs are estimated as a percentage from the fuel consumption for each vehicle. The depreciation costs for the available and the other new vehicles and equipments that are required for collection the separated waste are estimated. The depreciation costs depend upon the price of vehicles and equipments with their life time. The insurances costs are the yearly average costs for the insurance of the vehicles.

SW separation at source of reusable and recyclable material start at the source of waste generation, by the residents, Local Governments Units (LGUs) employees or private sector. There are several methods of SW separation at source, such as curbside collection and/or drop off center.

Curbside collection:

Curbside collection system is used by residents and/or laborers to separate the waste according to the different components, and then put each component at the curbside to be collected by the waste employees.

Separation will be done at household levels. Plastic bags of different colors and labels would be distributed to households with clear information of what and how to separate recyclables at source. A special collection program would be set with solid waste management council to collect the recyclables regularly and bring them to special containers that would be placed at the transfer station facility. The staff then separate the wastes as it is being picked up, placing each type of the waste into a separate compartment directly in the vehicle.

Drop-off centers:

Drop-off centers are centralized locations where the people take their wastes to be disposed off according to different components. The waste laborers collect and separate the waste at these centers. The drop-off centers must be designed and constructed in suitable locations taking into consideration particular conditions that should meet the acceptable operation procedures by the community. To evaluate and select the most appropriate drop-off system, critical factors such as location, material handled, population, number of centers, operation, and public information must be considered. Drop-off centers are preferably located at road junctions or at locations near community residents. This increases the convenience for the community residents to participate in the drop-off collection programs.

There are many advantages of applying SW separation at source such as; achieving high separation rates; promotes clean, the least dangerous for groundwater contamination, marketable materials; limiting levels of contamination. On the other hand, the main disadvantage is the

high investments costs in addition to the stakeholder's participation. Since without their participation, the whole project will fail.

Separation at source highly depends on the stakeholder's participation in the SW separation at their houses into different categories, after many conversational interviews with the involved people in the SW management. Therefore, this option seems not feasible. However, for more reliable and concise conclusion, three questionnaire types were designed and applied on 609 sample; 583 Local people questionnaire, 20 involved people in the SW service employees and 6 Local Governmental Units Questionnaire. As a result, the questionnaires results enhanced the first expectations. The main results of the questionnaires are provided hereafter.

Households Questionnaire:

A sample of 583 people; 47.5% for Tulkarem city, 37.3% for villages, 15.2% for camps were distributed to 57.8% males and 42.2 females, on the other hand the most respondents aged around 26-35 years old, and the most received university education, More than 64 % of the respondents own their houses, while about 36 % are renting for living, besides, more than 49% of the houses has number of members 5-7 capita. The purpose of the questionnaire is to investigate the people willingness to start source separation. Around 63% of the questioned people refuse to separate the SW at their houses into categories after providing them with colored plastic pages. In fact, they have many reasons for such a decision as follows; not convinced at all with such process, the housewife can't do that on a long term, recyclable and reusable materials have small amounts and not worth to separate, no space for the plastic pages, no enough time to

perform that. On the other hand, the other 37% of people show their interest to separate their SW at house and have following reasons; conserving the environment; benefiting from the recyclable and reusable materials. Worth mentioning, that the people who showed their interest to participate in the SW separation at source are comprised of high educated people, their family consists only of two members, have high income and relatively luxurious houses.

Local Governmental Units Questionnaire:

A sample of 6 questionnaires was distributed to Tulkarem municipality, Anabta municipality, Kufr Al Labad municipality, Bal'a municipality, Beit Lead Municipality and Iktaba village council.

95% covered by the solid waste service by the local authority which is high percentage, and 80% of people committed to pay SW collection fees, most of them in the big municipalities that use pre-paid system of SW service with electricity card, 33.3% pay SW collection service with water bill, which is a chance for people to avoid paying bills, so most of the municipalities and village councils suffer from financial problems for SW services.

The questionnaire investigates their opinion of SW separation and 83.3% stated that their local people do not have the awareness to perform such process on a reliable and long term basis. Although 66.7% see SW recycling is feasible, the localities have no attitudes and plans for SW recycling.

Involved people in the SW service employee's Questionnaire:

The questionnaires targeted twenty SW service employees who are working at the municipalities, village councils and joint services council for solid waste management (workers at WS-transfer station). They were chosen since they are in contact with the people for the SW issues for a long time.

A survey of 20 questionnaires was distributed for 90% male and 10% female in different localities, 55% from villages, 20% Tulkarem city and 25% from camps. 50% of the questioned people has age range 36-45 years old and 55% reach secondary educational level. On the other hand 55% are drivers, 10% SW collectors, 10% street cleaners, 5% accountant, 3% admins and 12% other occupations. 30% of SW workers have another job beside their work as agriculture works, 20% works in business and 50% other works. 35% of the average monthly income of SW workers around 1000-1500 NIS, 25% range between 1501-2000 NIS, 10% (2001-2500 NIS), 25% (2501-3000 NIS) and 5% more than 3000 NIS.

95% of the respondents supported the idea of separation in their localities and 5% do not agree, but 65% prefer applying SW separation at Wadi Shaer transfer station maintained that, at source SW separation is not worth. They justified their opinion in several points which were raised also above from the local people themselves and from the officials at Bal'a, Anabta, Kufer Al-Labad, ZF project manager. 35% see it is better to separate the SW at homes.

5.3.3 **Separation at WS-Transfer station:**

As mentioned earlier, the SW transfer station is a facility constructed to gather and later transport the waste. This is normally for local communities that are far from the landfill more than 20km. In this case, the solid waste is collected by the collection vehicles and is transported, unloaded at transfer station to be reloaded by vehicle trailers, which transport the waste to the landfill. WS transfer station is designed to serve the part of Tulkarem beneficiaries by receiving the SW from them as temporary location. Then transport it to ZF landfill in Jenin governorate which is located 23km north of the transfer station.

The SW separation at WS transfer station might be one of the following scenarios;, manual separation and mechanical separation. These scenarios are elaborated hereafter.

5.3.3.1 Manual separation- scenario one:

Manual separation is possible if total benefits of the recyclable materials are higher than the total expenses of labors' salaries. In this case, the SW compactors and tractors unload the SW at the transfer station floor space around 400 m^2 area as seen in Figure 10**.** Then, the laborers separate the SW manually for some kind of recyclable material of some items such as; plastic, cartoon/paper and metals. After that, a loader (bulldozer) will load the remaining SW to the container which is to be transferred to ZF landfill.

Figure 10: Schematic diagram for Wadi Shaer Transfer Station

At this scenario, the percentage of the SW separation of the recyclable materials is expected to be very low. More importantly, unloading the SW at WS-JSC transfer station for many hours will spread emission odors, accumulating insects, rodents and distorts the aesthetic view of the area. Therefore, separation mechanism should be done as quickly as possible maximum half an hour between the compactors by increasing number of laborers.

As mentioned above, the revenues from the manual separation for small items such as plastic, cartoons and metals are expected to be very low. Such expectations are based on ZF landfill experience of the manual separation. The manual separation has been applied for the plastic, cartoon and metals. SW components for the receiving quantity of 400 ton/day (according to ZF study). But the separation percentages are very low, as illustrated in Table (36) and described as follows:

- The estimated average percentage of the plastic component in the received SW ZF Landfill is about 12%; therefore, the total plastic weight would be about 48 ton per day. However, the manually separated (collected) plastic quantities are about 0.7 ton/day. In other words, only about 1.5% of the plastic components at ZF-Landfill can be separated manually.

- The average percentage of cartoon and paper component in the received SW ZF Landfill is about 14%. Therefore the total cartoon and paper weight is about 56 ton per day. However, the manually separated (collected) cartoon and paper quantities are about 1 ton/day. In other words, only about 1.8% of the cartoon and paper components at ZF-Landfill can be separated manually.

- The average percentage of metals component in the received SW ZF Landfill is about 4%. Therefore, the total metals weight is about 16 ton per day. However, the manually separated (collected) cartoon and paper quantities are about 0.2 ton/day. In other words, only about 1.3% of the metals components at ZF-Landfill can be separated manually.

Table (36): The SW separation percentages experience for three SW components at ZF landfill which receives about 400ton/day (ZF, 2011)

SW component	Percentage %	Total weight (ton/day)	Manual separated weights (ton/day)	Separation percentage %
Plastic	12	48	0.7	1.5
Carton and Paper	14	56	1	1.8
Metals	4	16	2	1.3

5.3.3.2 Mechanical Separation (Recycling plant)- scenario two:

Recycling, separation and composting plant is a facility employing the required technology to process, separate, classify municipal waste, and to create or recover reusable materials that can be sold or reused by a manufacturer as a substitute for or a supplement to virgin raw materials. The term "recycling facility" shall not mean transfer station or landfill for solid waste (Kunaecheva, 2006).

In the mechanical separation, high percentage of the recyclable materials can be separated. In this case, the SW is unloaded by the SW compacter or tractor in the reception area of the plant. Then, the solid waste is fed to the plant by loaders, where the waste is mechanically treated. This includes; tearing of the plastic bags, classification on sizes, and automatic and manual separation of various components such as ferrous and non-ferrous metals, plastics, paper, board, and glass.

It is important to apply the compost method to reduce solid waste quantities, the cost of transferring to ZF landfilll and to use the result as soil fertilizer. The process of compost depends on the principle of aerobic fermentation of organic waste during 8 to14 weeks, where the decomposition of these residues under conditions of temperature, humidity and the presence of adequate ventilation. Around 10 tons of recycled organic wastes should be sent to the compost plant per day, that not all of recyclable materials can be benefited of.

As regards the manner of preparation of the compost site, it can be summarized in the following steps:

1. Basins are equipped with a length of 30 meters and 3 meters wide.
2. Basins are filled with red soil of 30 cm high.
3. Distribute a layer of the remnants of green plants above the soil layer.
4. Put a layer of recycled organic waste over green plants layer.
5. Put a layer of the remnants of green plants above the organic waste layer.
6. The height of the layers is about 1.5 meter above the Red Dust surface.
7. Spraying the layers with water and flipping them continuously depending in the PH, humidity and temperature of the atmosphere and layers.

The separation percentage of the organic matter is expected to be 35%, paper and cartoon 30%, plastics 35%; metals 20% glass 5% while textiles and others are not expected to be separated.

Table (37): The expected recyclable materials for mechanical separation (ZF, 2011)

SW type	Selling price NIS/ton	Recyclable percentage
Organic	100	35
Paper and cartoon	270	30
Plastics	800	35
Metals	500	20
Glass	120	5

5.4 Cost Analysis:

The cost analysis refers to the assessment of the viability, stability and profitability of the transfer station project in Tulkarem Governorate.

This section clarifies and estimates the capital and the running costs for operating manual mechanical separation plant, the total revenues for selling the recyclable materials, the Cost-benefit analysis, and the cash flow diagram for next twenty years.

5.4.1 Capital cost

The Capital costs are incurred on the purchase of lands, buildings, constructions and equipments to be used in the production of units in addition to the depreciation. At this project the invested costs at the beginning of the period include; land preparations, construction, equipments and vehicles. The total capital cost for WS-TS beneficiaries is expected to be 1.87 Million US$, these costs were estimated according to similar operating plants in the area (according to Assairafi transfer station). This cost will allocate annually from10-20 years as a depreciation expenses based on the general depreciation standard rate for construction, equipment and vehicles. Table (38) represents the capital costs for the study separation option at WS-TS.

