A Mathematical Model to Predict the Components' Generation of Solid Waste and Residents' Concerns Towards Solid Waste Management Facilities in Nablus and Jenin Districts

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This Thesis was Submitted in Partial Fulfilment of the Requirements for the Master Degree in Water and Environmental Engineering from the Faculty of Graduate Studies at Birzeit University- Palestine

Birzeit University

2015

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This thesis was prepared under the supervision of Prof. Issam A. Al-Khatib and has been approved by all members of the examination committee:

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Date of Defense 6/6/2015

Abstract

Because solid waste management (SWM) facilities should be socially accepted along with other things, and as an effort to help decision makers in assessing public supports to solid waste (SW) facilities, this study was made. By understanding the kinds of wastes being thrown, waste can be identified to contribute in waste minimization and improve resource efficiency. Type of waste affects health and environmental impacts, better waste composition information can also improve the managing and the planning of SW facilities such as recycling for example, by knowing what components in the waste can be reused.

This study is about developing an efficient mathematical model to predict the future generation rates and components of municipal solid waste in Palestinian localities in Nablus and Jenin Districts, and to assessing people's concerns and attitudes to SWM facilities.

A questionnaire was designed based on literature reviews, and distributed in the two governorates after the samples size was calculated for each governorate and each area in it (Urban, rural and refugee camps). Monthly quantities of solid waste in the two governorates were compiled for the years of 2011, 2012 and 2013, in parallel with collecting data about waste composition percentage. Statistical Package for Social Science (SPSS) and MS. Excel were employed to extract results needed.

The questionnaire respondents were generally males, 32.8% aged between 36-45years, 65.2% of respondents had bad image of waste and 25% had an experience of visiting a solid waste facility. Five principal factors were found when correlation with concerns made for the questionnaire (nuisance, pollution, planning, facility management and dwelling). The analysis showed that differences in awareness levels were found according to age, sex and locality type. The discriminant analysis showed consistency between impact and what citizens thoughts. As for attributes 67%-69% of those who had opposed attitude toward visit a facility of solid waste facility never visited one, and 51%-56% of those who had "favor" attitude toward visit a facility of solid waste facility had visited one, this indicate that "opposed" attitude decreased for those who visited a Solid Waste facility and vice versa.

The mean value of the daily generated solid waste for the whole study area was 0.95 kg/cap/day. Seven multiple-variable regression equations and models were derived for estimating the daily generated total solid waste and its components. The indicators of valid procedures showed that the models have high reliability and highly significant in predicting the components of SW; Variance Inflation Factor (VIF) values were less than the critical value which equals 10, and the values of mean squared errors (MSE) and mean of the squared prediction errors (MSPR) were close to each other (the difference were not more than 0.001). The previous indicators showed that the relations in the models were statistically significant. The developed models' results may help the decision-makers to put better plans in SWM and for SWM facilities.

إهــداء

الى قدري الاجمل و الاوفر حظا.. الى من يخجل الفؤاد ان يهديهما مثل هذا العمل المتواضع اذ أنهما اعظم و اجلّ قدرا

~ أُمّي و أَبّي ~

الى أساتذتي الذين أناروا الطريق فوجب علي شكرهم

الى الرائعين زوجي و اولادي ملجئي و سكينتي

الى رفاق العمر من نمى حبهم في طينة تكويني اخوتي و اخواتي

الى وطني و مدينتي

الى لغتي التي لم يشأ القدر ان تخط حروف رسالتي بها

الى الاصدقاء الاوفياء

الى الذين سنحبهم و لا نعرفهم بعد

الى كل من أحبنا و كل من منحنا البسمة يوما

Acknowledgment

Prima facie, I am grateful to Allah for the well and for the good health he gave me to complete this research.

My deep thanks go to Prof. Dr. Issam A. Al-Khatib for his endless support and thoughtful discussions with me. I cannot adequately identify the deep wisdom and continual optimism that Prof. Dr. Al-Khatib shared with me throughout my work on thesis from idea to reality. I can only say thank you.

Furthermore I would like to thank all local authorities that showed high cooperation in giving data.

I also like to thank the administration of Zahrat Alfinjan landfill especially Eng. Mohammed Ass'adi for giving data to complete this research.

I would like to thank Mr. Marwan Zuhud and Mr. Ismail Fukhaidah, for their help in Statistics.

I like to thank the participants in filling the questionnaire for their precious time.

Many thanks to my loved ones, who have supported me to finish this thesis, by encouraging me and helping me to hold out until I finished, and to my kids for the inspiration. I will forever be grateful for such love.

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Abbreviations

TSW	Total solid waste
MSW	Municipal Solid Waste
NIMBY	Not In My Back Yard
NIS	New Israeli Shekel
PCBS	Palestinian Central Bureau of Statistics
Pop	Population
SPSS	Statistical Package for Social Science
UNRWA	United Nations for Relief and Work Agency
UNEP	United Nation Environment Program
WHO	World Health Organization
SWM	Solid Waste Management
SW	Solid Waste
MSE	Mean Squared Error
MSPR	Mean of the Squared Prediction
VIF	Variance Inflation Factor
Cap	Capita
WB	West Bank
ln	Natural logarithm function
W_T	Total solid waste
W_G	Glass solid waste
W_{PL}	Plastic solid waste
W_P	Paper solid waste
W_O	Organic solid waste
W_{Tx}	Textile solid waste

SW_m	Solid waste measured.
SW_p	Solid waste predicted.
$W_{PL\ (m)}$	Measured paper solid waste
$W_{PL\ (P)}$	Predicted paper solid waste
$W_{Tx\ (m)}$	Measured textile solid waste
$W_{tx\ (P)}$	Predicted textile solid waste

Chapter One

Introduction

1.1 Background

Municipal solid waste (MSW) is an issue which had to be dealt with by all communities all over the world. Scarcity of land available for waste landfilling, in addition to political, safety, and financial constraints, all make the precise estimation of the amount of MSW a very crucial task. In addition to landfilling considerations, accurate determination of solid waste generation actually affected other aspects of MSW management, including waste collection, transfer, and recycling (Mors et al., 2012; Al-Yaqout et al., 2002).

Public opinion and involvement is needed for the development and plans implementation in waste management projects, also the support of residents will help the success of waste management decisions, Public in general cares about health problems, economic and environmental impacts, their concerns are related immediately with their educational levels. More educated families care more than others with lower level of education. Waste management system which usually owned by government should take into account residents opinion and concerns of important issues related to waste management (Desa et al., 2012).

Mathematical model helps researchers to understand and evaluate predominant strategies for handling the waste, and to predict the waste generation rate in order to find the growth pattern. Graphs and curves need to be blotted and examined; this is helpful for achieving good waste management (Sabour et al., 2007).

Choosing the site of the solid waste facilities (landfill, incinerator or recycling facility) is a very difficult problem, it needs accurate evaluation because the position should be selected carefully by decision makers & residents of that area to make desirable facilities locations (Desa et al., 2012).

Solid waste management (SWM) could be applied at many places in the world while the technologies of the solid waste are not developed sufficiently to appropriate the population growth and waste rate, that's increases the waste management storage problems thus people concerns because they usually have no knowledge how to share the responsibility (Dokas and Panagiotakopoulos, 2006).

Understanding people's concepts and concerns gives good communication with them for better solid waste management facilities. Pollution and health risks, damage to environment, nuisance as odor, noise and dust, reliability of facility and others, all are factors effected the acceptance of solid waste management facilities, but pollution and health affect had the highest rate, people's acceptance also affected by social factors such as age and sex, environmental awareness, education and population, also limited information of SWM facilities increasing the fear about risks that may occur (Katoch and Kumar, 2008; Jahandideh et al., 2009).

1.2 Research Objectives

The main objectives of this research is to (I) investigate people's concerns and attitudes to solid waste management (SWM) facilities in Nablus and Jenin Districts, and to (II) develop an efficient and mathematical model to predict the future generation rates and compositions of municipal solid waste (MSW) at the same area.

1.3 Thesis Structure

Chapter 1: Introduction; general background of the thesis to explain what's coming and what to expect.

Chapter 2: Methodology

Chapter 3: Literature Review to describe how this research related to previous researches.

Chapter 4: Results and Discussion.

Chapter 5: Conclusions and Recommendations

1.4 Problem statement

Solid waste in Palestine needs to be more organized; large areas are not being covered by waste management facilities, many illegal landfills distributed in the country, many of those landfills are not controlled by ministry of health. Quality of services is much better in many districts but still faces many challenges due to Israeli occupation, some geographic characteristics, low rate of waste collection fees, shortage of facilities and equipments, lack of the municipalities' ability to communicate some areas, low level of strategic plans, and people unawareness.

Many waste management problems still exist in many areas, solid wastes stay at streets and not being collected in appropriate way, sometimes these wastes being burned or accumulated at streets, unawareness of public makes the problem worse by throwing wastes in streets or outside the waste containers and burning the wastes in or outside the containers.

Bad management of solid wastes could create bad odor, flies, insects and pathogens. The dangerous materials could be leak to groundwater and affect plants, animals and humans which make serious health problems.

People in Palestine concern about these problems and surely have a say about waste facilities and waste management procedures around their areas. This thesis study people's concerns about the facilities of solid waste management and creating a mathematical model that predicts the composition and generation of solid waste.

Chapter Two

Methodology

2.1 General

The aim of this research is to study people concerns about solid waste facilities in Nablus and Jenin district as a part, while the other part is to develop a model to predict the generation of components of solid waste in the two districts.

All data and information regarding the composition and generation of solid waste in Nablus and Jenin Districts has been gathered from: (i) Palestinian Central Bureau of Statistics (PCBS), (ii) Jenin and Nablus Joint Services Councils, (iii) Nablus Municipality, and (iv) literature review. Analyses were made in terms of various components (plastic, textile, paper, metal, organics, and others). A mathematical model to predict solid waste generation rate for any desired year has been developed based on previous information.

A questionnaire has been made to investigate people's concerns and attitudes toward SWM facilities. All of the interviewed citizens requested to answer the questions after they had been asked to suppose that a specific facility (incinerator, landfill and recycling facility) constructed near their homes.

The questionnaire addressed residents of three different types of localities: city, village, and a Refugee camp, these localities represent all communities with various life styles in the research area. In another word the sample size was selected based on scientific procedures to select a suitable sample size in survey research.

A statistical analysis carried out by using Statistical Package for Social Science (SPSS) and MS. Excel. The analysis made had been taking into consideration socioeconomic differences for residents' age, gender, income, education level and then they have been associated with many SWM aspects as fairness, importance etc.

The other part of this research aimed to investigate Composition and Generation of solid waste in Nablus and Jenin districts. A mathematical model has been developed by using multiple regression analysis to predict the quantity and components of solid wastes in the two districts.

2.2 People concerns about solid waste facilities in Nablus and Jenin district

2.2.1 Questionnaire

A designed questionnaire has been made to investigate people's concerns and attitudes to SWM facilities. The questionnaire was distributed in Jenin and Nablus districts including the two cities camps and villages.

The questionnaire started with personal attributes questions such as age, sex and address.

Then it made up of four parts divided into two subjects; the first one was about how much people concern about different SWM aspects (parts 1, 2 &3), the second one was about people attitudes toward SWM facilities (part 4).

The first part (Q7-Q19) included questions to know people's concerns about SWM damages.

The second part (Q20-Q27) was about management aspects of SWM facilities.

The third part (Q28-Q32) cases were assumed such as (receiving other cities waste, having SW facility around the area of people's houses).

The fourth part (Q33-Q36) asked about people's attitude toward SWM treatment facilities.

A statistical analysis had been carried out using Social Package for Statistical Science (SPSS) and MS. Excel.

2.2.2 Sample size

Sample size for Jenin district

The questionnaires had been distributed into Jenin and Nablus districts for people above 16 years old, divided into three major areas in each district (urban, rural and refugee camps).

From PCBS the number of occupied houses in 2007 was found as 46,541 houses, and then sample size had been calculated by Steven K. Thompson equation (Thompson, 2012) as follow:

$$n = \frac{N \times p(1-p)}{[[N-1 \times (d^2 \div z^2)] + p(1-p)]}$$

n: Sample size.

N: community size = 46,541.

Z: critical value for confidence =1.96

d: the margin of error= 0.05

P: 0.5

Sample size = 381.

From PCBS number of houses distributed in:

Urban = 7461 (16.03%)

Rural = 37,079 (79.67%)

Refugee camp= 2001 (4.3%).

So questionnaires needed for

Urban = 61

Rural = 304

Refugee camp= 16.

Sample size for Nablus district

From PCBS the number of occupied houses in 2007 was 58,750 houses.

Sample size can be calculated by Steven K. Thompson equation (Thompson, 2012) as follow:

$$n = \frac{N \times p(1-p)}{[[N-1 \times (d^2 \div z^2)] + p(1-p)]}$$

n: Sample size.

N: population sample size.

Z: critical value for confidence.

d: the margin of error.

P: 0.5

Sample size = 381.

From PCBS number of houses distributed in:

Urban = 24,717 (42.07%)

Rural = 28,477 (48.47%)

Refugee camps= 5,556 (9.46%).

So questionnaires needed for

Urban = 160

Rural = 185

Refugee camp= 36.

2.2.3 Data collected

The questionnaires were distributed in Jenin and Nablus governorates as below:

- Nablus and Jenin cities.
- Jenin, Asker and Balata camps.
- 48 villages from both governorates.

Simple statistical techniques SPSS 18 was used to analyze data and extracting results as followed:

- Factor analysis

- Profile of Respondents

- Attitude toward SWM facilities (discriminant analysis, association analysis between attitude and concern and relation with concerns).

- Influence of respondent attributes to acceptability of SWM facilities (correlation with experience of visiting a facility, correlation with general attitudes and correlation with personal attribute).

2.3 Mathematical modelling to predict the future generation rates and compositions of municipal solid waste

Multiple regression analysis was used in this research based on two variables; (TSW) and population, to predict the quantities and compositions of solid wastes in Nablus and Jenin governorates.

Knowing the quantities and the composition of the wastes will help in improving various waste facilities, the components of waste depend on social conditions as well as economical, because that data was collected for various areas with different social and economical conditions (cities, villages and refugee camps) in order to get more realistic answers.

2.3.1 Data collected

For the amount of solid waste in Nablus and Jenin districts monthly data were taken from Zahrat Alfinjan landfill and Nablus municipality for the two cities, camps and rural areas for the years 2011, 2012 and 2013. Date related to SW composition and the components proportion were taken from previous research made for Zahrat Alfinjan landfill after reviewing other researches and finding that the mentioned research was the most appropriate one; in the mentioned study around 33450 kg of wastes were separated, the separation method was done near daily disposal area and the separated wastes were including organics and food, cartoons and papers, Glasses, Textiles, metals, plastics and other hazardous and bulky wastes (Alsadi, 2009). After the waste components were identified, the amount of each component has been calculated and then simple regression analysis was developed to get the results as seven multiple regression models; TSW equation made as function of “population” and the components of solid waste made as function of “population” and “TSW”.

Chapter Three

Literature Review

3.1 Study area

The main waste management method of disposing solid waste in Palestine was dumping waste in random unmonitored open sites. 161 dumping sites were located in West Bank (WB) and 3 dumping were found in Gaza in 2005. Generally SWM, collection and disposal are the responsibility of the municipalities, in Nablus city Al-Sairafi transfer station was constructed 8km from the centre of the city, with an area up to 6acres, the transfer station started working since 2007 on 6 acres land area also in Jenin an organized landfill constructed in 2000 south-west Jenin city with area of 95 Acres to receive solid waste from north of the West Bank (ARIJ, 2009). Figure 3.1 shows the study area location in Palestine.

Figure 3.1: Study area location in Palestine (PCBS, 2013).

3.1.1 Nablus district

Nablus district locates in the North of the West Bank , 69km far from Jerusalem, with longitude (35,16) and latitude (38,13) coordinates, Nablus has warm moderate climate, hot dry at summer with temperature up to 30 °C , cold and rainy winter with degrees down to 3°C (PCBS, 2010). Nablus district population at the mid- year 2013 is 364,333 with Population Density (capita/km2) of 602 (PCBS, 2013).

Figure 3.2 shows Nablus governorate which contains Nablus city as a centre of it, beside other 10 municipalities each contains up to 4000 inhabitant; Aqraba, Beata, Hwara, Jamaeen, Qabalan, Sabastia, Rojeeb, Bet-Dajan, Bet-Forik, Almasaken. And almost 50 villages each contains up to 1000 inhabitants, plus the Askar, Balata and Áyn Alma' refugee camps (PCBS, 2010).

Nablus Municipality has the largest service system in Palestine according to SWM; part of its job is to collect the waste for all the city and old city (70km2) except the camps where the collection is carried out by the UNRWA to the final land disposal in Zahrat Alfinjan landfill in Jenin (27km from Nablus), from the transfer station "Al-Sairafi Station" east of the district serving the city and other villages around the city (ARIJ, 2009).

Al-Sairafi station located northeast Nablus, 8Km from the center of the city, and received140 ton of waste daily, it serves the city, the villages in it and the camps too, the station recycles food residues and other organic wastes under certain heat, air flow, humidity and the existence of microorganism to make compost for the land and for some animals (NM, 2012).

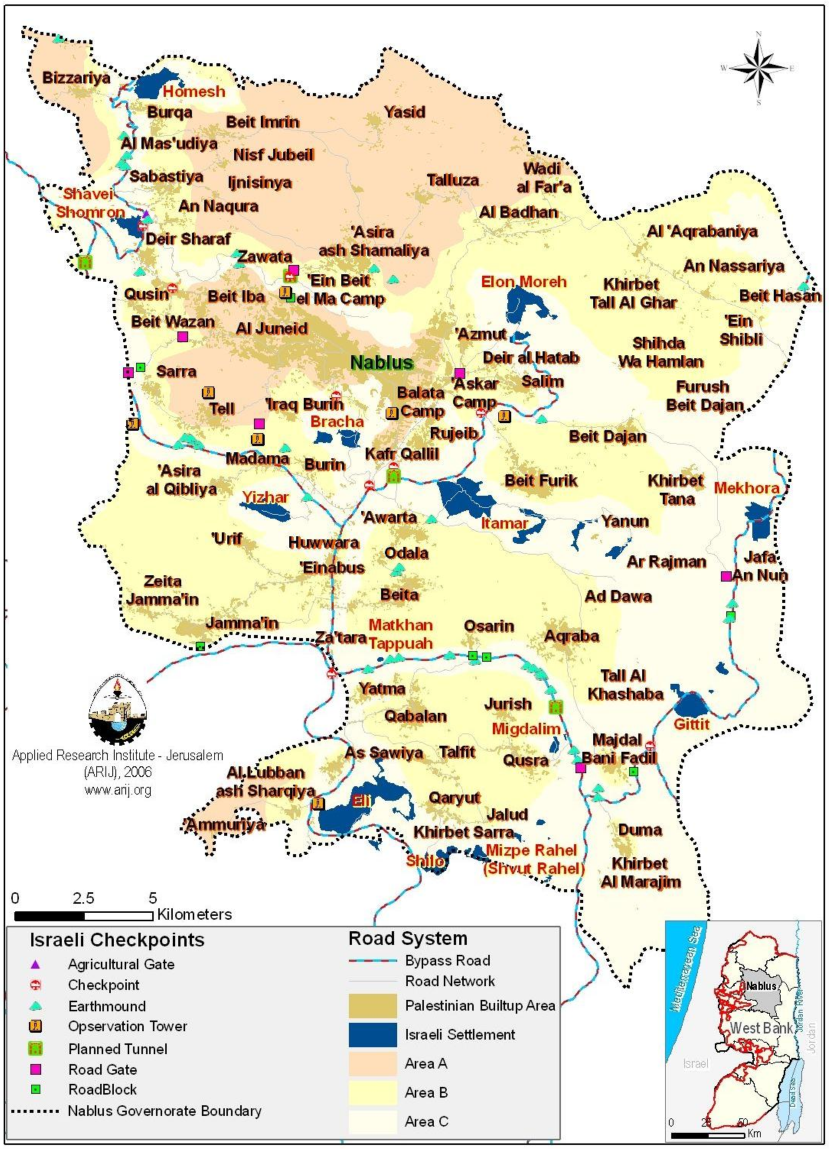

Figure 3.2: Nablus governorate (ARIJ, 2007).

3.1.2 Jenin district

Jenin located about 43 km north of Nablus, 169km far from Jerusalem. It locates on longitude (35,18) and latitude (32,28), Jenin climate has a little different climate than that which prevails Palestine, because of its topographic location (it is surrounded by many heights and mountains which made it has less benefits of west and west-south winds which bring rains usually and made the climate moderate, Jenin receives less rain than surrounded cities and has higher temperatures (PCBS,2010).

Jenin district population mid- year 2013 is 295,985 with Population Density (capita/km2) of 508 (PCBS, 2013).

Figure 3.3 below shows Jenin governorate map. It contains Jenin city as a centre of it, beside to 12 municipalities (up to 4000 inhabitants): Kofradan, Ya’bad, Selit Al-Daher, Qabatya, Arrabih, Birqeen, Seelit Al-Harethiyyah, Al-Zababdih, Faqoo3a, Al-Yamoon, Kofor-Raée, Methaloon, Jab’. And contains almost 30 villages (up to 1000 inhabitants), plus to Jenin’ refugee camp (PCBS, 2010).

Zahrat Alfinjan landfill in Jenin is the first organized landfill in Palestine, opened in 2000 to serve all the northeast West Bank governorates (Jenin, Tulkarm, Tubas, 90% of Qalqiliya and 80%of Nablus, it locates in Wadi Ali between Arrabih and Ajja (eastnorth of Ajja), 17 km to the south of Jenin city and 24 km north of Nablus, the project cost 14 millions $ on 240 dunums 95 of them in use now and for 15 years later as a first stage. The landfill contains access road, weighbridge, waste deposition area, leachate collection system, gas system, vehicle washing facility and recycles pilot plant. The landfill is expanding from a planned 200,000 to approximately 600,000 beneficiaries (ARIJ, 2009; Al-Batnij 2013).

