An-Najah National University

Faculty of Graduate Studies

EVALUATION OF A PILOT PROJECT FOR MUNICIPAL SOLID WASTE SEPARATION AT SOURCE IN BURQEEN –JENIN, 2021 ACASE STUDY

By

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

2022

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Acknowledgements

First and foremost, praises and thanks to the GOD, the Almighty, for His showers of blessings throughout my research work to complete the research successfully and for the HIS messenger, Prophet Muhammad (peace be upon him).

Secondly I would like to express my special thanks of gratitude to my supervisors who gave me in doing a lot of research and I came to know about so many new things I am really thankful to her.

I would like to thank my parents for their love, prayers, care and sacrifices for my education and preparation for my future.

I am very grateful to my husband and children, for their love, understanding, prayers and continued support to complete this research work. I also thank my brothers and sisters for their support and valuable prayers. Special thanks go to my friends and all family members for the keen interest shown in completing this letter successfully.

Declaration

I, the undersigned, declare that I submitted the thesis entitled:

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

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Date: 11/10/2022

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EVALUATION OF A PILOT PROJECT FOR MUNICIPAL SOLID WASTE SEPARATION AT SOURCE IN BURQEEN –JENIN, 2021: A CASE STUDY

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Abstract

The West Bank in Palestine generates almost (900,000 ton/year); Zahrat al-Finjan landfill, the West Bank largest sanitary landfill, receives massive amounts of municipal solid waste every day that exceeds its capacity, leading to a potential disastrous situation. As a result, a transition from a landfill-based to a more integrated waste management system is required.

This study assessed the environmental, economic and social effectiveness of a pilot project for municipal solid waste (MSW) separation at source in Burqeen -Jenin in 2020 by comparing population awareness of the 3Rs (Reduce, Reuse, Recycle) principle and willingness to separate waste, weights of waste that reach landfills and costs of MSW management before and after the project application. Standardized questionnaires to 305 samples from the town were distributed at the pre/post phase of the project. Then, it was analyzed statistically using the SPSS 22 program. Joint service council (JSC)-Jenin collected and measured the waste generated before and after the project application. Waste collection service costs were calculated and compared before and after project implementation using Burqeen Municipality Archive.

The findings revealed a significant increase in the local community's knowledge and awareness of SWM and the 3Rs principle, with the percentage of people who do not understand the concept of 3Rs falling from 15.4% to 5.2%. the percentage of citizens participation in waste sorting increased from 0% to 21%. The results confirmed that the separation of MSW at source reduces the percentage of waste that reaches the landfill

by 22.2% after one year, and it also positively affects the municipality economic benefits were cost shifted from negative to positive.

This study concluded that implementing MSW separation at source will increase population awareness of MSWM, increase municipal financial interest, and reduce waste access to landfill, and it is recommended that solid waste separation at the source be expanded.

Keywords: municipal solid waste (MSW); Palestine; separation at source; waste reduction; 3Rs.

Chapter One

Introduction and Theoretical Background

1.1 General Background

These days the environment and its protection is one of the most important issues globally. The progress of the human beings and the society is measured by its ecological footprint which measures the demand on and supply of nature, whereas, the smaller ecological footprint, the more developed and sustainable society is (Ecological Footprint, 2021).

One of the most important things that affect the environmental footprint is human waste and the way it deals with it**.** Unsuitable management of waste generation, collection, transport and treatment will impact negatively of environment elements including air, water and land. Which will increase the eco-print .Therefore; solid waste management has become one of the vital issues to protect environment and public safety (GFN, 2021).

Municipal solid waste (MSW) consists of everyday items that we use and then discard, such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, and batteries. This originates in our homes, schools, hospitals, and workplaces. (EPA, 2013).

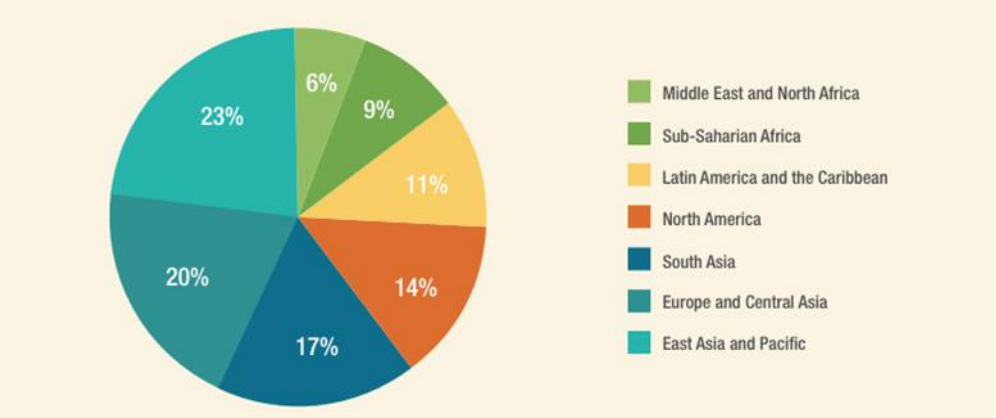
Waste generation is increasing rapidly around the world; in 2016, (2.01) billion tons of MSW were generated annually, with (33%) of it not being managed in environmentally safe aspects. Globally, per capita waste generated per day averages (0.74) kilograms. However, it varies greatly depending on many socioeconomic factors, ranging from (0.11) to (4.54) kilograms (World Bank Group, 2022).

In reality, this generation is a byproduct of urbanization, economic development, and population growth. As nations and cities grow in population and wealth, offer more products and services to citizens, and participate in global trade and exchange, they generate an increasing amount of waste that must be treated and disposed of (World Bank Group, 2018).

Unfortunately, the global waste is expected to reach 3.40 billion tones by 2050, more than double population growth over the same period (World Bank Group, 2013).

Figure 1.1

Waste generation worldwide by region



Note: Adopted from world Bank Organization website: Trends in Solid Waste Management. The Worldbank.waste/trends_in_solid_waste_management.html, 2016.

Middle East and North Africa (MENA), produce at least 6 percent of worldwide waste generation. By 2050, total waste generation is expected to duplicate there (World Bank Group, 2022).

Waste generated classification based on composition is critical because it influences the physical characteristics of the waste, such as density, moisture content, and calorific value, which in turn influences waste management policy and the technology used for collection and treatment (ISWA, 2015).

In general, waste is categorized into organic and a non-organic material which is called recyclable materials (paper, plastic, glass and metals) as the table 1.1 describe.

Table 1.1

Types of wastes and their sources

Type	Source
Organic	Food scraps, yard (leaves, grass, brush) waste, wood process residues
Paper	Paper scraps, cardboard, newspapers, magazines, bags, boxes, wrapping paper, books, shredded paper, and paper beverage cups. Strictly speaking paper is organic but unless it is contaminated by food residue, paper is not classified as organic
Plastic	Bottles, packaging, containers, bags, lids, cups
Glass	Bottles, broken glassware, light bulbs, colored glass
Metals	Cans, foil, tins, non-hazardous aerosol cans, appliances (white goods), railings, bicycles
Others	Textiles, leather, rubber, multi-laminates, e-waste, appliances, ash, other inert materials

Note: Adopted from World Bank Organization website: A Roadmap for Reform for Policy Makers. World Bank, Washington, DC. © World Bank. "World Bank Group. 2018. Municipal Solid Waste Management"

The organic structure is the largest one from all waste composition worldwide, which making up 44 percent of global waste, dry recyclables (plastic, paper and cardboard, metal and glass) amount to another 38 percent of waste. (World Bank, 2018)

There are many factors that influence the Waste composition, such as level of economic development, cultural norms, geographical location, energy sources, and climate, the most important one is the economic level of the country. As a country has more income, the populations become wealthier and more urbanized, so the consumption of inorganic materials (such as plastics, paper, and aluminum) increases, while the relative organic fraction decreases (GWMO, 2015).

In middle- and low-income countries the organic fraction is around 46 to 53% however in high-income countries its averaging 34% (GWMO.2015)

1.2 Theoretical background of municipal solid waste management (MSWM)

Solid waste management (SWM) used to entail simply collecting and transporting waste to remote locations for disposal. Some waste was collected and transported properly, but a portion of it was not. They were sometimes burned to reduce volume and attract animals and rats. However, due to the increasing value of land, insufficient space, and the environment's limited carrying capacity, these practices are being challenged, potentially threatening human health (GWMO, 2015).

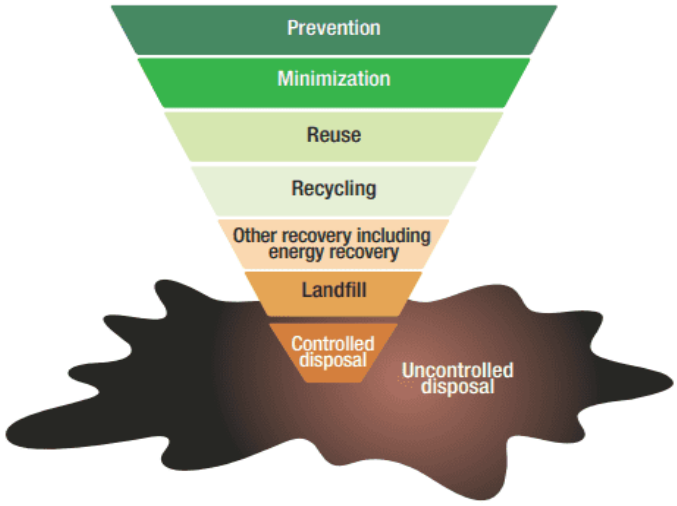
As a result, many countries around the world begin to establish local institutions in charge of policy development and regulatory oversight in the waste sector. Which are start to establish and adopt a waste management system based on health, environmental and scientific basics, taking into consideration the financial and social environmental factors(World Bank Group-Road map, 2018).

The basic method of waste management is the ‘waste management hierarchy’ which appears in the early 1970s.The hierarchy started as the ‘three Rs’ — reduce, reuse, recycle — but now a fourth R is frequently added — recovery .

The higher we go to the top of the pyramid, the better the management method but the decision of what method the countries use are financial, environmental, social and the degree of management that already present in the country.

Figure 1.2

waste management hierarchy



Note: Adopted from united nation e-book: Global Waste Management outlook. https://www.unep.org/resources/report/global-waste-management-outlook. (GWMO, 2015).

Until the 1960s, uncontrolled disposal (via open dumping and open burning) was the norm everywhere, and according to the World Bank, it is still the norm in most developing countries. This practice poses significant public health and environmental risks.

Then many methods of waste disposal were improved. Incineration of waste is one of the simplest and earliest methods of waste disposal, which it can reduce the volume of disposed waste by up to 90% (what a waste: A Global Snapshot of Solid Waste Management, 2018). In the past it was by an open-burning of waste now it's discouraged due to severe air pollution associated with low temperature.

The waste streams with very high amounts of packaging materials, paper, cardboard, plastics and agricultural waste are using in incineration for high volume reductions in waste disposed. Then the ash and non-combustibles waste needs to be landfilled by a complimentary sanitary landfill, as bottom.

Now, waste incineration mainly includes energy recovery which is less pollution than incineration without recovery but with more costs.

Landfilling is a common final disposal way for waste, should be done in an engineered and operated site to protect the environment and public health.

Actually, reducing GHG (Greenhouse Gas) emissions, landfill gas (LFG) produced by anaerobic decomposition of organic sections can be recovered and the methane (about 50% of LFG) burned with or without energy recovery. Unfortunately, proper landfilling is not always practiced, particularly in developing countries (United Nations Publications, 2017).

The upper level of the pyramid is the 4Rs- reduce, reuse, recycle and recover. In this study we will focus on its implementation effectiveness in Palestine.

Recover of waste is mainly for organic ones, which mean transfer it to organic soil fertilizer. There are many mechanisms for composting (open / close system) differs in techniques, inputs, cost and environmental impacts.

The other 3Rs (reduce, reuse and recycle) is the healthier ones, which help to diminish the waste producing quantity.

Separating solid waste is important to improve management methods, as there are two main ways to do it: separation at source or separation at sorting line. To achieve more effective results, separation at the source of the waste must be applied. The researcher was intending to evaluate a pilot project for MSW separation at source.

1.3 Financing and costs recovery of municipal solid waste management

The total cost of a SWM system includes all collection, transportation, and disposal costs. It's important to keep in mind that it may influence the ultimate decision on SWM strategies. So, it is often one of the greatest concerns for municipalities.

A waste management financing model is made up of four parts (The client, the operator, revenues and costs).

The client is recognized as the waste producer (residents who generate waste or municipalities that have assumed responsibility for MSWM). The operator who carries out waste management services "on site". Costs are divided into investment finance, which are required to cover capital costs if new infrastructure is needed, and operating costs, which are incurred to operate the facility. (Global Waste Management Outlook (GWMO), 2015).