Table (38): Capital costs for the study separation options at WS-TS

Direct transport to ZF option						
No.	**Item**	**NO.**	**Cost US$**		**life Cycle Year**	**Depreciation per Year (US$)**
1	trailer	2	165,000		10	33000.0
2	loader	1	25,000		8	3125.0
3	containers (32m3)	11	7,000		3	25666.7
	Total capital Cost			**197,000**		**61,792**
	Total			**258,792**		
	Cost per year			**12,940**		
Manual separation option at WS-TS						
1	trailer	2	165,000		10	33000.0
2	loader	1	25,000		8	3125.0
3	containers (32m3)	8	7,000		3	18666.7
	Total capital Cost			**197,000**		**54,792**
	Total			**251,792**		
	Cost per year			**12,590**		
Mechanical separation option at WS-TS						
1	land preparation	1	50,000		0	0
2	Construction and equipments according to assairafi	1	1,500,000		15	100,000
3	trailer	1	165,000		10	16500.0
4	loader	1	25,000		8	3125.0
5	lifter	1	150,000		10	15000.0
6	containers (32m3)	7	7,000		5	9800.0
	Total capital Cost			**1,897,000**		**144,425**
	Total			**2,041,425**		
	Cost per year			**102,071**		

Finally, the depreciation expenses include both the capital items and the operational equipment and vehicles, calculated by dividing the cost for each item on the useful life.

The table shows that the mechanical separation option has the highest rate of capital cost which equals **2,041,425 US$**, and the other options are nearly equal.

Operation and administrative Cost:

Operating and administrative cost is the total costs to operate and maintain the project of WS-TS including labor, fuel, maintenance, wages and salaries. These operating cost categories were estimated as follows:

Salaries of staff are assumed to base on similar conditions of such jobs at SWM-JSC of Tulkarem. Fuel expenses represent the fuel quantity consumed for operating vehicles and equipment which estimated depend on the distance (km\day), the consumption litters fuel\km and the cost per liter. The electricity expenses are estimated based on the plant size, actual working hours and the electricity cost per KW. The maintenance expenses calculated as a percentage of the total fuel cost. The insurances cost is the yearly average cost for the insurances of the vehicles. In addition to (8.57 $/ton/day) gate fees.

Table (39) presents the estimated operating and administrative costs for the direct transport option, while the detailed estimations for these costs categories are illustrated in Appendix (C).

Table (39): Running costs for the for the direct transport from TS to ZF option

Cost item	US $ /year
Salaries	81,684
Fuel consumption	106,320
Insurances	10,420
Maintenance	63,792
Utilities	6,480
Gate fees	310,803
Total cost	**579,499**

Table (40) summarizes the operational costs for the separation at transfer station by manual separation. The salaries' costs have estimated for the staffs that will work in separation at the transfer station, which are drivers, foremen and laborers. The fuel consumptions costs have estimated for all waste vehicles that will be required for the operation such as trailers and loader. The maintenance costs for the required vehicles are estimated as a percentage from the yearly fuel consumption. The costs the of depreciation depends on the prices of the vehicles with their life time. The insurances of the vehicles depend on the average cost of the current situation of Wadi Shaer transfer station vehicles. The utilities also depend on the average costs of the current situation of Wadi Shaer transfer station expenditures. All the details of the operation costs estimation are illustrated in appendix (C).

Table (40): Running costs for the manual separation option

Cost item	US $ /year
Salaries	93,600
Fuel consumption	97,002
Insurances	10,420
Maintenance	58,201.20
Utilities	6,480
Gate fees	309,196
Total cost	**574,899**

Table (41) summarizes the operational costs for the separation at transfer station through the separation plant. The salaries costs are estimated for the staffs that will work in separation at the separation plant, which are plant manager, mechanical engineer, accountant, drivers and laborers. The fuel consumptions costs are estimated for all waste vehicles that will be required for the plant such as trailer, loader and lifter. The maintenance costs for the required vehicles are estimated as a percentage from the yearly fuel consumption. The maintenance costs for the plant are estimated as a percentage from the yearly cost of the plant equipment. The costs of the depreciation depend on the costs price of the plant equipments and vehicles with their life time. The electricity costs are estimated through identifying the required power for the plant in Kilo Watt per hour and the price of kilo. The insurances of the vehicles are dependent on the average cost of the current situation of Wadi Shaer transfer station vehicles. The utilities also are dependent on the average costs of the current situation of Wadi Shaer transfer station expenditures. All the details of operation costs estimation are illustrated in appendix (C).

Table (41): Running costs for the mechanical recycling plant option

Cost item	US $ /year
Salaries	174,000
Fuel consumption	117,427
Electricity	144,552
Maintenance	70,456
Insurances	10,420
Utilities	6,480
Gate fees	229,962
Total cost	**753,297**

5.4.2 Revenues

Revenue is income that a company receives from its normal business activities, usually from the sale of units. The revenues from the SW manual and mechanical separation at WS-TS are the recyclable materials that would be sold to the market. The main factors considered in calculating the revenues are; population, generation rate, selling price, recyclable percentage and SW types which divided into five main categories paper/ cartoon, plastics and metal for manual separation. Organic, paper and cartoon, plastic, metals, glass and wood) for mechanical separation.

Basing on this experience of ZF landfill manual separation, rough estimations have been conducted to predict the revenues from manual separation at WS-TS depending on the pilot separation that was done for Tulkarem District municipal waste in the manual separation scenario for 2011- 2020 year. Appendix (D) explains the results which show that the total revenues are very low.

According to the mechanical separation, the expected net weights of the separated recyclable materials were calculated based on the WS-TF

beneficiaries (study area), per capita generation, composition percentage, the separation percentage and the selling prices. The total revenues per year seem great. However, the benefits are important. The financial analysis is given later. Appendix (D) illustrates the expected net weights and revenues of the recyclable materials at WS-JSC area in the period 2011 -2020.

It is important to mention that direct transport from TS to ZF option has zero revenue.

The prices of each component for the separated waste are considered depending on the questions for the expert persons through interviews, meetings, mails and calling. The yearly quantities and revenues from marketing each component in different zones have estimated and illustrated in appendix (D). It is clear that the recyclable percentages for manual separation is too low in comparison with the mechanical separation. This is shown in Tables (42) and (43).

Table (42): The expected net weights and revenues of the recyclable materials for manual separation at Tulkarem area in 2011

			2011/ 99.36		
SW type	**Selling price NIS/ton**	**Recyclable percentage**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**
Paper, cartoon	270	1.8	0.27	97.9	26438.2
Plastics	800	1.5	0.17	63.6	50918.0
Metals	500	1.3	0.07	25.9	12965.2
				187.5	**90,321.5**

Table (43): The expected net weights and revenues of the recyclable materials for mechanical separation at Tulkarem area in 2011

			2011/ 99.36		
SW type	**Selling price NIS/ton**	**Recyclable percentage**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**
Organic	100	35	46	5838.9	583,890
Paper and cartoon	270	30	15	1632	440,640
Plastics	800	35	11.7	1485.1	1,188,080
Metals	500	20	5.5	398.9	199,450
Glass	120	5	4.3	78	9,360
				9,433	**2,421,420**

The above tables show the increasing of yearly revenues due to expected increase of separated waste quantities, but there is a great difference of the revenues between manual and mechanical separation for the mechanical separation.

Table (44) summarizes the revenues costs from the different local communities according to the cost of each ton and the yearly generated waste. The waste quantities are according to waste projection and the costs per each ton are according to the costs of operation that have be summarized, the revenues increased yearly due to increased waste quantities.

The first option (direct transport to ZF) has no revenue, but the average revenue for the manual and mechanical separation options are **45,488 US$** and **1,107,349 US$** respectively.

Table (44): The expected revenues for the separated waste for manual and mechanical

Year	Revenue/direct transport to ZF US$/year	Revenue/manual US$/year	Revenue/mechanical US$/year
2011	0	25806	691,834
2012	0	27875	725,578
2013	0	29358	757,791
2014	0	31059	794,120
2015	0	32930	819,357
2016	0	34786	873,641
2017	0	36757	915,611
2018	0	38593	954,328
2019	0	40821	1,000,511
2020	0	43071	1,048,127
2021	0	44,615	1,099,130
2022	0	46,819	1,145,637
2023	0	49,443	1,201,040
2024	0	52,103	1,256,950
2025	0	54,893	1,316,003
2026	0	57,812	1,377,637
2027	0	60,882	1,441,971
2028	0	63,975	1,505,349
2029	0	67,326	1,574,694
2030	0	70,843	1,647,662
Total	**0**	**909,767**	**22,146,971**
Avg.	**0**	**45,488**	**1,107,349**

5.4.3 Benefit cost analysis:

Cost- benefit analysis is a technique used to compare the various costs associated with the investments with the benefits that it proposes to return. The benefits in WS-TS project is the total amount of revenues received of selling recyclable materials, while costs covers the administrative and operational cost incurred during the period of the study. Net profit calculated by deducting costs from total revenues. If costs are greater than revenues, loss occur. But if revenues are greater than costs,

gain occur. Total revenues, total cost and benefits were calculated for the period 2011-2020 and presented in Tables 47, 48 and 49.

After calculating the total costs and the total revenues for the project**,** a yearly inflation rate was added for both cost and revenue, 3% and 2% (asking experts of the percentages) respectively. But according to the cost, the inflation rate was added to the cost of three main items, salaries, fuels, and maintenance excluding electricity and depreciation, and the capital costs for mechanical separation is distributed for the ten years to the costs. Worth mentioning that the exchange rate for US$ to NIS is estimated 3.5 NIS/US$.

Table (45) clarify that The direct transport to ZF landfill option has zero revenues incurred an average yearly loss of **540,933 US$**. So, this option is unfeasible based on the current financial estimation.

Table (45): Benefits for direct transport to ZF landfill

Year	Revenue US$/year	Total cost US$/year	Annual gain or loss (US$/year)
2011	0	579,499	-579,499
2012	0	598,001	-598,001
2013	0	617,136	-617,136
2014	0	636,881	-636,881
2015	0	657,303	-657,303
2016	0	678,380	-678,380
2017	0	700,181	-700,181
2018	0	722,682	-722,682
2019	0	745,924	-745,924
2020	0	769,944	-769,944
2021	0	355,293	-355,293
2022	0	365,445	-365,445
2023	0	375,901	-375,901
2024	0	388,691	-388,691
2025	0	397,900	-397,900
2026	0	458,724	-458,724
2027	0	421,265	-421,265
2028	0	433,081	-433,081
2029	0	457,974	-457,974
2030	0	458,451	-458,451
Total	**0**	**10,818,654**	**-10,818,654**
Avg	**0**	**540,933**	**-540,933**

Table (46) clarify that The manual recycling plant at Tulkarem district incurred an accumulated loss for the first 20 years has a total of **-9,731,858 US$** and the average loss rate is **486,593 US$**. the manual SW separation at SW-TS is unfeasible alternative based on the current financial estimation.

Table (46): Benefits for the manual recycling at WS-TS

Year	Revenue US$/year	Total cost US$/year	Annual gain or loss (US$/year)
2011	25806	574,899	-549093
2012	27875	593,221	-565347
2013	29358	612,170	-582812
2014	31059	631,716	-600657
2015	32930	651,929	-618999
2016	34786	672,793	-638007
2017	36757	694,370	-657613
2018	38593	716,653	-678060
2019	40821	739,647	-698826
2020	43071	763,417	-720346
2021	45507	351,270	-305763
2022	47755	361,302	-313546
2023	50432	371,634	-321202
2024	53145	382,276	-329130
2025	55991	393,237	-337246
2026	58968	404,527	-345559
2027	62100	416,156	-354056
2028	65255	428,133	-362879
2029	68673	440,470	-371798
2030	72260	453,178	-380918
Total	**921140**	**10,652,998**	**-9731858**
Avg	**46057**	**532,650**	**-486593**

Clearly, the mechanical recycling plant at WS-TS incurred an accumulated loss for the first five years has a total of **119,732 US$** and till the year 2030, the accumulated gain is **6,899,275 US$** and the average gain is **344,964 US$** Therefore, the mechanical SW separation at SW-TS is feasible alternative based on the current financial estimation.