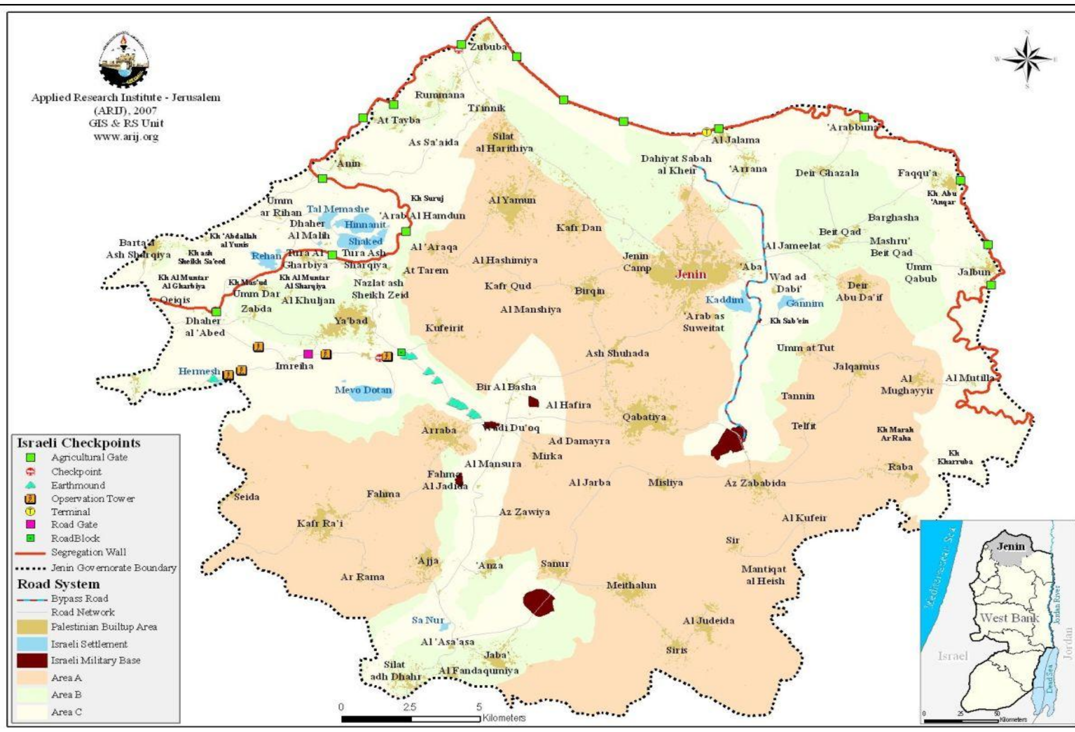

Figure 3.3: Jenin governorate (ARIJ, 2007).

3.2 Solid waste management:

Humans have been producing solid waste since they exist, historically man cares about public health, scarcity and security of resources, small communities were bury solid waste out of their living area, or throw the wastes in rivers and other water bodies but as population increased; odors and diseases spread, in the middle ages, streets were full of odors, mud, household waste and still water, thus creating serious problems, In developing countries industrial revolution led to rapid development in waste management, sanitation began to take place in London, governmental interest in public health and developing better solid waste management practices through legislation and enforcement, the first municipal priority was collecting and removing immediate solid waste from residential areas. After the second war the principle disposal method was still the landfill but with high amount of plastics and other industrial contents which have been disposed into industrial container, then it developed to the recovery of energy from waste. In developing countries poor waste management practices remains severely problematic, many poor countries face the same 19th century problems of developed ones such as high urbanization, degrading sanitary and high levels of morbidity and many other challenges such as urbanization, inequality, economic growth, cultural and socio- economic aspects, polices, governance and institutions (Marshall and Farahbakhsh, 2013).

The causes of the solid waste management problems in developing countries are lack of polices, enabling legislation and people unawareness. Poor funding leads to inappropriate technology and inadequate facilities, in Nigeria solid waste management is deteriorated because of economic aspects, lack of technical aspects such as maintenance, inappropriate technology and operations, plus psychological aspects including government attitudes, public attitudes, groups behaviour, and lack of education (Agunwamba,1998).

In Manila, many of the health problems caused by improper waste disposal, people dump household waste in random pick-up points which cause pathogens increasing. In Manila generation of wastes are very rapid while collection services are getting worse. Open dumps are the common type of landfills that increase the existing of rats, flies, mosquitoes and many disease causing creatures. Burning wastes are common too causing bad odors and affecting people health specially those who live around the dump sites, plus that many children try to pick some waste that can be sold such as cardboards plastic and others (Bernardo, 2008)

3.3 Solid waste management in Palestine:

According to the Palestinian central bureau of statistics (PCBS), the generation of solid waste is 78,644 tons/month in the Palestinian territory, 80% of it is organic waste, and the daily production is 2,321 tons/day (1,710 in West Bank and 611 in Gaza), the daily residential SW production per household 3.5 kg/day in Palestine as an average of West Bank solid waste generation 3.9kg/day and Gaza Strip solid waste generation of 2.7 kg/day. Because of lack of national appropriate statistics and the challenges due the occupation many hurdles has been found in organizational, legislative, technical, environmental, and financial levels that makes SW production, sources and composition hard to be known (Ministry of Local Government, 2010).

SWM in Palestine faces many challenges such as; political situations, Incapability of rehabilitation or close the random landfills to reduce the environmental health and aesthetic impacts, the shortage of experts in waste minimization, reuse and recycle, absence of an appropriate mechanism to collect and treat special wastes, and lack of knowledge in reducing gas emissions from landfills to avoid the greenhouse impacts. (Ministry of Local Government, 2010).

Solid waste threatens the nature, in the past wastes in Jenin were collected and putdown in agricultural or empty lands, now Zahrat Alfinjan landfill designed with area up to 180-350 acres for life time up to 20 years, the landfill located in Wadi Ali 15 km south Jenin city, the landfill designed, to decrease water sources pollution, to improve air quality, and to close unplanned random landfills where the wastes were continuously burning with no covers and no equipments.

Nablus municipality collects waste then move it to Al-Sairafi transfer station only transfer station in Nablus, after that the waste transferred to Zahrat Alfinjan dumping site. The Municipality provides collection services to the whole city (70km²) including the old city, while the city camps (Balata Refugee Camp, Asker Refugee Camp, and Al-'Eyen Refugee Camp) the waste collection services is a responsibility of UNRWA, but the transferring and dumping of solid waste is undertaken by the Municipality (ARIJ, 2009).

Palestine as a developing country is facing a complicated situations in SWM, poverty, lack of awareness, traditions, and political situations are making the improvement of SWM very difficult. Bad behaviours from the residents such as throwing the garbage outside the containers & in the streets are leading to make many health and managerial problems. Israeli side also considered as a major problem, it prevents and hampers many environmental projects and evolutions that could be done, regional Joint service waste management councils in north, center and south of West Bank to be established and close most random dumping sites, if and only if Israeli side gives an approval for it (Al-Batnij, 2013).

3.4 People concerns of solid waste management:

Public concerns acting as SWM drivers, burning and wrong ways of solid waste disposal gave public bad indication about SWM, so while they know the importance of solid waste management facilities they're still rather to locate solid waste away from where they are living as a reaction of any new SWM even if it is clean or sustainable, this reaction called "Not in My Backyard" or NIMBY, many people can't give a certain choice of their patterns because of unsustainable patterns comes from habits, routine, lack of knowledge, social expectations and cultural values, actually SWM does not highly appear on the list of public concerns (Marshall and Farahbakhsh, 2013).

Beliefs, morals, attitudes and social ideals affect the way the people treat waste, wealthy people generate more wastes, poor people are more mingled with waste, public generally don't cooperate very well with waste workers, sometimes dumping waste in families left for children so and because of their small stature the wastes left on the ground, that action makes workers spending more time in waste collection, agencies also ignored the important role of public opinions, and they don't make much effort to let social structure involve , the governments should put plans motivate public, only in Nigeria offer specialized courses on waste management (Agunwamba, 1998).

In Kuwait, the location of a solid waste facility had nothing to do with public concerns, unplanned dumping in the sand quarries had been used in 90’s , health problems have risen in residential areas around the old landfills, for helping decision makers how to involve residents in SWM, questionnaire was made for a sample of heads of households to find the public response towards siting of solid waste facilities, 50% were aware of the negative impacts of solid waste facility, the research fined an important role to the media in increasing awareness toward solid waste, the results also demonstrated that the awareness levels depended on awareness, age, nationality and education, the results indicated too that the relative importance of the facility selection factors according to public was 16% for social, 22% for safety, 29% for environment and 33% for economic (Al-Yaqout et al.,2002).

In Malaysia at UKM university a questionnaire was made in to assess the attitudes and behaviours toward SWM for first year students, it was determined that 60% of them had positive attitudes towards re-use, recycling and reduce, the research also showed that all of the students had high levels of practices and responsibility regarding SWM, However, the university still need to raise the students education and awareness level of waste in order to change their habits, traditions and behaviour (Desa et al.,2012).

In Japan, public is highly concerned about solid waste facility siting, inefficient siting of waste disposal facilities causes many social problems such as increasing waste management costs and shortage of waste treatment and disposal facility, the research was made to resolve between residents and municipality for the selection of the treatment and disposal site, it aimed to discuss the subject of risk communication for the waste disposal system in Japan by making personal interviews and questionnaires, as a result the inhibition according to mutual relationship factors were identified, it showed that the biggest inhibition factor was the residents’ distrust of municipality officers, and the factor identified from the officers of the municipality were: incomplete information disclosure, incomplete public participation, in adequate procedures of communication, but the common factors between them two were the lack of knowledge on risk and waste management, and lack of information sources (Ishizaka and Tanaka ,2003).

USA and Europe suffered from a lack of public support of siting facilities of hazardous waste. In Netherland Host community compensation can be defined as a form of equity adjustment, people's opinion divided between strongly opposed to receive a waste and others who accept compensation, in four hosting communities the rejection rate of a community-level compensation offer were between 78-91.5 percent that means that people's willingness to accept hazardous waste did not increase when compensation offer concerned, because they it is no panacea (Mors et al., 2012).

3.5 Solid waste management problems

Safe and well performing SWM facilities is the goal of solid waste management (SWM), achieving this goal requires experience in operation and needs safety rules, SWM has always frequent facilities and technologies, because of that the operators experience can be limited which makes problems to appear in the facility (Doka and Demetrios,2006).

Research on resident's concerns and visual performance for solid waste management facilities is still limited, in Malaysia a study was made to understand the perceived visual quality of waste storage facility in Kuching, Sarawak, Malaysia a mobile garbage bins has been providing to residents, this has improved the SWM system, the second objective was to investigate the problems of solid waste management(SWM) systems as perceived by the public, 60% of respondents disagreed that problems such as damaged bins, exposed container, and unsuitable location of waste containers cause visual pollution but 52.8% of them thought that overflow waste from container caused unpleasant sight (Chung et al., 2009).

In Palestine families that have collecting waste services from Local Authority was 71.5% in 2013 (77.8% in the West Bank and 59.9% in Gaza), families that have collecting waste services from UNRWA 8.5%, and 2.3% of them are receiving the service from private agencies, while 8.3% of the families have no collection services at all (PCBS,2013).

Solid waste causes hazardous to human health, harm to living resources and it's even cause damage to structures of the legitimate uses of the environment, many solid waste management facilities use poor operation procedures, major developments have occurred with respect to landfill technology and legislative control of the categories of wastes, a technology called incineration is an alternative treatment process with heat recovery and waste gas cleaning and composting acceleration but it fails to eliminate pathogenic agents and immobilise heavy metals, but the answers about the effects of the practices on public health and environmental safety still unanswered, reduction, recycling, separation and modification are used to help reducing solid waste which contain toxic organics, metals and metalloids, non- biodegradable inorganics; no doubt untreated solid waste contains components to cause infectious diseases but there is no current process can totally eliminate such risks, every way of treatment has its own side effects (Hamer, 2003).

In many developing countries, many problems are facing SWM systems such as; lack of financial supports, unsuitable technology & management, problems in collection systems, old bad & small numbers of containers in many places, dispersed waste block the drainage systems, lack in equipment& vehicles beside the lack of its maintenance abilities, transferred waste is less than the actual quantity, lack of studies of environmental assessment, random collection systems, deficiency of specialists in SWM, lack of awareness, and lack of legislations& plans for SWM (Al-Batnij 2013).

3.6 Solid Waste generation and composition

Although the composition of solid waste has changed through history, the most dramatic changes have occurred during the second half of the twentieth century, table 3.1 below presented a table of historical composition of waste in the last century in the UK, and

Figure3.4 presented differences of waste generations in the beginning of last decade of the last century (Chandler et al., 1997).

Table 3.1: Historical composition of solid waste in UK (Chandler et al., 1997).

Waste category	1935	1963	1968	1974	1975	1978	1980	1982	1986	1988
Plastic	-	-	1	2.9	3	5.7	7	8.8	6	7.5
Paper	14	23	37	26.8	31.1	25.2	29	22.8	33	25
Putrescible	14	14	18	21.3	35.5	28.3	25	23.7	20	22.8
Metals	4	8	9	8.5	5.3	7.2	8	9.6	8	13.4
Glass	3	9	8	9.5	9.3	11.8	10	9.6	9	3.5
Dust/Cinders	57	39	22	19.8	12.3	13.9	14	16.7	10	13.4
Textiles	2	3	2	3.5	1.7	2	3	2.6	4	7.6
Others	5	4	3	6.9	1.8	5.9	4	6.2	10	5.8

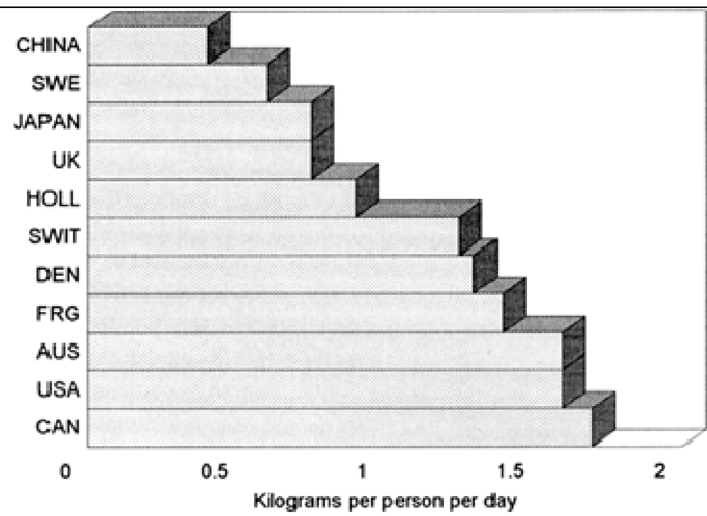

Figure 3.4: Differences of waste generation of ten different countries in 1990 (Chandler et al., 1997).

SWM depends strongly on the life style; it differs from high income countries, middle income country, and low income countries. Figure 3.5 shows SWM composition vs. average income after united nation environment programme (Twardowska et al., 2004).

In Palestine household solid waste components were classified in 2013 as; food wastes, papers and cardboards, plastic, agricultural waste, baby's nabs and others, food residues quantity considered the main component of household solid waste, papers and cardboards are considered the second component in household solid waste, in 2013 the average range of generation of solid waste for 77.3% of the families was less than 4.0 kg/ day for the family and only 22.7% of families generate more than 4 kg/day per family (PCBS, 2013).

For Palestine in 2013; the total daily produced quantity of household solid waste was 2,321.2 tons/day, daily generation SW was 2.7 kg/day for a household in average, and was 0.5 kg/cap/day as an average per capita. In the West Bank in 2013; the total daily produced quantity of household solid waste (Ton) in was 1,274.5 tons/day, the average household daily production of household solid waste was 2.6 Kg/day, the daily SW production of household 0.5kg/day per capita as an average, in Gaza in 2013; the total daily produced quantity of household solid waste (Ton) in was 744.1 tons/day, the average household daily production of household solid waste was 2.8 Kg/day, and the average daily production of household solid waste per capita was 0.4 kg/day (PCBS,2013).

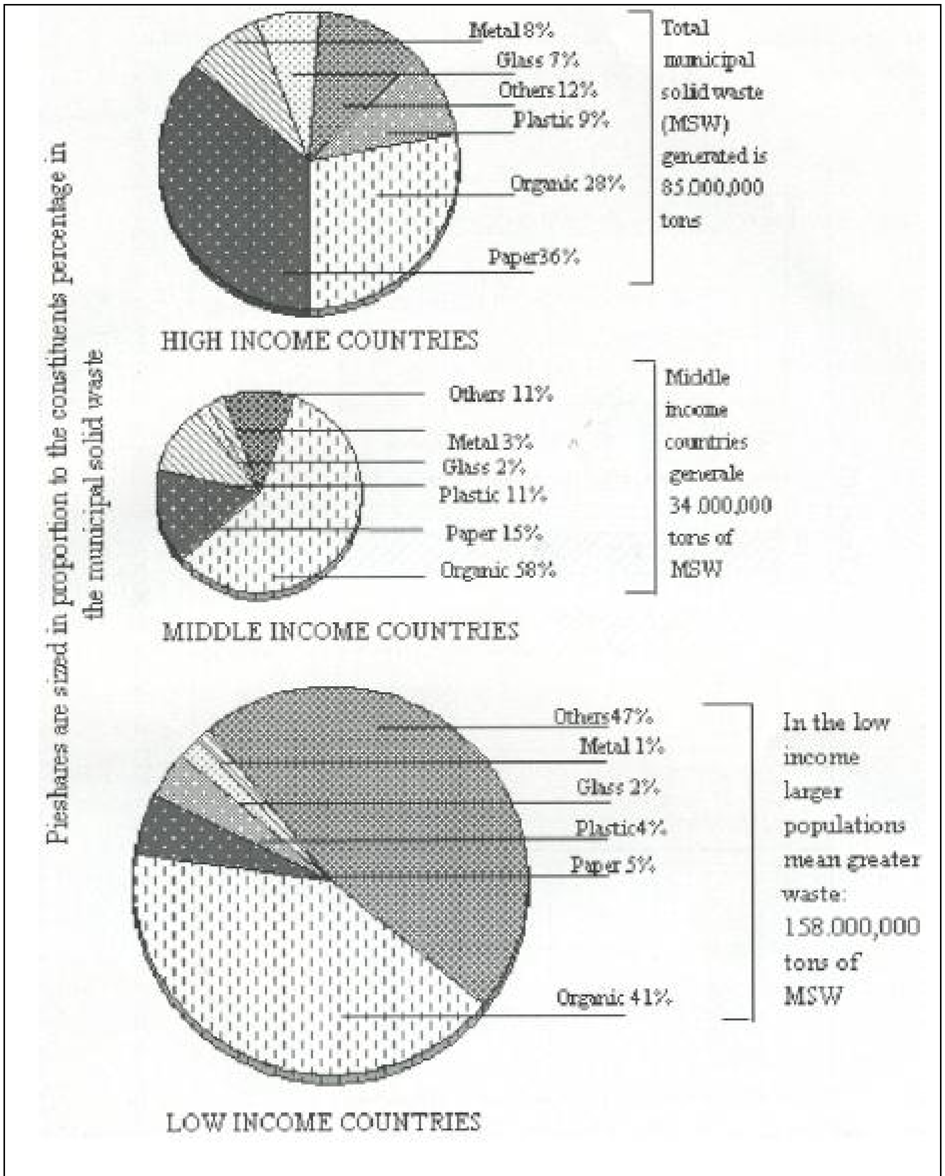

Figure 3.5: MSW composition vs. average income (Twardowska, 2004).

By region and locality type; in Palestine The average household daily generation for Urban was 2.7Kg/household, for Rural was 2.8Kg/household and for Camps it was 2.8Kg/household, in West Bank The average household daily generation for Urban was 2.6Kg/household, for Rural was 2.7Kg/household and for Camps it was 2.7Kg/household and in Gaza The average household daily generation for Urban was 2.8Kg/household, for Rural was 3.1Kg/household and for Camps it was 3.0Kg/household (PCBS, 2013).

A study was made in Japan with average household size 6.5 results, an average household production of waste is 3.2kg/day or 0.5kg/capita/day, 88% of waste generated was collected by garbage collectors and 2% left on the street, the composition of solid wastes commonly generated by the households are food, yard waste, papers, cardboard, cans (metals), glass, Plastics, cell phones, diapers and napkins (Bernardo, 2008).

Solid waste can be classified as; organic (putrescible such as food, garden waste and others, un-putrescible such as paper, lather, wood and others), and inorganic (degradable such as metals, and un-degradable such as glass, ceramic, concrete and others), landfills can be classified as; open dump, controlled dump and sanitary dump(only Zahrat Alfinjan dump site in Palestine), the density of waste affected by its composition, when economic status is high wastes from kitchen decrease, while the total SW weight increase (paper, metal and glasses increase) and the total density of waste decrease. For a study made in Nablus, Palestine sample was taken from the transfer station in the city to study the composition of waste for Nablus and surrounded city, the results was as the following: organic with 63% of components and 73% of weight , Papers and cardboards with 10% of components and 5% of weight, Plastic with 8% of components and 5% of weight, inert with 4% of components and 4% of weight, textile with 3% of components and 3% of weight, glass components and 2% of weight and others (such as leather and wood) with 6% of components and 5% of weight (Abu Zahra,2006).

3.7 Mathematical modelling for prediction SW generation and composition

Proper planning and operation of solid waste management system is highly affected by MSW streams. Analysis and proper predictions of solid waste quantities, rapid waste generation growth, lack of information and affection of variable uncontrolled factors on waste generation, cause the forecasting to be a complex engineering problem. In developing countries models by artificial intelligence are useful in this field. Various methods of forecasting MSW generations are existing, in Tahran, Iran weekly SW generated in the period of 2008 to 2011 was used as input data for generation models (Abbasi et al.,2012).