Fees paid by the community are typically the primary source of revenue. There is also, Supports from the general budget of the municipality, particularly for low-income households. In additional to revenue from services provided by the waste collection company under a separate contract with the municipality, such as street cleaning, or with other (private) parties, such as collection and transportation of nonhazardous industrial waste.Finally, Profits from the sale of separated/sorted recyclables (World Bank Group-Road map, 2018).

It's important to know that Municipalities must decide the percentage of service costs to be allocated to the fee, which is a policy decision (global waste management outlook (GWMO), 2015). Commonly, costs for collection of mixed waste and separated fractions, bring station management, transport to final disposal, treatment, education and communication should be fully covered by the fee. So operational costs mainly covered by fees (World Bank Group-Road map, 2018).

Fixed costs/ capital this is mainly the largest amount of costs which include infrastructures and equipment's, municipalities can get from its existing resources or banks loans, grants/loans from international financing institutions and inter-governmental grants

Any capital financing must be justified by an investment feasibility study that considers the activity's sustainability, particularly its effect on fees and the ability to pay.

1.4 Management of municipal Solid Waste in Palestine

1.4.1 SW generation in Palestine

Sadly, due to the Israeli occupation, the issues and data in Palestine are divided into West Bank (WB) and Gaza Strip (GS)

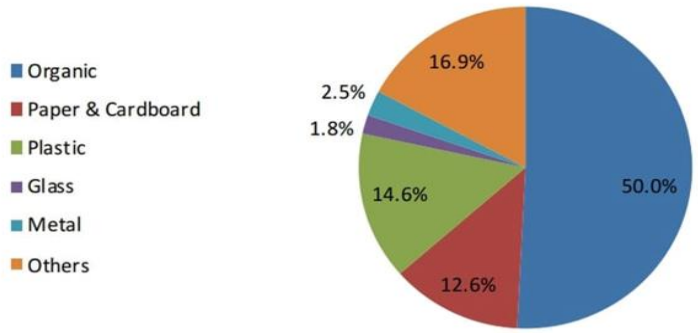
In the WB, the MSW generation is 2,622 ton / day (957,030 ton/year) with generation per capita is 0.91kg/Cap.day in 2019.JSCs (Joint Services councils) are collecting 65% of the generated waste (1,711 tons/ day),Local Governmental Units (LGUs) and UNRWA collecting the remaining quantities. The generation of MSW in the Gaza Strip is estimated at 1,330 tons / day (485,450 tons / year) and the average generation per capita is 0.7 kg / day (MOLG-JICA, 2019).JSCs are collecting 12% of the generated municipal waste (157 ton/day), LGUs and UNRWA collecting the remaining quantities (MOLG-JICA,2019)

1.4.2 MSW composition in Palestine

Palestine, is consider a part of MENA region and a lower middle country income, the organic waste constitutes a percentage 50% of total MSW production (MOLG-JICA 2019).

Figure 1.3

Solid waste composition in west bank



Note: Adopted from the e-book of Data Book Solid Waste Management of Joint Service Councils West Bank and Gaza "Ministry of Local Government - Japan International Cooperation Agency. (2019").

1.4.3 MSWM in Palestine

In general, Palestine MSWM is considered a landfilling base one.

There are three operating landfills (LF) at WB: Zahret Al Fenjan (ZF) sanitaryLF for the northern part of WB, Al Menya LF for the southern part of WB, and Jericho LF for the Jericho. Another planned LF is the Rammun Sanitary LF, which will serve the central part of WB. However, this LF has not yet been constructed due to numerous political obstacles. Accordingly, some of the waste from the middle area is taken to ZF or Al Menya LF, while many other areas take their waste to random dumpsites area (Yoshida & Muferreh, 2019). Joint Service Councils (JSCs) which are a quasi–governmental and regional entity established according to the Local Government Law and work under MOLG monitoring. It's managed by a Board that consists of local Authorities (municipalities and village councils). There are 14 JSCs responsible for solid waste management in the WB and GS (MOLG-JICA, 2019.

Figure 1.4

Land fillies present in Palestine

Sanitary Landfill	Location	Targeted Area	Served Area	Received Quantity (tons/day)	Management Responsibility
Zahret Al Fenjan	Jenin Governorate	North of West Bank	Jenin Area Tubas Area Tulkarem Area Qalqelia Area Nablus Area Parts of Ramallah Area (Ramallah City, Al Bireh City, and Bitunia City)	1,200	Jenin JSC
Jericho	Jericho Governorate	Jericho Governorate	Jericho Area	55	Jericho JSC
Al Menya	Bethlehem Governorate	South of West Bank	Hebron Area Bethlehem Area NE&SE Jer. Area	1,000	Hebron & Bethlehem Higher Council
Biet Anan	Jerusalem Governorate	North and North west Jerusalem	North and North west Jerusalem & part of Ramallah LGUs	90	N&NW Jerusalem JSC
Juhr Eldik	Gaza Governorate	Gaza & North Governorates	Municipalities of Gaza Governorate	700	Gaza Municipality
Dier El Balah	Al Wasta Governorate	Al Wasta & Khan Yonis Governorate	Al Wasta & Khan Yonis Governorate	430	JSC South Gaza
Old Sofa	Khan Yonis	Rafah Governorate	Rafah Governorate	170	JSC South Gaza
New Sofa	Khan Yonis	Al Wasta , Khan Yonis & Rafah	Al Wasta , Khan Yonis & Rafah	Inaugurated on 12 June 2019, will be functional on July	JSC South Gaza

Note: Adopted from Data Book Solid Waste Management of Joint Service Councils West Bank and Gaza. "Ministry of Local Government - Japan International Cooperation Agency. (2019").

Due to the long distance between areas, LF transfer stations (TS) were created to storage waste then send it to the LF. There are 11 TS in the WB and 3 in GS. Six are managed by JSCs, four TSs by LGUs, and one (Al Abdali TS) is controlled by the Israeli side. Unfortunately Many Random dumpsites still founded especially in Ramallah and Al Bireh Governorate due to the obstacles in the establishment of a sanitary LF in the central area(MOLG-JICA, 2019).

Figure 1.5

The random dumpsite in Palestine

#	Location (Governorate)	No. of random Dumpsites	No. of LGUs using Dumpsites	Population No. (year 2017)	Quantities (ton/day)
1	Salfit	9	20	79,000	66
2	Nablus	12	20	92,410	77
3	Ramallah & Al Biereh	50	67	215,144	200
4	North Gaza	3	4	326,704	390
5	South Gaza	3	3	55,642	53
Total		77	114	768,900	786

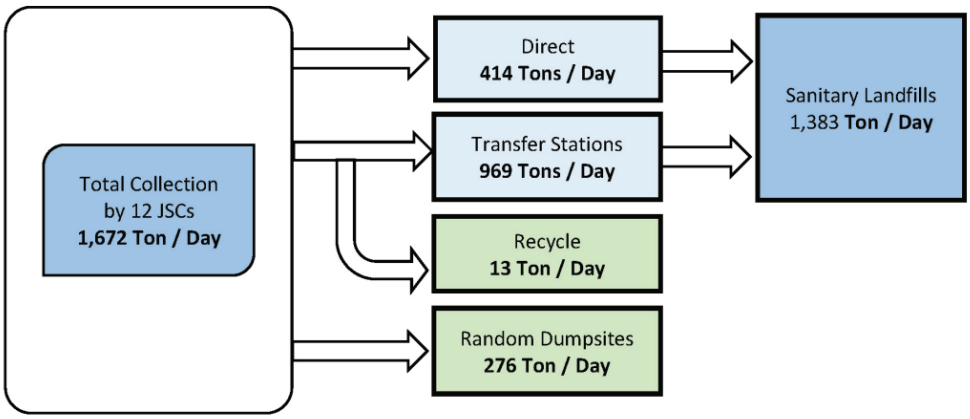
Note: Adopted from Data Book Solid Waste Management of Joint Service Councils West Bank and Gaza. "Ministry of Local Government - Japan International Cooperation Agency. (2019"). (MOLG-JICA, 2019)

1.4.4 Waste disposal system in Palestine

The current disposal system is presented in the next figure.

Figure 1.6

Disposal system for MSW in Palestine



Note: Adopted from Data Book Solid Waste Management of Joint Service Councils West Bank and Gaza. "Ministry of Local Government - Japan International Cooperation Agency. (2019").

1.4.5 The National Strategy for Solid Waste Management

The Ministry of Local Government established the first National Strategy for Solid Waste Management (NSSWM) (2010-2014). (MOLG). It is regarded as the global framework for all decisions and programs aimed at improving the waste management system from landfilling base management to more integrated waste management.

Then the second NSSWM was adopted to complete the first one in August 2017 the next table summarizes its objectives (CESVI, 2019).

Table 1.2

Objectives of the second NSSWM, 2017

Achievement	Status in 2017	Proposed Status in 2022
Percentage of recycled materials	< 1%	30%
Percentage of transferring organic materials into low quality compost for the purpose of coverage	2.5%	15%
Coverage of residential areas	95%	100%
Service coverage by JSCs	76%	100%
House separation of SW	0%	20%
Coverage of sanitary landfills	53%	100%

Note: Adopted from CESVI international e-report" Solid Waste Management in Occupied Palestinian Territory – West Bank Including East Jerusalem & Gaza". (2019, December).

It also included indicators that were proposed to be met by 2022, such as:

1. Rehabilitated/closed 20% of the current random dump sites in the West Bank and Gaza Strip.
2. Gas treatment systems are installed in 2-50% of sanitary landfills.
3. 15% decrease in hazardous waste disposal.
4. At least six recycling projects are underway.
5. At least three public awareness projects involving civil society are required.

To achieve these goals, many pilot projects were carried out in the country in collaboration with the MOLG and other international organizations concerned with waste management and environmental issues (CESVI, 2019).

1.5 Project area

1.5.1 Burqeen town

Burqeen is a Palestinian town in Jenin Governorate in the northern West Bank, located about 4 km southwest of Jenin. According to the Palestinian Central Bureau of Statistics (PCBS) census, it had a population of 7670 in 2020.

The town occupies an area of around 19, 4 km². The majority of its population depends on agriculture as a main source of their income (PCBS, 2016).

It produces about 8 tons of waste per day that collected and transported to ZF by JSC (Joint Service Council) (JSC, 2020).

1.5.2 Zahrat Al-Finjan landfill

ZF landfill is the largest sanitary landfill in the West Bank located in the governorate of Jenin, covering an area approximately 200 dunums. It was established in 2007 with the cooperation of the Palestinian National Authority and the World Bank. (JSC, 2020).

ZF landfill replaced 86 random dumps scattered throughout the northern West Bank, covering an area of 1,200 dunums used for housing and agriculture. As a result, it resolved a major issue.

The landfill receives nearly 1200ton/day, around 4300,000 m3/year. The total capacity according to the design was around 3M m3, which is finished at the end of 2018. An extension was created by JSC and MOLG by construction new cells that's make additional capacity 1.5Mm3. The LF was created for northern governorate in the WB this shortage of capacity happen due Ramallah, and Al-Bireh joint.

However, landfilling for all waste generated, especially with increase population and generation of waste is not the ideal technique anymore.

1.5.3 The Pilot project of SW separation at source in Burqeen

JICA (Japan International Cooperation Agency) which is an international non-government organization that have environmental concerns and fund project that have appositive impact in environment. Burqeen municipality received funding from the Agricultural Relief in order to establish compost plant from agricultural and organic

waste then have fund from JICA to purchase special containers for waste separation in the town in December 2020, as well as to implement awareness campaigns and intensive workshops for the population in order to raise their awareness of the issue and problem of municipal waste, as well as to guide them to the method of separation that will be used in the town.

According to the town needs, population and waste generation and other specific standards. Eng. Mohammad Sadi the technical manager of ZF landfill decided the numbers and technical specifications of used containers. The next table shows the containers specifications and numbers that used in the town for the project.

Table 1.3

Containers quantities and specifications for Burqeen SW separation at source project, 2021

Container	Color	Number	Uses
240L Plastic container	Brown	150	Organic Waste(streets)
20L solid waste brown bens	Brown	875	Organic waste(homes)
2m3 steel container	Blue	30	Cardboard
2m3 steel container	Green	10	Plastic
240L steel container	Red	22	Meat waste
15m3 Roll-on Roll-of containers	Green	3	Storage use
1m3 steel green containers	Green	60	Mixed waste

Project management plan was designed in cooperation among MOLG, JSC and JICA, JSC this plan includes: containers procurement, awareness campaign, workshops and system operation. the workshops conducted for various segments of the community (housewives, business owners and schools' students) these workshops aim to raise their knowledge in SWM, project details and guide them how to separate their wastes.

Also, an eco-summer camp for kids between (6-12y) were conducted in order to training them to separate the waste into different components and encourage them to be a part of other awareness campaigns. Containers and collection schedule were distributed around the town, with continuous awareness campaigns and monitoring.

Table (1.4) illustrates the daily SW collection plan for the recyclable material organic waste from Burqeen town.