Table (47): Benefits for the mechanical recycling plant at WS-TS

Year	Revenue US$/year	Total cost US$/year	Annual gain or loss
2011	691,834	753,297	-61,463
2012	740,090	772,557	-32,467
2013	772,947	792,591	-19,644
2014	810,002	813,259	-3,257
2015	835,744	838,645	-2,901
2016	891,114	856,326	34,788
2017	933,923	878,999	54,924
2018	973,415	902,633	70,782
2019	1,020,521	926,825	93,696
2020	1,069,090	951,798	117,292
2021	1,121,113	647,792	473,321
2022	1,168,550	662,383	506,167
2023	1,225,061	677,411	547,650
2024	1,282,089	692,889	589,200
2025	1,342,323	708,833	633,490
2026	1,405,190	725,254	679,936
2027	1,470,810	742,168	728,642
2028	1,535,456	759,589	775,867
2029	1,606,188	777,534	828,654
2030	1,680,615	796,016	884,599
Total	**22,576,074**	**15,676,798**	**6,899,275**
Avg	**1,128,804**	**783,840**	**344,964**

5.4.4 Cash flow diagram:

The cash flow analysis is a type of financial analysis that compares the timing and amount of cash inflows with the timing and amount of cash outflows. The cash flow position can greatly affect the sustainability. These effects may not be apparent from a cost-benefit analysis. So this section shows the amount of cash out and in for the period of 10 years. At 0 time, the investment amount 1,897,000 US$ (should be paid as a capital cost, while the revenues (cash in) at the same time is zero, definitely there is a deficit of 1,897,000 US$ (capital cost) at the first year of investment. But during the next three years, the increase in “cash out” flow which covers

the running costs with an inflation rate, exceed the increase in (cash in) which represents the total revenues received from selling the recyclable items with an inflation rate, then at year 2014 and year 2015 cash in equals cash out, and after that oppositely increase in cash in more than cash out at year 2016 to year 2030. The difference mainly refers to the small quantities of the recycled wastes at WS-TS. The cash flow diagram is presented in Figure (11), the values are in million.

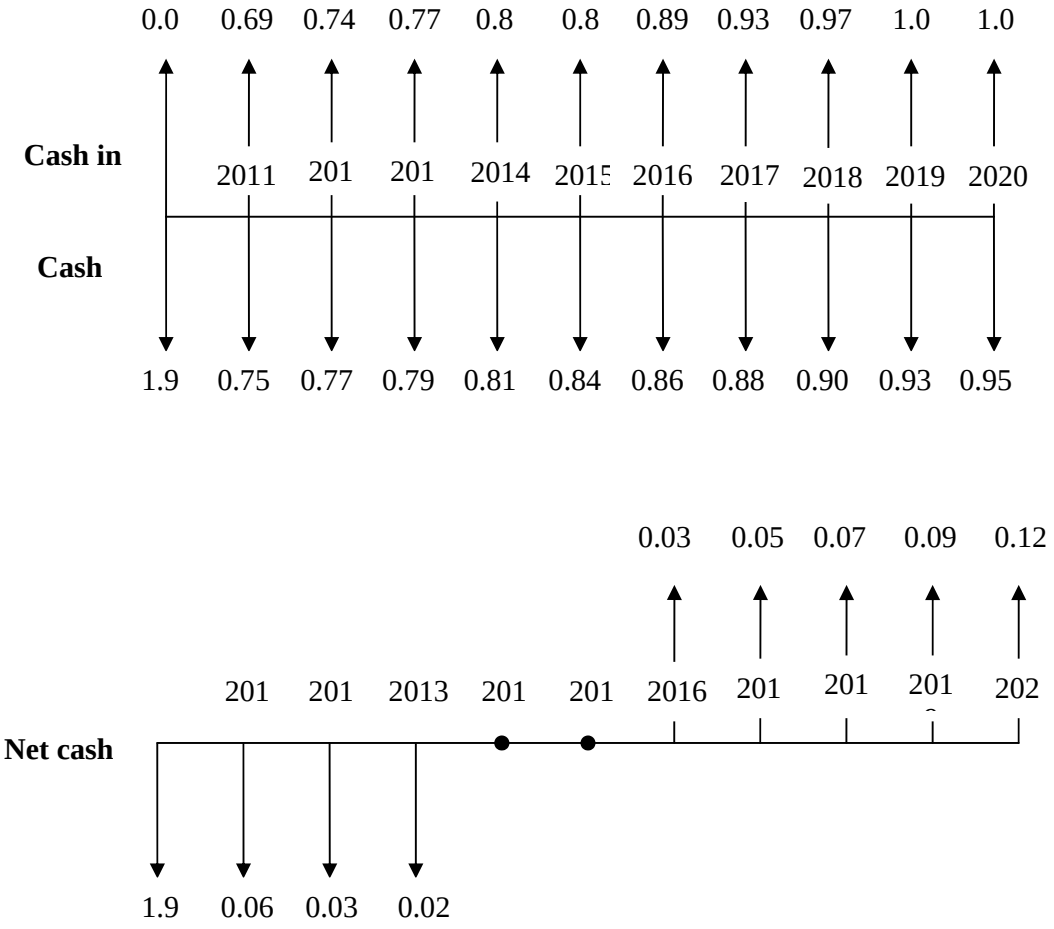

Figure 11: Cash flow diagram for the mechanical separation plant scenario at Tulkarem area

5.4.5 Time value of money

The time value of money is the value of money figuring in a given amount of interest earned over a given amount of time. The time value of money is the central concept in finance theory.

For example, $100 of today's money invested for one year and earning 5% interest will be worth $105 after one year. Therefore, $100 paid now or $105 paid exactly one year from now both have the same value to the recipient who assumes 5% interest; using time value of money terminology, $100 invested for one year at 5% interest has a future value of $105.

The method also allows the valuation of a likely stream of income in the future, in such a way that the annual incomes are discounted and then added together, thus providing a lump-sum "present value" of the entire income stream.

All of the standard calculations for time value of money derive from the most basic algebraic expression for the present value of a future sum, "discounted" to the present by an amount equal to the time value of money. For example, a sum of FV to be received in one year is discounted (at the rate of interest i) to give a sum of PV at present:

$FV = PV (1+i)^n$.

1. PV (present value): is the value at time= 0.
2. FV (future value): is the value at time= n.

3. i : is the discount rate, or the interest rate at which the amount will be compounded each period, I for one year for a dollar currency = 1.5. (according to Arab Bank and Amman-Cairo Bank).

4. n: is the number of periods (not necessarily an integer).

The concept of time value of money is important for applying Benefit/Cost ratio by calculating the present value of total costs and present value of benefits. The B/C ratio is computed by dividing the annual benefit by the annual cost. the costs is the operation costs for separation options. The costs were estimated for next 20 years taking into consideration the yearly inflation for the cost. The benefits are the differences between the revenues and costs, where the benefits are increased due to increasing of revenues. Increasing the revenues refer to consider the fees per ton that have estimated for the operation costs that take into consideration all options.

Table (48): Benefit costs ratio for Study Separation options.

Year	Direct Transport	Manual Separation	Mechanical Separation
2011	-1	-0.96	-0.08
2012	-1	-0.95	-0.04
2013	-1	-0.95	-0.02
2014	-1	-0.95	0.00
2015	-1	-0.95	0.00
2016	-1	-0.95	0.04
2017	-1	-0.95	0.06
2018	-1	-0.95	0.08
2019	-1	-0.94	0.10
2020	-1	-0.94	0.12
2021	-1	-0.87	0.73
2022	-1	-0.87	0.76
2023	-1	-0.86	0.81
2024	-1	-0.86	0.85
2025	-1	-0.86	0.89
2026	-1	-0.85	0.94
2027	-1	-0.85	0.98
2028	-1	-0.85	1.02
2029	-1	-0.84	1.07
2030	-1	-0.84	1.11
Total	-20	-18.05	9.42
Avg.	-1	-0.90	0.90

The B/c ratio for the direct transport to ZF and manual separation options is negative, so they excluded from consideration. In mechanical separation option, the first three years the ratio is negative, then in year 2014 and 2015 the ratio is zero, after that it get gradually increasing, from year 2027 to year 2030 are the best years because B/C ratio is greater than

1.0, so it is considered economically justified. The average B/C ratio for this option is 0.9 (near to 1), this option is the best.

5.4.6 Salvage Value:

Salvage value is the estimated value that an asset will realize upon. Its sale at the end of its useful life. The value is used in accounting to determine depreciation amounts and in the tax system to determine deductions.

Within the tax system, when a person donates a car he or she receives a tax deduction. The value of this deduction depends on the salvage value of the car. This salvage value is determined to be the current fair market value that could be obtained had the car been sold on that day rather than donated.

The salvage value is used in conjunction with the purchase price and accounting method to determine the amount by which an asset depreciates each period. For example, with a straight-line basis, an asset that cost $5,000 and has a salvage value of $1,000 and a useful life of five years would be depreciated at $800 = ($5,000-$1,000/5 years) each year.

Table (49) and table (50) show the salvage value for study separation options. The cost of end life of the vehicles is expected by specialist persons.

Table (49): Salvage value for the manual and no separation options.

No.	Item	NO.	Cost US$	cost of end life US$	life Cycle Year	salvage value US$
1	trailer	2	165,000	13200	10.0	327360.0
2	loader	1	25,000	2000	8.0	24750.0
	Total		**190,000**			**352,110**

Table (50): salvage value for the mechanical separation option.

No.	Item	NO.	Cost US$	cost of end life US$	life Cycle Year	salvage value US$
1	trailer	2	165,000	13,200	10.0	327,360.0
2	loader	1	25,000	2,500	8.0	24,687.5
3	lifter	1	150,000	12,000	10.0	148,800.0
	Total		**340,000**			**500,848**

Table (49) shows that manual separation and no separation options has the same salvage value **(352,110 US$)**, the salvage value for the mechanical separation option is **(500,848 US$)**.

5.4.7 Break Even Point:

Since the mechanical separation plant scenarios failed even to cover the costs, a breakeven point should be calculated to estimate the SW quantities that would achieve zero profit. This means that the total revenues will equal total costs at this point.

To calculate this point, the fixed and variable cost should be calculated separately. The variable cost is a cost that directly proportional to the volume of recycled material, which includes (salaries, maintenance, fuel, and electricity) consumed to operate and recycle SW in the transfer station. On the other hand, the fixed cost is a periodic charge that does not vary with business volume; this cost covers the total depreciation deducted annually for construction and equipment. The total net weight ton/ year is

the total quantity of SW which should be treated in the transfer station, so the variable cost per ton is estimated. Finally, the average price represents the average price for the five SW types recycled in the transfer station with 2% yearly inflation (Al-Sa'di, 2009).

For example, in the year 2011, the transfer station should separate 23tons/day of SW in addition to the total daily generation and recycle 6 tons/day to break even. In other words, these quantities need to be recycled to cover the variable and the fixed cost at the mechanical separation plant at WS-TS. Table (51) illustrates the total SW quantity to reach zero profit. The table shows the yearly decrease in the needed tons to break even. This decrease is a result of income closely to the years of a good gain from SW recycling operation.

Table (51): The total SW quantities that should be received at recycling plant to reach zero

Items		2011	2012	2013	2014	2015
Annual variable cost (NIS)		1,772,523	1,810,520	1,849,658	1,889,970	1,931,491
Annual fixed cost (NIS)		357,249	357,249	357,249	357,249	357,249
Total net weight ton/year		9,433	9,730	10,022	10,323	10,165
Variable cost per ton per type		187.91	186.09	184.55	183.09	190.02
Average price		358	365.16	372.46	379.91	387.51
SW types	1-(V/P)	0.48	0.49	0.50	0.52	0.51
	BEP IN NIS=F/(1-{V/P})	751,918.8	728,484.3	708,112.1	689,554.5	700,994.3
	BEP IN TONS YEARLY=F/(P-V)	2,100.3	1,994.9	1,901.2	1,815.0	1,809.0
	BEP IN TONS PER DAY	5.8	5.5	5.2	5.0	4.9
	Total quantity of tons inter the transfer station	23.0	21.9	20.8	19.9	19.8

****V: variable cost.**
P: Average Price.
F: Fixed cost.
BEP: Break Even Point.

Chapter Six

Results and Discussions

6.1 Results and discussions:

The study investigated the comparative analysis of the solid waste separation options in Tulkarem District (Wadi Shaer transfer station beneficiaries).