Two models were used to predict the rate of medical waste generation in Fars Province hospitals in Iran, the goal of the research was devoted to offer a suitable model to predict waste quantities because the prediction of the amount of waste is helpful in storage, transportation and disposal of waste management, the results show the benefits of each linear and non-linear relationship between the effective parameters on the rate of medical waste generation and generation rate, in conclusion the results of the study may play useful role in establishing a proper medical waste management (Jahandideh et al.,2009).

In Deemed University, India; mathematical model was developed to study the relation between biomedical waste generation and type of ailment from three facilities for two years, most models can help in the assessment of waste risks, environmental impact and the cost-benefits analysis, the data used were monthly rates of waste to predict the generation of biomedical waste, that can help in resources planning, enabling strategies and for putting guidelines for more efficient environmental strategies (Katoch and Kumar,2008).

In Iran a research was made to study hospital quality and quantity of waste, by developing a mathematical model to calculate the generation of infectious waste for any year, they found that the components of wastes depends on social and economic status of the patients. The results shows that if the infectious wastes have been collected separately then that generated waste will be reduced by 15.1% this shows that the appropriate management reduces waste generation (Sabour et al., 2007).

In Irbid, Jordan a research was made to develop waste quantity prediction model that estimate waste quantities at any hospital, model representing the relationship between quantity of waste and both number of beds and patients, the research also find the components of waste which was as, papers 38.54%, plastic 27.25, textiles 10.86, garbage 8.55%, needles 1.66%, metals 23.8% and glass 10.50%, as a result of the whole study improvements were recommended for disposal practices, waste management programs, and in regulation & legislations (Awad et al., et al 2004).

Chapter Four

Results and Discussion

4.1 The assessment of people's concerns and attitudes to SWM facilities

4.1.1 Profile of respondents

By using simple statistical techniques the data were analyzed after collecting it on spreadsheets and using SPSS 18 for the analysis of the data taken from the questionnaires.
The attributes of the respondents in the questionnaire were mentioned in (V01-V06), and the attitude of them mentioned in (V33-V36). Figure 4.1 summarize the attitudes and attributes analysis.
Respondents were generally males (over than 50%), 32.8% aged between "36-45" years, highest percentage of females were from village locality with 80% rate. The results showing that 25% of the respondents have experience in visiting an SWM facility (V36), people has willing to participate in SWM planning with 16.1% (V35). The lower score for having willingness to participate in planning in camp locality was with 2.9%. Concern for recycling was around 38.2%, and waste had such a bad image (V33) with 65.2%.

Similar researches were made (Al-Yaqout et al.,2002) had 71% of the respondents as men and 29% females, the majority of the respondents were 18-22 years old. Other research showed that half of the respondents had visited SWM facility, 70% of them were willing to participate in solid waste planning and 80% of them were concern of recycling (Rahardyan et al., 2004).

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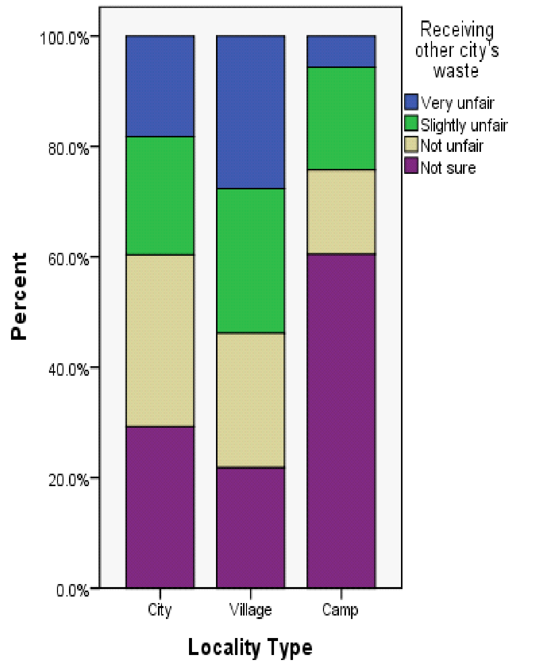


Fig.4.1.1: V28

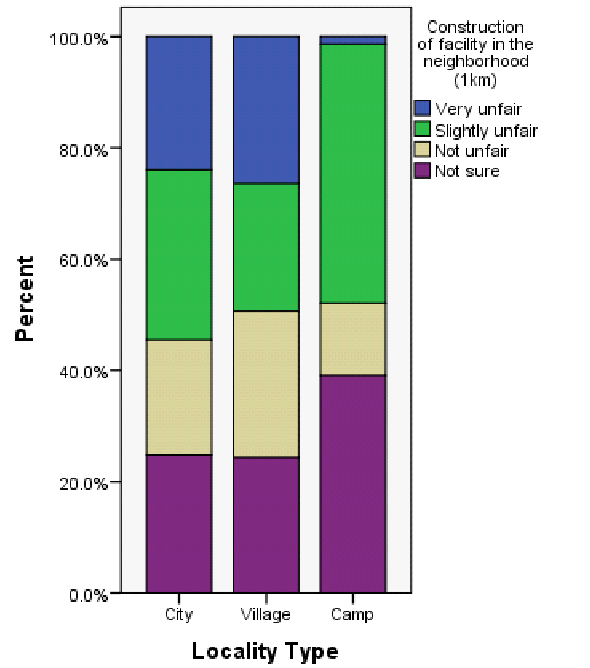


Fig.4.1.2: V29

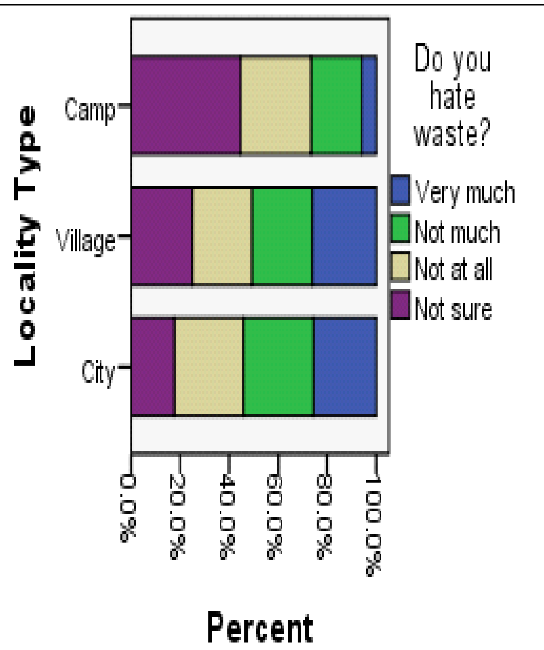


Fig.4.1.3: V33

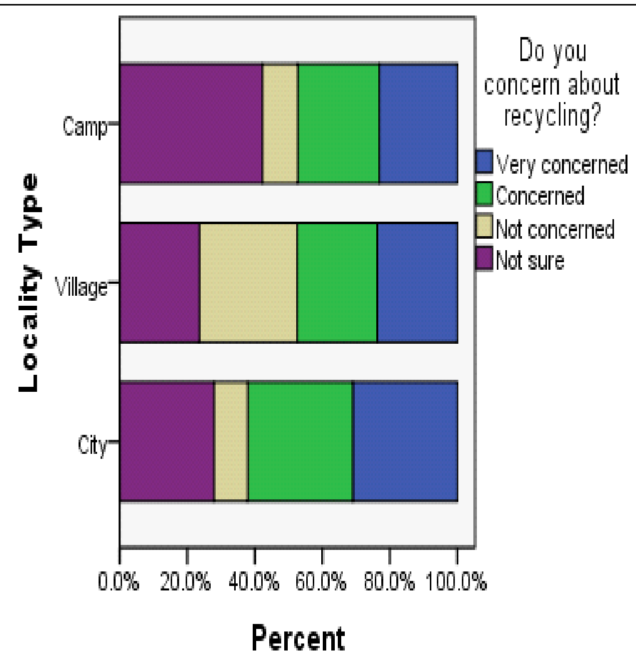


Fig.4.1.4: V34

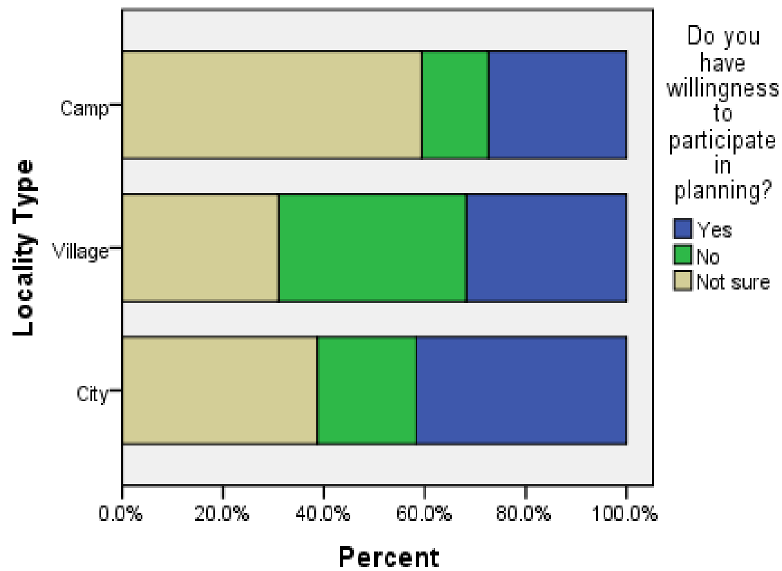


Fig.4.1.5: V35

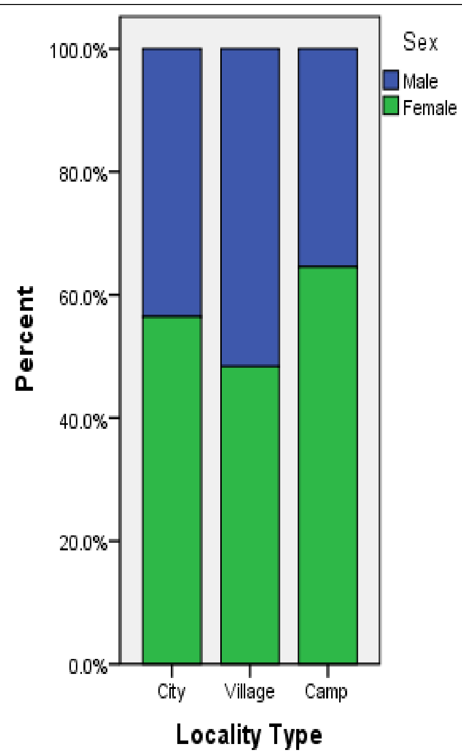


Fig.4.1.6: V4

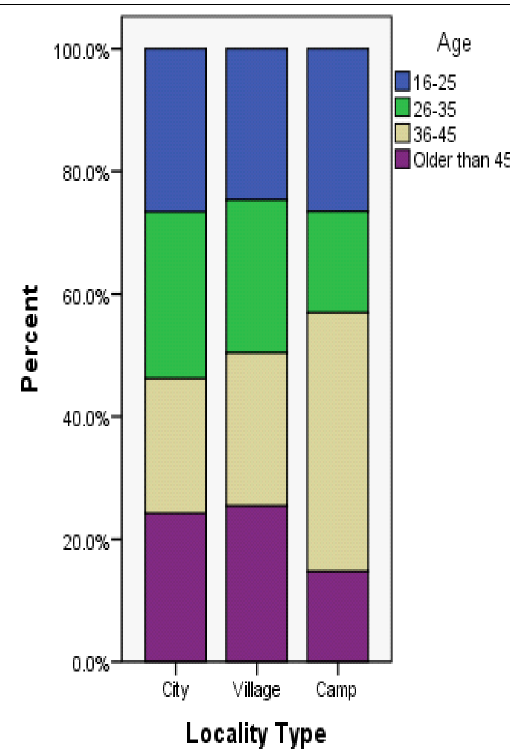


Fig.4.1.7: V5

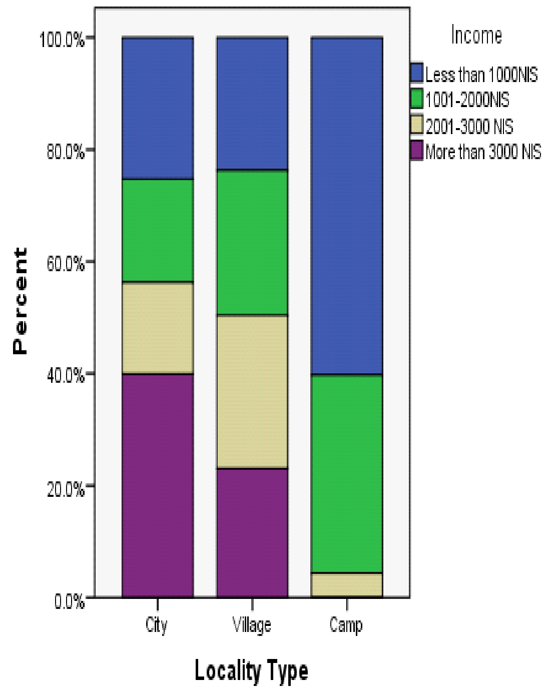


Fig.4.1.8: V6

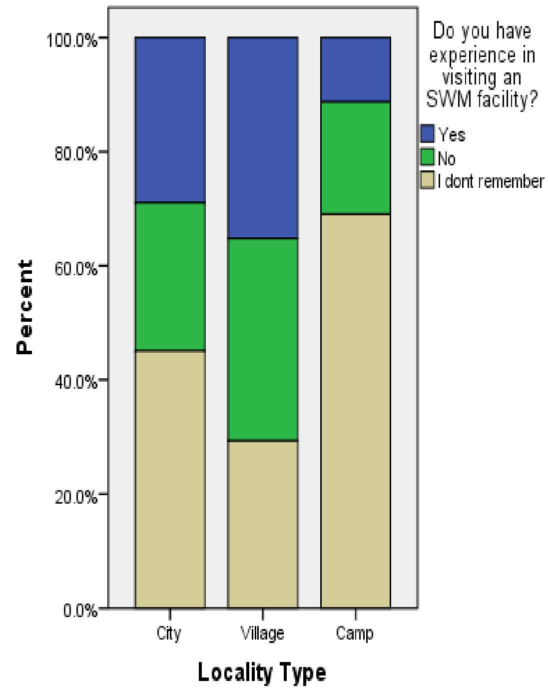


Fig.4.1.9: V36

Figure 4.1: Statistics of respondents.

Figure 4.1 also shows the questions related to unfairness of siting of a facility and construction one in the neighborhood (V28 and V29); people thought it was unfair to have a facility near their homes(V29) more than receiving wastes from other cities (V28). Village locality was more concern about having an SWM facility in their neighborhood than city and camp localities. The city locality prefers to have a facility in their neighborhood over receiving waste from other cities with small difference.

Four sub-groups have been created from the items of the questionnaire; (the status and effectiveness of the facility, information disclosure on operation/management, reliability of technology, financial stability of the facility owner, clarify the mechanism and the procedures in the facility, initial cost, operation and maintenance cost and post closure property value) items fall under the **''reliability''** subgroup, the (soil pollution, water pollution, air pollution) items fall under the **"pollution",** the (decrease of property value, deterioration of living environment, influence on farm products, stench and noise of collection vehicles, stench and noise of landfill, traffic congestions caused by collection vehicles and flies, rodent, crows) items fall under the

”Nuisance” subgroup, and the (plant and animal harm, forest harm) items fall under **‘damage to natur**e’’ subgroup.

In Fig. 4.2, concerns about impacts (V07–V27) are compared among three surveyed locality types. 3 to 0 scores was the rate of answers, 3 is for ‘‘very worried’’, and 0 for ‘‘not worried at all’’. The Answer of ’’Not sure’’ was excluded. Items of concern were arranged by an overall average score.

The four sub-groups Comparison showed that ‘‘reliability” had the highest rating with 2.14, “pollution” with 2.02,” Nuisance” with 1.84 and ‘damage to nature’’ with 1.72 (average score was taken for every sub-group). The values were closed to each others; this was an indication that people concern about all variables and they were not focusing on one object. In ‘‘reliability’’, ‘the status and effectiveness of the facility’’ was the highest concern, and ‘Influence on farm products’’ was the weakest among all concern items. ‘‘damage to nature’’ sub-group was the lowest between the whole groups and reliability had the highest rating.

When the comparison made among locality type, village locality type had the higher ratings than (city and camp) in most concern items except the most of ‘‘Nuisance’’ and "Reliability" items like “traffic accidents caused by collection vehicles, influence on farm products, Clarify the mechanism and the procedures in the facility, initial cost, Operation and maintenance cost, "Post closure property value” for the favor of city locality.

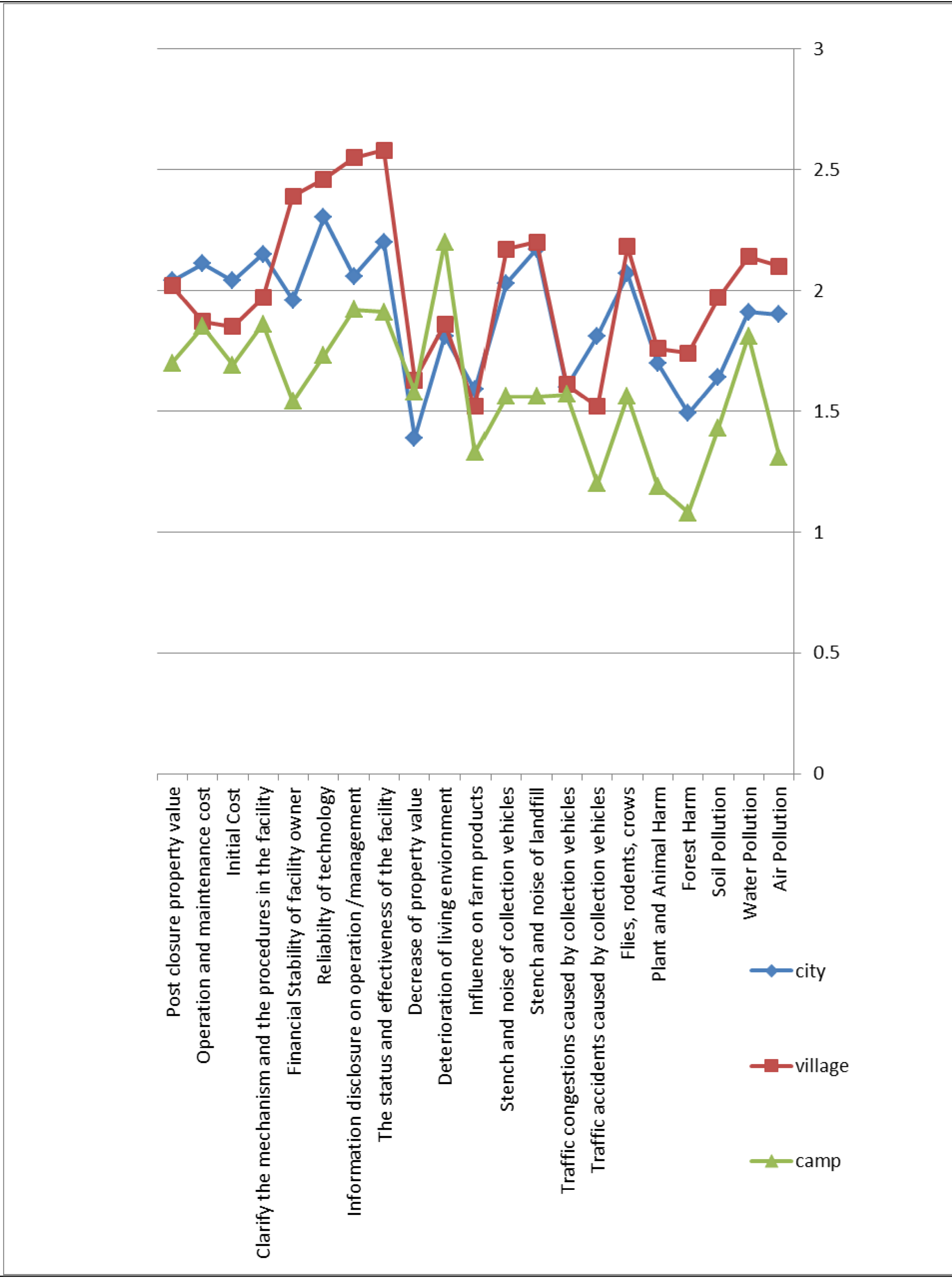


Figure 4.2: Rating of concerns according to locality type.

Camp locality showed the lower value for most items and the lowest item was "damage of nature", this denotes to low environmental pressure in camp locality. The higher rating for ‘‘reliability’’ was in cities localities.

in agreement of our research solid waste doesn't have a bad image in Japan but higher percentage of people thought it was unfair to receive waste from other municipalities than the case having solid waste facility in their neighborhood, Pollution and health effect had the highest rating, followed by reliability, damage to nature and cost (Rahardyan et al.,2004). Another research in Japan (Ishizaka & Tanaka, 2003) showed that Residents felt that there was a strong possibility of environmental pollution because of SW, and they were concerned about the movement of transportation vehicles (noise and odor).

Ranked impacts based on the survey sample in Kuwait were descending as the following: Environmental pollution 49.7%, Air pollution 42%, Health hazards 39.6%, bad Oder 21.6% (Al-Yaqout et al., 2002).

4.1.2. Factor analysis

In this section principal components were extracted from concern variables (V7–V27), by using the principal component method and varimax rotation method, principal components shown in Table 4.1. Loadings above 0.6 are usually considered ‘‘high’’ and Loadings below 0.4 are ‘‘low’’, 0.5 was used as a criterion (Rahardyan et al., 2004).

Variables were arranged by its component loading in each factor. Fig. 4.3 shows plotted component loadings. The first component named **(Pollution and health effect)** factor; ‘‘air, water, soil pollution, (V07–V09)’’ and ‘‘damage to nature (V10, V11)’’ were included in this group, that means that the previous impacts were considered similar by respondents.