Table 1.4

SW collection Plan in Burqeen town during SW separation at source project implementation, 2021

Day of the week	Collected material	receiving area
Saturday	Organic	Compost plan
Sunday	Dry waste	Landfill
Monday	Organic waste	Compost plan
Tuesday	Cartoon and cardboard	Compost plan
Wednesday	Organic waste	Compost plan
Thursday	Dry & organic	Compost plan and landfill

1.6 Problems Statement

Many countries around the world have been suffered from different waste crises due to a shortage of technology and resources to effectively treat the waste generated (GWO, 2015). As a result, waste management is becoming increasingly important in all countries, with significant consequences for human health, environmental preservation, sustainability as well as national economy.

MSW generation statistics in Palestine is scarce; ZF landfill, the largest sanitary landfill in the West Bank, receives massive amounts of MSW every day that exceed its capacity, indicating a potentially disastrous situation. As a result, a transition from a landfill-based waste management system to a more integrated one is required.

So, in this study, we investigated the feasibility and effectiveness of applying the system of waste separation at source in Palestine, which is considered a basic key component for the development of a waste system. Thus, we studied a pilot project implemented by MOLG and JICA in the town of Burqeen-Jenin.

1.7 Significant of the study

The project in Burqeen, which aimed to separate MSW at source and compost production, is a first stage of improving the management system in the country. Therefore, the economic, environmental and social impacts of the project need to be studied in order to identify the strengths and weaknesses of such projects in Palestine.

The aim of this evaluation is to determine the effectiveness of the project. The results will be used to decide whether or not the project can be expanded to other townes and municipalities. It will also assist policy makers in developing SWM strategies and allocating resources to such projects.

1.8 Aim of the study

Initial Evaluate the effectiveness of MSW separation in Burqeen(environmentally, economically and socially).

1.9 The objectives of the study

1. Study health and environmental effects of applying SW separation at source system.
2. Measure the cost effectiveness (ILS/ton) of applying the solid waste separation at source in the town
3. Asses population awareness of solid waste separation at source before and after applying SW separation system in the town

1.10 Research questions

- Does the new system improving the level of solid waste management in burqeen and reducing its environmental impact?
- Is there a financial difference in the application of the waste separation at source system and the mixed collection system?
- • Are there statistically significant differences in the use of solid waste separation at the source system in relation to waste management awareness in Burqeen town?
- Is the awareness campaigns and workshops raise the Burqeen population awareness of MSWM and separation of waste?

1.11 Study hypothesis

- Separation at source for MSW will reduce the SW generation in the town about 40% after one year of applying SW separation at source system
- Cost effectiveness (ILS / ton) of applying a MSW separation at source in the town is higher than cost effectiveness (ILS /ton) of collection and disposal system
- Population awareness toward solid waste separation at source will increase after applying the project and its awareness campaigns.

Chapter Two

Literature Review

Many studies on solid waste management and related methods have been undertaken all around the world. Many researches have been improved in order to better understand SWM choices and their effects on the environment and economy.

This chapter will include researches that focus on the effect of MSW system development on the environment, as well as the financial and social impacts on municipalities. This chapter also shed lights on studies that evaluate implementations of new solid waste management techniques, such as Burqeen project.

2.1 Studies find that improper waste disposal management has a significant negative impact on the environment

Numerous studies have demonstrated that when waste is burned, the toxins and particulate matter released into the air can cause respiratory and neurological diseases (climate central, 2014). Furthermore, the studies confirmed that organic waste entering waterways reduces the available oxygen and promotes the growth of harmful organisms. Moreover, waste management contributes nearly 5% of global greenhouse gas emissions, primarily due to food waste and improper waste management (Bhada-Tata and Hoornweg 2016).

In 2017, a study in Dhanbad, India, used life cycle assessment tools to assess the potential environmental impacts of various municipal solid waste management (MSWM) scenarios (LCA). The study includes the following scenarios: collection and transportation (denoted as S1); a baseline scenario of recycling, open burning, open dumping, and finally unsanitary landfilling without energy recovery (denoted as S2); composting and landfilling (denoted as S3); and recycling and composting followed by landfilling of inert waste without energy recovery (denoted as S4) (denoted by S4).

The results indicated that the scenario S1 has the highest impact on marine aquatic eco toxicity and abiotic depletion. And S2 had the highest impact on global warming, acidification, eutrophication, photochemical oxidation, and human toxicity. However, S3 had the highest impact on abiotic depletion (fossil fuels), fresh water aquatic eco toxicity, terrestrial eco toxicity and ozone layer depletion. However, due to recycling of

packaging waste and landfilling of inert waste, S4 had the least impact on any of the environmental impact categories.

Landfilling without energy recovery of mixed solid waste was discovered to be the worst disposal option. The scenario S4 was investigated as the most environmentally friendly technology and recommended that it be considered for strategic MSWM planning for the study area. (Yadav&Samadder, 2017).

2.2 Previous studies that evaluate pilot projects for different SWM strategic

JICA collaborated with Sri Lanka's Central Environmental Authority (CEA) in 2017 to implement a project from 2017 to 2019, with the goal of introducing source separation at households and subsequent separate collection by local municipalities (Sato et al., 2020).

Two pilot projects based on solid waste management plans were implemented in Ratnapura Municipal Council (RMC) and Kataragama Pradeshiya Sabha Town (KPS), with the goal of reducing the amount of solid waste landfilled. The study's goal was to describe the methods used and the results obtained through Sri Lanka's pilot projects.

The pilot project in RMC consisted of distribution of household compost bins and the separate collection to five types of waste: 1) biodegradable Waste, 2) plastic and polythene, 3) paper and cardboard, 4) glass, metal and coconut shells, and 5) other residual waste .

The average amount of separated biodegradable waste separated and delivered to the compost site increased from 2.3 tons per day in 2017 to 5.1 tons per day in 2018 and 10.5 tons per day in 2019.

The quantity of waste disposed at the last location of disposal (landfill) has dropped significantly from 35.8 ton/day in 2017 to 28.7 ton/day in 2018 and 22.1 ton/day in 2019.

The pilot project in KPS involved of separate waste into three types of: 1) biodegradable waste; 2) recyclables including paper, cardboard, plastic, polyethylene, iron and coconut shells, broken glass and glass bottles; and 3) other residual waste.

Before the project, KPS collected 70.2 tons of biodegradable waste per month, which increased to 99.7 tons per month in November 2018 after one year of operation. The amount of recyclable waste collected increased steadily from 1.9 tons per month in November 2017 to 4.5 tons per month in November 2018.

The increase in biodegradable and recycling waste will result in a decrease in mix waste disposal from 81.5 tons per month in September 2018 to 24.6 tons per month in November 2018.

Amount of waste disposed at final disposal site decreased from 40.7 ton/month in October 2017 to 35.4ton/month in October 2018.

The study concluded that applying the MSWM by separation at source with suitable awareness campaign and monitoring is able to decrease the final amount of waste that reaches the landfill (Sato et al., 2020).

In 2019 a study conducted in Hangzhou, the capital city of Zhejiang Province, China which has been practicing rural waste source classification ((2+T classification) bio degradable waste, other waste, and toxic waste) in rural areas since 2014 .The study aimed to evaluate the feasibility of the '2 + T' classification method in rural areas.An economic and social analysis was done. It included three pilot projects with three different scenarios for the method of waste separation and collection method (Li et al., 2019).

In Scenario A, residents are required to deposit their source-separated waste at a centralized location where it is collected daily, so there are no small garbage bins at each resident's gate.

In scenario B, biodegradable and other wastes were deposited in the doorway and collected door-to-door by collectors on a daily basis. The collector can instantly evaluate and supervise each householder's classification behavior using this method, which ensures the quality of source classification.

In scenario C, biodegradable waste was collected daily from the doorway, while other waste was collected every two days and delivered to a centralized collection point.

In general, the costs in all scenarios are heavily influenced by tools, infrastructure, manpower increases, advertising, and awareness campaigns. Patterns B and C, on the other hand, require more workforce than Pattern A. The costs of advertising and awareness campaigns gradually decreased in all scenarios.

The results showed that the percentage of biodegradable waste exceeded 50%which is confirmed the previous studies. Also results show that scenario A is the lowest total cost for applying but it was difficult to monitor the behavior of the residents in the SW separation and their compliance .

Finally, in the three typical scenarios, Pattern B with classified deposit in the doorway and door-to-door collection of biodegradable and other waste showed the best scenario and performance participation, with the exception of the operating cost(Li et al., 2019).

Another study was conducted in China in 2020 to assess the impact of MSW classification on the economy, resources, and environment by using Tianjin, China as a case study from 2006 to 2017. The findings show that as the separate rate rises, the socioeconomic benefits shift from negative to positive values, with the maximum socioeconomic benefit reaching 0.36% of Tianjin's GDP.

According to the environmental assessment, waste at classification could have reduced greenhouse gas emissions (CO2-equivalent) by 1.03 to 1.46 million tons per year from 2006 to 2017. The findings also show that for every 1% increase in the separate rate, the amount of annual land saved could have ranged between 502.92 and 2918.59 m2.

The study concluded that separate waste at source must be implemented throughout the country, and policymakers must encourage residents to actively participate in waste classification actions (Wang & You, 2021).

2.3 Studies conducted to assess the community awareness of solid waste management, as well as their opinion and willingness to commitment into SW separation

A study conducted in 2017 in a Region of Municipality of Tehran, Iran to examining household participation in 3R waste practice and the reasons of non-participant residents in order to formulation of local 3R waste strategies, particularly on separation

at source and recycling activities of the residents. A questionnaire surveyed 486 households was taken (Ahmadi, 2017).

The results show that only 26% of the households take part in waste reduction activities and 20% participate in practice reuse and 29% in separation at source. The study revealed the barriers of household's participation in 3Rs waste practice, and categorized them under the three main categories, behavioral, awareness and situational barriers. It showed that 48%of residents who didn't do the 3Rs principle, they Attribute this to behavioral reasons like (forgetting what to do, it's not a habit of their lifestyle and lack of time) also the study determining the situational barriers like (collection, transfer and transport practices are acted by improper bin collection systems, poor route planning, lack of information about collection schedule and, insufficient infrastructure (Ahmadi, 2017).

Another study was conducted in Kermanshah, Iran, in 2019 to assess the knowledge, attitude, and practice (KAP) of 1750 females regarding source separation and reduction, recycling, and the harmful effects of solid waste mismanagement on the environment and human health. Almasi and colleagues (2019).

The findings indicate a link between participant demographics (age, occupation, education, family size, and marital status) and solid waste management. According to the study, 79% and 86% of Kermanshahi women had adequate knowledge and attitudes toward solid waste management, respectively. However, 77% of them demonstrated poor separation and recycling practices.

The study also found that women with academic degrees and government jobs had better knowledge and attitudes (p 0.05). However, no significant differences in knowledge and attitude regarding the consequences of SW mismanagement on human health and the environment were found across marital status, family size, and age (p > 0.0). Almasi and colleagues (2019).

Another study in Iran used a questionnaire survey of 2400 Abadan residents to assess their knowledge, attitudes, and practices (KAP) regarding solid waste (SW) reduction, source separation and recycling, collection, and willingness to pay (WTP) for SW services. The findings revealed a very positive attitude toward participating in SW source separation and recycling plans. However, they demonstrated a lack of knowledge

of the various steps of SW management and a lack of ability to practice these steps. The researcher also investigated the relationship between KAP of SW source separation and recycling and demographic variables such as age, education level, gender, and occupation. Furthermore, it was discovered that education level and occupation were two significant factors influencing residents' WTP (2 = 24.083, p-value 0.0001)..(Babaei et al., 2015)

A community based cross-sectional study design was used to find the KAP of the highland residents at the community level in Thailand, from November 2016 to January 2017. This study indicated finding that participants' knowledge of MSW management is high, but the levels of attitude and practice are neutral and moderate, respectively (Laor et al., 2018)

Chapter Three

Methods

3.1 Study Design

A case study was conducted.

3.2 Study site and setting

The study conducted in Burqeen town southwest of Jenin Governorate which is considering an agriculture town.

3.3 Population

The target population were subjects that live in Burqeen town and consider as a part of SW system (producing, collection).

The town population is 7670 (PCBS, 2020) and according to PCBS the average of Palestinian family size is 5.1 so there is approximately 1500 beneficiaries in Burqeen which is meet with participants in waste fees in Burqeen Municipality.

3.4 Sample Size Calculation

According to the below equation we decide the sample size at confidence level 95%,margin of error 0.05 and standard deviation 0.5 and 1.96 z-score

Sample Size =[z2 * p * (1 - p) / e2] / [1 +

(z2 * p * (1 - p) / (e2 * N))

N (population size) = 1500

Z(z-score) is a constant value for 95% confidence => 1.96 z-score

e (margin of error) = 0.05

p (standard of deviation) = 0.5

The sample size is 305 beneficiaries

3.5 Inclusion and exclusion criteria

According to the survey distributions all waste service beneficiaries in Burqeen are included in the study with excluding for persons who is less than 18 years old.