1. Three options of MSW separation systems were discussed for Tulkarem District:

    a. **Option 1**: Direct transport from WS-Transfer station to ZF landfilll (existing situation/Zero Separation). In this option, a transfer station would only receive the unloaded SW from tractors and compactors of Tulkarem beneficiaries and later transport it to ZF landfill by RORO trailers.

    b. **Option 2**: Separation at source: Curbside collection system is used by residents and/or laborers to separate the waste according to the different components, and then put each component at the curbside to be collected by the waste employees. Other definition for it is: Drop-off centers which is centralized locations where the people take their wastes to be disposed off according to different components. The waste laborers collect and separate the waste at these centers.

    c. **Option 3**: Separation at WS-Transfer station with two scenarios

c.1 **Scenario 1**: Manual separation: the SW compactors and tractors unload the SW at the transfer station floor space around 400 m² area**.** Then, the laborers separate the SW manually for some kind of recyclable material of bulky items such as; plastic, cartoon/paper and metals**.**

c.2 **Scenario 2:** Mechanical separation scenario (recycling plant): is a facility employing the required technology to process, separate, classify municipal waste, and create or recover reusable materials that can be sold or reused by a manufacturer as a substitute for or a supplement to virgin raw materials.

2. The main objective of this study is conducting a comparative analysis of solid waste separation options, the options are being compared and evaluated based on cost analysis. The main points for the comparative analysis are:

a. Recyclable wastes quantities:

Option 1: source separation is cancelled as I explained before.

Option 2: direct transport to ZF ➔ zero separation.

Option 3: separation at transfer station: have two scenarios

Scenario 1: manual separation. The table below shows the recyclable solid wastes for manual and mechanical separation at the transfer station. It is clear that the recycled percentages are too low and the average percentages are around 0.62%, this percent is nearly nothing- it is not deserved to be

mentioned, so the resulted solid waste quantities that should be transferred to Zahret Al Finjan is nearly equal to the second option (direct transport to ZF).

Table (52): Recyclable waste quantities for manual and mechanical separation

			Manual separation		Mmechanical separation	
Year	**SW quantities ton/day**	**SW quantities ton/year**	**total separated weight ton/year**	**recycled percent %**	**total separated weight ton/year**	**recycled percent %**
2011	99.36	36266	187.5	0.517	9433	26.0
2012	102.86	37544	198	0.527	9730	25.9
2013	106.49	38869	209	0.538	10022	25.8
2014	110.24	40238	221	0.549	10323	25.7
2015	114.13	41657	234	0.562	10165	24.4
2016	118.15	43125	247	0.573	10995	25.5
2017	122.32	44647	261	0.585	11340	25.4
2018	126.63	46220	274	0.593	11668	25.2
2019	131.09	47848	290	0.606	12031	25.1
2020	135.71	49534	306	0.618	12408	25.0
2021	140.50	51283	323.1	0.630	12812.9	25.0
2022	145.45	53089	338.8	0.638	13179.5	24.8
2023	150.58	54962	357.9	0.651	13608.5	24.8
2024	155.88	56896	376.8	0.662	14013.5	24.6
2025	161.38	58904	396.7	0.673	14452	24.5
2026	167.07	60981	417.4	0.684	14903.6	24.4
2027	172.96	63130	439.2	0.696	15369.1	24.3
2028	179.05	65353	462.3	0.707	15844.9	24.2
2029	185.37	67660	486.1	0.718	16316.2	24.1
2030	191.90	70044	511.1	0.730	16824.4	24.0

Scenario 2: mechanical separation. As it is mentioned before the table below details the SW recycled percentages. The recycled percentages are moderately good and the average of the percentages is around 25%. The

percentages are decreasing, but it is a smooth decrease, on the other hand, the total separated weight is increasing. So the resulted solid waste quantities that should be transferred to Zahret Al Finjan is decreased and the benefits from the recycling is more than the transferred quantities.

A rough estimation: 24.4% of the waste is recycled, so in 2015 the total amount of generated waste is 10165 ton/year ➔ the solid waste quantities that should be transferred to ZF is: 41657 – 10165 = 31,492 ton * 8.57 $/ton (gate fees)

= 269,886.4 $ at the end of the year.

For 2011/ manual separation, 0.517% of the waste is recycled, so in 2011 the total amount of generated waste is 36266 ton/year ➔ the solid waste quantities that should be transferred to ZF is: 36266 – 187.5 = 36,078.5 ton * 8.57 $/ton (gate fees)

= 309,192.7 $ at the end of the year.

For 2011/ mechanical separation, 26% of the waste is recycled, so in 2011 the total amount of generated waste is 36266 ton/year ➔ the solid waste quantities that should be transferred to ZF is: 36266 – 9433= 26,833 ton * 8.57 $/ton (gate fees)

= 229,958.8 $ at the end of the year.

b. Operational costs per ton

Table 52 summarizes the operational costs analysis for the study options, which include the total costs for each item, the costs per the ton of

waste and the costs percentages for these items. The costs per ton for each option are estimated according to the quantity of waste as the follows:

(Cost (US $)/year)/ (waste quantity (ton/year))

The costs percentage is estimated for all operational items.

Table (53): Summary of operational costs for SW separation options

Direct Transport			
Cost item	**US $ /year**	**US $ /ton**	**Percentage %**
Salaries	81,684	2.25	14.10
Fuel consumption	106,320	2.93	18.35
Insurances	10,420	0.29	1.80
Maintenance	63,792	1.76	11.01
Utilities	6,480	0.18	1.12
Gate fees	310803	8.57	53.63
Total cost	**579,499**	**15.98**	**100.00**
Manual Separation			
Cost item	**US $ /year**	**US $ /ton**	**Percentage %**
Salaries	93,600	2.58	16.28
Fuel consumption	97,002	2.67	16.87
Insurances	10,420	0.29	1.81
Maintenance	58,201.00	1.60	10.12
Utilities	6,480	0.18	1.13
Gate Fees	309,196.17	8.53	53.78
Total cost	**574,899**	**15.85**	**100.00**
Mechanical Separation			
Cost item	**US $ /year**	**US $ /ton**	**Percentage %**
Salaries	174,000	4.80	23.10
Fuel consumption	117,427.00	3.24	15.59
Electricity	144,552	3.99	19.19
Maintenance	70,456.00	1.94	9.35
Insurances	10,420	0.29	1.38
Utilities	6,480	0.18	0.86
Gate Fees	229,962.24	6.34	30.53
Total cost	**753,297**	**20.77**	**100.00**

Table (53) summarizes the total operational costs per ton for each option. The cost for option 1 is around 16 $/ton. For option two, scenario 1 (manual separation) is 15.85 $/ton and 20.77 $/ton for scenario 2 (mechanical separation).

Although the mechanical separation has the highest rate, the gate fees is lower than the direct transport and manual separation, but the salaries of the mechanical separation are the highest.

It is seen that the operation cost per ton for direct transport is nearly equal to the manual separation, and the gate fees take around 50% of the operation costs.

c. Solid waste revenues

The costs revenues are identified for this study through estimating the costs benefits from the marking the separated waste and from the fees collection. Table (54) summarizes the revenues of the solid waste options and scenarios.

Table (54): Summary of the revenues for solid waste separation options

Year	Revenue/direct transport to ZF US$/year	Revenue/manual US$/year	Revenue/mechanical US$/year
2011	0	25806	691,834
2012	0	27875	725,578
2013	0	29358	757,791
2014	0	31059	794,120
2015	0	32930	819,357
2016	0	34786	873,641
2017	0	36757	915,611
2018	0	38593	954,328
2019	0	40821	1,000,511
2020	0	43071	1,048,127
2021	0	45507	1,121,113
2022	0	47755	1,168,550
2023	0	50432	1,225,061
2024	0	53145	1,282,089
2025	0	55991	1,342,323
2026	0	58968	1,405,190
2027	0	62100	1,470,810
2028	0	65255	1,535,456
2029	0	68673	1,606,188
2030	0	72260	1,680,615
Total	**0**	**921140**	**22,576,074**
Avg.	**0**	**46057**	**1,128,804**

Option 1: source separation is omitted.

Option 2: direct transport to ZF ➔ zero revenues,

Option 3: separation at transfer station: have two scenarios:

Scenario 1: manual separation. The revenues are increasing yearly due to separation, in 2011 the revenues equal 25,806 $ at the end of the year, but this value will not cover the salaries (93,600 $) or the fuel consumption and other expenditures, it will only cover the insurances and utilities. The total revenues for the next 20 years is **921,140$** and the average is **46,057$** and this is not sufficient.

Scenario 2: Mechanical separation. The revenues are increasing yearly due to separation, in 2011 the revenues equal 691,834 $ at the end of the year, this value will cover 91.8% of all expenditures with gate fees, and this is high percentage. The total revenues for the 20 years is **22,576,074$** and the average is **1,128,804$**.

d. Solid waste benefits

Table (55), shows the average benefits for the options.

It is obvious that option 1 has no benefits and it losses 540,933$ yearly. Tulkarem Joint Services Council for solid waste management depends mainly on its expenditures on fees that the members should pay, but unfortunately most of them don't pay their fees which lead to deficit for Tulkarem JSC, that reflects its ability to present services for the localities.

Table (55): Average yearly benefits for solid waste separation options

SW option	Average yearly benefits from 2011-2030 US$
Option1: direct transport	-540,933
Option 2: source separation	cancelled
Option 3:separation at TS Scenario 1: manual separation	-486,593
Scenario 2: mechanical separation	344,964

Scenario 1: It losses 486,593$ yearly, the average yearly gate fees is assumed to be 309,000 $, but it is better than the first option, the difference of loss between them is 54,340 $ for the manual separation.

Scenario 2: This choice is the profitable, the average annual gain from it is 344,964 $, so Tulkarem JSC can reduce the solid waste transfer fees to the minimum.

The solid waste separation options are explained and evaluated, but it is found that the source separation option is rejected by households, LGUs and SW services employee, this was performed by exploring the SW separation at the source by applying three questionnaires' types of total 583 persons. The results revealed that the SW separation at source is not feasible in the study area. This is because SW separation at source implies highly stockholder's participation. However, the questioned people show little awareness of such process. Moreover, they did not show interest to perform that on reliable and long term basis.

Solid waste management in Tulkarem localities is not good and organized because Tulkarem Joint Services Council for solid waste management is just responsible for Wadi Shaer transfer station (transfer solid waste from the station to the Zahret Al Finjan. The local authorities are suffering from the high costs due to the expenditures resulted from salaries, maintenance, insurances and utilities for solid waste collection in addition to the solid waste transferring fees.

The result of the study showed that option three (separation at transfer station) scenario 2 (mechanical separation) is better than the other options. It is important for this option to know where is the break event point to avoid loss from first year operation, the transfer station should separate 21tons/day of SW in addition to the total daily generation and recycle 5 tons/day to break even.

Chapter Seven

Conclusions and Recommendations

At the end of this study, many recommendations can be drawn as follows;

- Tulkarem for SWM-JSC should adopt the mechanical separation scenarios at WS-TS, if they contracted with addition authorities to transfer their solid waste in the transfer station to avoid deficit in the first three years and the transportation costs will decrease.
- If it is difficult for the SWM-JSC to apply mechanical separation, they can apply manual separation to cover simple part of the expenditures.
- SWM-JSC should apply effective solid waste management at its communities, by applying the SW collection from communities by distributing the compactors in a proper way and conducting effective routes for SW collection. Moreover, by transporting the solid waste from the TS to ZF-landfill each day and do not allow keeping it to the next day to avoid odor emissions and insects.
- SWM-JSC should perform the planned public awareness campaign to raise the people awareness about the SW issues.

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Site visits:

The site visits is quite important to have a close look on the situation. Many visits have been conducted to municipalities, the city, villages, camps and SWM-JSC of the study area to gather information about SWM in the municipalities and councils in addition to explore the beneficiary's willingness to participate in the SW separation at source in their communities and to be in touch with households perceptions towards SW separation by spreading questionnaires.