Second component named **(Nuisance)** factor (V12, V13, V14, V15, V16, and V17. As seen in Fig.4.3 ‘‘Flies, rodents, crows (V12)’’ also had high loadings in 'pollution’’ component.

(Facility Management) was the third component "the status and effectiveness of the facility (V20), information disclosure on operation management (V21), reliability of technology (V22), financial stability of facility owner (V23)".

the fourth factor "clarify the mechanism and the procedures in the facility"(V24), "initial Cost" (V25), "operation and maintenance cost"(V26),"post closure property value" (V27) were related to **(Planning).**

"Deterioration of living environment"(V18) and "decrease of property value"(V19) called **(Dwelling)** factor.

Table 4.1 : Principal components of concerned variables by factor analysis

Variable	Principle component	Component 1	2	3	4	5
Air Pollution	Pollution	0.59[a]	0.26	0.35		0.24
Water Pollution	Pollution	0.59[a]	0.35	0.26	0.05	0.33
Soil Pollution	Pollution	0.76[a]	0.31	0.13		0.11
Forest Harm	Pollution	0.82[a]	0.15			
Plant and Animal Harm	Pollution	0.77[a]	0.19	0.06	0.11	0.11
Flies, rodents, crows	Nuisance	0.50[b]	0.62[a]	0.22	0.09	
Traffic accidents caused by collection vehicles	Nuisance	0.12	0.68[a]	0.20		0.27
Traffic congestions caused by collection vehicles	Nuisance	0.11	0.73[a]	0.11	0.06	0.36
Stench and noise of landfill	Nuisance	0.38	0.71[a]	0.20		
Stench and noise of collection vehicles	Nuisance	0.34	0.74[a]	0.16		
Influence on farm products	Nuisance	0.28	0.50[a]		0.18	0.38
Deterioration of living environment	Dwelling	0.26	0.19		0.07	0.83[a]
Decrease of property value	Dwelling	0.06	0.17	0.09	0.15	0.85[a]
The status and effectiveness of the facility	Facility Management	0.09	0.06	0.83[a]	0.16	0.07
Information disclosure on operation /management	Facility Management			0.83[a]	0.11	0.08
Reliability of technology	Facility Management	0.18	0.08	0.75[a]	0.16	0.06
Financial Stability of facility owner	Facility Management	0.09	0.07	0.76[a]	0.05	
Clarify the mechanism and the procedures in the facility	Planning		0.11	0.22	0.78[a]	0.08
Initial Cost	Planning	0.12	0.09	0.11	0.88[a]	0.05
Operation and maintenance cost	Planning	0.09	0.07	0.08	0.88[a]	
Post closure property value	Planning	0.12	0.24	0.08	0.74[a]	0.12

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Significant of 0.5 was used as criterion to identify component. Variables in each principal component are sorted in the order of component

a Components loading >0.5,.

b Components loading >0.4 and less or equal 0.5

*Rotation converged in 5 iterations

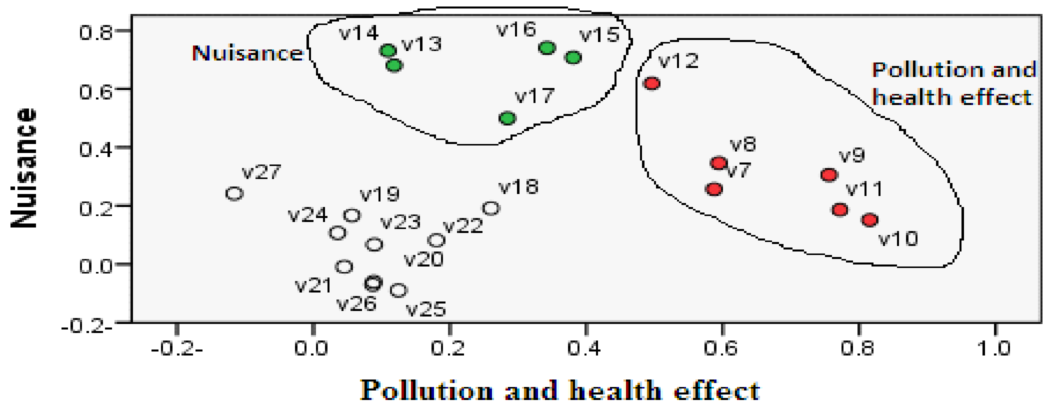


Fig.4.3.1: Nuisance and pollution and health effect components plot

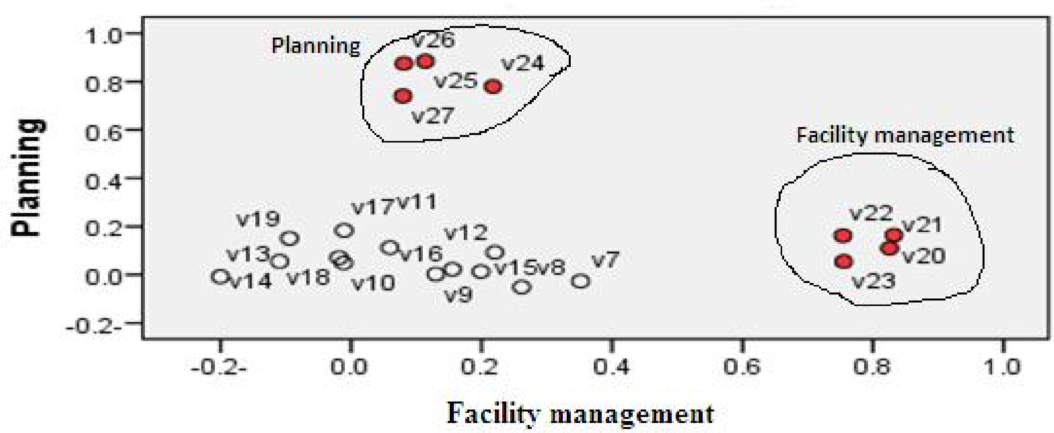


Fig.4.3.2: Planning and facility management components plot

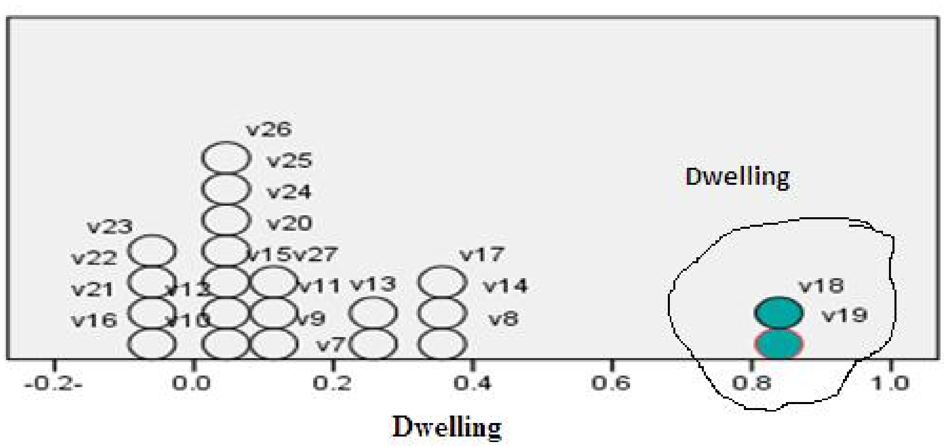


Fig.4.3.3: Dwelling component plot

Figure 4.3: Plotting of component loadings

4.1.3 Attitude toward SWM facilities

4.1.3.1 Relation with concerns

This section studied the relation between degree of concern (V07–V24) and attitudes toward construction of SWM facilities (V30-V32), the answers "very unfair" and "slightly unfair" considered as "oppose" attitude, answer of "not unfair" considered as "favor" attitude, and "not sure" answer considered "not concern" attitude.

The opposition rate was calculated as 0.60–0.98 for an incinerator, 0.59–0.98 for a landfill, and 0.50–0.97 for a recycling facility for location type.

Figure 4.4 illustrated plots of an average rating for concern variables for each different attitude group. The percentages of respondents are shown in the figure.

Values of the ‘‘not concerned’’ group was lower than "opposed" and "favor" groups. This shows that people who don’t have a clear attitude to a SWM facility are the people with no concern about pollution, damage, nuisance and reliability, it's worth mentioning that a research made in Japan had the same results that people with no clear attitude those who had no concern about other variables and components such as pollution, damage and else (Rahardyan et al., 2004).

The gap between the groups ‘‘opposed’’ and ‘‘favor’’ attitudes were large, especially for some impacts, such as pollution, damage, nuisance and reliability for the three facilities.

The less "opposed" facility was a recycling facility with average of 1.902, followed by an incinerator with average of 1.905 and a landfill with an average of 1.915.

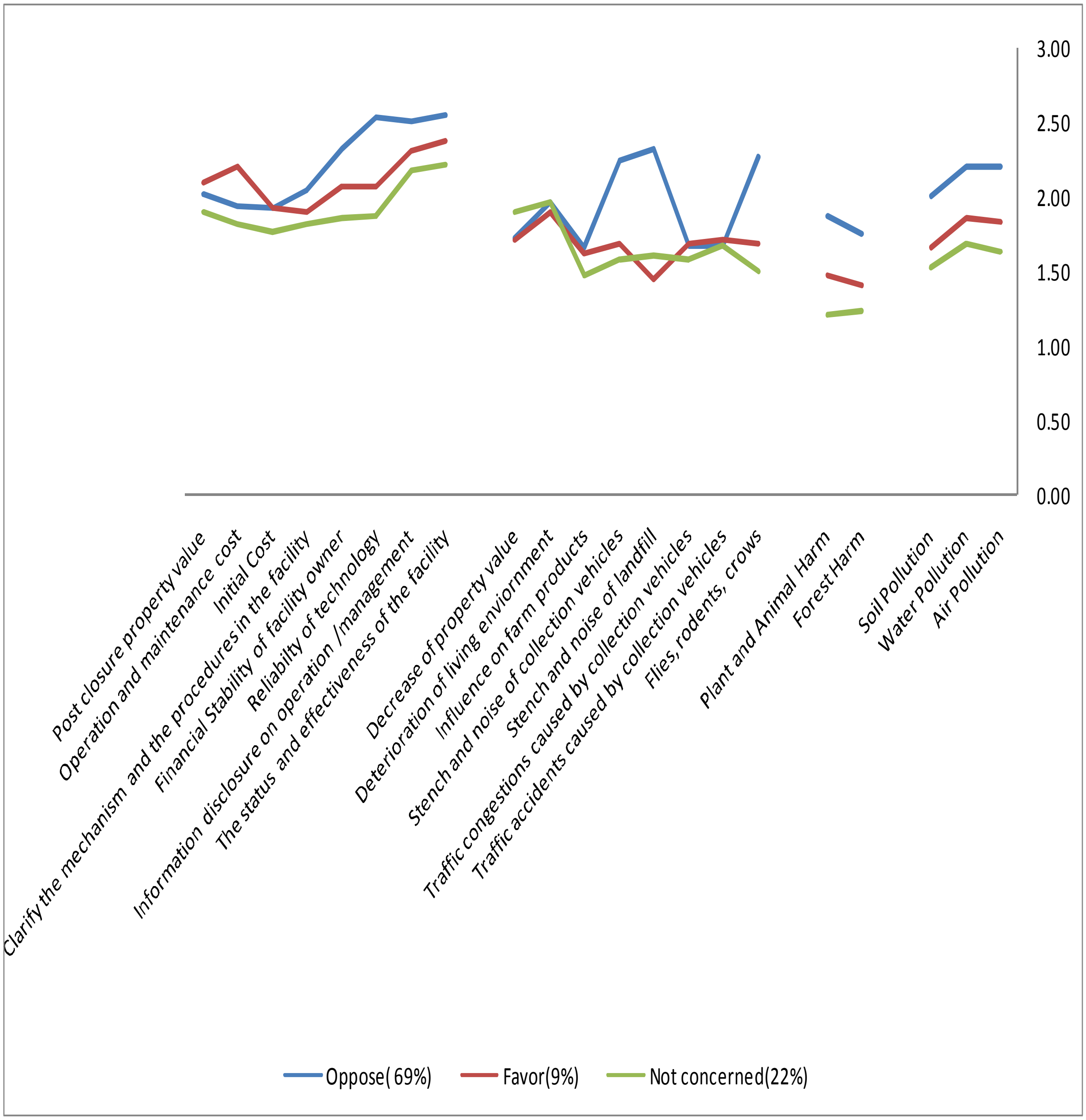


Fig.4.4.1: For incinerator

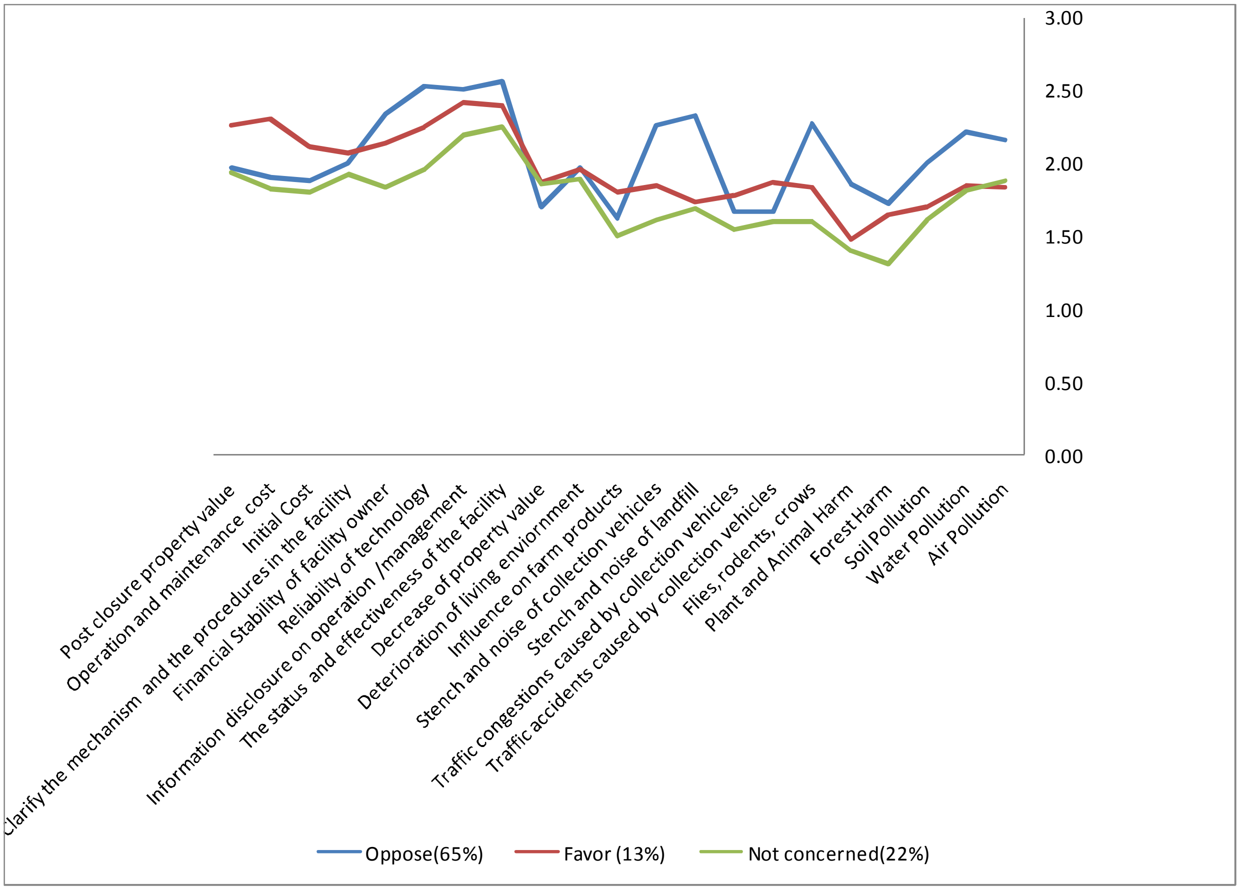


Fig.4.4.2: For recycling facility

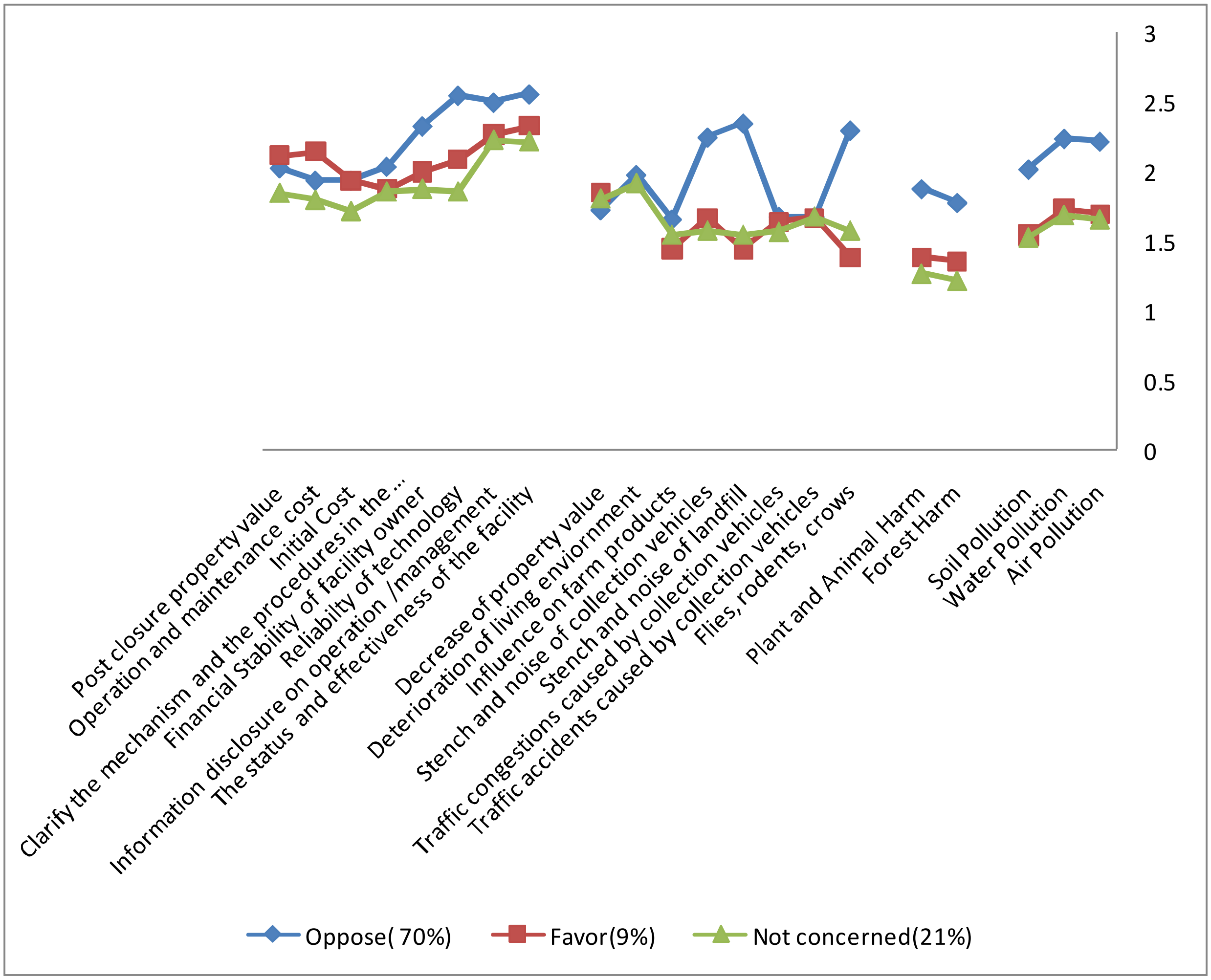


Fig.4.4.3: For landfill

Figure 4.4: Rating of concerns by different attitude group to construction of SWM facility

4.1.3.2 Association analysis between attitude and concern

To find a relation between two variables Good-Kruskal Gamma was used, measures the strength of association of the cross tabulated data with Gk coefficient values range between -1 to 1. Value of 1 related to "favor" attitude, value of 0 related to "opposed" attitude (Rahadyan et al., 2004). Table 4.2 shows the results beside a Chi-square test.

In this simple correlation as seen in Table 4.2; ‘‘Soil Pollution’’, ‘‘Forest Harm’ ,‘‘Plant and Animal Harm’’, "Flies, rodents, crows", "Stench and noise of landfill", "Stench and noise of collection vehicles", "Reliability of technology"," Financial Stability of facility owner", "Operation and maintenance cost" had a significant correlation with attitudes to **Incinerator** facility, it means that some people may opposing a facility because of impacts which considered minor. "Air Pollution", "Water Pollution", "Soil Pollution", "Forest Harm", "Plant and Animal Harm", "Flies, rodents, crows", "Stench and noise of landfill", "the status and effectiveness of the facility", "Information disclosure on operation management ","reliability of technology", "financial stability of facility owner" were the items that had a significant correlation with attitudes for **landfill**. There was a significant relation found for **recycling** facility and "water pollution", "Soil Pollution", "Plant and Animal Harm", "Flies, rodents, crows", "Stench and noise of landfill", "Financial Stability of facility owner", "Operation and maintenance cost" which implies that these items impact could provide a reason for people to oppose this facility.