According to financial analysis the costs of (collector's salaries, vehicles diesel and maintenance) are excluded that's because it's provided by Jenin- JSC and it's not the municipality responsibility. According to environmental impact (waste reduction) there are no exclusion criteria

3.6 Data collecting tools

Many tools used in this study according to the object assessed:

3.6.1 Standardized Questionnaires

Standardized questionnaires used for assessing population awareness of solid waste separation at source before and after applying SW separation system in the town.

Two types of questionnaires were distributed; pre implementation and post implementation that's to evaluate the effective of awareness campaigns which conducted by researcher as a coordinator for the project during the preparation of the project by assessing the population awareness of SWM (3Rs principal).

The questionnaires designed after studying a previous questionnaires conducted by JICA and JSC. The pre-questionnaire consisted of 27 questions divided into three parts; the first covered participant demographic data, the second general questions related to the MSWM in order to assess population awareness of the 3Rs principal. The final section is used to assess population satisfaction with current waste services and solid waste separation practices.The post questionnaire consisted of 11 questions distributed as three parts without demographic data (the same participants in the pre-questionnaire), the first part is to assess population knowledge of 3Rs principal after a year of population awareness and workshops and after 4 months of implementing the project and start separation at source. The second part reflected person's attitude of the project and if there has apply the separation of waste, finally, questions that reflect people's satisfaction of the project process.

3.6.2 ZF, JSC and Burqeen municipality records

Data of waste separated and reached the landfill in addition to the service cost were collected through data agenda from the municipality, JSC and ZF

1. ZF agenda was used to study the reduction of waste. ZF has an agenda with all waste weights that reached the landfill from each area saved at computerized system. It was used as a reference of Burqeen waste weights before applying SW separation at source (in 2021) and the new weights after the implementation of the project. The average of waste(ton/month) was compared for both years.
2. Using Burqeen municipality records to compare the cost effectiveness (ILS/ton) for MSW service before the project applying with the assumed costs that this study predict.

3.7 The validity and reliability of the questionnaires

These questionnaires are taken from a previous researches from JSC, audited by specialists engineers in JSC- Jenin and MOLG see (appendix (6.1)) .the questionnaires reliability confirmed by conducting a pilot for 10 subjects in the municipality of Burqeen under the supervision of the project manager and the technical engineer of ZF in order to assess the understanding of questions, time needed for finishing.

3.8 Ethical considerations

First, the necessary approvals were obtained from Al-najah National University's IRB, and then questionnaires were distributed to participants in Berqeen town to gain access to the stockholders agenda.

The study proposals were submitted to Al-Najah University's Ethics Committee for ethical approval with the goal of ensuring and preserving the rights of research participants as well as the capabilities of researchers to be qualified and have basic research principles.

The participants voluntarily participated in this research, and they were always reminded of their right to withdraw from the study at any time, and they were allowed to ask any direct questions or request clarification. Each participant signed a consent form containing private information such as the study's objectives and the researcher's contact information, minor risks of annoyance were explained, their rights to

confidentiality and anonymity were outlined, no names would be mentioned in the analysis, and the data was secured with limited access to the researcher only. Only use the data for scientific purposes.

3.9 Data collection procedure

It's critical to note that there are many ways for questionnaires distribution conducted in this study. The pre- questionnaires distributed in the town in June 2021, the researcher herself met some of people, explained the aim of the study and explained any misunderstanding when needed. Some of it was placed in the electricity charging office in the municipality, and the responsible employee there dealt with people and clarified the purpose of the study and explained what they did not understand. As well as there is a digital form of the questionnaire was published in the municipality Facebook page and the project Facebook page. 305 pre-questionnaires were collected in the period (June - July 2021)

Post-questionnaires were distributed during the period of (May-June 2022) in the town of Burqeen, by door to door meeting during the project monitoring program ,at electricity charge office and via internet 305 questionnaire were collected.

Waste weights were collected monthly during the period from (15/1/2022-15/3/2022) through the Zahrat al-Finjan balance, and based on it, the average waste reach the ZF for the year 2022 was predicted and compared with the year 2021.

Financial data of MSW service were collected from Burqeen municipality archive in 2021 and (15/1/2022-15/3/2022) included cost of the service and its revenues.

3.10 Data analysis plan

The researcher used (SPSS22) statistical packages descriptive part includes frequency, percentage, graphs, and cross tabulation test as appropriate for questionnaires data statistical processing. For other data the researcher used Microsoft Excel 2010 for calculations.

3.11 Limitations and Strengths point

The pilot project as the study faced some limitation during implementation due to Covide 19 pandemic situation.

1. Social distancing policies and the prevention of gatherings have delayed workshops and awareness campaigns and purchasing of materials which caused a little delay in the workflow.
2. technical barrier during the project operation. The scattering of houses in the areas of the outskirts of the town, which made it difficult to collect waste and deliver containers, and negatively affected the citizens' satisfaction with the project in those areas.

On the other hand, there are a number of strengths that help the researcher to continue the study. The most important is a fund for the implementation of the project (equipment, awareness campaigns and compost plan), which usually reduces the cost of project implementation.

Chapter Four

Results

4.1 Overview

This chapter presents the study findings, which include:

- The characteristics of the questionnaire respondents, as well as the average percentages of responses for each of the survey items before and after the implementation of SW separation at the source project.
- Weight reduction of waste results
- Cost effectiveness analysis results before and after the project.

4.2 Questionnaire results

As previously mentioned in the study, the sample size was 305 participants. However not all participants had the desire to fill all the socio demographic data, researcher respected that.

Table 4.1

Distribution of Burqeen demographic data, Burqeen, 2022

Variable	Category	N.	%
Gender	Male	164	53.8
	Female	139	45.6
	Total	303	99.3
Age	17-22y	41	13.4
	23-30y	66	21.6
	31-40y	73	23.9
	41-60y	93	30.5
	>60y	26	8.5
	Total	299	98.0
Income	≤1500	44	14.4
	1501-3000	105	34.4
	3001-6000	126	41.3
	>6000	21	6.9
	Total	296	97.0
Education Level	High school or less	142	46.6
	Diploma or Bachelor's degree	145	47.5
	Postgraduate	16	5.2
	Total	303	99.3

notice the sample nearly has a percentage of male (53.8%) a little more than female (45.6%).It's important to highlight that (76%) of the population are between 23 and 60 years old as follows, (23-30y), (31-40 y) and (41-60y) with percentage respectively, (21.6%), (23.9%) and (30.5%). This indicates that most of the study sample have house responsibilities and mature- enough to determine their knowledge, opinion and satisfaction toward MSW which make the results more reliable.

(75.7%) of sample has an income between 1501-6000 ILS/ month as the following, (3001-6000 ILS) and (1501-3000) with percentage (41.3%) and (34.4%) respectively this reflects that nearly half of the sample is from the middle economic category, and this fits with reality of Palestinian society.

(46.6)% of study sample has an education of high school or less and (47.5%) have a diploma or bachelor studies. However, only (5.2%) have advanced education degrees.

Table 4.2

3Rs principle knowledge rate of Burqeen population, before and after applying the project

The question (variable)	Answer	Pre implementation of the project		Post implementation of the project	
Did you know what are the 3Rs principal (reduce, reuse & recycle) mean?		No.	%	No.	%
	Yes, but i do not understand it	78	25.6	20	6.6
	Yes and understanding it	180	59.0	269	88.2
	No, don't know it	47	15.4	16	5.2
Pearson chi-square		0.459			

The pre implementation assessment reveals that (59%) of the sample knew the 3Rs principal and understood it, which is considered that they have a strong knowledge. Whereas (25.6 %) knew it but didn't understand it correctly this is considered a weak knowledge. However, just (15.4%) how didn't hear about 3Rs previously. So, the sample reflects a satisfied knowledge in 3Rs in the pre-implementation status.

After the awareness campaigns implementation the ratio of persons who knew and understood 3Rs increase dramatically from 59% into 88.2% that's indicate a success awareness of the project campaigns in raising population awareness toward 3Rs and MSWM.

A cross tabulation test between level of 3Rs knowledge level before and after the project applied was done, and results appear that there is no significant tabulation between them with chi-square 0.459>.05

Table 4.3

Distribution of Burqeen population participation in events related to MSWM before and after the project implementation

The question(variable)	Pre implementation of the project		Post implementation of the project	
	Category	N.	%	N.	%
Did you Participate in any of these activities (cleaning campaigns, composting campaigns, workshops) or any events related to SWM?	Yes	120	39.3	198	65
	NO	185	60.7	107	35
	Total	305	100	305	100
Pearson chi-square		0.868			

From the above table, it's clearly obtained that community participation toward events related to MSW raise from (39.3%) before the project implementation to (65%) after the projects awareness campaign and workshops. That's ensuring the project increase community attention toward MSW problem and management in Palestine.in addition to increase population participation in MSWM related events. However,(35%) of the population study answered that they didn't attend to any of project's events and reasons dxwere obtained in table (4.4)

Correlation test between participant's participation before and after the project applying was done and results revealed that there is no statistical significant correlation between them. With chi-square 0.868>.05.

Table 4.4

Distribution of reasons for not participation in the project events

The question(variable)	Post implementation of the project		
Reasons of not participating in the project events	Category	N.	%
	Did not know about this events time before	28	26.2
	Events location didn't fit me	12	11.2
	Events time didn't fit mine	20	18.7
	Have no desire to participate	47	43.9

It’s clearly that most of not participation reason was due to absents of desire for events attending (43.9%) which is consider as self-reason. however, lack of events details was the second reason with (26.2%) that’s indicate a shortage in events advertising during the implementation also there is a reasons due to unsuitable time or locations of events which considering as events- management reason.

The MSWM used by municipalities affect community’s satisfaction toward its services. Service provide satisfaction for Burqeen population was assessed before and after the project implementation. Table (4.5) illustrates Burqeen population satisfaction before and after applying the project.

Table 4.5

Burqeen population satisfaction before and after the project

The question(variable)	Category	Pre implementation of the project		Post implementation of the project		Pearson chi-square
		N.	%	N.	%	0.654
Are you satisfied with the current waste collection service?	Yes	108	35.4	101	33.1	
	No	197	64.6	204	66.9	
Has there been an accumulation of waste in your area during the past three months?	Yes, most the times	139	45.6	159	52.1	0.702
	Yes, some times	121	39.7	104	34.1	
	Rarely	40	13.1	27	8.9	
	Never	5	1.6	15	4.9	
	Total	305	100.0	305	100.0	

In general, Burqeen community shows a low level of satisfaction toward municipality service for SW in both levels (pre/post) solid waste separation at source as the results showed more than half of population unsatisfied of service in both stages. However, applying SW separation at source project in the town declined the satisfaction of community more than it was before. That, it declined from 35.4% into 33.1%. Results revealed the cause of this dropping by asking about waste accumulation in the town areas. An increase in people who answered that the waste accumulation happens most of the time increase from 45.6% 52.1% was obtain. Unfortunately that's indicating miss management in waste collection schedule after the project implementation, so the schedule needs to be updated also found another vehicle to transport waste.

In the pre-implementation stage, it was necessary to measure some variable that's important to take under consideration in the project planning and operation. Table (4.6) shows Burqeen population willingness, to participate and financially supports SW separation at source project in the town

Results revealed that correlation between people satisfaction before and after applying the project has not a statistical significant correlation, with chi-square 0.654 > .05 and chi-square 0.702 for correlation between waste accumulation before and after the project applying which is considering that there is no statistical correlation.

Table 4.6

Burqeen population willingness, to participate and financially support the SW separation at source project in the town

Variable	Category	Pre- Implementation of the project N.	%
Willingness to pay extra fees	Yes	61	20.0
	Yes, but with simple amount	127	41.6
	No	117	38.4
Willingness to separate waste	Yes	135	44.3
	Yes, but with simple efforts from me	122	40.0
	No	31	10.2
	Not Sure	17	5.6
	Total	305	100.0

The results above insure that Burqeen community has a strong desire to support the SW separation at source in their town financially, where (20%) of population have a willingness to pay extra fees for municipality to improve SW services in the town, (41.6%) showed a willingness to pay a little-extra waste collection fees to improve the town's waste management service. Whereas just (38.4%) answered that they will not pay any extra fees to improve the MSWM in the town which consider a low ratio.

The sample was asked about their attitudes toward solid waste separation at source implementation in the town and if they think that they will separate their waste and participate in the project or not. (44.3%) answered (yes) in all conditions and (40%) answered that they will separate their waste if the efforts required from them are simple. however, (10.2%) of people answered that they will not. so, the sample has a satisfied attitude level toward MSW separation at source. People was asked about the cause of absent willingness and desire to separate waste see figure (4.1).