In these visits, meetings were held with the WS-JSC employees, Zahret Al-Finjan Landfill in Jenin, Accountant and engineering department in addition to the executive manager, Tulharem Joint Services Council for Solid Waste Managemet Accountant department and the executive manager and the last is Assairafi transfer station in Nablus, I met the engineer. The meetings were in conversational themes.

Appendices

Appendix (A)

Table form for solid composition test

Total weight……
Sample
weight……
Weather……
Date: ……

Items	Weight (kg)	%
Organic		
Plastic		
Cartoon		
Paper		
Wood		
Glass		
Metals		
Textile		
Others		
Sum		100.00

Appendix (B)

Expected total recyclable materials quantities in Tulkarem area in the horizon of 2011- 2030 year.

	2011		2012		2013		2014		2015		2016	
	% SW	ton/day	% SW	ton/day	% SW	ton/day	% SW	ton/day	% SW	ton/day	% SW	ton/day
Organic	46.0	45.71	45.1	46.39	44.2	47.07	43.2	47.62	42.3	48.28	41.4	48.91
Plastics	11.7	11.63	12.0	12.31	12.2	13.03	12.5	13.82	12.8	14.62	13.1	15.45
cartoon	11.0	10.93	11.3	11.59	11.5	12.29	11.8	13.05	12.1	13.82	12.4	14.63
Paper	4.0	3.97	4.0	4.16	4.1	4.36	4.1	4.56	4.2	4.78	4.2	5.00
Wood	4.4	4.37	4.4	4.57	4.5	4.78	4.5	5.00	4.6	5.23	4.6	5.47
Glass	4.3	4.27	4.4	4.52	4.5	4.77	4.6	5.05	4.7	5.33	4.8	5.62
Metals	5.5	5.46	5.6	5.75	5.7	6.05	5.8	6.37	5.9	6.70	6.0	7.04
Textiles	9.0	8.94	9.0	9.30	9.1	9.68	9.1	10.08	9.2	10.48	9.2	10.91
Others	4.1	4.07	4.1	4.26	4.2	4.46	4.2	4.67	4.3	4.89	4.3	5.12
	100.0	**99.36**	**100.0**	**102.86**	**100.00**	**106.49**	**100.0**	**110.24**	**100.00**	**114.13**	**100.0**	**118.15**

		2017		2018		2019		2020		2021	
	% SW	ton/day	% SW	ton/day	% SW	ton/day	% SW	ton/day	% SW	ton/day	% SW
Organic	40.5	49.54	39.6	50.15	38.6	50.60	37.7	51.16	42.3	51.70	36.8
Plastics	13.4	16.33	13.6	17.25	13.9	18.25	14.2	19.26	12.8	20.32	14.5
cartoon	12.7	15.47	12.9	16.36	13.2	17.33	13.5	18.31	12.1	19.33	13.8
Paper	4.3	5.23	4.3	5.47	4.4	5.73	4.4	5.99	4.2	6.27	4.5
Wood	4.7	5.72	4.7	5.98	4.8	6.25	4.8	6.53	4.6	6.83	4.9
Glass	4.9	5.93	4.9	6.26	5.0	6.61	5.1	6.96	4.7	7.33	5.2
Metals	6.1	7.40	6.1	7.78	6.2	8.18	6.3	8.59	5.9	9.02	6.4
Textiles	9.3	11.35	9.3	11.80	9.4	12.28	9.4	12.78	9.2	13.29	9.5
Others	4.4	5.35	4.4	5.60	4.5	5.86	4.5	6.13	4.3	6.41	4.6
	100.00	**122.32**	**100.0**	**126.63**	**100.0**	**131.09**	**100.0**	**135.71**	**100.00**	140.50	100.00

		2022		2023		2024		2025		2026	
	% SW	ton/day	% SW	ton/day	% SW	ton/day	% SW	ton/day	% SW	ton/day	% SW
Organic	40.5	52.22	35.9	52.70	35.0	53.00	34.0	53.42	33.1	53.80	32.2
Plastics	13.4	21.42	14.7	22.59	15.0	23.85	15.3	25.13	15.6	26.51	15.9
cartoon	12.7	20.41	14.0	21.53	14.3	22.76	14.6	24.00	14.9	25.34	15.2
Paper	4.3	6.55	4.5	6.85	4.6	7.17	4.6	7.50	4.6	7.76	4.6
Wood	4.7	7.13	4.9	7.45	5.0	7.79	5	8.14	5	8.43	5
Glass	4.9	7.72	5.3	8.13	5.4	8.57	5.5	9.02	5.6	9.51	5.7
Metals	6.1	9.47	6.5	9.94	6.6	10.44	6.7	10.96	6.8	11.51	6.9
Textiles	9.3	13.83	9.5	14.38	9.6	14.96	9.6	15.57	9.6	16.11	9.6
Others	4.4	6.70	4.6	7.00	4.7	7.33	4.7	7.66	4.8	8.09	4.9
	100.00	145.45	**100.0**	150.58	**100.0**	155.88	**100.0**	161.38	**100.00**	167.07	100.00

		2027		2028		2029		2030	
	% SW	ton/day	% SW	ton/day	% SW	ton/day	% SW	ton/day	% SW
Organic	40.5	54.14	31.3	54.43	30.4	54.50	29.4	54.69	28.5
Plastics	13.4	27.97	16.2	29.33	16.4	30.92	16.7	32.57	17
cartoon	12.7	26.76	15.5	28.08	15.7	29.62	16	31.22	16.3
Paper	4.3	8.03	4.6	8.56	4.8	8.95	4.8	9.30	4.8
Wood	4.7	8.73	5.1	9.27	5.2	9.69	5.2	10.07	5.2
Glass	4.9	10.01	5.8	10.49	5.9	11.05	6	11.69	6.1
Metals	6.1	12.09	7	12.64	7.1	13.27	7.2	13.99	7.3
Textiles	9.3	16.68	9.6	17.51	9.8	18.22	9.8	18.89	9.9
Others	4.4	8.55	4.9	8.74	4.9	9.14	4.9	9.49	4.9
	100.00	172.96	**100.0**	179.05	**100.0**	185.37	**100.0**	191.90	**100.00**

Appendix (C)

Detailed tables for the operation and administrative cost costs of the research options

1- Direct transport from WS-Transfer station to ZF land fill

Salaries:

#	Staff	Frequency	Salaries $/month/ laborer	Total salaries $/ month	Total Salaries per year $
1	Drivers	2	770	1,540	18480
2	loader	2	600	1,200	14400
3	foreman	1	485	485	5820
5	cleaner	1	415	415	4980
6	mechanical	1	142	142	1704
7	Guard	1	415	415	4980
		Subs total		**4,197**	**50364**
		Administration			
8	Executive manager	1	1465	1465	17580
9	Accountant	1	618	618	7416
10	Secretary	1	527	527	6324
		Subs total		**2610**	**31320**
		Grand total		**6,807**	**81684**

Fuel consumption:

#	Item	Frequency	Avg Fuel cons/month $	Total Fuel cons	Cost $/year
	trailer	2	4,000	8,000	96000
	bagger	1	860	860	10320
	Total				**106320**

Maintenance :

#	Item	**Number**	**Fuel cost per year $**	**maintenance %**	Cost $/year
	trailer	2	96000	60	57600
	Loader	1	10320	60	6192
		Total Cost			**63792**

Insurances:

#	Item	Frequency	Avg yearly insurances $	Total cost $
1	trailer	2	4,575	9150
2	loader	1	1270	1270
	Total			**10420**

Utilities:

#	Item		Avg monthly cost $	avg yearly cost $
1	Electricity, water and communications		540	6480
	Total			**6480**

2- Separation at transfer station- manual scenario Salaries

#	Staff	Frequency	Salaries $/month/ laborer	Total salaries $/ month	Total salaries $/ year
1	Drivers	4	800	3,200	38,400
2	Foremen	2	650	1,300	15,600
3	Laborers	6	550	3,300	39,600
		Total			**93,600**

Fuel consumption:

#	Item	Frequency	Working day/year	Fuel cons. Liter/km	Distance Km/day	Cost $/liter	Cost $ /year
	trailer	2	317	1	75	1.7	80835
	loader	1	317	0.75	40	1.7	16167
	Total						**97002**

Maintenance calculations for the manual separation:

#	**Site separation Maintenance**	**Number**	**Fuel cost per year $**	**Maintenance %**	**Cost $ / year**
1	trailer	2	80835	60	48501
2	loader	1	16167	60	9700
	Total				**58201**

Insurances:

#	Item	Frequency	Avg yearly insurances $	Total cost $
1	Skip-lift trailer	2	4,575	9150
2	loader	1	1270	1270
3	laborers	5		0
	Total			**10420**

Utilities

#	Item		Avg monthly cost $	avg yearly cost $
1	Electricity, water and communications		540	6480
	Total			**6480**

3- Separation at transfer station- mechanical scenario Salaries

Labor skills for mechanical separation scenario

#	**Site separation**	**Number**	**Salaries per month**	**Total salaries**	**Total Salaries**
	Staff		**per laborer**	**per month**	**per year**
			US$	**US$**	**US$**
1	plant manager	1	2800	2800	33600
2	Mechanical Engineer	1	1800	1800	21600
3	accountant	1	1000	1000	12000
4	Drivers	3	800	2400	28800
5	Laborers	10	650	6500	78000
	sub-total			**174000**	
	Total Cost				

Fuel Consumption calculations for the mechanical separation scenario

#	Site separation Fuel Consumption	No.	working day per year	fuel consumption liter per km	Distance km per day	cost $/liter	Cost $ /year
1	trailer	1	317	1	100	1.7	53890
3	loader	1	317	0.75	50	1.7	20209
4	lifter	1	317	0.67	120	1.7	43328
	Total Cost						**117427**

Maintenance calculations for the mechanical separation scenario

#	Site separation Maintenance	Number	Fuel cost per year $	maintenance %	Cost $ / year
1	trailer	1	53890	60	32334
3	loader	1	20208.75	60	12125
4	Lifter	1	43327.56	60	25997
	Total Cost				**70456**

Electricity calculations for the mechanical separation scenario

#	Site separation items	Power KW/hour	Power KW/Day (7.5 hour/day)	cost (US $)/KW	Total Cost (US $)/Year (317day/year)
1	Plant operation	300	3000	0.152	144552
	Total cost				**144552**

Insurances

#	Item	Frequency	Avg yearly insurances $	Total cost $
1	trailer	2	4,575	9150
2	loader	1	1270	1270
	Total			**10420**

Utilities

#	Item		Avg monthly cost $	avg yearly cost $
1	Electricity, water and communications		540	6480
	Total			**6480**

Appendix (D)

The expected net weights and revenues of the recyclable materials for manual separation at Tulkarem area in 2011 and 2012 years

			2011			2012		
SW type	**Selling price NIS/ton**	**Recyclable percentage**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**
Paper, cartoon	270	1.8	0.27	97.9	26438.2	15.3	103.4	27,918
Plastics	800	1.5	0.17	63.6	50918.0	12	67.6	54,080
Metals	500	1.3	0.07	25.9	12965.2	5.6	27.3	13,650
				187.5	**90,321.5**		**198**	**95,648**

The expected net weights and revenues of the recyclable materials for manual separation at Tulkarem area in 2013 and 2014 years

			2013			2014		
SW type	**Selling price NIS/ton**	**Recyclable percentage**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**
Paper, cartoon	270	1.8	15.6	109.1	29,457	15.9	115.2	31,104
Plastics	800	1.5	12.2	71.1	56,880	12.5	75.4	60,320
Metals	500	1.3	5.7	28.8	14,400	5.8	30.3	15,150
				209	**100,737**		**221**	**106,574**

The expected net weights and revenues of the recyclable materials for manual separation at Tulkarem area in 2015 and 2016 years