Table 4.2: Association of concerned items and attitudes towards SWM facilities

Number	Items	Incinerator		Landfill		Recycling facility	
		GK coef	Chi sq. sig	GK coef	Chi sq. sig	GK coef	Chi sq. Sig
v7	Air Pollution	-0.27	0.1	-0.39	0.008**	-0.19	0.14
v8	Water Pollution	-0.29	0.08	-0.43	0.004**	-0.29	0.02*
v9	Soil Pollution	-0.3	0.05*	-0.46	0.001**	-0.3	0.013*
v10	Forest Harm	-0.3	0.04*	-0.42	0.002**	-0.2	0.08
v11	Plant and Animal Harm	-0.34	0.03*	-0.42	0.004**	-0.28	0.02*
v12	Flies, rodents, crows	-0.48	0.004**	-0.74	0.000**	-0.41	0.001**
v13	Traffic accidents caused by collection vehicles	0.04	0.77	0.05	0.72	0.16	0.15
V14	Traffic congestions caused by collection vehicle	-0.07	0.36	-0.10	0.17	-0.07	0.25
v15	Stench and noise of landfill	-0.67	0.000**	-0.65	0.000**	-0.49	0.000**
V16	Stench and noise of collection vehicle	-0.61	0.000**	-0.60	0.000**	-0.55	0.000**
v17	Influence on farm products	-0.02	0.9	0.06	0.96	0.19	0.1
v18	Deterioration of living environment	0.03	0.88	-0.02	0.88	0.21	0.1
V19	Decrease of property value	0.16	0.02*	0.13	0.07	0.15	0.02*
V20	The status and	-0.53	0.000**	-0.50	0.000**	-0.51	0.000**

	effectiveness of the facility						
V21	Information disclosure on operation/management	-0.56	0.000**	-0.51	0.000**	-0.51	0.000**
V22	Reliability of technology	-0.70	0.000**	-0.70	0.000**	-0.61	0.000**
v23	Financial Stability of facility owner	-0.31	0.04*	-0.59	0.000**	-0.52	0.000**
v24	Clarify the mechanism and the procedures in the facility	-0.18	0.18	-0.21	0.09	-0.05	0.68
v25	Initial Cost	0.03	0.84	-0.006	0.97	0.19	0.11
v26	Operation and maintenance cost	0.33	0.05*	0.23	0.12	0.39	0.001**
v27	Post closure property value	0.09	0.53	0.04	0.77	0.21	0.07

Chi sq: Chi –square test; GK: Goodman-Kruskal Gamma.
** Significant at the 1% level, * significant at the 5% level, no stars at all: not significant.

4.1.3.3 Discriminant analysis

Discriminant analysis was applied, to find the influence of concerns on attitudes to facilities. Concerns in (V7–V19) are related to management of an SWM facility and not directly related to the type of facility.

The data which showed attitudes of ‘‘favor’’ which included (not worried answers) or ‘‘opposed’’ which included (slightly worried, worried, very worried answers) were used in the analysis (excluding ‘‘not sure" answer), positive values reflect ‘‘favor’’ attitudes and a negative values reflect ‘‘opposed’’ attitudes. Fig. 4.5 shows the standardized coefficients of the discriminant functions.

As shown in fig.4.5, the highest negative value was seen in "influence on farm product" for incinerator, "traffic congestions caused by collection vehicles" for Landfill and "Forest Harm": for Recycling facility these items seemed to have role into predict ‘‘opposed’’ attitude.
"traffic accidents caused by collection vehicles", "traffic congestions caused by collection vehicles", "influence on farm products", "decrease of property value", "initial cost", "operation and maintenance cost", "post closure property value" and ‘‘deterioration of living environment’’ had positive values, thus indicates ‘‘favor’’ attitude.

Inconsistency between possible damage and the citizens' opinion found in this research; (with the negative values of pollution and the positive value of influence on farm product and deterioration of living environment from landfill). Similar disagreement was found in a research made in Japan and concludes that" appropriate information on SWM is essential for better understanding" (Rahardyan et al., 2004).

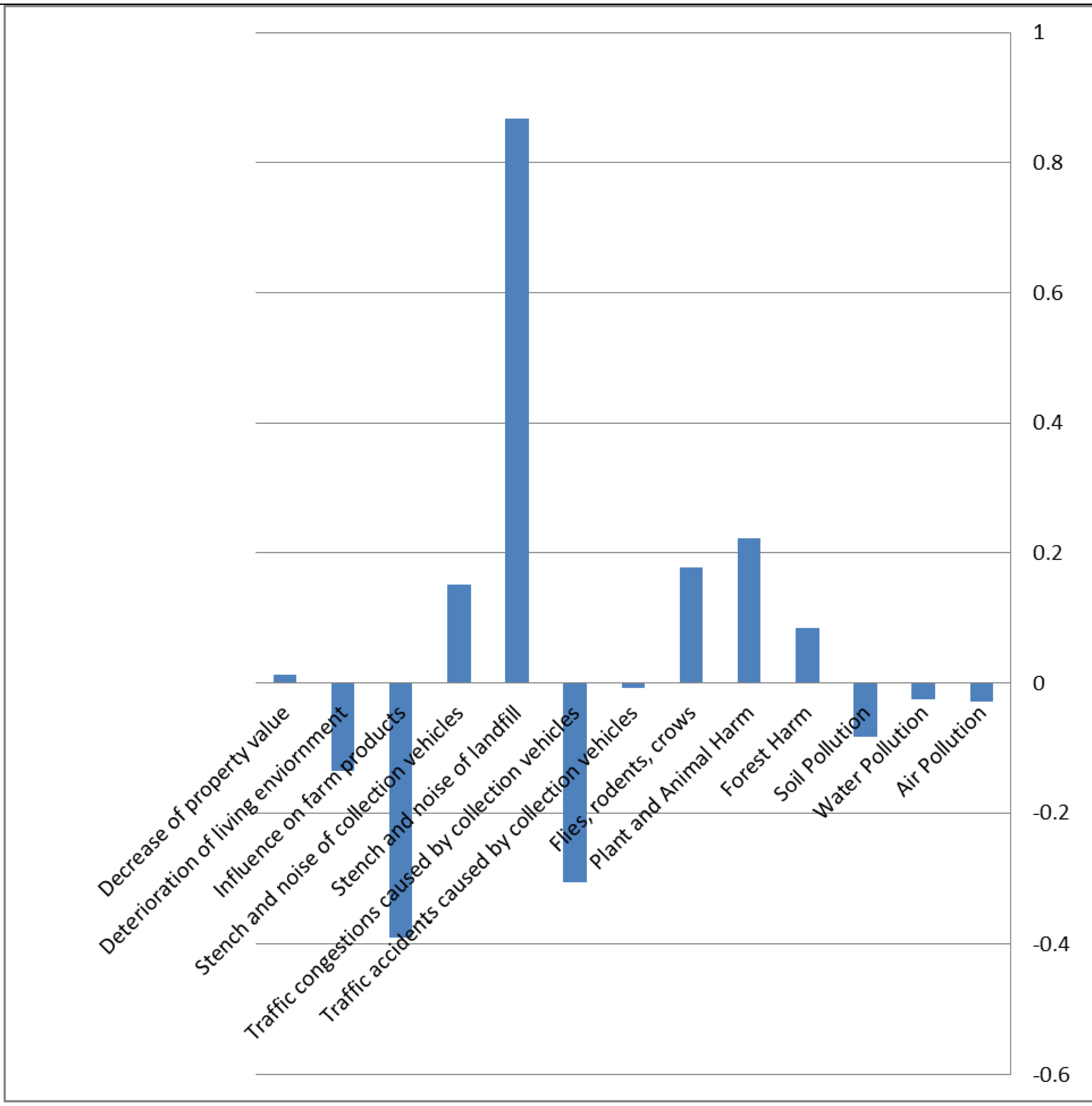


Fig 4.5.1: Incinerator

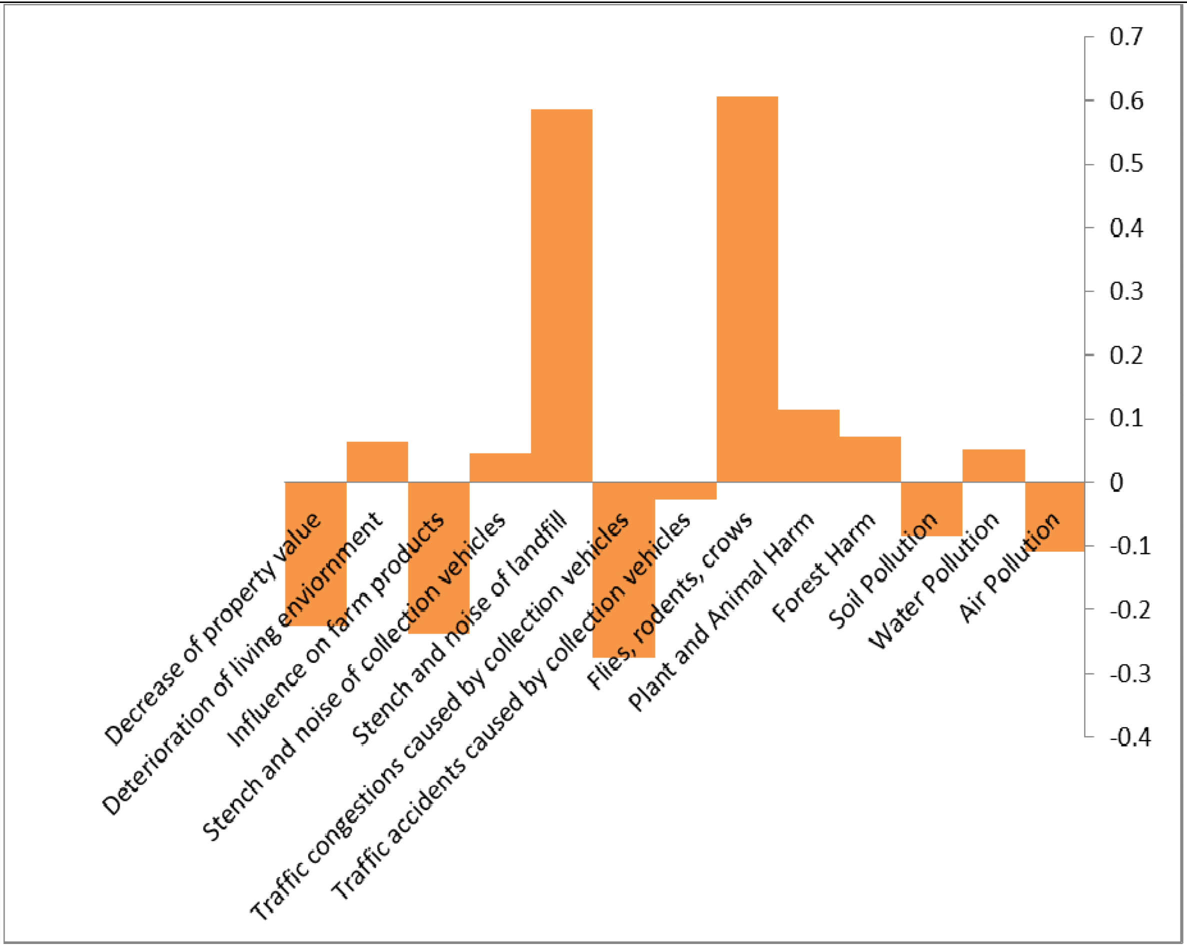


Fig 4.5.2: Landfill

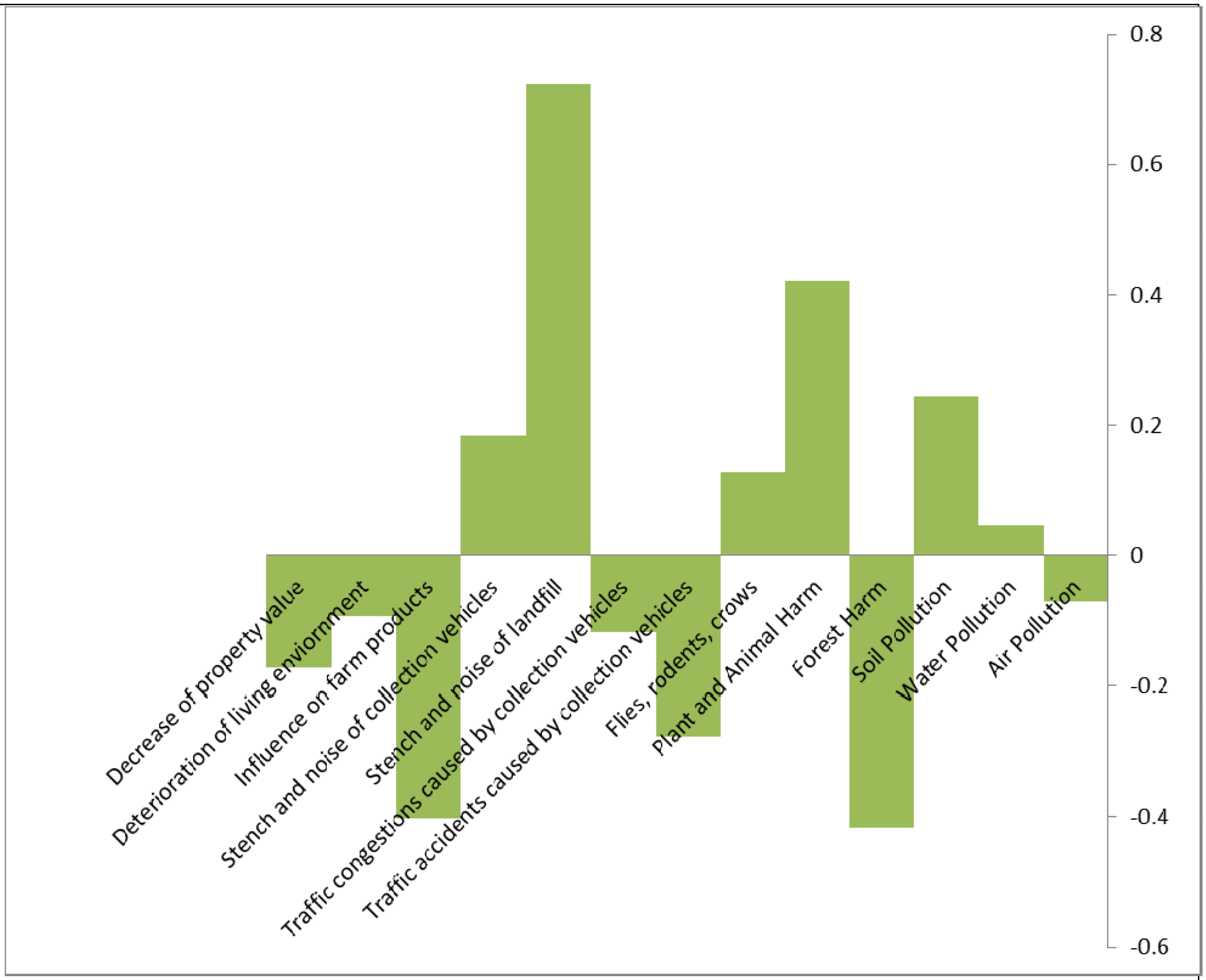


Fig 4.5.3: Recycling Facility

Figure 4.5: Standardized discriminant function coefficients of discriminant functions.
The prediction correct percentage: incinerator77.1%, Landfill 77.5%, recycling facility 74.2%

4.1.4 Influence of respondent attributes to acceptability of SWM facilities

4.1.4.1 Correlation with personal attribute

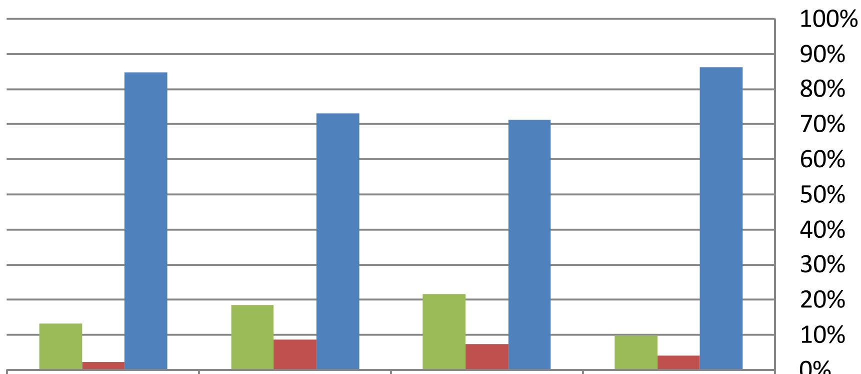
Correspondence analysis was used to show the correlation of respondents attributes (V01-V06) with attitudes. In this analysis, the relation with "Existing of a SWM facility 1 km from your home" was discussed.

Figures 4.6, 4.7 and 4.8 show the results for relation of personal attributes (age, gender and locality type) with fairness attitudes to three facilities.

80% of males tended to show "very unfair" attitude toward landfill facility being 1 km near their homes, 81% for incinerator and 75% for recycling facility. Meanwhile 71% of females tended to show "very unfair" attitude toward landfill facility being 1 km near their homes, 72% for incinerator and 64% for recycling facility.
70% of respondents aged between (26-35) years, thought it was "very unfair" to locate a landfill 1km around their homes, 67% for recycling facility and 71% for incinerator.
Villagers had the highest opposed attitude "very unfair" between all localities (city, camps and villages) 79% of them believe that it's "very unfair" to have a landfill beside your home, 76% for recycling and 80% for incinerator facility.

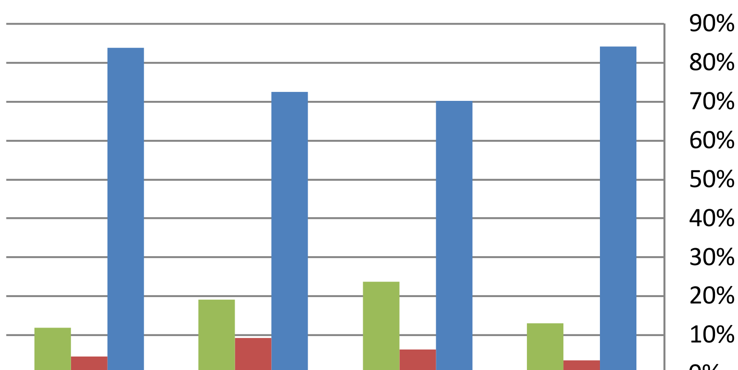
From the previous it can be said that males who had lived in villages and aged between (16-35) years, have a tendency toward "unfair" attitudes. Older people more than 35 years old, females who had lived in city type of locality tended to show ''not unfair'' attitudes or ''not sure'' attitudes.

Similar results was found in Japan where people aged between 40s and 50s show favor attitudes toward SWM facilities more than younger people who showed less concerns about it, it showed that SWM facility siting strongly correlated with "opposed" attitudes toward such facilities, but with a difference that recycling facilities had more "favor" attitudes than other facilities (Rahardyan et al., 2004). Conversely it was in Malaysian research which showed that 60% of the study sample (university students) had positive attitude towards SWM and 40% showed negative attitudes (Desa et al., 2012). When correlating between age and awareness of landfill problems, Al-Yaqout et al., (2002) concluded that older people were more aware of the problem.



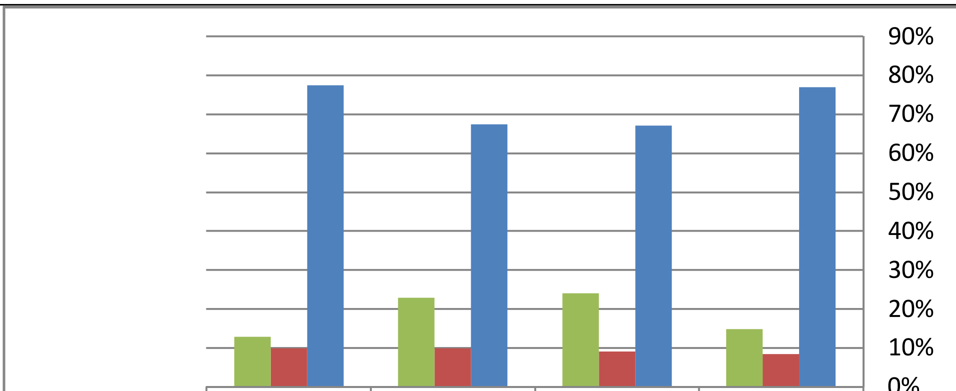
	Older than 45	36-45	26-35	16-25
Very unfair	85%	73%	71%	86%
Not unfair	2%	9%	7%	4%
Not sure	13%	18%	22%	10%

Fig4.6.1: Existing of incinerator 1 km from your home according to age variable.
Chi square value = 18.3, P value= 0.005 and df= 6



	Older than 45	36-45	26-35	16-25
Very unfair	84%	72%	70%	84%
Not unfair	4%	9%	6%	3%
Not sure	12%	19%	24%	13%

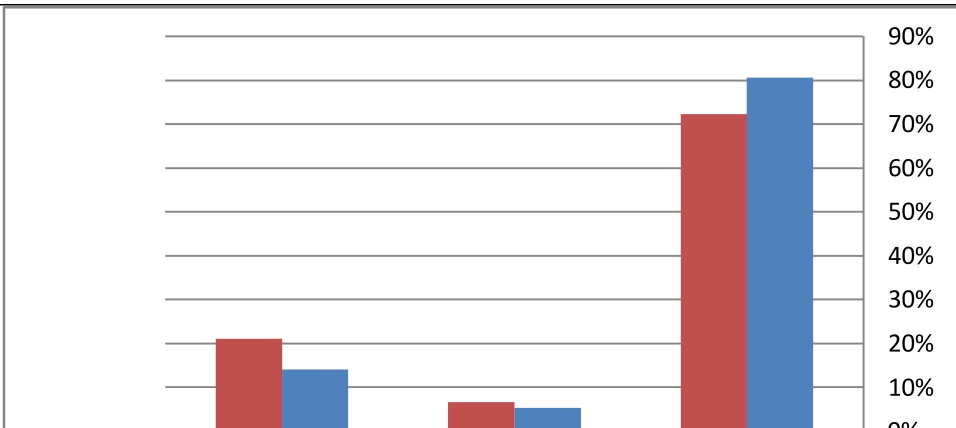
Fig4.6.2: Existing of landfill1 km from your home according to age variable
Chi square value= 16.98, P value=0.009 and df= 6



	Older than 45	36-45	26-35	16-25
Very unfair	77%	67%	67%	77%
Not unfair	10%	10%	9%	8%
Not sure	13%	23%	24%	15%

Fig4.6.3: Existing of recycling facility 1 km from your home according to age variable.
Chi square value=9.88, P value=0.129 and df= 6

Figure 4.6: Correspondence of attitudes toward SWM facilities according to age variable.