Figure 4.1

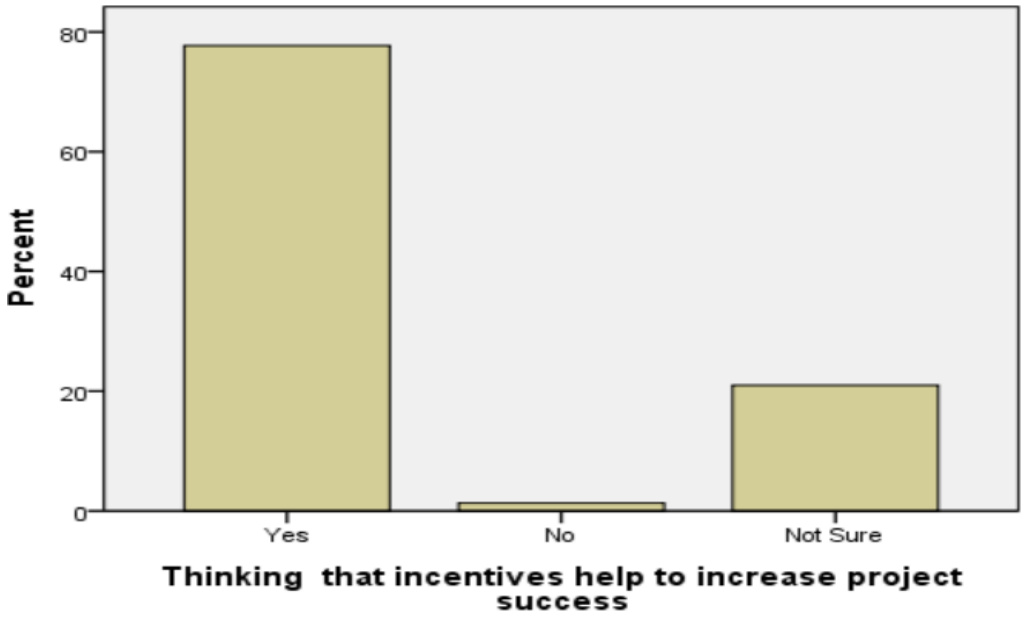
Main reasons of absent willingness to separate waste at Burqeen, 2022

According to these results, we can find that the most important reason for disappearing of willingness to separate waste at Burqeen community was the absent of desire and thinking that separation needs time and efforts. This is normal when a new culture or life style introduced to a society. However this results insights lights to the important of awareness campaigns and workshops, and ensuring the important of creating an incentive strategy to raise the community desire and willingness to separate waste and participate in the projects events. The below chart shows (Figure 4.2) the sample

opinion when they were asked if they think that an offerings incentives will make the SW separation at source project succeed or not.

Figure 4.2

Community opinion if incentives will help SW separation at source project to succeed or not. Burqeen, 2022



Cross tabulation test was conducted to study a correlations between socio-demographic status and person's awareness, attitude and practice of SWM. A "P "value <0.05 consider as significant and take under consideration.

See (table A.1) in appendix (A)that reveals that participant's gender (independent) and willingness to separate waste (dependent) has a positive relationship with "p" value 0.029. Also, correlation between education level (independent), knowledge of 3Rs, willingness to separate waste and willingness to pay extra fees were tested. table (A.2) in appendix (A).

From the previous mentioned table, It is clear the importance of education, as the level of education for respondents was affected their knowledge of 3Rs (P value 0.00),their willingness to separate waste (P value 0.006) and willingness to pay extra fees (p value 0.001)

A statistical relationship between knowing of 3Rs principle (independent) and satisfaction of MSWM "p" value 0.003 in the pre- implementation status see table (A.3) Which confirm that knowing 3Rs decrease current persons satisfaction.

It was important to analysis the post implementation questionnaire to evaluate the project operation. Table (A.4) shows the percentage of the availability of sorting containers among the participants, which reflects the percentage of containers distribution in the town. Notably, results reveal that (75.4%) of the study sample receive the suitable containers for waste sorting which consider nearly the three-quarter of the sample.

From table (A.5) we can confirm that most of the population study receive enough information and instructions (66.2%) which approve the successful of the projects campaigns to cover and include most of the Burqeen community.

Table (A.6) distributes Burqeen population participation in waste sorting , results revealed a high participation in solid waste separation at source at the first stages of the project, where (24.6%) answered that they sorting waste all the time and (38.4%) answered that they sorting waste but with unstable commitment. despite this, 37% of the study sample didn't sort waste at all.

A according to table (A.7) reasons of not waste sorting can be divided into two categories. Project operation-cause and self –causes. It's good to know that nearly half of who didn't sort waste (58.4%) was due unavailability of containers (operation-cause) and self-causes (no time and no desire) can be minimized by concentrate awareness campaigns and applying an incentives strategy were table (A.8) illustrate population opinion if an incentives will help to succeed the project and encourage people to commit in SW separation or not. We can reflect that 78% of population that it will help people to commit in separation and succeed the project.

About the Practice of SWM in Burqeen before the project implementation was studied. the sample commitment in waste bills pay, separate waste and participation in community events related to MSWM were analyzed .Results reveals that Burqeen community have a high commitment in pay waste bills that (90.2%) pay the bills directly to the municipality, that's almost fits the fact that municipality reports showed that 97% of bills revenues had paid. however, it showed very week level of separation at

source, where the percentage of SW separation at source in the town was 0% and the system of SW service is limited into mixed waste collection and transfer it to ZF landfill.

4.3 Weight reduction of waste

Before implementing MSW separation at source system, the town average generation of total mixed waste (no separation) is 200 ton/month (JSC, 2020). All of generated waste is transferred directly to ZF for landfilling.

During the implementation of the project, there were some problems that faced the JSC and municipality which was a delay in the supply of sorting containers for more than 5 months that's led to delay the containers distribution in the town. In spite of this delay, a massive awareness campaigns were conducted for the local community.

After distribution the recycled containers, and due to the lack of commitment of the people to separate the waste in 100% percent and delay in operate the composting plant The JSC is still continuing collect the waste as mixed.

Because of that the researcher has decided to consider weights assumption for the expected waste that separated after discussion these assumption with Eng. Mohammad Al-Saadi (Technical manager of the Services Council) .These assumptions were conducted according monthly monitoring for the distributed containers and local community in Burqeen.

Applying the project and containers distribution was done as three stages start from 15/1

/2022 in to 15/4/2022 and by dividing the town into three zones (A, B&C) that's to facilitate the containers distribution and monitoring process (Table 1) in appendix A illustrate weights of supposed organic separated in Burqeen town from 15/1/2022-15/5/2022, Table (2) shows Weights of supposed separated cardboard that reach the station from 15/1/2022-15/5/2022 and Table 3:Weights of supposed separated plastic in Burqeen from 15/1/2022-15/5/2022 Table 4 explain the total assumed reduction of all type of waste form 15/1/2022 -15/5/2022 in Burqeen which appear appositive result of the project.

Finally, Table (5) comparing the total waste weight that reach ZF landfill from Burqeen pre/post waste separation

4.4 Cost effectiveness analysis

See table (A.14) in appendix (A) that summarize the pre and post costs of MSWM in Burqeen and it primarily shows that applying the MSW sorting decrease the total costs of MSW service in the municipality

4.4.1 Waste service revenues

Table (6) illustrate MSW service supposed revenues for the Burqeen municipality pre /post applying the project. Its clear from the table that sources of incomes increase after the project applying.

4.4.2 MSW service net profit

Table (7) describe Burqeen municipality MSWM net profit before and after applying MSW separation at source

Chapter Five

Discussion

5.1 Introduction

The study findings are discussed in terms of the study's aims and objectives, as well as the study variables, conclusion, and future recommendations.

5.2 Questionnaires results

5.2.1 Demographic Characteristic of the study participants

Before starting the operation of the project, “a pre- implementation questionnaire " has distributed to study the population and its awareness toward MSW. In addition to that studying the relationship of socio-demographic situation of people and their awareness, practices of separation and their desire to participate in this SW separation at source project was very important in order to help the project decision-makers to create and approve the appropriate procedures in the project planning and operation phase.

Results revealed that men percentage was little more than female see table (4.1) and approximately half of population are from the middle economic classification with education level of diploma or bachelor exactly as most of Palestinian societies. When the correlation between persons socio-demographic status and other variables studied findings revealed that the gender of participants has a significant "P" value (0.029) impact on people's willingness to separate waste and participate in the project (P-value 0.05) see the table (4.6) It is clear that the females have more desire to separate waste than males. That’s agree with a previous study that conducted in Iran which also revealed a significant correlation between gender and willingness to separate waste were also founded that females had more desire to sorting waste than males (Zoroufchi Benis et al., 2019)which also fit the study of Daphan City (Babaei et al., 2015) . Depend on this result, it is recommended to consider females as one of the main audience in the project.

In addition to that, results insured that education have the most important role in determining person’s awareness, attitudes toward MSW. A significant relationship between individual education level and knowledge of 3Rs principal was obtained with” P” value (0.000). it’s clear from see table (A.2) that 16.2% of participants who has an

education level of high school or less answered that they didn't know the 3Rs principle at all. Whereas 9.6% of persons that have diploma or bachelor, also their answers where they didn't know anything about the 3Rs, but all of post graduated persons answers were that they know the concept of 3Rs. As results to above mention the education has a direct relationship with people awareness of 3Rs principal so, we confirm that when the education level increases the person's knowledge of 3Rs will rise too. In fact, this was consistent with previous research, which found that women with academic degrees and government jobs had better knowledge and attitudes (p 0.05) (Almasi et al., 2019)

According to the findings of (Babaei et al., 2015), the relationship between KAP of SW source separation and recycling and demographic factors such as age, education level, gender, and occupation. Furthermore, it was discovered that education level and occupation were two significant factors influencing residents' WTP (2 = 24.083, p-value 0.0001). (Babaei et al., 2015).

This result gives us a great incentive to strengthen our efforts on awareness workshops, materials and campaigns with focusing of students in schools and universities. As well as create more methods and strategic to increase education level of 3Rs and MSW issues.

Also, it's affect person's attitudes toward MSWM as the Results showed that education and willingness to pay extra fees has a "value (0.001), education and willingness to separate waste has " p " value (0.006) By focusing in table (A.2) we will notice that (15.5%) from persons with low level of education (high school or less) answered that they have not any desire or willingness to separate waste. Whereas, just (6.2%) of persons with middle education answered that. However, all high level education persons answered that they have willingness to separate waste. So, there is a linear relationship of education and person's willingness to separate waste and participate in the project. that's fits with other previous study which conducted in Iran that found also a correlation with significant P value between education level and willingness to separate waste (Zoroufchi Benis et al., 2019) as well confirms (Babaei et al., 2015) which was unearthed that increasing respondents' education level provided the most significant clusters of source separation and recycling knowledge, as well as their willingness to recycle. this results important because its insights the project stockholders to focus on persons with high level of education and make them a part of the project (volunteers,

public speakers….) to influence the other segments of community. And to concentrate the awareness campaigns especially in schools and education centers.

Also education level has a linear relationship with person's willingness to pay extra fees for MSW service in order to increase the service quality. Where, 49.3% of people who has a low education level answered that they have no willingness to pay extra fees for any reasons. 31% of people with middle education level and 6.3% of people with high education level answered that. Others socio demographic variables including income have no statistical significant with persons awareness, opinions and willingness toward MSWM.

Surprisingly, the pre-questionnaire results revealed that there is a statistical relationship between knowing of 3Rs principle and satisfaction of current MSW service with "p" value 0.007 see table (A.3). It show that (10.2%) of persons who didn't know or hear about 3Rs before are not satisfied about the current situation of MSWM in Burqeen before implementing the project. And (62.9%) of persons who know the 3Rsand understanding it are not satisfied too. From hear we can reveal that knowing of 3Rs has a negative relationship with people satisfaction of the management of waste service. Actually, that's highly logic because when person know the 3Rs and understand it and its effect he will has a more desire to improve the service of waste management to more integrated one.

5.2.2 Knowledge of 3Rs, attitudes and practice of population toward MSWM assessment in Burqeen before and after the project

According to the table (4.5), the sample has a satisfied awareness level of 3Rs principal were (59%) of the sample knew the 3Rs principal and understood it, which is considered that they have a strong knowledge. Whereas (25.6 %) knew it but didn't understand it correctly this is considered a weak knowledge However just (15.4%) how didn't hear about 3Rs previously. sample attitudes toward solid waste separation at source was moderate were, (44.3%) of population think that they will participate in SW separation at source in all conditions, (40%) will separate their waste if the efforts required from them are simple. however, (10.2%) of people answered that they will not. Figure (7) show reasons of willingness absent, where (38.7%) of who answered they will not separate waste was due to lack of desire to participate which is consider as an

individual cause can be solved by applying an incentives for community. Also a (38.7%) answered that due to their thinking that waste separation need time and complicated which is can be change by raising awareness by workshops, advertising and campaigns.