			2015			2016		
SW type	**Selling price NIS/ton**	**Recyclable percentage**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**
Paper, cartoon	270	1.8	16.3	122.2	32,994	16.6	128.9	34,803
Plastics	800	1.5	12.8	80	64,000	13.1	84.7	67,760
Metals	500	1.3	5.9	32	16,000	6	33.6	16,800
				234	**112,994**		**247**	**119,363**

The expected net weights and revenues of the recyclable materials for manual separation at Tulkarem area in 2017 and 2018 years

			2017			2018		
SW type	**Selling price NIS/ton**	**Recyclable percentage**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**
Paper, cartoon	270	1.8	16.9	135.8	36,666	17.2	143.1	38,637
Plastics	800	1.5	13.4	89.7	71,760	13.6	94.3	75,440
Metals	500	1.3	6.1	35.4	17,700	6.1	36.7	18,350
				261	**126,126**		**274**	**132,427**

The expected net weights and revenues of the recyclable materials for manual separation at Tulkarem area in 2019 and 2020 years

			2019			2020		
SW type	**Selling price NIS/ton**	**Recyclable percentage**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**
Paper, cartoon	270	1.8	17.6	151.6	40,932	17.9	159.6	43,092
Plastics	800	1.5	13.9	99.8	79,840	14.2	105.5	84,400
Metals	500	1.3	6.2	38.6	19,300	6.3	40.6	20,300
				290	**140,072**		**306**	**147,792**

The expected net weights and revenues of the recyclable materials for manual separation at Tulkarem area in 2021 and 2022 years

			2021			2022		
SW type	**Selling price NIS/ton**	**Recyclable percentage**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**
Paper, cartoon	270	1.8	18.3	168.9	45,603	18.5	176.8	47,736
Plastics	800	1.5	14.5	111.5	89,200	14.7	117.1	93,680
Metals	500	1.3	6.4	42.7	21,350	6.5	44.9	22,450
				323	**156,153**		**339**	**163,866**

The expected net weights and revenues of the recyclable materials for manual separation at Tulkarem area in 2023 and 2024 years

			2023			2024		
SW type	**Selling price NIS/ton**	**Recyclable percentage**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**
Paper, cartoon	270	1.8	18.9	187	50,490	19.2	196.6	53,082
Plastics	800	1.5	15	123.7	98,960	15.3	130.6	104,480
Metals	500	1.3	6.6	47.2	23,600	6.7	49.6	24,800
				358	**173,050**		**377**	**182,362**

The expected net weights and revenues of the recyclable materials for manual separation at Tulkarem area in 2025 and 2026 years

			2025			2026		
SW type	**Selling price NIS/ton**	**Recyclable percentage**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**
Paper, cartoon	270	1.8	19.5	206.8	55,836	19.8	217.3	58,671
Plastics	800	1.5	15.6	137.8	110,240	15.9	145.4	116,320
Metals	500	1.3	6.8	52.1	26,050	6.9	54.7	27,350
				397	**192,126**		**417**	**202,341**

The expected net weights and revenues of the recyclable materials for manual separation at Tulkarem area in 2027 and 2028 years

			2027			2028		
SW type	**Selling price NIS/ton**	**Recyclable percentage**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**
Paper, cartoon	270	1.8	20.1	228.4	61,668	20.5	241.2	65,124
Plastics	800	1.5	16.2	153.4	122,720	16.4	160.8	128,640
Metals	500	1.3	7	57.4	28,700	7.1	60.3	30,150
				439	**213,088**		**462**	**223,914**

The expected net weights and revenues of the recyclable materials for manual separation at Tulkarem area in 2029 and 2030 years

			2029			2030		
SW type	**Selling price NIS/ton**	**Recyclable percentage**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**
Paper, cartoon	270	1.8	20.8	253.3	68,391	21.1	266	71,820
Plastics	800	1.5	16.7	169.5	135,600	17	178.6	142,880
Metals	500	1.3	7.2	63.3	31,650	7.3	66.5	33,250
				486	**235,641**		**511**	**247,950**

The expected net weights and revenues of the recyclable materials for mechanical separation at Tulkarem area in 2011 and 2012 years

			2011/ 99.36			2012 / 102.86		
SW type	**Selling price NIS/ton**	**Recyclable percentage**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**
Organic	100	35	46	5838.9	583,890	45.1	5926.3	592,630
Paper and cartoon	270	30	15	1632	440,640	15.3	1723.3	465,291
Plastics	800	35	11.7	1485.1	1,188,080	12	1576.8	1,261,440
Metals	500	20	5.5	398.9	199,450	5.6	420.5	210,250
Glass	120	5	4.3	78	9,360	4.4	82.6	9,912
				9,433	**2,421,420**		**9,730**	**2,539,523**

The expected net weights and revenues of the recyclable materials for mechanical separation at Tulkarem area in 2013 and 2014 years

			2013			**2014**		
SW type	**Selling price NIS/ton**	**Recyclable percentage**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**
Organic	100	35	44.2	6013	601,300	43.2	6083.9	608,390
Paper, carton	270	30	15.6	1819.1	491,157	15.9	1919.3	518,211
Plastics	800	35	12.2	1659.7	1,327,760	12.5	1760.4	1,408,320
Metals	500	20	5.7	443.1	221,550	5.8	466.8	233,400
Glass	120	5	4.5	87.5	10,500	4.6	92.5	11,100
				10,022	**2,652,267**		**10,323**	**2,779,421**

The expected net weights and revenues of the recyclable materials for mechanical separation at Tulkarem area in 2015 and 2016 years

			2015			2016		
SW type	**Selling price NIS/ton**	**Recyclable percentage**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**
Organic	100	35	38.9	5671.7	567,170	41.4	6248.8	624,880
Paper, carton	270	30	16.3	2037	549,990	16.6	2147.6	579,852
Plastics	800	35	12.8	1866.3	1,493,040	13.1	1977.3	1,581,840
Metals	500	20	5.9	491.6	245,800	6	517.5	258,750
Glass	120	5	4.7	97.9	11,748	4.8	103.5	12,420
				10,165	**2,867,748**		**10,995**	**3,057,742**

The expected net weights and revenues of the recyclable materials for mechanical separation at Tulkarem area in 2017 and 2018 years

			2017			2018		
SW type	**Selling price NIS/ton**	**Recyclable percentage**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**
Organic	100	35	40.5	6328.7	632,870	39.6	6406.1	640,610
Paper, carton	270	30	16.9	2263.6	611,172	17.2	2384.9	643,923
Plastics	800	35	13.4	2093.9	1,675,120	13.6	2200.1	1,760,080
Metals	500	20	6.1	544.7	272,350	6.1	563.9	281,950
Glass	120	5	4.9	109.4	13,128	4.9	113.2	13,584
				11,340	**3,204,640**		**11,668**	**3,340,147**

The expected net weights and revenues of the recyclable materials for mechanical separation at Tulkarem area in 2019 and 2020 years

			2019			2020		
SW type	**Selling price NIS/ton**	**Recyclable percentage**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**
Organic	100	35	38.6	6464.2	646,420	37.7	6536	653,600
Paper, carton	270	30	17.6	2526.4	682,128	17.9	2660	718,200
Plastics	800	35	13.9	2327.8	1,862,240	14.2	2461.8	1,969,440
Metals	500	20	6.2	593.3	296,650	6.3	624.1	312,050
Glass	120	5	5	119.6	14,352	5.1	126.3	15,156
				12,031	**3,501,790**		**12,408**	**3,668,446**

The expected net weights and revenues of the recyclable materials for mechanical separation at Tulkarem area in 2021 and 2022 years

			2021			2022		
SW type	**Selling price NIS/ton**	**Recyclable percentage**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**
Organic	100	35	36.8	6605.2	660,520	35.9	6670.7	667,070
Paper, carton	270	30	18.3	2815.4	760,158	18.5	2946.5	795,555
Plastics	800	35	14.5	2602.6	2,082,080	14.7	2731.4	2,185,120
Metals	500	20	6.4	656.4	328,200	6.5	690.2	345,100
Glass	120	5	5.2	133.3	15,996	5.3	140.7	16,884
				12,813	**3,846,954**		**13,180**	**4,009,729**

The expected net weights and revenues of the recyclable materials for mechanical separation at Tulkarem area in 2023 and 2024 years

			2023			2024		
SW type	**Selling price NIS/ton**	**Recyclable percentage**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**
Organic	100	35	35	6732.8	673,280	34	6770.6	677,060
Paper, carton	270	30	18.9	3116.3	841,401	19.2	3277.2	884,844
Plastics	800	35	15	2885.5	2,308,400	15.3	3046.8	2,437,440
Metals	500	20	6.6	725.5	362,750	6.7	762.4	381,200
Glass	120	5	5.4	148.4	17,808	5.5	156.5	18,780
				13,609	**4,203,639**		**14,014**	**4,399,324**

The expected net weights and revenues of the recyclable materials for mechanical separation at Tulkarem area in 2025 and 2026 years

			2025			2026		
SW type	**Selling price NIS/ton**	**Recyclable percentage**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**
Organic	100	35	33.1	6824	682,400	32.2	6872.5	687,250
Paper, carton	270	30	19.5	3445.9	930,393	19.8	3622.2	977,994
Plastics	800	35	15.6	3216.1	2,572,880	15.9	3393.6	2,714,880
Metals	500	20	6.8	801.1	400,550	6.9	841.5	420,750
Glass	120	5	5.6	164.9	19,788	5.7	173.8	20,856
				14452	**4,606,011**		**14,904**	**4,821,730**

The expected net weights and revenues of the recyclable materials for mechanical separation at Tulkarem area in 2027 and 2028 years

			2027			2028		
SW type	**Selling price NIS/ton**	**Recyclable percentage**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**
Organic	100	35	31.3	6915.9	691,590	30.4	6953.6	695,360
Paper, carton	270	30	20.1	3806.8	1,027,836	20.5	4019.2	1,085,184
Plastics	800	35	16.2	3579.5	2,863,600	16.4	3751.3	3,001,040
Metals	500	20	7	883.8	441,900	7.1	928	464,000
Glass	120	5	5.8	183.1	21,972	5.9	192.8	23,136
				15,369	**5,046,898**		**15,845**	**5,268,720**

The expected net weights and revenues of the recyclable materials for mechanical separation at Tulkarem area in 2029 and 2030 years

			2029			2030		
SW type	**Selling price NIS/ton**	**Recyclable percentage**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**	**Composition**	**Net Weight Ton/year**	**Revenues NIS/year**
Organic	100	35	29.4	6962.2	696,220	28.5	6986.8	698,680
Paper, carton	270	30	20.8	4222	1,139,940	21.1	4433.8	1,197,126
Plastics	800	35	16.7	3954.7	3,163,760	17	4167.6	3,334,080
Metals	500	20	7.2	974.3	487,150	7.3	1022.6	511,300
Glass	120	5	6	203	24,360	6.1	213.6	25,632
				16,316	**5,511,430**		**16,824**	**5,766,818**

Appendix (E)
Questionnaires

1- Households questionnaires

بسم الله الرحمن الرحيم

تحية طيبة و بعد,,

الباحثة شيرين راضي حمادة تقوم بعمل دراسة حول فصل النفايات الصلبة في منطقة طولكرم مقابل النقل المباشر لمكب زهرة الفنجان، و هذا الاستبيان يهدف لأخذ رأي المواطنين ومدى تقبلهم لفكرة الفرز المنزلي للنفايات.

إن تعبئتكم الإستمارة بصدق و موضوعية و جدية سيكون له الاثر الكبير على دقة هذه الدراسة المقدمة للحصول على درجة الماجستير في هندسة المياه و البيئة من جامعة النجاح الوطنية.