	Not sure	Not unfair	Very unfair
Male	14%	5%	81%
Female	21%	7%	72%

Fig 4.7.1: Existing of incinerator 1 km from your home according to gender variable
Chi square value= 5.4 , P value=0.067 and df= 2

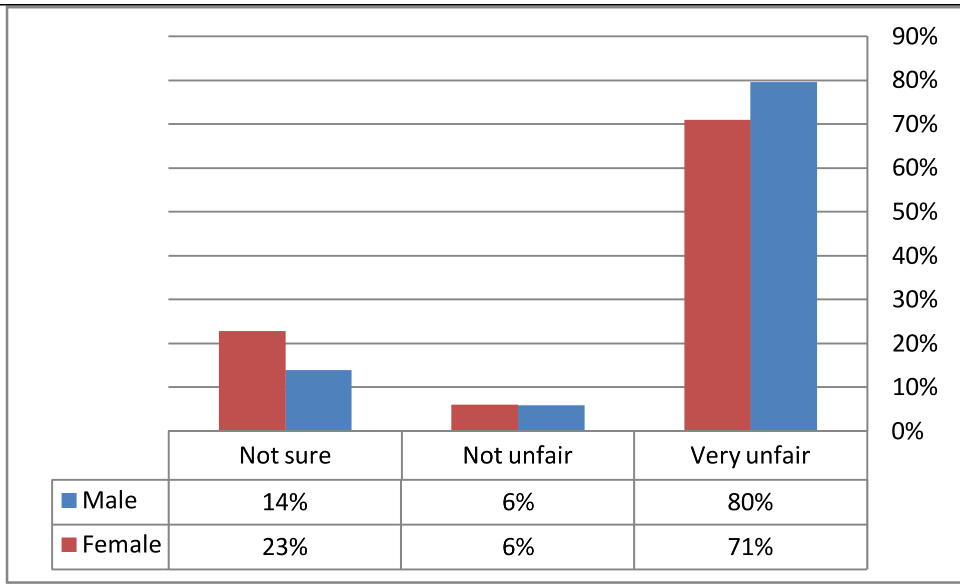


Fig 4.7.2: Existing of Landfill 1 km from your home according to gender variable
Chi square value= 6.28, P value=0.043 and df= 2

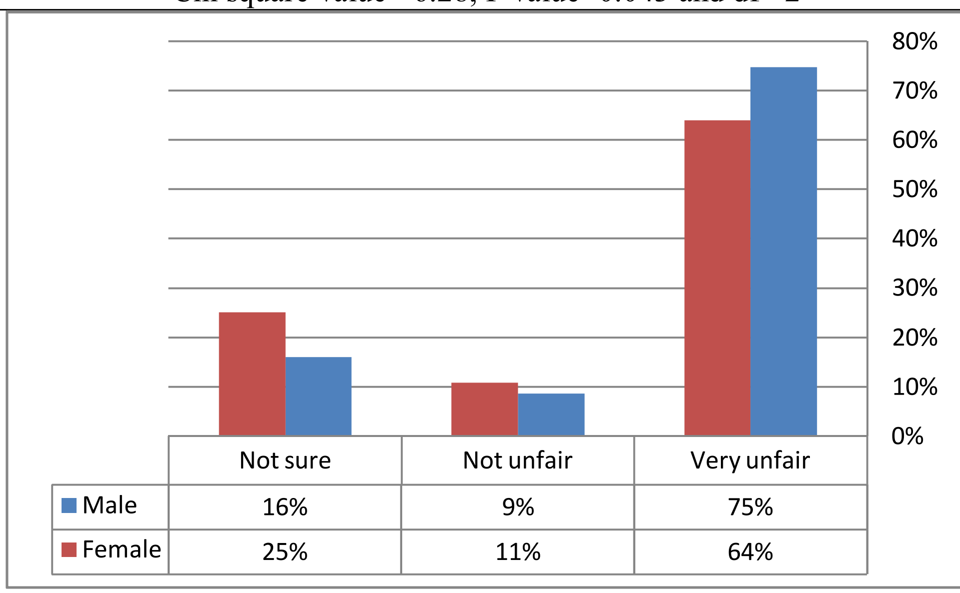
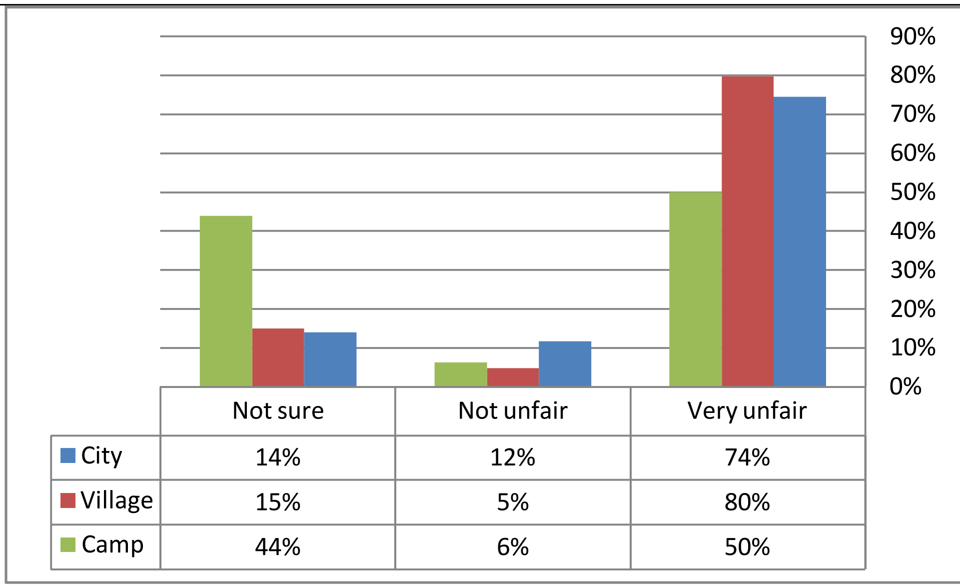


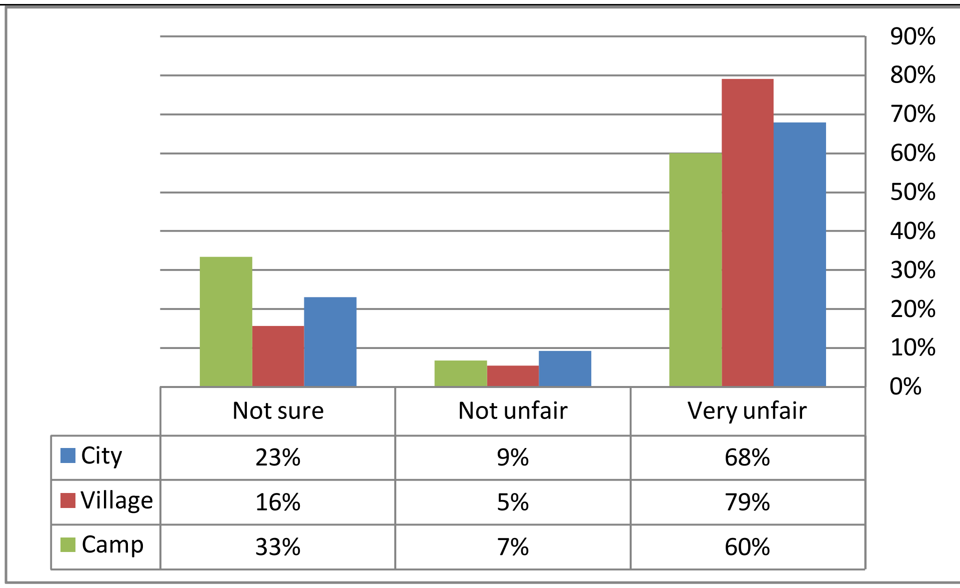
Fig 4.7.3: Existing of Recycling facility 1 km from your home according to gender variable
Chi square value= 7.42, P value=0.025 and df= 2

Figure 4.7: Correspondence of attitudes toward SWM facilities according to gender variable



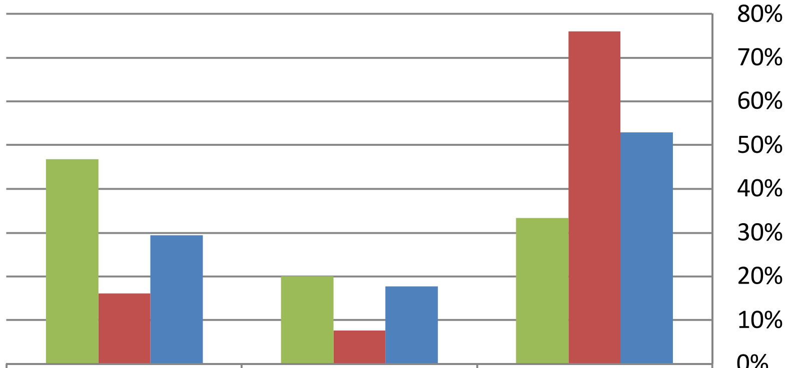
	Not sure	Not unfair	Very unfair
City	14%	12%	74%
Village	15%	5%	80%
Camp	44%	6%	50%

Fig 4.8.1: Existing of incinerator 1 km from your home according to locality type variable.
Chi square value=15.74 , P value=0.003 and df=4



	Not sure	Not unfair	Very unfair
City	23%	9%	68%
Village	16%	5%	79%
Camp	33%	7%	60%

Fig 4.8.2: Existing of landfill 1 km from your home according to locality type variable
Chi square value=8.42 , P value=0.077 and df=4



	Not sure	Not unfair	Very unfair
City	29%	18%	53%
Village	16%	8%	76%
Camp	47%	20%	33%

Fig 4.8.3: Existing of recycling facility 1 km from your home according to locality type variable. Chi square value=30.85 , P value=0.000 and df=4

Figure 4.8: Correspondence of attitudes toward SWM facilities according to locality type

4.1.4.2 Correlation with experience of visiting a facility

The relation with ‘‘experience of visiting an SWM facility (V36) was studied in Fig. 4.9, apart from other attributes, because the tendency with attitude was clear. Most residents who had never visited a SWM facility showed an ‘‘opposed’’ attitude (slightly unfair, very unfair), while ‘‘favor’’ attitude (not unfair) was for those who answer yes for visiting one.

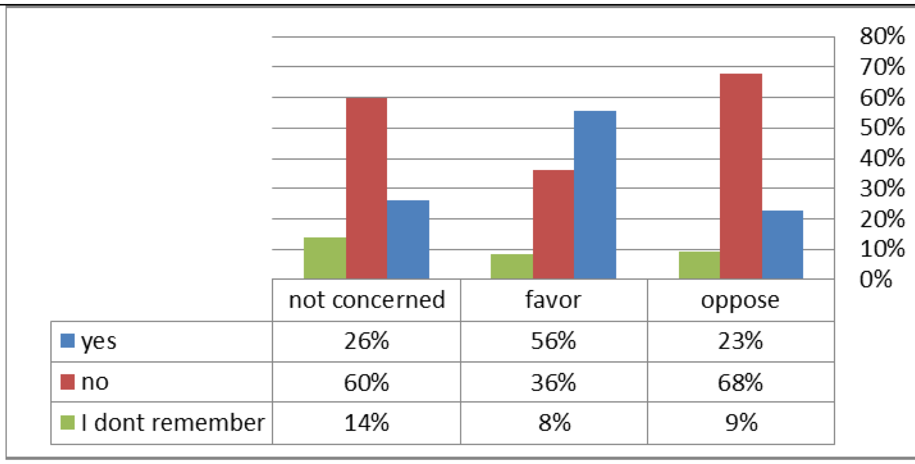
(Not sure) mentioned as “not concerned”

68% of the respondents who had "oppose" attitude toward incinerator facility never visit one, and 56% of the respondents who had "favor" attitude toward the facility had visit one.

67% of the respondents who had "oppose" attitude toward landfill facility never visit one, and 54% of the respondents who had "favor" attitude toward the facility had visit one.

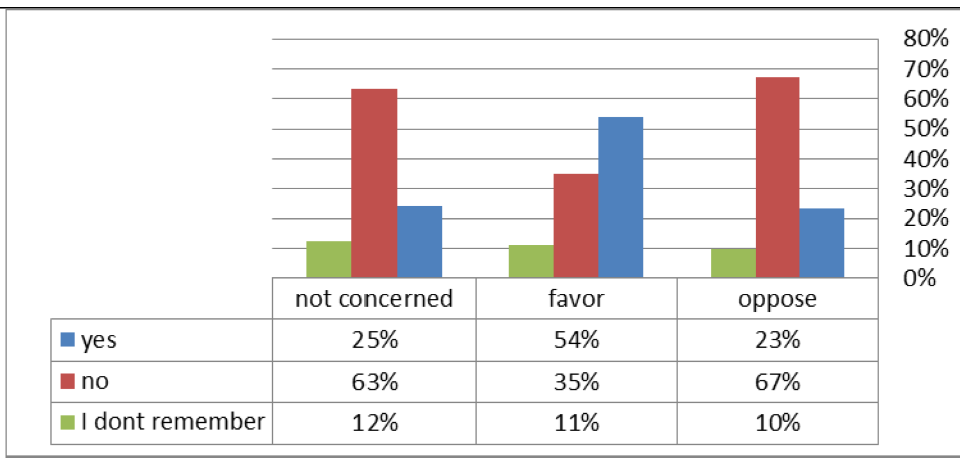
69% of the respondents who had "oppose" attitude toward incinerator facility never visit one, and 51% of the respondents who had "favor" attitude toward the facility had visit one.

It's obvious that the attitude is very much correlated with the visit of the facility, that's been mentioned in a research made in Japan suggested that "unknown facilities tend to be opposed", and underline the importance of the communication with the residence when there is a siting of new facility (Rahardyan et al., 2004).



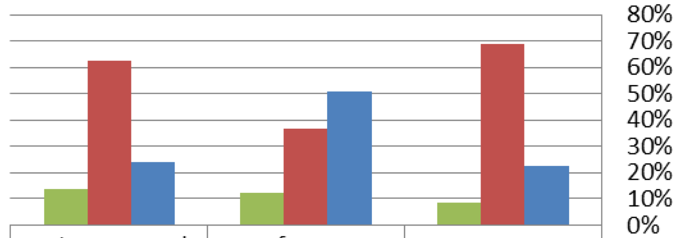
	not concerned	favor	oppose
yes	26%	56%	23%
no	60%	36%	68%
I dont remember	14%	8%	9%

Fig 4.9.1: Attitude to Incinerator



	not concerned	favor	oppose
yes	25%	54%	23%
no	63%	35%	67%
I dont remember	12%	11%	10%

Fig. 4.9.2: Attitude to Landfill



	not concerned	favor	oppose
yes	24%	51%	23%
no	62%	37%	69%
I dont remember	14%	12%	9%

Fig. 4.9.3: Attitude to recycling facility

Figure 4.9: Correlation of experience of visiting SWM facility with attitudes.

4.2 Mathematical model development to predict generation rates and compositions of municipal solid waste

The second part of this research was made to predict the generation of solid waste in Jenin and Nablus districts. Multiple Linear Regression Models were used for this purpose. Monthly amounts of solid waste were collected from Zahrat Alfinjan Landfill, Nablus and Jenin Municipalities for the years of 2011, 2012, and 2013.Population of each area in the two districts were collected from PCBS. The percentage of solid waste components (glass, plastic, papers, organics, textiles and others) were calculated (table 4.6).

4.2.1 Solid waste generation rate and composition

Table 4.3 shows a summary results of range and weighted average of SW values; monthly (t/month) and daily (Kg/cap/day) quantities for urban, rural and camps localities in Nablus and Jenin districts in the time interval of 2011-2013. The mean of all study area was **0.95** kg/cap/day.

Table 4.3: daily quantities of SW generation rates for urban, rural and camps in Nablus and Jenin districts in the time interval of 2011-2013.

Region	**SW General rate (t/month)**	**weighted average (t/month)**	**SW General rate(kg/cap/day)**	**Mean (kg/cap/day)**
Urban	1506-5100	3303	1.18-1.54	1.36
Rural	332-3306	1819	0.46-1.12	0.79
Refugee Camps	145-302	223.5	0.44-0.94	0.7

The highest generation rate was found at the urban region 1.36 kg/cap/day, and the lowest was for the refugee camps (0.7). That actually make sense due to the fact of the generation rate depends on socio-economic status of citizens.

Similar research was made at 2007 for Tubas, Tulkarm and Jenin localities showed that the cities had the highest generation rate (1.51kg/cap/day) and the camps had the lowest rate (0.52kg/cap/day) due to higher living standards in cities, villages had average generation rate of 0.65, the results were consistent with global outcomes for developing country (Al-Khatib et al., 2007).

Tables 4.4 and 4.5 show generation rates determined in other studies for different countries and global regions. The tables clearly reflects the difference between the SW average generation rates between developed – high income countries (USA and UK had average SW generation rate of 2 kg/cap/day and 1.4 kg/cap/day respectively) and developing – poor income countries (Palestine, Kashmir and India had had average SW generation rate of 0.95, 0.629 and 0.535 kg/cap/day respectively) due to the disparity among countries in levels of economic development and ability for recreation, that's also obvious in table 4.5 which showed that Organisation for Economic Co-operation and Development (OESD) countries had the highest SW average rate (2.2 kg/cap/day) compared with other global regions.

Table 4.4: Solid waste generation rate for various countries around the world.

Country	**SW generation rate (kg/cap/day)**	**SW average generation rate (kg/cap/day)**	**References**
Palestine	0.44-1.54	**0.95**	Present study
Pakistan	0.288-0.97	0.629	(Bhat et al.,2012)
India	0.2-0.87	0.535	(Annepu, 2012)
UK	-	1.4	(ETC/SCP,2013)
USA	-	2	(EPA,2012)
Malaysia	-	1.2	(Budhiarta et al., 2012)

Table 4.5: Solid waste generation rate for global regions in the world (World Bank, 2013).

Region	SW generation rate (kg/cap/day)	SW average generation rate (kg/cap/day)
East Asia	0.29-2.1	0.65
China	0.44-4.3	1.1
Latin America & Caribbean	0.1-14	1.1
Middle East & North Africa	0.16-5.7	1.1
South Asia	0.12-5.1	0.45
OESD (Organisation for Economic Co-operation and Development)	1.1-3.7	2.2

Many researches were made to determine the percentage of solid waste composition in Palestine and in Zahrat Alfinjan landfill table (4.6) below shows the percentage of solid waste composition in Zahrat Alfinjan landfill in 2009, this data had been used in extracting results.

Table 4.6 : The percentage of components of SW in Zahrat Alfinjan landfill (Al Sa'di,2009)

Solid waste component	Percentage (%)
Organics and food	53.73
Papers and cardboard	3.43
Plastic	11.53
Glass	3.73
Metals	2.43
Textile	10.93
Others	4.20

Tables (4.7) and (4.8) show the percentage of solid waste composition in Kuala Lumpur city in Malaysia and in USA. It's obvious that in Palestine the principle component of the SW is "organic and food". The tables emphasize that poor and developing countries have, less waste, more organic portion and less papers, plastics, glasses or metals.

Table 4.7 : The percentage of components of SW in Kula Lumpur (Malaysia) (Budhirata et al.,2012

Solid waste component	Percentage (%)
Food	74
Papers	1
Plastic	21
Wood	1
Others	3

Table 4.8: The percentage of components of SW in USA (EPA, 2012).

Solid waste component	Percentage (%)
Food waste	14.5
Papers	27.4
Plastic	12.7
Glass	4.6
Metals	8.9
Rubber & leather	8.7
Yard trimming	13.5
Others	3.4

4.2.2 Multiple regression predictive models

Multiple-variable regression models have been derived to predict the SW components for Jenin and Nablus district in kg/day. Seven solid waste (SW) components equations (Eqs. 1-7) were derived from multiple regression predictive models. All components are in ton/month, where the total solid waste (TSW) was made as a function of population, while the other six components (glasses, plastics, papers, organics, textiles and others) were made as a function of “population” and “TSW”.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

where ln: is natural logarithm function.

W_{T} : total solid waste

W_{G} : glass solid waste

W_{PL}: plastic solid waste

W_{P}: paper solid waste

W_{O}: organic solid waste

W_{Tx}: textile solid waste

Linear regression analysis is the most used of all statistical techniques: it studies the linear relationships between variables. The empirical prediction models for the components are significant at a confidence level 99.9%. Table 4.9 shows a summary of statistics multiple regression predictive models, the table gives us values of main indicators ; the coefficient of determination (R square) which was close to 1 in all models and indicated that the data fit the statistical models , model standard error (the errors were small in all models), model F-statistic , model coefficient, coefficient t-static, Variance Inflation Factor (VIF) which was less than the critical value of 10 (acceptable) and confidence level (Al-Khatib et al., 2015).