About the Practice of SWM in Burqeen before the project implementation, the researcher study the sample commitment in waste bills pay , separate waste and participation in community events related to MSWM .Results reveals that that Burqeen community have a high commitment in pay waste bills that (90.2%) pay the bills directly to the municipality, that's almost fits the fact that municipality reports showed that 97% of bills revenues had paid (Burqeen Municipality, 2021). however, it shows very week level of separation at source, were the percentage of SW separation at source in the town was 0% and the system of SW service is limited into mixed waste collection and transfer it to ZF landfill. According to population participation in events related to MSWM , results showed that (60.7%) did not was apart in any event related to SWM. this can be considered as a week community participation in SWM events. So, we can conclude that Burqeen community has a satisfied knowledge of 3Rs with moderate attitude and weak practice. This result is similar to (Laor et al., 2018)

5.2.3 Comparison of population Satisfaction toward SWM service situation before and after the project implementation

Table (4.7) shows population satisfaction before the implementation, (35%) of population explained that they have enough satisfaction in the current service, but (64.6%) have not. The reasons of dissatisfaction discovered when they had been asked about waste accumulation, (45.6%) of sample answered that waste accumulated in the town most of times, (39.7%) answered that accumulation happened sometimes. In the other hand, just (13.1%) answered with rarely accumulations of waste happened and only (1.6%) answered with never. That's indicates that local community was suffered from waste accumulation and mismanagement in the town before the project implementation. So, they had low satisfaction level toward MSW service.

Unfortunately, Burqeen population satisfaction toward MSW service decreased after four months of the project implementation, results showed that persons who answered that they are enough satisfied decline from 35.4% into33.1% that's due increasing waste

accumulation in the town see table (4.7). People who answered that most of the time there is accumulated waste in the streets increased from 45.6% into 52.1% .

Therefore, we can conclude Burqeen community has weak satisfaction toward MSW service before the project implementation and this weakness increase after the applying of MSW separation at source project. This is unexpected and opposite result for the main goal of the project and reject other previous study that observed an increase in population satisfaction of MSW service after MSW separation at source) (Babaei et al., 2015). The main reason of satisfaction declining is increasing the waste accumulation in the town. According to the municipality and the manager of the project, its happened due to mismanagement in waste collection schedule , limited waste collection resources finally the time when the post questionnaire was distributed played a big role in this dropping that's, it was Ramadan and waste generation especially the organic section were raise(total generation of waste raise to 10 ton) which increase the pressure in waste collection service with one vehicle for all town regions (JSC-Jenin, 2022).

5.2.4 Comparison of Burqeen population awareness, opinion, practice and satisfaction toward MSWM before and after the project implementation

It's clear from table (4.5) that awareness level of Burqeen population increase after the project awareness campaigns, where ratio of people who know the 3Rs and understand it rise from (59%) to (88.2%) which is consider high increase. In the other side, the ratio of persons who didn't know what the 3Rs declined 10.2 times from (15.4%) into (5.2%). This result meets with other previous study that confirms the ability of awareness campaigns to raise people knowledge in MSWM (Almasi et al., 2019).

In addition to that its succeed to increase population participation in events related to the MSWM, see table(4.3) that reveals how the ratio of people who didn't participate in any event related to MSWM declines nearly by half from 60.7% into 35%.

About population practice of SW separation at source, a high shift improvement was done in the town. A MSW separation at source increased from 0% before the project implementation into approximately 22% after one year of the project applying (JSC-Jenin,2022).

In the other side, before the project, Burqeen population showed high willingness and desire to separate waste and participate in the project. Where, 44.3% of the population study showed willingness to separate waste in all conditions, 40% reveal that they have the desire too but, with simple effort needs from them. However, just 10.2% answered that they have no desire to separate waste and participate in the project. In the other side the post implementation questionnaire show that people who answered that they always separated their waste during the four months 24.6% , 38.4% answered that they separated waste some times and who didn't separate waste at all was 37%. Even so, the assumed amount from separated waste from the town during the four month was nearly 22% . from here we can confirm that population of study has satisfied knowledge of 3Rs with high willingness to separate waste but its willingness is higher than its actual practice that's fits other related previous study conducted in Iran which insured that population had a satisfactory knowledge and willingness to separate with poor practice (Almasi et al., 2019).

5.2.5 Waste containers distribution and community instruction to separation waste

The post questionnaire results showed that (24.6%) of the study population didn't receive any specific containers for waste separation see table (A.4). In the other hand, table (A.7) shows reasons of not sorting waste (58.4%) of people who didn't separate waste due to absent of the specific containers. So, failure to provide containers was a reason why most people didn't separate waste despite their desire to do.

Table (A.5) reveals that 21% of the population study didn't receive any of waste separation instruction. That's mostly fits the ratio of people who didn't receive containers.

5.3 Weight reduction of waste

5.3.1 Municipal solid waste generation before the project

As we confirmed before, in the period before implementing MSW separation at source system, the town generation of total mixed waste is nearly200 ton/month. All of generated waste is transferred directly to ZF for landfilling. (JSC, 2021)

5.3.2 Waste weight after separation at source in Burqeen

After implementing MSW separation at source system, suitable colored containers were distributed in the town (see annex (E)). Residents start to separate their wastes according municipality recommendations.

Suitable schedule for waste collection was established see table (1.4), organic waste and separated recyclable materials (cartoon &plastic) were transferred to the compost station for storage. Then organic waste used for compost and recyclables waste prepared for sale however, other wastes (mixed) transfer to ZF.

5.3.3 Organic waste weights

In the first month (15/1-15/2 2022) the containers were distributed in (A) zone, which consist of 25% from town area, it is supposed to generate 25% of the town generated waste that's mean 25% of 200 ton that's equal to 50 ton of total waste half of them is organic so, the supposed generated organic waste is 25 ton /month. But the zone generates 10 ton / month of organic waste according to JSC records; this indicates ratio of SW separation for organic waste in this zone at the first month was almost (40%). And reduction ratio of the total generated waste is (5%)

Separation ratio 40% considers a good beginning and good indication for people responding to the municipality workshops and recommendation.

In the second period (15/2/2022-15/3/2022) the containers distribution extended to new zone (B) which take place 35% from the town area. (60%) from the town start to separate organic waste.

In this zone, the generated waste supposed to be 120 ton / month but in fact the weight of organic waste generated was 24 ton. This is considering 40% of total waste in the zone and 12% of waste reducing in all towns.

From 15/3/2022- 15/4/2022 containers distributed in to all town, so all the town is now under the study.

The supposed weight of total waste is approximately, (200 ton / month), (100 ton) of it is food waste. However expectation of real separated organic waste generated was 45 ton/month which is22.2% from all waste generated in the town ,45% from all organic waste generated from the town and its indicate the people commitment in separation.

In the period 15/4/2022-15/5/2022, weights of separated organic waste were expected to reach 39 ton. This is considering 39% of organic waste generated and 19.5% from all generated waste.

See table (A.9) which summarized the assumed weights of generated organic waste in the town. Thus the organic waste reduction after three months of the project applying is 30%

The expected Organic waste that will be reduced from the town in the period (15/4/2021 -15/5/2021)

5.3.4 Weights of cardboard and paper waste separated

Cardboard and paper containers had distributed in all town locations from the beginning. Choosing these locations depend at the expected producing for paper & cardboard. It was focused in institutions areas and businesses.

The expected quantity of separated carton and paper for the period 15/1/2022 – 15/2/2022 was (8 ton) which is considering 4% from the total waste generated.

Cardboard ratio from the total waste in Palestine is 14% (JSC, 2022). So, it is supposed that the town produce 28 ton / month whereas it expected that the produced weights was around 8 ton that's mean just 28.5% from the generated cardboard were separated that's because its containers distribution is limited in the areas of high cardboard producing (supermarkets,,,,,)

At the period from 15/2/2022-15/3/2022 cardboard separated weight was supposed to reach 10 ton /month which is considering 5% from total waste.

During 15/3/2022-15/4/2022 the weight of separated cardboard was 15 ton /month which is consider 7.5% from the total waste.

Finally, at the period from 15/4/2022 -15/5/2022 the expected weight of separated cardboard was around 20 ton. This is considering 9.5% from the total waste generated. See the table (A.10) that summarized these supposed weights of separated cardboard during the three months.

5.3.5 Weights of supposed separated plastic

These containers were distributed in all town locations with focusing in areas high production like schools, supermarkets from the beginning of the project.

At the first period the weight of separated plastic was approximately 2ton/month which is 1 % from total waste, in the next period it was approximately3ton/month which is 1.5% from total waste, in the third period separated weight was approximately 4 ton/month which is 2% from total waste. Finally, in the last period the expected weights of separated bottles was around 4 ton also that's 3% from the total waste generated. See the table (A.11) that summarizes the weights of separated bottles during the four months.

From table (A.12) which illustrates the supposed weights of waste that are separated from the town during three months (Organic, cardboard & plastic) and the weights of the expected separated waste, in addition to that percentage of waste reduction. Weights of separated waste in one year is supposed to reach 549.6 ton so the waste that reach the landfill will be 1850 ton see table (21)

So , it's clear that applying SW separation at source reduce the amount of waste that reach the landfill and raise the amount of sorting waste that's fits other studies (Wang & You, 2021) and (Sato et al., 2020).

5.4 Costs effectiveness analysis results

In fact, waste collection services impose significant financial obligations to municipalities, regardless of whether the service is restricted to collection and transfer or involves more advanced technics like separation and composting.

The researcher's intent was to conduct a financial analysis of the municipality's costs and revenues before and after the pilot project's operation in order to determine if the

waste separation at source is more cost-effective than limiting the service in collection and transfer or not.

5.4.1 Waste service costs

See table (22) that illustrate the costs of MSW service incurred by Burqeen Municipality before and after the project implementation.

5.4.2 Pre separation costs

The town waste generation approximately 200 tons/month (ZF, 2021). Special waste trucks from JSC-Jenin collect the waste and transfer it to ZF landfill. Burqeen Municipality pays 133 ILS/ton as collection, transfer and landfilling fees for the JSC.

32452 ILS/month and 389424 ILS/ year was the total amount of fees that Burqeen and a Qofrathan(a Small town near Burqeen) paid to JSC according to JSC records (ZF, 2021).Burqeen paid 81% from this amount. So, the total fees that Burqeen municipality paid was 315433.44

Berqeen has 436 containers, distributed in the town neighborhoods .The costs of containers purchasing amounted to 19,860 ILS/ year (Burqeen municipality, 2020). So, the present costs of MSWM it's restricted to the costs of equipment's (containers) and ZF fees335, 293.44 ILS/year.

5.4.3 Post separation costs

The pilot project of MSW separation at source in Burqeen is funded from JICA in a value 200,000 ILS.180,000 ILS for containers with a suitable colors and specifications, 20,000 ILS for awareness requirements (materials, advertisements and workshops). However the amount of wastes reached the landfill is declining (due to separation) so the fees is decline too. According to the assumed weights of separated waste the amount of the waste that reach the landfill decreased from 2400 ton /Y to 1850 ton/Y, so ZF fees will decrease into 246050

5.4.4 Waste service revenues

In the pre implementation stage, the main and only revenues to the municipality from MSW service are resident's bills; residents pay for the municipality 19 ILS/M.

The municipality has been implemented a pre-payment system for waste collection bills, in which the citizen pays their bill when they pay their electricity invoice. Thus, the municipality increased the collection rate of bills and reduced debts, as the collection rate reached 97%.

In the town, there are 1500subscriptions for the waste collection service.so the proposed revenues should be 28500 ILS/Mon &342000ILS/Y but the actual revenues is 331,740 ILS/Y (Burqeen Municipality, 2020)

However, after implementation the MSW separation at source in the town Burqeen municipality creates revenues beside of bills. It now has Revenues from separated recyclable materials sale for the local recycling factories.

Locally, factories buy cardboard and paper sorted cardboard in one package and paper in another one, and compressed for100 ILS/ ton and 50 ILS/ton without sorting and compression. Due to lack of a paper compressor at the current stage, it was approved that the separated carton and paper will be sold at 50 ILS/ ton for a local recycling factory in Jenin. Since it is expected to produce 156 tons per year, the profit from the sale will be 7800 ILS/Y

Separated Plastic was supposed to reach 39 ton/Y. in the local market, clean sorted crushed plastic is sold in 600 -1000ILS /ton. Burqeen municipality agreed with a plastic recycling factory in Burqeen to buy the separated plastic in 100 ILS/ ton without sorting and without any modification. So, the total supposed revenues will reach 3900 ton /Y

The separated organic waste will transfer to the compost plan by free because it is under the municipality control. In this study the, the factory is treated as a separate financial unit, and the costs of its establishment, operation, or profits have not been calculated. It's important to notify that bills revenues still the same without any different. See table (23) that summarized the costs and revenues of MSW service before and after the project implementation.

5.4.5 Conclusions

This study concludes that project of solid waste separation at source in Burqeen town succeed to advance the community awareness of MSW and 3Rs principal, the community participation in events related to MSWM in addition to raising separation at source ratio from 0% in 2021 to 22.9% in 2022. So, the study accepted the hypothesis of increasing the population awareness toward MSWM after the awareness campaigns and the project applying.