شاكرين لكم تعاونكم و حسن اهتمامكم

الباحثة: شيرين حمادة

إستبانة لدراسة قابلية المواطنين لفصل النفايات المنزلية في بيوتهم

في منطقة محافظة طولكرم

إستبانة المواطنين

1) **اسم المنطقة** .....
2) **نوع التجمع**
أ) مدينة ب) قرية ج) مخيم
3) **الجنس**
أ) ذكر ب) أنثى
4) **العمر**
أ) أقل من 25 ب)26-35 ج) 36-45 د)أكثر من 46
5) **مستوى التعليم**
أ) مرحلة أساسية ب) مرحلة ثانوية ج)جامعي
د) دراسات عليا ه) أخرى
6) **طبيعة المنزل**
أ) مستقل ب) شقة في مبنى أو عمارة
7) **عدد أفراد الأسرة الذين يعيشون في المنزل**
أ) 2-4 ب) 5-7 ج) 8-10 د) اكثر من 10

8) **هل تعلم ما المقصود بالنفايات الصلبة**
أ) نعم ب) لا
9) **كيف تتخلص من النفايات الصلبة في منزلك**
أ) وضعها في حاوية البلدية
ب) أمام البيت ليتم جمعها لاحقا من قبل عمّال البلدية
ج)غير ذلك.....(وضح/ي)
10) **من الذي يقوم عادة بإلقاء النفايات في الحاوية**
أ) الأب ب) الأطفال ج) الأم د) الاولاد البالغون
11) **هل تعلم أين تذهب النفايات بعد جمعها من قبل البلدية**
أ) نعم ب) لا

12) **كم معدل وزن النفايات المنزلية الكلي الذي تنتجه اسرتك في اليوم الواحد(كغم = كيلو غرام)**
أ) 1-2كغم ب) 3-4كغم ج) 5-6كغم د) 7-9 كغم ه) 10-11كغم و) أكثر من 11كغم
13) **بتقديرك حدد/ي نسبة انتاج النفايات في المنزل (نسبة مئوية100%)**
أ) مواد عضوية (بقايا طعام, اوراق شجر,....) .....%
ب) ورق و كرتون .....%
ج) خشب .....%
ح) بلاستيك .....%
د)زجاج .....%
ه)معادن (حديد, المنيوم, ...) .....%

و) أقمشة و ملابس .....%
ي) غير ذلك .....%

المجموع 100%

14) هل تعلم كم تبلغ رسوم خدمة النفايات الشهرية على منزلك
أ) نعم،،،كم تبلغ؟.....شيكل/شهر ب) لا
15) هل تقوم بدفع رسوم النفايات بانتظام (شهري)
أ) نعم ب) لا
16) هل لديك معرفة بالمخاطر الصحية و البيئية لتراكم النفايات في المناطق العشوائية و حول الحاويات
أ) نعم ب) لا
17) هل لديك المعرفة بكيفية إعادة استخدام النفايات
أ) نعم ب) لا
18) هل لديك القناعة بجدوى إعادة استخدام النفايات في المنزل (متل الاقمشة, أقنية البلاستيك للعصائر و الكولا, ... الخ)
أ) نعم ب) لا
19) هل تقوم بإلقاء الاشياء التي لا تلزمك و من الممكن أن يستفيد منها الاخر مثل الملابس و بعض الادوات
أ) نعم ب) لا
20) كيف تتخلص من بقايا الطعام
أ) التخلص منها مع النفايات ب) إعادة استخدامها كسماد عضوي
ج) طعام للحيوانات د) غير ذلك ..... حدد/ي
21) هل تعلم ما المقصود بعملية فرز النفايات الصلبة
أ) نعم ب) لا
22) هل لديك المعرفة بأهمية فرز النفايات في المنزل
أ) نعم ب) لا

23) هل تعلم ماذا سيحدث في النفايات بعد فرزها
أ) نعم ب) لا

24) هل تعلم أن عدم فرز النفايات قد يؤدي لاستخدامها من قبل الحيوانات و الطيور و بالنتيجة التسبب بأمراض مختلفة
أ) نعم ب) لا
25) هل تعلم ما المقصود بالدبال (الكومبوست)
أ) نعم ب) لا
26) هل لديك الاستعداد لاجراء عملية الدبال (الكومبوست) في حديقة المنزل (تحويل بقايا الطعام و مخلفات الحديقة الى سماد عضوي) في حال تدربكم على ذلك
أ) نعم ب) لا

27) هل لديك استعداد لفرز النفايات المنزلية الناتجة الى انواع رئيسية و هي: الزجاج, البلاستيك, المعادن, الورق, المواد العضوية.... الخ و ذلك اذا طلب منك خلال توزيع اكياس مجانية ذات الوان خاصة ليدل على نوع ما بداخلها من نفايات لاغراض الاستفادة من المخلفات

أ) نعم ب) لا

إذا كان الجواب نعم،، من فضلك أذكر الأسباب (يمكن ذكر أكثر من سبب)

أ) الحفاظ على البيئة ب) إستفادة البلدية من المواد المفصولة إما بإعادة الإستخدام أو التصنيع

ج) القدرة على ذلك (توفر الوقت والجهد والمكان) د) غير ذلك.....(حدد/ي)

إذا كان الجواب لا،، من فضلك أذكر الأسباب (يمكن ذكر أكثر من سبب)

أ)عدم الإقتناع بذلك ب) عدم مقدرة ربة البيت على القيام بذلك ج)عدم توفر المكان لذلك

د)عدم وجود وقت للقيام بذلك ه) غير ذلك.....(حدد/ي)

28) هل انت على استعداد للمشاركة المالية في رسوم الفرز و إعادة الاستخدام إن لزم

أ) نعم ب) لا

29) هل ترى بأنه من المُجدي فصل النفايات في المكب إلى أنواع مثل المواد العضوية، المعادن، الورق والكرتون، البلاستيك ومن ثمّ اعادة تصنيعها

أ) نعم ب) لا

إذا كان الجواب نعم،، من فضلك أذكر الأسباب (يمكن ذكر أكثر من سبب)

أ) الحفاظ على البيئة ب) الإستفادة من المواد المفصولة إما بإعادة الإستخدام أو التصنيع

ج) الفائدة المالية من هذه العملية على المواطنين والبلدية د) غير ذلك.....(حدد/ي)

إذا كان الجواب لا،، من فضلك أذكر الأسباب (يمكن ذكر أكثر من سبب)

أ) كمية المواد القابلة للفصل قليلة وغير مجدية ب) تحتاج إلى وقت وجهد كبيرين

ج)المخاطر الصحية على العاملين في الفرز د) غير ذلك.....(حدد/ي)

30) هل لديك الاستعداد للمشاركة في لجنة بلدية لإدارة هذا القطاع

أ) نعم ب) لا

31) هل تفضل اعطاء جميع أعمال الفرز لشركة خاصة و ليس للبلدية

أ) نعم ب) لا

32) إذا قررت الهيئة المحلية إجراء عملية الفرز على مستوى المنزل, فما مدى تعاونكم من أجل تنفيذ القرار, و على أي شكل

أ) عدم الإلتزام

ب) الالتزام على مستوى المنزل

ج) تنبيه غير الملتزمون بضرورة الالتزام

د) إبلاغ الهيئة بشأن المخالفين

33) هل تحب إضافة ملاحظات أو إقتراحات؟.....

2- Local Governmental Units Questionnaires

إستبانة لدراسة قابلية المواطنين لفصل النفايات في بيوتهم
في منطقة محافظة طولكرم
إستبانة الهيئات المحلية

1) **اسم البلدية/ الهيئة .....**
2) **عدد المشتركين الحاليين في خدمة النفايات الصلبة .....**
3) **نسبة تسديد المشتركين للخدمة.....**
4) **ما هي نسبة السكان التي تغطيهم خدمة النفايات بشكل عام .....**
5) **ما هي النسبة التي تغطيها مساهمة المواطنين في مجال الجمع و الترحيل**
6) **ما هي النسبة التي تغطيها البلدية لاتمام خدمة جمع و ترحيل النفايات؟ .....**
7) **ما هو مقدار رسوم جمع النفايات الشهري (بالشيكل):**
أ) للأسر ب) للفرد
8) **ما هي طريقة تحصيل رسوم جمع النفايات**
أ) على اشتراك الكهرباء ب) على اشتراك الماء ج) أخرى

9) **هل يوجد قوانين و انظمة (لوائح) داخلية تحكم عملية ادارة النفايات الصلبة**
أ) نعم ب) لا ج) لا ادري
اذا كان الجواب نعم هل يتم تطبيقها
أ) كليا ب) جزئيا ج)لا تطبق
10) **عدد العاملين في خدمة النفايات الصلبة**

الوظيفة	العدد	دوام كلي	دوام جزئي
إداري			
مفتش			
عامل جمع النفايات			
عامل نظافة			
سائق			
غير ذلك.....			

11) **هل تجدون عمال بسهولة للعمل في قسم النفايات عند الحاجة**
أ) نعم ب) لا
اذا كان الجواب لا, ما هو السبب .....
12) **كم يبلغ متوسط أجور عمال النفايات في بلدتكم (شيكل/شهر)؟ .....**
13) **كيف يتم جمع النفايات**
أ) كل يوم ب) كل يومين ج) كل 3 أيام د) كل أسبوع
14) **كيف تجبى النفايات**
أ) بالدفع المسبق ب) فواتير شهرية ج) كلاهما

15) **الاليات المتوفرة**

الرقم	نوع الالية	العدد	الوضع العام (سيئة-جيدة-جيدة جدا)	استئجار	ملك	نوع المادة المصنوعة
1	تراكتور					
2	سيارة جمع 5 طن					
3	سيارة جمع 8 طن					
4	سيارة جمع 12 طن					
5	سيارة جار و مجرور					
6	باجر (لرص النفايات)					
7	مكبس					
8	حاوية 1م^3					
9	حاوية 3م^3					
10	حاوية 5م^3					
11	حاوية 8م^3					
12	حاوية 30م^3					
13	عربات يدوية					
14	غير ذلك					

16) هل يوجد نظام لصيانة الاليات

أ) نعم ب) لا

17) هل يوجد نظام لصيانة الحاويات

أ) نعم ب) لا

18) ما هو توجه البلدية (الهيئة) توجه حول فرز النفايات الصلبة على مستوى المنزل (من المصدر)

أ) فرز منزلي ب) فرز على مستوى الهيئة ج) لا فرز

19) هل ترى بأنّه من المُجدي في بلدتكم فصل النفايات إلى أنواع مثل المواد العضوية، المعادن، الورق والكرتون، البلاستيك ومن ثمّ إعادة إستخدامها أو تصنيعها؟

أ) نعم ب) لا ج) ليس لدي فكرة

إذا كان الجواب <u>نعم</u>،، من فضلك أذكر الأسباب (يمكن ذكر أكثر من سبب)

أ) الحفاظ على البيئة **ب)** الإستفادة من المواد المفصولة إما بإعادة الإستخدام أو التصنيع

ج) الفائدة المالية من هذه العملية على المواطنين والبلدية د) تقليل حجم النفايات

ه) غير ذلك.....(حدد/ي)

إذا كان الجواب <u>لا</u>،، من فضلك أذكر الأسباب (يمكن ذكر أكثر من سبب)

أ) كمية المواد القابلة للفصل قليلة وغير مجدية **ب)** تحتاج إلى وقت وجهد كبيرين

ج) المخاطر الصحية على العاملين في الفرز د) عملية الفصل مكلفة من الناحية المالية

ه) غير ذلك.....(حدد/ي)

20) اذا حصلت عملية الفرز، كيف سترى طريقة مشاركة البلدية (الهيئة) في عملية الفرز

أ) المشاركة بالادارة ب) المشاركة بالرسوم فقط ج) لا مشاركة

21) **اذا حصلت عملية الفرز, كيف سترى طريقة القطاع الخاص في عملية الفرز**

أ) القيام بالمهمة كاملة ب) المساهمة المادية في بداية العمل ج) غير ذلك

22) **ما هو توجهكم حول فصل النفايات من قبل الموطنين في منازلهم (وضعها في اكياس ملونة) أو فصلها بعد تجميعها في محطة الترحيل التابعة للمجلس؟**

أ) فصل النفايات من قبل الموطنين في منازلهم

ب) فصلها بعد تجميعها في محطة الترحيل التابعة لمجلس وادي الشعير

ج) لا توجه نحو الفصل

23) **اذا ارتأيتم الى تطبيق خطة الفرز المنزلي, كيف ستوقومون بدفع الناس الى عملية الفصل**