Table 4.9: Summary of statistics multiple regression predictive models

Predictive Model	Model R-Square	Model Standard Error	Model F-Statistic	Model Coefficients	Coefficient t-Statistic	Coefficient VIF	Confidence Level
Eq. (1)	0.942	0.24	2170.49	7.623	251.736	-	99.9%
				5.658E-22	25.064	1.301	99.9%
				-17514.817	-41.379	1.301	99.9%
Eq. (2)	0.994	0.08	10047.89	2.5527	72.290	-	99.9%
				.041	59.120	7.650	99.9%
				-1.115E+04	-2.530E+01	5.108	99.9%
				-5.808E-38	-1.222E+01	3.408	99.9%
				-3.321E+24	-8.176E+00	1.755	99.9%
Eq. (3)	0.994	0.08	10047.89	3.681	104.249	-	99.9%
				.041	59.120	7.650	99.9%
				-1.115E+04	-2.530E+01	5.108	99.9%
				-5.808E-38	-1.222E+01	3.408	99.9%
				-3.321E+24	-8.176E+00	1.755	99.9%
Eq. (4)	0.994	0.08	10047.89	3.8367	108.653	-	99.9%
				.04118	59.120	7.650	99.9%
				-1.115E+04	-2.530E+01	5.108	99.9%
				-5.80754E-38	-1.222E+01	3.408	99.9%
				-3.3212E+24	-8.176E+00	1.755	99.9%

Eq. (5)	0.994	0.08	10047.89	5.2203	147.833	-	99.9%
				.04118	59.120	7.650	99.9%
				-1.115E+04	-2.530E+01	5.108	99.9%
				-5.80754E-38	-1.222E+01	3.408	99.9%
				-3.3212E+24	-8.176E+00	1.755	99.9%
Eq. (6)	0.994	0.08	10047.89	3.628	102.73	-	99.9%
				.04118	59.120	7.650	99.9%
				-1.115E+04	-2.530E+01	5.108	99.9%
				-5.80754E-38	-1.222E+01	3.408	99.9%
				-3.3212E+24	-8.176E+00	1.755	99.9%
Eq. (7)	0.994	0.08	10047.89	2.671	75.651	-	99.9%
				.04118	59.120	7.650	99.9%
				-1.115E+04	-2.530E+01	5.108	99.9%
				-5.80754E-38	-1.222E+01	3.408	99.9%
				-3.3212E+24	-8.176E+00	1.755	99.9%

Table 4.10 shows the values of mean squared errors (MSE) and mean of the squared prediction errors (MSPR), the values are close to each other which mean that the MSE indicator was not seriously awry and it provided high predictive ability of the model derived.

Table 4.10: MSE and MSPR associated with the seven multiple-variable regression models.

Dependent variable	**MSE**	**MSPR**
Ln (TSW)	0.06	0.07
Ln (Glass)	0.007	0.006
Ln (Plastic)	0.007	0.006
Ln (Paper)	0.007	0.006

Ln (Organic)	0.007	0.006
Ln (Text)	0.007	0.008
Ln (Other)	0.007	0.008

Figures 4.10 shows an example of a normal probability plot (to identify substantive departures from normality), Histogram (to show that there were no fundamental deviations from the assumptions of normality) and scatter plots (to show that the standardized residual are highly independent) for W_T, the other six similar figures for the rest components ($W_{G,}$ $W_{PL,}$ $W_{P,}$ $W_{O,}W_{Tx}$ and W_{others}) are shown in appendix A.

All the obtained indicators have estimated that the derived predictive regression models for all components fit the data and have high predictive ability. So, the derived general models (eight equations) are effective and reliable to be used in generation estimation.

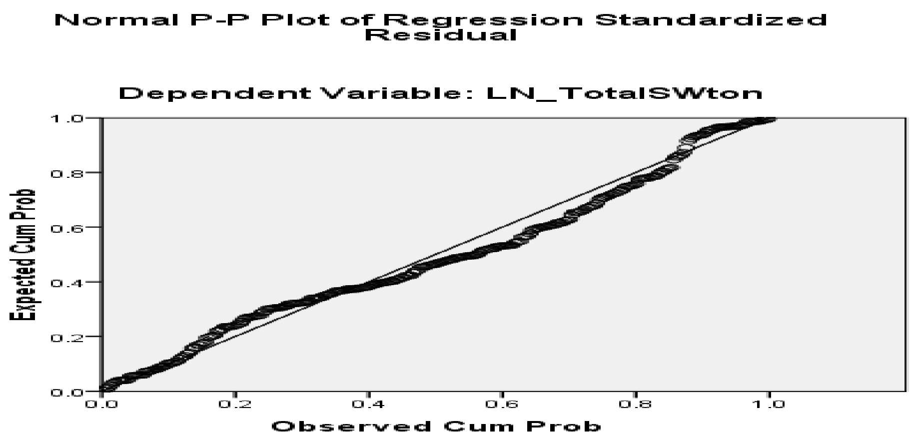


Figure 4.10.1 Normal p-p plot of expected versus observed cumulative probabilities of residuals of $Ln(W_T)$.

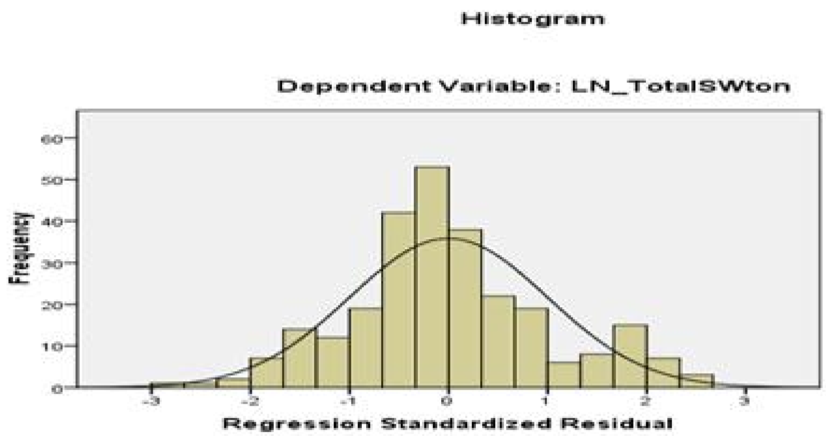


Figure 4.10.2. Histogram of standardized residuals for the dependent variable $ln(W_T)$.

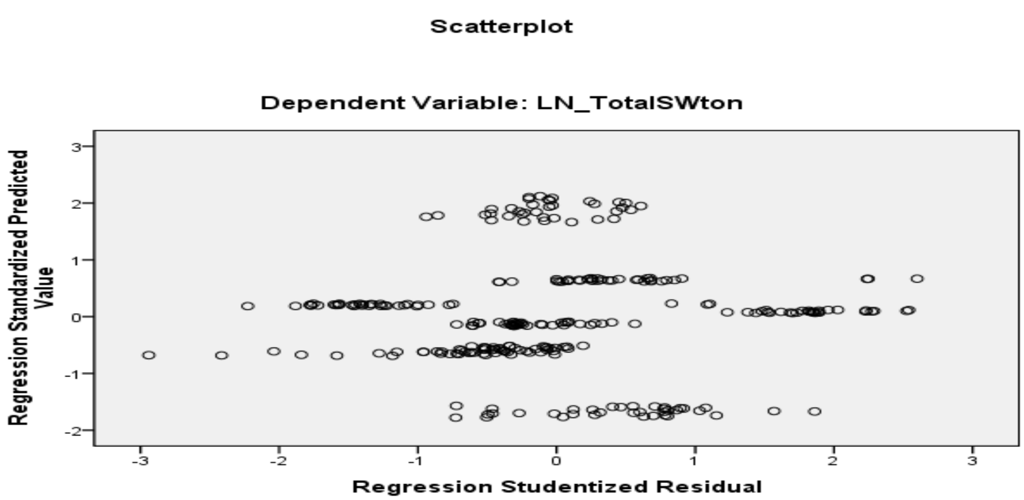


Figure 4.10.3. Scatter plot of standardized residuals for the dependent variable ln (W_T).

Figure 4.10: Normal pp plot, Histogram and Scatter plot figures for the dependent variable *ln* (*TSW*).

4.2.3 SW prediction and numerical example

By using the previous equations from 1-7, the prediction of SW for TSW, glass, plastic, paper, organic, textile and others can be calculated accurately, the overall error in the prediction can be known from the following equation:

$$Error\ (\%) = \left|\frac{SW_m - SW_p}{SW_m}\right| \times 100\% \qquad (8)$$

Where:

SW_m: Solid waste measured.

SW_p: Solid waste predicted.

Table 4.11 shows a numerical example for the paper and textile SW prediction in Qabatya, measured data was for 2011, the predicted results in the example were measured by using the Eqs.4 and 6 as function of " population" and" TSW (equation 1)". The percentage errors were estimated by using Eq. 8. The errors in the tables have small values which gives an indication that the data fit the statistical models.

$W_{P\,(m)}$: Measured paper solid waste

$W_{P\,(P)}$: Predicted paper solid waste

$W_{Tx\,(m)}$: Measured textile solid waste

$W_{tx\,(P)}$: Predicted textile solid waste

Table 4.11: Numerical example for the paper and textile SW prediction in Qabatya for 2011

Month	**$W_{P\,(m)}$ (ton/month)**	**$W_{P\,(P)}$ (ton/month)**	**Error % (W_P)**	**$W_{Tx\,(m)}$ (ton/month)**	**$W_{tx\,(P)}$ (ton/month)**	**Error % (W_{tx})**
Jan.	105.8742	102.20	3.52	85.909	83.47	2.87
Feb.	105.8742	102.30	3.43	85.909	83.55	2.78
March	98.8698	98.44	0.42	80.226	80.43	0.265
April	108.9723	104.24	4.43	88.423	85.11	3.811
May	99.1392	98.77	0.36	80.444	80.70	0.326
June	106.5477	103.05	3.33	86.456	84.16	2.69
July	114.7644	107.82	6.24	93.123	88.01	5.64
Aug.	117.3237	109.38	7.0	95.200	89.27	6.43
Sep.	123.2505	112.88	8.78	100.009	92.10	8.24
Oct.	108.7029	104.64	3.80	88.205	85.44	3.17
Nov.	113.6868	107.58	5.5	92.249	87.82	4.91
Dec.	108.0294	104.44	3.37	87.658	85.28	2.74

Chapter Five

Conclusions and Recommendations

5.1 Conclusions

In order to study people concerns and attitudes toward SWM facilities a questionnaire was made and distributed in study area, then to estimate waste composition and components for any desired year, mathematical model was derived the following is the conclusion of the most notable results:

- The questionnaire respondents' attributes were generally males aged 36-45 years, 25% of them had experience in visiting SWM facility, 38.2% concerns about recycling and 65% had bad image of waste.
- Higher percentage of those who thought it was unfair having an SWM facility in their neighbourhood was at villages.
- Village locality had the highest rating of concern in most concerns items than city and camp localities and the camps had the lowest rating of concern.
- Five principle components were extracted from Varimax method: pollution and health effect, nuisance, planning, facility management and dwelling.
- The relation between attitudes toward construction and degree of concerns for incinerator was 69% opposed, 9% favor and 22% not concerned , for recycling was 65% oppose, 13% favor and 22% not concerned and for landfill it was 70% oppose, 9% favor and 21% not concerned.
- In discriminant analysis inconsistency between what residents believe and the real damage were found.
- The respondents who tended to the unfair attitude were aged between 16-35 lived mostly in villages, mails with 2001-3000 shekels income. And the most respondents who tended to the not unfair or not sure attitudes were females more than 45 years old, lived in cities and had less than 1000 shekels income.

- Opposed attitude decreased when people visit the facility and vice versa, that supported what've been said before “unknown facility tends to be opposed".
- Based on part two primary results, the average daily SW generation rates are 1.36 kg/cap/day in urban areas, 0.79 kg/cap/day in rural areas,0.7 kg/cap/day in refugee camps and a mean value of 0.95 kg/cap/day for all areas.
- Daily generations had been gathered to create a multiple-variable regression model for each mean of the TSW with a function of population parameter, and other seven components with function of two parameters; TSW and population.
- High reliability and significance of the derived multi-variable predictive models had been shown by the main indicators used.
- Model validation included normal probability plots, histogram of standardized residual plots, scatters plots of the standardized residuals and means of squared prediction errors (MSPR) and demonstrated that the derived models were adequate for SW prediction.
- This research may play a useful role in establishing better solid waste management regarding to waste facilities, healthcare, environmental aspects, collection, generation, transportation and others.

5.2 Recommendations

Public awareness in Palestine needs to be enhanced; stakeholders should create appropriate way to do that weather was it for schools, institutions, or even by public lectures. Young people should understand more about the role of SWM facilities such as landfills, incinerators and recycling facilities. People participation in decision-making of planning is needed in order to make public trust what is being done. More future waste composition studies is recommended to be done and budget needs to be set in order to to improve waste minimization management.

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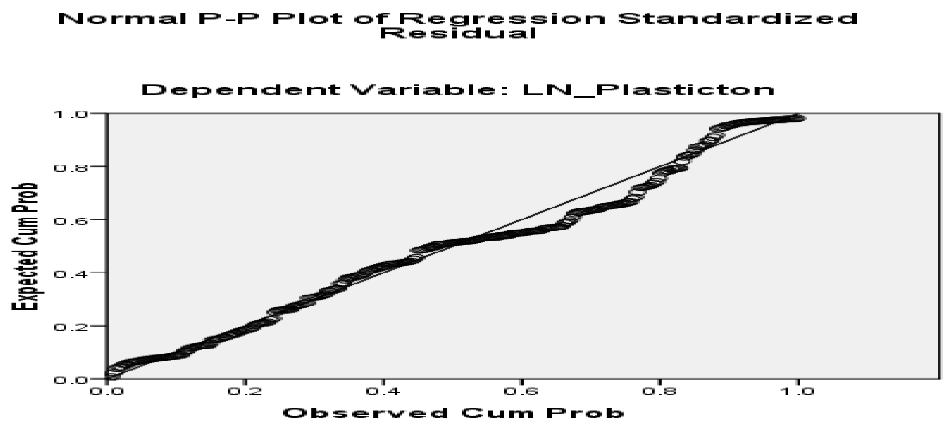
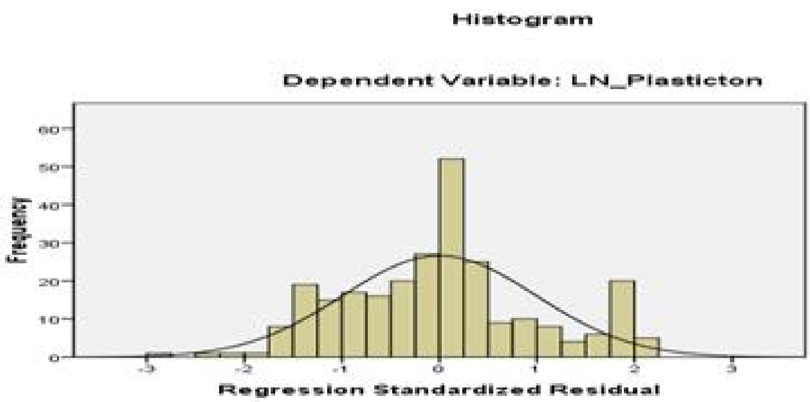
Appendix A

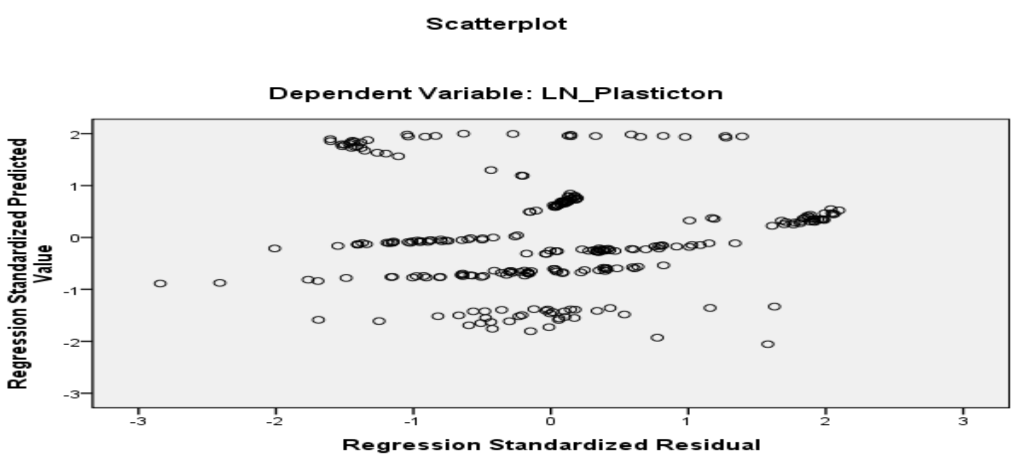
Figures of Normal pp, Histogram and Scatter plots for *ln* (variables)



Normal p-p plot of expected versus observed cumulative probabilities of residuals of $ln(W_{PL})$

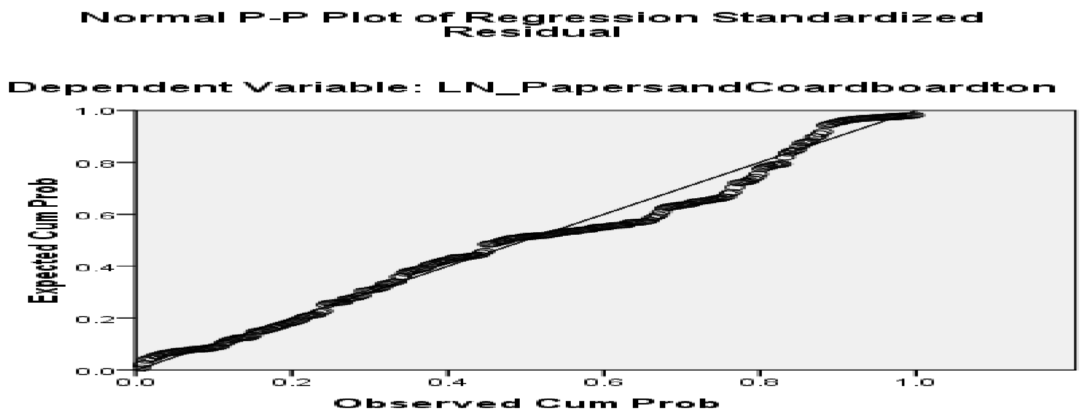


Histogram of standardized residuals for the dependent variable $ln(W_{PL}))$

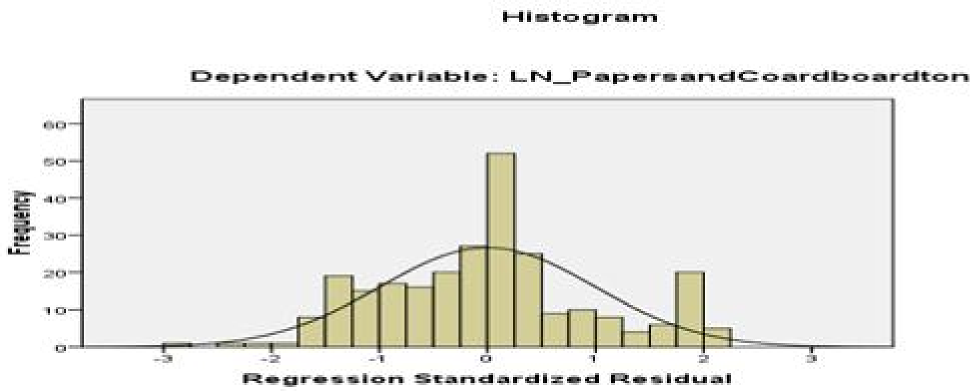


Scatter plot of standardized residuals for the dependent variable $ln(W_{PL})$

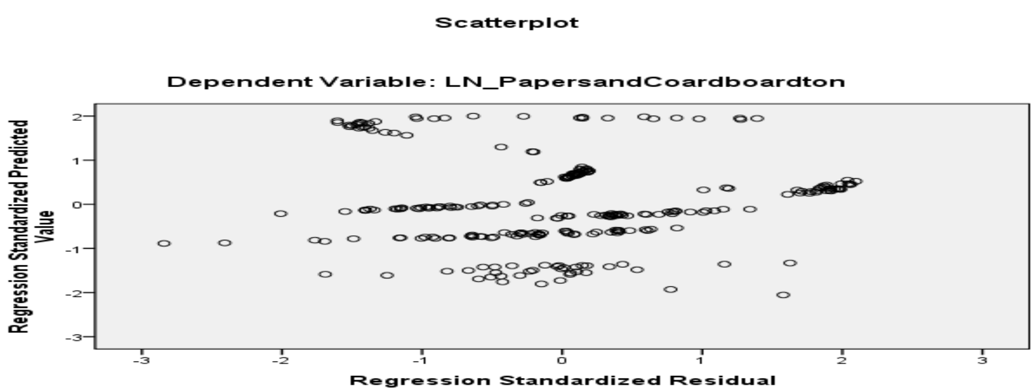
FigureA1: Normal pp plot, Histogram and Scatter plot figures for the dependent variable $ln(W_{PL})$



Normal p-p plot of expected versus observed cumulative probabilities of residuals of *ln*(W_P)

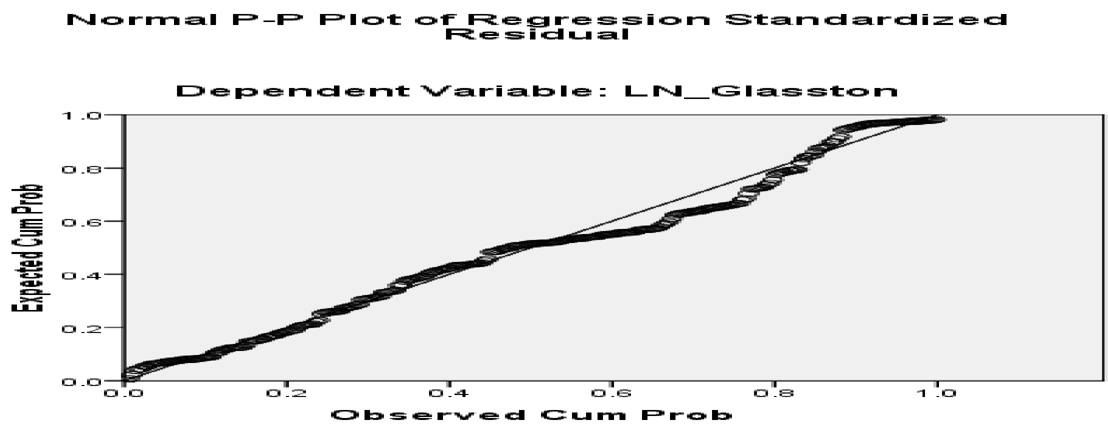


Histogram of standardized residuals for the dependent variable *ln*(W_P)