According to the study hypothesis that the project will decrease the amount waste that reached ZF into 40%, the study approved that the amount of waste reached ZF landfilling will decrease from 2400 ton /year into 1850 ton , the decline is about 22.9%. However, it's also a good ratio and good beginning.

About the economic benefit, the study approved that applying MSW separation at source is more effectiveness that limiting the service into collection and landfilling. Where, the net profit for the municipality before the project implementation was a negative value (3553.44 - ILS). Whereas it supposed to have a positive one after a complete year of project implementation (37390 ILS)

5.5 Recommendations

- Burqeen municipality should find more popular method to advertise the events details and make events of the project has a flexible time and place. That 26.2% from persons who didn't participate in the project events were didn't know about the events at all. And 11.2% , 18.7% due to unsuitable location and time respectively.

- Burqeen Municipality should find an incentives strategy in order to encourage the community to separate waste and raise their desire in participation of the project events. According to the questionnaires results, 43.9% of people who didn't participate in the project events and 21.2% from who didn't separate waste answered that they has no desire to do that. In addition to that 78% of population answered that they think that incentives will encourage the community to separate waste.

- Burqeen municipality should find a supporter vehicle to transport the separated waste, where the collection schedule raise the accumulation of waste in the town and decrease the population satisfaction.in addition to that, MOLG and JSC should help the municipality to find another waste vehicle and support it.
- Policy makers in the goverment should Focusing on waste management and environmental health in educational materials from schools to universities, where the study approved that education level has a direct relationship with knowledge of 3Rs and MSWM.

- MOLG should apply MSW separation at source project at all Palestinian municipalities for its benefits economically, environmentally and socially.

List of Abbreviations

Abbreviation	Meaning
MENA	Middle East and North Africa
WB	West Bank
GS	Gaza Strip
JSCs	Joint Services councils
LGUs	Local Governmental Units
LF	landfill
ZF	Zahret Al Fenjan
MOLG	Ministry of Local Government
NSSWM	National Strategy for Solid Waste Management
PCBS	the Palestinian Central Bureau of Statistics
JICA	Japan International Cooperation Agency
LCA	life cycle assessment
SWM	solid waste management
LFG	landfill gas
GHG	Greenhouse Gas
3Rs	reduce, reuse and recycle
MSW	Municipal solid waste

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Appendices

Appendix A

Tables of Study

Table A.1

Chi-square test between participants gender and their willingness to separate waste

Willingness to separate waste	Gender		Chi-square value P value
	Male N(%)	Female N(%)	
			0.029
Yes, but with simple efforts needed from me	56 34.1%	66 47.5%	
Yes	75 45.7%	59 42.4%	
Maybe	10 6.1%	6 4.3%	
No	23 14.0%	8 5.8%	
Total	164 100.0%	139 100.0%	

Table A.2

Chi-square test between participants' education level and knowledge of the 3R level, willingness to separate waste, and payment of extra fees

Knowledge of 3Rs	Education level			Value P value
	High school or less	Diploma or bachelor degree	Post graduate studies	
	N(%)	N(%)	N(%)	0.000
Yes, but i dot understand it	48 (33.8%)	27 (18.6%)	2 12.5%	
Yes and understanding it	58 (40.8%)	108 (74.5%)	14 87.5%	
No, dont know it	23 (16.2%)	10 (6.9%)	0 0%	
Not Sure	13 (9.2%)	0 0%	0 0%	
Willingness to separate waste				0.006
Yes	55 38.7%	66 45.5%	13 81.3%	
Yes, but with simple efforts needed from me	55 38.7%	64 44.1%	3 18.8%	
Maybe	10 7.0%	6 4.1%	0 0%	
No	22 15.5%	9 6.2%	0 0%	
Total	142 100%	145 100%	16 100.0%	
Willingness to pay extra fees				0.001
Yes	24 16.9%	30 20.7%	6 37.5%	
Yes,but a simple amount	48 33.8%	70 48.3%	9 56.3%	
No	70 49.3%	45 31.0%	1 6.3%	
Total	142 %100.0	145 100.0%	16 100.0%	

Table A.3

Correlation between knowledge of 3Rs principal and person's satisfaction

Satisfaction of current situation	Knowledge of 3Rs			Chi-sequare value P value
	Yes, but i dot understand it	Yes and understanding it	No, I don't know it	
	N(%)	N(%)	N(%)	0.003
Yes	25 23.1%	56 51.9%	27 25.0%	
No	53 26.9%	124 62.9%	20 10.2%	
Total	78 100%	180 100%	47 100%	

Table A.4

Availability of suitable colored containers for SW separation

The question(variable)	Post implementation of the project		
	Category	N.	%
Did you receive at home and neighborhood suitable colored containers for waste separation?	Yes	230	75.4
	No	75	24.6
	Total	305	100.0

Table A.5

Distribution of instruction of SW separation delivery in Burqeen, 2022

The question(variable)	Post implementation of the project		
	Category	N.	%
Did you receive suitable information and instructions of waste separation?	Yes	202	66.2
	Yes, but not enough	39	12.8
	No	64	21
	Total	305	100.0

Table A.6

Population commitment in SW separation in Burqeen, 2022

The question(variable)	Post implementation of the project		
	Category	N.	%
Do you sort waste in your home or workplace?	Yes	75	24.6
	Some times	117	38.4
	No	113	37
	Total	305	100.0

Table A.7

Distribution of reasons of not separating

The question(variable)	Post implementation of the project		
	Category	N.	%
If you didn't sort waste in your home / work , why ?	Have no desire	24	21.2
	Have no time	23	20.4
	No suitable containers available	66	58.4
	Total	113	100.0

Table A.8

Distribution of Burqeen community opinion of incentives important

The question (variable)	Pre- implementation of the project		
	Category	N.	%
Are you thinking that applying of an incentives system will increase theopportunity of the project success?	Yes	238	78
	No	4	1.3
	Not Sure	63	20.7
	Total	305	100.0

Table A.9

Weights of supposed organic separated in Burqeen town from 15/1/2022-15/5/2022

Month period	Supposed separated Organic waste weights	Supposed separation ratio from generated organic waste	Supposed Reducing ratio from the total generated waste	Zone/Total*
15/1/2022-15/2/2022	10 ton	40%	5%	A/Total
15/2/2022 – 15/3/2022	24 ton	40%	12%	A+B/Total
15/3/2022-15/4/2022	45 ton	54%	22.2%	A+B+C/Total
15/4/2022 - 15/5/2022	39 ton	39%	19.5%	A+B+C/Total
Average	29.5	43%	14%	

Total = A+B+C

Table A.10

Weights of supposed separated cardboard that reach the station from 15/1/2022-15/5/2022

Month period	Supposed separated cardboard waste weights	Supposed separation ratio from generated cardboard waste	Supposed Reducing ratio from the total generated waste
15/1/2022-15/2/2022	8 ton	28.5%	4 %
15/2/2022 – 15/3/2022	10ton	35.7%	5.7%
15/3/2022-15/4/2022	15ton	53.5%	7.5%
15/4/2022-15/5/2022	19 ton	67.8%	9.5%
Average	13ton	46.3%	19.2%

Table A.11

Weights of supposed separated plastic in Burqeen from 15/1/2022-15/5/2022

Month period	Supposed cardboard waste separated weights(ton)	Supposed Reducing ratio from the total generated waste
15/1/2022- 15/2/2022	2	1 %
15/2/2022 – 15/3/2022	3	1.5%
15/3/2022- 15/4/2022	4	2 %
15/4/2022-15/5/2022	4	2%
Average	3.25	1.6%

Table A.12

Total of assumed reduction of all type of waste form 15/1/2022 -15/5/2022 in Burqeen

Type of separated waste	Supposed Weights of separated waste (ton/ 4 month)	Supposed average weight from separated waste (ton /month)	Supposed separation ration by month	Supposed weights of separated waste in year 2022 (ton / year)	Supposed separation ration by year
Organic waste	118	29.5	14.75 %	354	14.75 %
Cardboard	52	13	6.5%	156	6.5%
Plastic	13	3.25	1.61%	39	1.61%
Total separated waste	183	45.75	22.9%	549	22.9%

Table A.13

Comparison of total waste weight that reach ZF landfill from Burqeen pre/post waste separation

Year	Weights reached the landfill (ton/ year)
2020	2400
2022(assumed)	1850

Table A.14

Costs of MSW services pre/post MSW separation at source implementation in Burqeen

Cost Source	Pre separation cost (ILS/Y)	Post separation supposed cost(ILS/Y)
Equipment (containers)	19860 ILS/Y	0 (funded by JICA)
ZF fees	315433.44 ILS/Y	246050
Awareness	00 (no awareness activities)	0(funded by JICA)
Human resources (new worker for the project)	00	24000
Total costs ILS/Y	335293.44	270050

Table A.15

MSW service supposed revenues for the Burqeen municipality pre /post applying the project.

Revenue source	Pre separation	Post separation(ILS/Y)
MSWS Bills	331740 ILS/Y	331740
Recyclable Cardboard revenues	00	7800
Recyclable plastic revenues	00	3900
Total revenues/year	331740	343440

Table A.16

Burqeen municipality MSWM net profit before and after applying MSW separation at source

Financial criteria	Pre implementation (ILS/Y)	Post implementation (ILS/Y)
Revenues (ILS/Y)	331740	343440
Costs (ILS/Y)	335293.44	270050
Net profit ILS/Y	3553.44 -	37390

Appendix B

Al-Najah National University's IRB approval

An-Najah
National University
Faculty of Graduate Studies
Dean's Office

جامعة
النجـــاح الوطنية
كلية الدراسات العليا
مكتب العميد

التاريخ: 2021/6/13

حضرة الدكتورة مريم الطل المحترمة
منسقة برنامج ماجستير ادارة الصحة العامة

تحية طيبة وبعد،

الموضوع : الموافقة على عنوان الاطروحة وتحديد المشرف

قرر مجلس كلية الدراسات العليا في جلسته رقم (405) المنعقدة بتاريخ 2021/5/27، الموافقة على مشروع الأطروحة المقدم من الطالب/ة ديالا برهان علي نعيرات، رقم التسجيل 11952380، تخصص ماجستير ادارة الصحة العامة، عنوان الأطروحة:

تقييم مشروع تجريبي لفرز النفايات البلدية الصلبة من المصدر في بلدة برقين – جنين ، 2021
Pilot Project for Municipal Solid Waste Separation at Source: System Evaluation in the Town of Berqeen – Jenin, 2021

بإشراف: 1) د. مريم الطل 2) د. محمد السيد

ملاحظة: لاعتماد الأطروحة وتسجيلها على الفصل الصيفي 2021/2020.

يرجى اعلام المشرف والطالب بضرورة تسجيل الاطروحة خلال اسبوعين من تاريخ اصدار الكتاب. وفي حال عدم تسجيل الطالب/ة للاطروحة في الفترة المحددة له/ا ستقوم كلية الدراسات العليا بالغاء اعتماد العنوان والمشرف

وتفضلوا بقبول وافر الاحترام ،،،

عميد كلية الدراسات العليا
د. عوني ابو حجلة

نسخة : د. رئيس قسم الدراسات العليا للعلوم الطبية والصحية المحترم
: عميد القبول والتسجيل المحترم
: مشرف الطالب

صادر
14. 06. 2021
جامعة النجاح الوطنية
كلية الدراسات العليا
الرقم المتسلسل:

فلسطين، نابلس، ص.ب 707، 7 هاتف:/2345115، 2345114، 2345113 (09)(972)* فاكسميل:2342907(09)(972)
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Appendix C

The pre-implementation questionnaire

استبيان لعملية ادارة النفايات الصلبة في بلدة برقين

يرجى العلم بأن الاستبيان المرفق هو إحدى خطوات استكمال درجة الماجستير في برنامج إدارة الصحة العامة من جامعة النجاح الوطنية للطالبة ديالا نعيرات. وعليه، فإن جميع البيانات التي سيتم جمعها ستحترم خصوصية المبحوثين وتتعامل معها بسرية تامة ولن يتم استخدامها الا لأغراض البحث العلمي.

مع الإحترام

بيانات عامة

الإسم:.....

1-العمر :

- 17-22
- 23-30
- 31-40
- 41-60
- اكبر من 60

2-الجنس:

- ذكر
- انثى

3-عدد الاشخاص الساكنين بالمنزل:

- 1-4
- 5-9
- 10 واكثر

4- معدل المصروف الشهري للعائلة ؟

- 1500 شيكل او اقل
- 1501-3000 شيكل
- 3001-6000 شيكل
- اكثر من 6000 شيكل

5-المستوى التعليمي للمبحوث:

- ثانوية عامة أو أقل.
- دبلوم أو بكالوريوس
- دراسات عليا

المفاهيم العامة والسلوك المتبع في التخلص من النفايات

6-هل تعلم ان البلدية تقوم بجمع النفايات و ارسالها لمكب زهرة الفنجان ؟

- نعم
- لا
- لا اعلم

7- هل تعتقد/ين ان برقين تواجه مشكلة بادارة النفايات الصلبة ؟

- نعم و يجب ايجاد حل سريع
- لا , الوضع الراهن جيد و يكفي
- لست متأكداً

8- هل تعتقد/ين ان مكبات النفايات الصحية الموجودة تقدم حلاً جيداً لمشكلة النفايات بالضفة الغربية ؟

- نعم
- لا
- لست متأكداً.