أ) عن طريق تعيين مراقب

ب) عن طريق اجبارهم بدفع مخالفات لمن لا يفرز

ج) حرمان من لا يفرز من خدمة النفايات

24) **هل ترى بأن هناك قابلية لدى السكان في منطقتكم لفصل النفايات في بيوتهم إلى أنواع مثل المواد العضوية، المعادن، الورق والكرتون، البلاستيك ؟**

أ) نعم ب) لا

إذا كان الجواب نعم،، من فضلك أذكر الأسباب (يمكن ذكر أكثر من سبب)

أ) وعي ومعرفة لدى الناس

ب) مقدرة على القيام بذلك

ج) إهتمام متزايد لدى الناس بعملية الفصل

د) غير ذلك..... (حدد/ي)

إذا كان الجواب لا،، من فضلك أذكر الأسباب (يمكن ذكر أكثر من سبب)

أ) عدم إقتناعهم بذلك

ب) عدم مقدرتهم على تنفيذ ذلك بشكل دائم ومستمر

ج) قلة التعليم والجهل وعدم الوعي لدى الناس بهكذا أمور

د) غير ذلك..... (حدد/ي)

25) **هل تحب إضافة ملاحظات أو إقتراحات؟.....**

3- Solid services employees questionnaires

إستبانة لدراسة قابلية المواطنين لفصل النفايات في بيوتهم
في منطقة مجلس خدمات وادي الشعير
إستبانة العاملين في خدمة النفايات الصلبة

1) **إسم البلدية / الهيئة التي تعمل فيها.....**
2) **نوع التجمع**
أ) مدينة ب) قرية ج) مخيم
3) **الجنس**
أ) ذكر ب) أنثى
4) **العمر:**
أ) أقل من 25 ب)26-35 ج) 36-45 د)أكثر من 46
5) **مستوى التعليم**
أ) أمي ب) مرحلة اساسية ج) مرحلة ثانوية د)جامعي
هـ) دراسات عليا
6) **عدد أفراد الاسرة الذين يعيشون في المنزل**
أ) 2-4 ب) 5-7 ج) 8-10 د) اكثر من 10

7) **منذ متى تعمل في خدمة النفايات الصلبة؟.....سنة**
8) **ما نوع العمل الذي تقوم به؟**
أ) سائق ب) جمع نفايات ج) نظافة الشوارع
د) جباية ه) محاسبة و) غير ذلك.....
(حدد/ي)
9) **مصادر الدخل**

المصدر	نسبة الدخل%
العمل في مجال النفايات الصلبة	
العمل في الزراعة	
العمل في التجارة	
اعمال اخرى .... حدد	

10) **يتراوح متوسط دخل الاسرة**
أ) اقل من 1000 شيكل ب) 1000– 1500 شيكل ج) 1501- 2000 شيكل
د) 2001– 2500 شيكل ه) 2501- 3000 شيكل و) اكثر من 3001 شيكل
11) **هل تقوم بعملك بشكل**
أ) يومي ب) جزئي ج) حسب الطلب
12) **هل تتوفر شروط الصحة و السلامة العامة في العمل (من حيث اللباس، القفازات، الاحذية،.....)**
أ) لا ب) بشكل جزئي ج) بشكل كامل

اذا كانت لا، ما هي الامور غير المتوفرة فيها .....
..... (وضح)

13) هل المؤسسة التي تعملون لديها تقوم بتأمينكم ضد الحوادث و الأمراض الناجمة عن طبيعة العمل
أ) نعم ب) لا

14) بتقديرك كم وزن النفايات التي تنتجها اسرتك يوميا (للفرد الواحد)
أ) 0.5 كغم/فرد ب) 0.6 كغم/فرد ج) 0.7 كغم/فرد د) 0.8 كغم/فرد ه) 0.9 كغم/فرد – فما فوق

15) هل تعلم ما المقصود بالنفايات الصلبة
أ) نعم ب) لا

16) هل تعلم ما المقصود بعملية فرز النفايات الصلبة
أ) نعم ب) لا

17) هل تعتقد أن هنالك إمكانية عملية لفرز النفايات في منطقتك
أ) نعم ب) لا ج) لا ادري

18) هل ترى بأن الظروف مهيأة في دائرتك لاجراء عمليات الفرز و اعادة الاستخدام
أ) نعم ب) لا ج) لا ادري

19) هل تعتقد بأن السوق المحلي مهيأ لإعادة استخدام النفايات الصلبة
أ) نعم ب) لا ج) لا ادري

20) أعط الترتيب من 1- 8 لأكثر النفايات التي يتم انتاجها بشكل عام (رقم 1 يشير الى النسبة الاكبر ... و رقم 8 النسبة الاصغر)

☐ مواد عضوية منزلية (بقايا طعام، اوراق شجر, ...)
☐ الورق
☐ الكرتون
☐ الخشب
☐ البلاستيك
☐ الزجاج
☐ معادن
☐ اقمشة و ملابس

21) هل ترى بأنّه من الأفضل فصل النفايات المنزلية إلى أنواع مثل المواد العضوية، المعادن، الورق والكرتون، البلاستيك ومن ثمّ إعادة إستخدامها أو تصنيعها؟
أ) نعم ب) لا

إذا كان الجواب نعم،، من فضلك أذكر الأسباب (يمكن ذكر أكثر من سبب)
أ) الحفاظ على البيئة
ب) الإستفادة من المواد المفصولة إما بإعادة الإستخدام أو التصنيع
ج) الفائدة المالية من هذه العملية على المواطنين والبلدية
د) غير ذلك..... (حدد/ي)

إذا كان الجواب لا،، من فضلك أذكر الأسباب (يمكن ذكر أكثر من سبب)
أ) كمية المواد القابلة للفصل قليلة وغير مجدية
ب) تحتاج إلى وقت وجهد كبيرين

ج) المخاطر الصحية على العاملين في الفرز
د) عملية الفصل مكلفة من الناحية المالية
ه) غير ذلك..... (حدد/ي)

22) برأيك هل من الأفضل فصل النفايات من قبل الموطنين في منازلهم (وضعها في اكياس ملونة) أو فصلها بعد تجميعها في محطة الترحيل الموجودة على شارع عنبتا؟

أ) فصل النفايات من قبل الموطنين في منازلهم
ب) فصلها بعد تجميعها في محطة واد الشعير لترحيل النفايات

23) هل تحب إضافة ملاحظات أو إقتراحات؟.....

جامعة النجاح الوطنية
كلية الدراسات العليا

مقارنة تحليلية لفصل النفايات مقابل الترحيل المباشر من منطقة طولكرم إلى زهرة الفنجان

إعداد
شيرين راضي حمادة

إشراف
أ. د. مروان حداد

قدمت هذه الأطروحة استكمالا لمتطلبات درجة الماجستير في هندسة المياه والبيئة بكلية الدراسات العليا في جامعة النجاح الوطنية في نابلس، فلسطين.

2011م

مقارنة تحليلية لفصل النفايات مقابل النقل المباشر
من منطقة طولكرم إلى زهرة الفنجان

إعداد
شيرين راضي حمادة
إشراف
أ. د. مروان حداد

الملخص

تعرف عملية إدارة النفايات الصلبة المتكاملة بأنها مجموعة الأعمال والتقنيات المتعلقة بالنفايات الصلبة وتشمل مراحل الفرز والجمع والنقل والتخزين والمعالجة والتدوير والتخلص النهائي منها.

تهدف هذه الأطروحة إلى إجراء مقارنة تحليلية لخيارات فصل النفايات من منطقة الدراسة مقابل الترحيل المباشر إلى زهرة الفنجان للمساعدة في اتخاذ القرارات السليمة في المستقبل وتهدف أيضا إلى تقييم سياسة إدارة النفايات الصلبة الحالية وتقدير الخيار الأقل كلفة.

إن مسؤولية مجلس خدمات إدارة النفايات الصلبة/طولكرم تكمن في إدارة محطة وادي الشعير وعملية ترحيل النفايات من محطة الترحيل إلى مكب زهرة الفنجان للهيئات المحلية المشاركة.

19 هيئة محلية مسؤولة بشكل فردي عن عملية جمع النفايات من مناطقها إلى نقطة ترحيل وادي الشعير. أن أعضاء المجلس هم: مدينة طولكرم، مجلس خدمات وادي الشعير، الكفريات ومجلس خدمات الصعبيات.

تم مناقشة الكثير من الدراسات المحلية، الإقليمية والعالمية لإدارة النفايات الصلبة، حيث استفدت منها في دراستي خاصة فيما يتعلق في خيارات فصل النفايات الصلبة والسيناريوهات

وطريقة المقارنة بين الخيارات وأهمية مشاركة الجماهير في اتخاذ القرارات وإجراء مقارنة تحليلية.

تم تطبيق مجالين لتحقيق هدف الدراسة وهي: عملية تطبيق فرز يدوي للنفايات والمسح الميداني عن طريق تطبيق استمارات لمنطقة الدراسة. حيث تم استخدام ثلاث أنواع من الاستبيانات: الأولى للأسر، الثانية للهيئات الحكومية أما الاستبيان الثالث فكان موجه للعاملين في خدمة النفايات. الهدف الرئيس للأستبيانات هو معرفة رأي الناس تجاه عملية الفصل من المصدر. وكانت النتيجة من جميع أنواع الاستبيانات هو أن الغالبية فضلوا فكرة الفصل لكن ليس من المصدر، حيث فضلوا ان تكون في محطة وادي الشعير. لذلك ليس هناك حاجة أو ضرورة لأجراء تحليل للتكاليف لخيار "الفصل من المصدر" لأنها ليست مجدية.

ان الهدف الرئيسي من عملية فصل النفايات هو تحديد عناصر النفايات الصلبة. والعناصر هي: مواد عضوية، بلاستيك، كرتون، ورق، خشب، زجاج، معادن، أقمشة ومواد أخرى.

تم دراسة ثلاث خيارات لفصل النفايات الصلبة لمنطقة طولكرم وهي: الترحيل المباشر إلى مكب زهرة الفنجان (البقاء على الوضع الحالي). الفصل عند المصدر والفصل في محطة ترحيل النفايات التابعة لوادي الشعير التي تتمثل في اثنين من السيناريوهات: فصل النفايات يدويا وفصلها ميكانيكيا. وتم أيضا دراسة وتقييم جميع الخيارات بطرق علمية صحيحة للوصول إلى الخيار الأفضل الأقل تكلفة والأكثر جدوى لعشرون سنة (إلى سنة 2030).

عناصر التحليل المالي لخيارات فصل النفايات هي: التكلفة الرأسمالية، التكلفة التشغيلية، العائدات، الفوائد وتحديد نقطة التعادل.

تم إقصاء خيار الفرز المنزلي بسبب عدم تقبل الناس لفكرة القيام بعملية الفرز في المصدر مبررين بعدم جدوى العملية و أنها تحتاج إلى وقت وجهد كبيرين. اما خيار الترحيل

المباشر إلى زهرة الفنجان ليس له عوائد مالية وبالعكس فإن المصاريف تزداد سنويا. معدل العوائد المالية لخيار الفرز اليدوي هو 45,488 دولار أمريكي, لكن هذا غير مجدي لان B/C يتجه للسالب.

أما خيار الفصل الميكانيكي للنفايات في محطة وادي الشعير له أكبر العوائد. و معدل العوائد الإجمالية خلال عشرون سنة حوالي 1,107,349 دولار أمريكي. لكن في السنوات الخمسة الأولى سيكون هناك خسارة إجمالية تقديرها 119,732 دولار أمريكي. ان نسبة B/C لهذا الخيار قريبة من الواحد الصحيح (0.90) لذا فإن خيار الفرز الميكانيكي هو الأفضل. من الضروري في هذا الخيار معرفة نقطة التعادل لتفادي الخسارة في المرحلة الأولى. لذلك، نقطة التعادل مهمة لتحديد كمية النفايات التي يجب فرزها، وهي 23 طن لليوم الواحد لعام 2011.