9— هل سمعت/ي بمفهوم (تقليل –اعادة استخدام –اعادة تدوير) للنفايات المنزلية؟

- نعم و لكن لم افهمه
- نعم و افهمه
- لا، لم اسمع به
- لا اعلم

في حال كانت إجابتك على السؤال السابق ضمن أحد الخيارين (أ) أو (ب)، الرجاء إجابة الاسئلة (10-11)، غير ذلك الرجاء التوجه لسؤال (14) مباشرة.

10- هل تعتقد/ين ان اعادة تدوير النفايات قد يخفف من مشكلة النفايات بشكل عام و يحسن من الوضع البيئي و الاقتصادي ؟

- نعم
- لا
- لست متأكداً

11- هل تعتقد/ين انه من الممكن تطبيق اعادة تدوير النفايات بفلسطين؟

- نعم
- لا
- لست متأكداً

12-هل تقوم بدفع فواتير جباية النفايات للبلدية ؟

- تصلني الفواتير وادفعها
- تصلني الفواتير ولا ادفع
- لا تصلني فواتير ولا دفع
- غير ذلك، وضح .....

13- هل تعتقد/ين ان عملية ادارة النفايات تشكل عبئا ماليا على مقدمي الخدمة (البلديات ومجلس الخدمات) من حيث جمع وترحيل ومعالجة؟

- نعم
- لا
- لست متأكداً

14- هل انت على استعداد لدفع رسوم اضافية مقابل تحسين خدمة النفايات و تطبيق مفاهيم (تقليل –اعادة استخدام – اعادة تدوير) النفايات بالبلدة؟

- نعم
- نعم ولكن بمبلغ رمزي
- لا

15- هل انت على استعداد لفصل نفايات منزلك لثلاث انواع (كرتون وورق، نفايات عضوية، بلاستيك) اذا تم توفير لك الامكانيات اللازمة؟

- نعم
- نعم، شريطة أن يكون الجهد المطلوب بسيطاً
- لا
- لست متاكدا

16- اذا كانت الاجابة على السؤال (15) ب (لا)، ما هو السبب؟ غير ذلك الرجاء الانتقال الى السؤال رقم 17

- ليس لدي رغبة
- ليس هناك فائدة من الفصل
- الفصل متعب و يحتاج لوقت اضافي انا لا امتلكه

17- هل تعتقد/ين بانه وجود نظام حوافز للمواطنين يزيد من فرصة نجاح تطبيق فصل النفايات من المنزل بالبلدة؟

- نعم
- لا
- لست متاكدا

18- هل سمعت سابقاً بمفهوم الزراعة العضوية ؟

- نعم، ولكن لا اعلم ما الفرق بينها وبين الزراعة بمفهومها العام
- نعم، واعلم الفرق بينها وبين الزراعة بمفهومها العام
- لا، لم اسمع بها سابقاً

19- هل تعتقد/ين بأنه من الممكن تحويل نفايات بقايا الطعام الى سماد عضوي؟

- نعم
- لا
- لست متأكداً

20- هل تعتقد/ين بأن استخدام الاسمدة الكيميائية في الزراعة له دور في انتشار العديد من الامراض الحالية؟

- نعم
- لا
- لست متأكداً

21- اذا توفر لك منتجات زراعية عضوية (تم استخدام الاسمدة العضوية فقط بزراعتها) هل تفضل/ين شراؤها على شراء المنتجات المروية باسمدة كيميائية؟

- نعم، اذا كان سعرها بنفس سعر المنتجات المروية بالسماد الكيمائي
- نعم، بجميع الاحوال
- لا اهتم بالفرق

22- هل انت مزارع أو تاجر خضروات أو أسمدة أو مبيدات حشرية (مجال الزراعة يشكل مصدراً أو أحد مصادر دخلك)

- نعم
- لا

في حال كانت إجابتك على السؤال رقم (22) بنعم، الرجاء اجابة سؤال (23). غير ذلك، الرجاء الانتقال للسؤال رقم (24)

23- ان توفر لك سماد عضوي / طبيعي، هل ستقوم/ين باستخدامه بدلا من الاسمدة الكيميائية ؟

- نعم، ان كان بسعر مناسب وجودة عالية
- نعم، فهو باي حال افضل من الاسمدة الكيميائية
- نعم، ولكن ساستمر باستخدام الاسمدة الكيميائية ولكن بكمية اقل
- لا، ساستخدم الاسمدة الكيميائية بكل الاحوال

24- برايك/ي ماهي الطريقة الامثل لنشر الوعي عن ادارة النفايات الصلبة و اهميتها ؟

- المدارس و الجامعات
- التلفاز و/أو المذياع
- وسائل التواصل الاجتماعي
- الاصدقاء والأقارب
- دورات توعوية و ورشات عمل
- غيرذلك , وضح .....

28- هل شاركت سابقا في فعاليات متعلقة بادارة النفايات الصلبة؟ اختر كل ما ينطبق

- حملات تنظيف في مكان سكنك
- حملات انتاج الكومبوست (السماد العضوي)
- فصل ذاتي للنفايات – لاستخراج المعادن مثلا
- المشاركة في ورشات عمل حول مفهوم (تقليل –اعادة استخدام –تدوير) النفايات
- لا لم اشارك

ممارسة فصل النفايات من مصدرها

31- هل انت راض/ية عن خدمة جمع النفايات يشكلها الحالي ؟

- نعم
- لا

32- خلال الفترة الماضية الشهرين الماضيين هل حدث تراكم للنفايات بالشارع او الحي (تأخر الجمع)؟

- نعم، معظم الاوقات
- نعم، احيانا
- نادرا
- ابدا

Appendix D

The post implementation questionnaire

استبيان لعملية ادارة النفايات الصلبة في بلدة برقين

يرجى العلم بأن الاستبيان المرفق هو إحدى خطوات استكمال درجة الماجستير في برنامج إدارة الصحة العامة من جامعة النجاح الوطنية للطالبة ديالا نعيرات. وعليه، فإن جميع البيانات التي سيتم جمعها ستحترم خصوصية المبحوثين وتتعامل معها بسرية تامة ولن يتم استخدامها الا لأغراض البحث العلمي.

مع الإحترام

بيانات عامة

الاسم :.....

رقم الاشتراك : .....

1- هل سمعت/ي بمفهوم 3Rs (تقليل –اعادة استخدام –اعادة تدوير) للنفايات المنزلية؟

- نعم و لكن لم افهمه
- نعم و افهمه
- لا، لم اسمع به

2- هل شاركت في الفعاليات المتعلقة بادارة النفايات الصلبة (ورشات العمل، المخيم الصيفي....)التي اقيمت بالبلدة ؟

- نعم، جميعها
- نعم ،بعضها
- لا

3- اذا كانت الاجابة ب (لا)، ما هو السبب ؟

- لم اعلم باقامة هذه الفعاليات
- موقع الفعاليات كان دائما بعيد عن حيي السكني
- موعد الفعاليات غير مناسب
- ليس لدي الرغبة

4- هل انت راض/ية عن خدمة جمع النفايات بشكلها الحالي ؟

- نعم
- لا

5- اذا كانت الاجابة السابقة لا ، فما هو السبب ؟

- ازداد تراكم النفايات بالبلدة (تاخر الجمع)
- ازداد عدد الحاويات بالبلدة بالتالي ادى الى صعوبة الحركة بالشوارع
- غير ذلك

6- خلال الفترة الماضية (الثلاث شهور الماضية) هل حدث تراكم للنفايات بالشارع او الحي (تأخر الجمع)؟

- نعم، معظم الاوقات
- نعم، احيانا
- نادرا
- ابدا

7- هل تم توفير حاويات خاصة لفصل النفايات المنزلية ؟

- نعم
- لا

8- هل تلقيت (أو أحد أفراد الأسرة) المعلومات الكافية حول طريقة الفصل الواجب اتباعها؟

- نعم
- نعم ولكن ليس بصورة كافية
- لا

-

9- هل تقوم/ين (أو أحد أفراد الأسرة) بفصل النفايات المنزلية؟

- نعم
- احيانا
- لا

اذا كانت اجابتك السابقة احدى اولى الخيارين اجب على السؤال (10) والسؤال (11)

10- هل تعتقد/ين انك قادر/ة على الاستمرار بفصل نفاياتك ؟

- نعم ، بكل الاحوال
- نعم، طالما بقيت البلدية قادرة على توفير الامكانات لذلك
- لست متاكدا
- لا

اذا كانت الاجابة السابقة لا ، حدد السبب .....

11- هل تشجع/ين المحيطين بك على فصل النفايات ؟

- نعم
- لا

Appendix E

Photos from the project

E.1 Waste containers distribution in Burqeen

Blue containers for Carton and papers waste

Brown containers for Organic waste

Yellowish –green containers for plastic waste

E.2 Awareness campaigns activities


SHOT ON REDMI 9
AI QUAD CAMERA

جـامعـــة النجاح الوطنية

كليـــة الدراســـات العليـــا

تقييم مشروع تجريبي لفرز النفايات البلدية الصلبة عند المصدر في برقين – جنين، 2021 دراسة حالة

إعداد

ديالا برهان علي نعيرات

إشراف

د. مريم الطل

د. محمد السيد

قدمت هذه الرسالة استكمالا لمتطلبات الحصول على درجة الماجستير في إدارة الصحة العامة، من كلية الدراسات العليا، في جامعة النجاح الوطنية، نابلس– فلسطين.

2022

تقييم مشروع تجريبي لفرز النفايات البلدية الصلبة عند المصدر في برقين– جنين، 2021 دراسة حالة

إعداد

ديالا برهان علي نعيرات

إشراف

د. مريم الطل

د. محمد السيد

الملخص

تنتج الضفة الغربية في فلسطين ما يقارب (900.000 طن/ سنة). يستقبل مكب زهرة الفنجان وهو أكبر مكب نفايات صحي فيها، كميات هائلة من النفايات الصلبة الخاصة بالبلدية كل يوم تتجاوز قدرته الإستيعابية، مما يشير إلى وضع كارثي محتمل. لذلك، من الضروي الانتقال من نظام طمر النفايات إلى نظام أكثر تكاملاً.

قيمت هذه الدراسة الفعالية البيئية والاقتصادية والاجتماعية لمشروع تجريبي لفصل النفايات البلدية الصلبة من المصدر في برقين– جنين عام 2020. من خلال مقارنة وعي السكان بمبدأ (التقليل، إعادة الإستخدام وإعادة التدوير) واستعدادهم لفصل النفايات كما قارنت أوزان النفايات التي تصل إلى مكبات النفايات وتكاليفها قبل وبعد تطبيق المشروع. تم توزيع استبيانات موحدة على 305 عينة من البلدة في مرحلة ما قبل/ بعد المشروع. ثم تم تحليلها إحصائياً باستخدام برنامج SPSS 22. قام مركز الخدمات المشتركة في جنين بجمع وقياس النفايات المتولدة قبل وبعد تطبيق المشروع. تم حساب ومقارنة تكاليف خدمة جمع النفايات قبل وبعد تنفيذ المشروع باستخدام أرشيف بلدية برقين.

كشفت النتائج عن زيادة كبيرة في معرفة ووعي المجتمع المحلي بإدارة النفايات الصلبة ومبدأ (التقليل، إعادة الإستخدام وإعادة التدوير)، مع انخفاض نسبة الأشخاص الذين لا يفهمونه من 15.4٪ إلى 5.2٪. كما ارتفعت نسبة مشاركة المواطنين في فرز النفايات من 0٪ إلى 21٪. أكدت النتائج أن فصل النفايات الصلبة الخاصة بالبلدية عند المصدر يقلل من نسبة النفايات التي تصل إلى المكب بنسبة 22.2٪ بعد عام واحد، كما أنه يؤثر بشكل إيجابي على الفوائد الاقتصادية للبلدية حيث تحولت التكلفة من سلبية إلى إيجابية.

خلصت هذه الدراسة الى أن تطبيق فصل النفايات الصلبة البلدية من المصدر سيزيد من وعي السكان بإدارة النفايات الصلبة، ويزيد الفائدة المالية للبلدية، ويقلل من كمية النفايات الواصلة إلى المكب، ويوصى بتوسيع فصل النفايات الصلبة من المصدر للمناطق الاخرى.

الكلمات المفتاحية: النفايات البلدية الصلبة، فلسطين، الفصل عند المصدر، تقليل النفايات، إعادة إستخدام وإعادة التدوير النفايات).