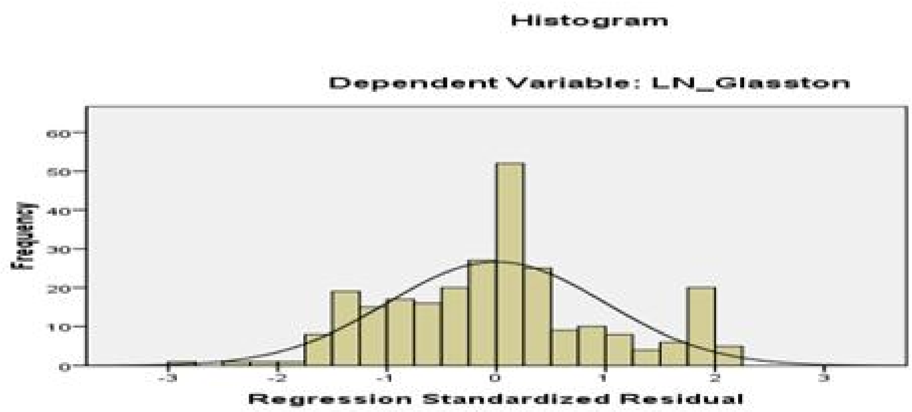


Scatter plot of standardized residuals for the dependent variable *ln (Paper*)

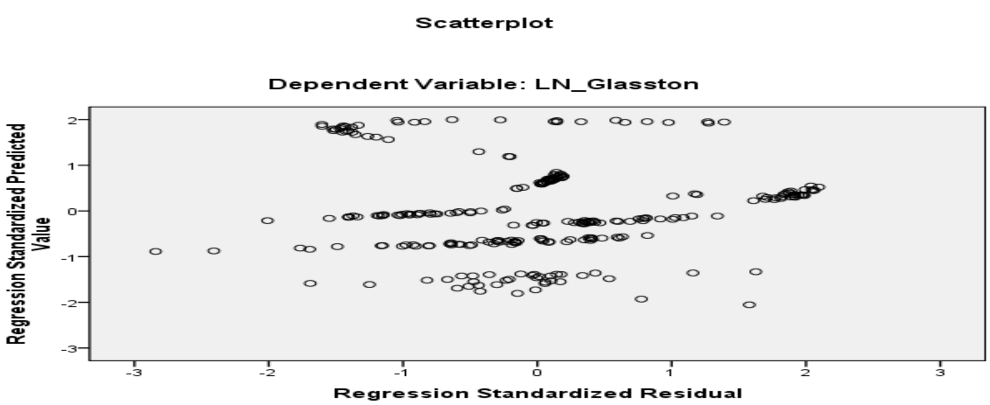
Figure A2: Normal pp plot, Histogram and Scatter plot figures for the dependent variable *ln*(W_P)



Normal p-p plot of expected versus observed cumulative probabilities of residuals of *ln*(W_G)

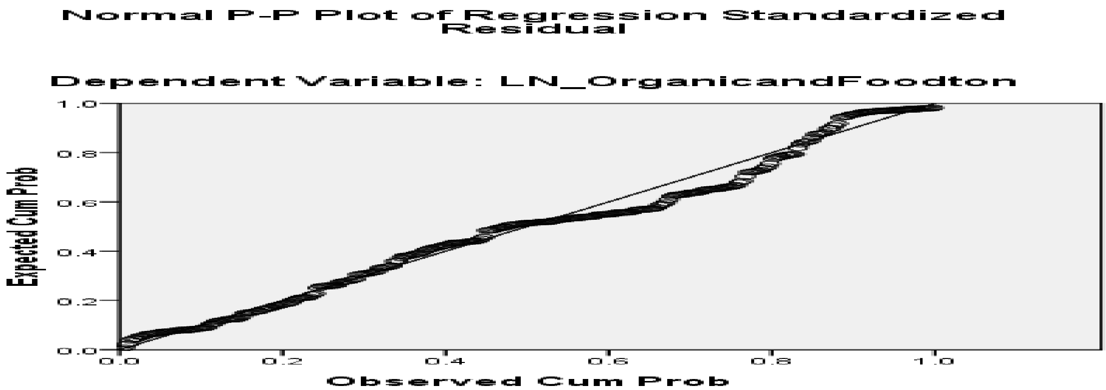


Histogram of standardized residuals for the dependent variable *ln*(W_G)

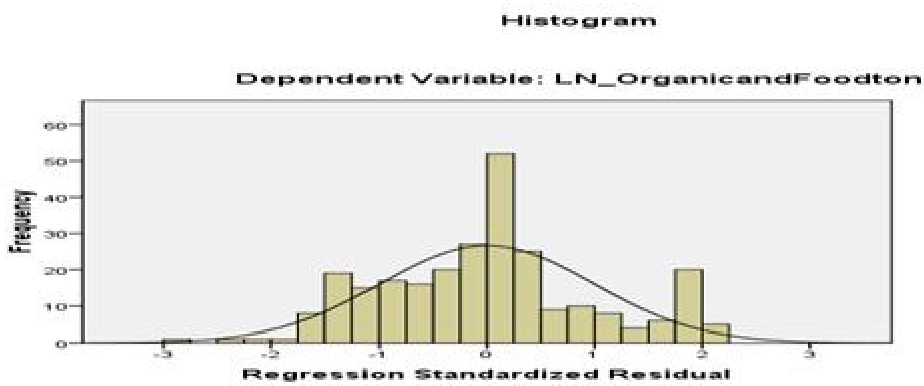


Scatter plot of standardized residuals for the dependent variable *ln*(W_G)

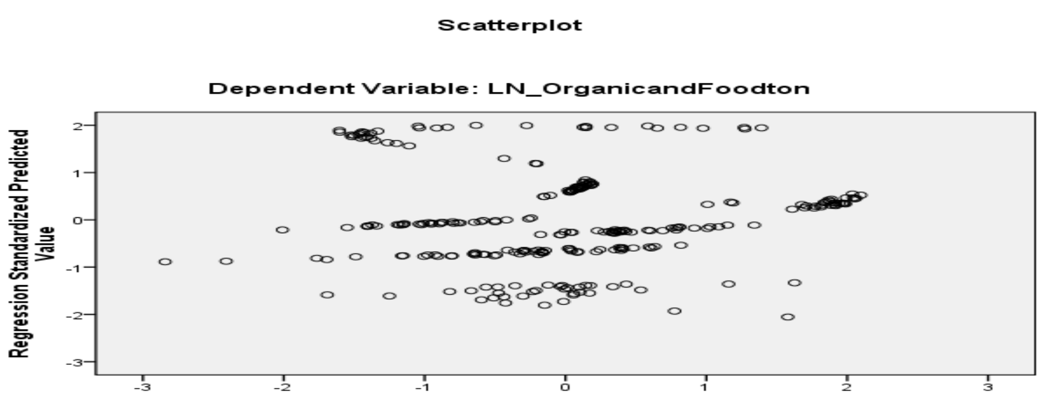
Figure A3: Normal pp plot, Histogram and Scatter plot figures for the dependent variable *ln*(W_G)



Normal p-p plot of expected versus observed cumulative probabilities of residuals of *ln*(W_O)

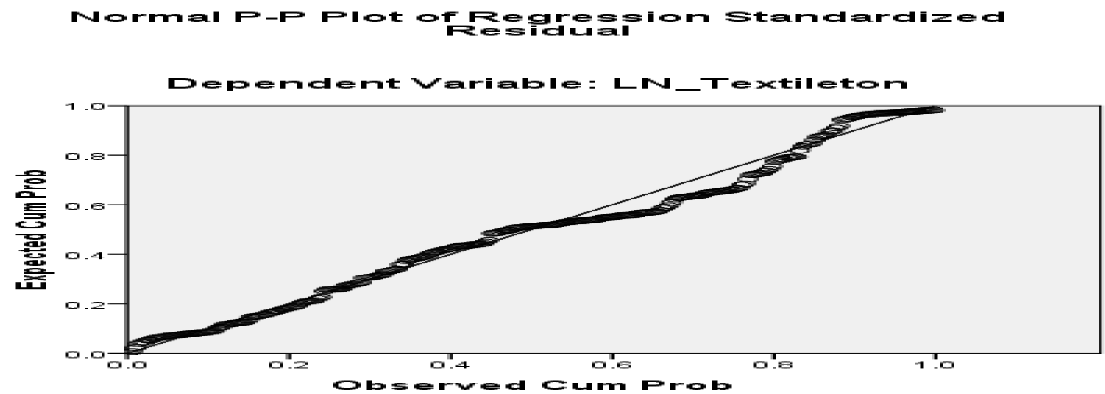


Histogram of standardized residuals for the dependent variable *ln*(W_O)

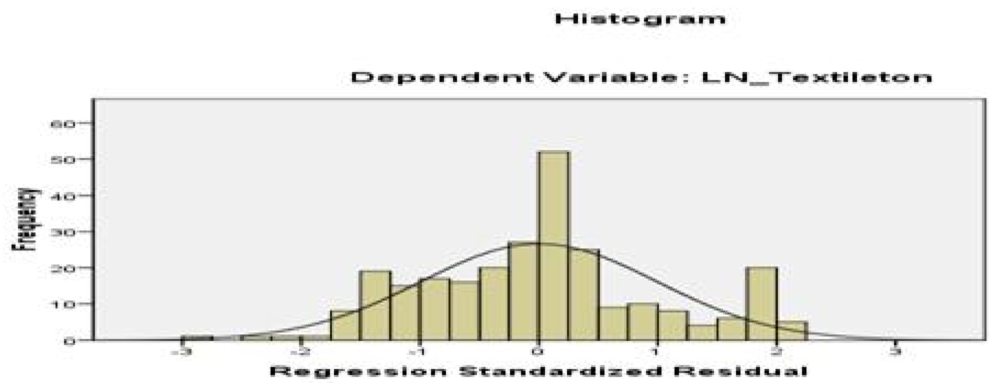


Scatter plot of standardized residuals for the dependent variable *ln*(W_G)

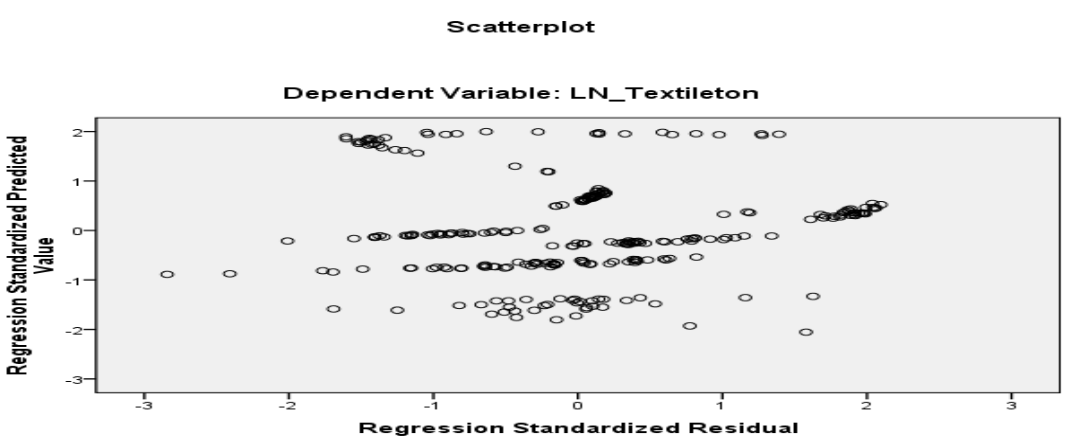
Figure A4: Normal pp plot, Histogram and Scatter plot figures for the dependent variable *ln*(W_O)



Normal p-p plot of expected versus observed cumulative probabilities of residuals of *ln*(W_{Tx})

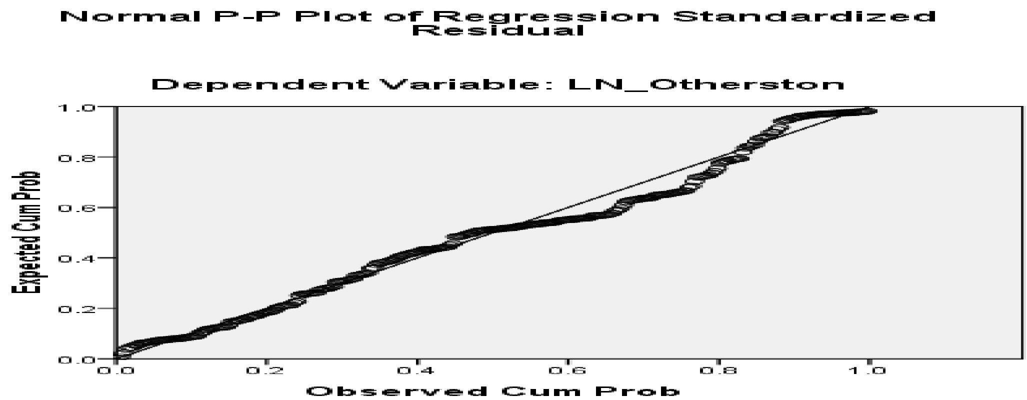


Histogram of standardized residuals for the dependent variable *ln*(W_{Tx})

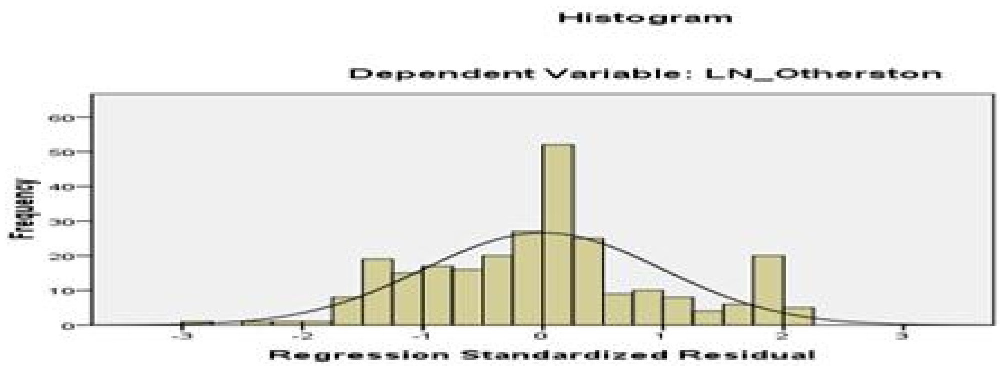


Scatter plot of standardized residuals for the dependent variable *ln*(W_{Tx}).

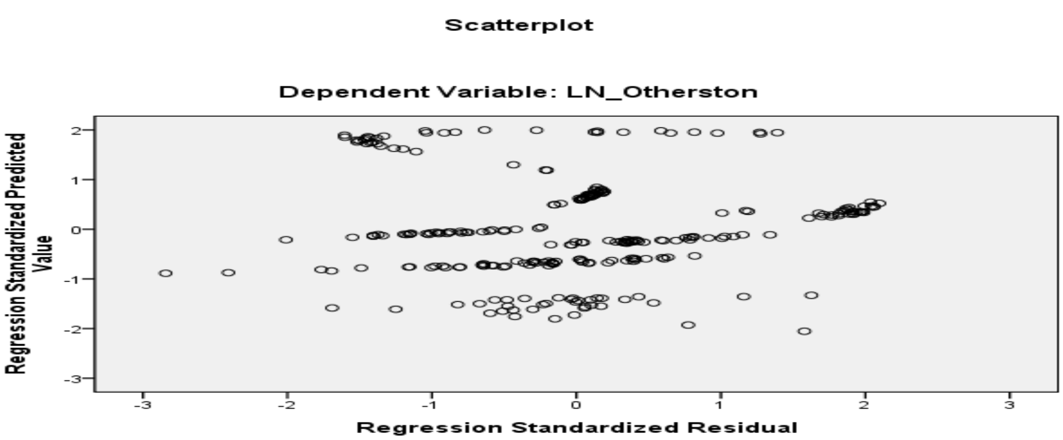
Figure A5: Normal pp plot, Histogram and Scatter plot figures for the dependent variable *ln*(W_{Tx}).



Normal p-p plot of expected versus observed cumulative probabilities of residuals of $ln(W_{other})$



Histogram of standardized residuals for the dependent variable $ln(W_{other})$



Scatter plot of standardized residuals for the dependent variable $ln(W_{other})$

Figure A6: Normal pp plot, Histogram and Scatter plot figures for the dependent variable *ln* (*Other*).

Appendix B

Questionnaire

استبانة حول تخوفات الجماهير تجاه مرافق إدارة النفايات الصلبة

أخي المواطن الكريم، أختي المواطنة الكريمة:

تقوم الباحثة نور السبوع , طالبة ماجستير في هندسة المياه والبيئة – السنة الثانية– في جامعة بيرزيت وتحت إشراف الدكتور عصام الخطيب , بعمل بحث كجزء من متطلبات رسالة الماجستير بعنوان

" نموذج رياضي لتوقع مكونات النفايات الصلبة ومعدل توليدها، وتخوفات السكان تجاه مرافق إدارة النفايات الصلبة في محافظتي نابلس وجنين "

يهدف هذا البحث الى:

1. تطوير نموذج رياضي لتوقع مكونات و معدلات انتاج النفايات الصلبة في التجمعات الفلسطينية في محافظتي نابلس و جنين.
2. تقدير تخوفات السكان و مواقفهم تجاه مرافق ادارة النفايات الصلبة في المحافظتين.

إن استجابتك وموضوعيتك في الإجابة عن هذه الاستبانة ستساعدان في جعل هذا البحث العلمي دقيقاً، لتوصلنا إلى أفضل النتائج التي من شأنها أن تساهم في زيادة الوعي البيئي لدى المواطنين .

شكراً للمساعدة في هذا البحث
مع الاحترام

Part one: Personal identifiable information

V01		Locality name	
V02		Locality type	1. City 2.village 3.camp.
V03		You are	1.Head of the family 2.other member of the family 3.else
V04		gender	1. Male 2. female
V05		age	1.(16-25) 2.(35-26) 3.(45-36) 4.(older than 45)
V06		Income	1. Less than 1000 NIS 2. (1001-2000NIS) 3.(2001-3000) 4.(more than 3000NIS)

Part two: Informatics data

First section:

Please suppose waste disposal facility (incineration facility, landfill, or material recovery facility) planned to be constructed in town where you live, concerning each item below, please select a relevant choice.

How worried are you from:

V07		Air pollution	1. Not worried 2.slightly worried 3.worried 4.very worried 5.not sure
V08		Water pollution	1. Not worried 2.slightly worried 3.worried 4.very worried 5.not sure
V09		Soil pollution	1. Not worried 2.slightly worried 3.worried 4.very worried 5.not sure
V10		Forest harm	1. Not worried 2.slightly worried 3.worried 4.very worried 5.not sure
V11		Animal and plant harm	1. Not worried 2.slightly worried 3.worried 4.very worried 5.not sure
V12		Flies, rodents, crows	1 Not worried 2.slightly worried 3.worried 4.very worried 5.not sure
V13		Traffic accidents caused by collection vehicles	1 Not worried 2.slightly worried 3.worried 4.very worried 5.not sure
V14		Traffic congestions caused by collection vehicle	1. Not worried 2.slightly worried 3.worried 4.very worried 5.not sure
V15		Stench and noise of the landfills	1 Not worried 2.slightly worried 3.worried 4.very worried 5.not sure
V16		Stench and noise of collection vehicle	1. Not worried 2.slightly worried 3.worried 4.very worried 5.not sure
V17		Influence on farm products	1. Not worried 2.slightly worried 3.worried 4.very worried 5.not sure
V18		Deterioration of living environment	1. Not worried 2.slightly worried 3.worried 4.very worried 5.not sure
V19		Decrease of property value	1.Not worried 2.slightly worried 3.worried 4.very worried 5.not sure

Second section:

in SWM How important to you personally is each of the following

V20		The status and effectiveness of the facility	1.Very important 2.slightly important 3.not important 4.not sure
V21		Information disclosure on operation/management	1.Very important 2.slightly important 3.not important 4.not sure
V22		Reliability of technology	1.Very important 2.slightly important 3.not important 4.not sure
V23		Financial stability of facility owner	1.Very important 2.slightly important 3.not important 4.not sure
V24		clarify the mechanism and the procedures in the facility	1. .Very important 2.slightly important 3.not important 4.not sure
V25		Initial cost	1 .Very important 2.slightly important 3.not important 4.not sure
V26		Operation and maintenance cost	1 .Very important 2.slightly important 3.not important 4.not sure
V27		Post closure property value	1 .Very important 2.slightly important 3.not important 4.not sure

.

Part three: What do you think about:

V28		Receiving other city's waste	1.Very unfair 2.slightly unfair 3.not unfair 4.not sure
V29		Construction of facility in the neighborhood (1 km)	1.Very unfair 2.slightly unfair 3.not unfair 4.not sure
V30		Existing of incinerator 1km from your home	1.Very unfair 2.slightly unfair 3.not unfair 4.not sure
V31		Existing of landfill 1km from your home	1.Very unfair 2.slightly unfair 3.not unfair 4.not sure
V32		Existing of recycling facility 1km from your home	1.Very unfair 2.slightly unfair 3.not unfair 4.not sure

Part four:

V33		Do you hate waste	1. Very much 2.not much 3.not at all 4. Not sure
V34		Do you concern about recycling	1. Very concerned 2.concerened 3.not concerned 4.not sure
V35		Do you have willingness to participate in planning	1. Yes 2. No 3.not sure
V36		do you have experience of visiting an SWM facility	1. Yes 2. No 3.I don't remember

الملخص

تتطلب مرافق النفايات الصلبة منشآت ان تكون مقبولة اجتماعيا، لأجل ذلك و كمحاولة للفت انتباه اصحاب القرار الى اهمية تقييم الدعم الاجتماعي لمثل تلك المرافق تم انجاز هذا البحث. يمكن ايضا المساهمة في تقليل النفايات و تحسين كفاءة استخدام الموارد من خلال معرفة طبيعة النفايات التي يتم انتاجها في المجتمع، ويؤثر نوع النفايات على الصحة العامة والبيئة المحيطة، وبالتالي فإن الحصول على معلومات جيدة متعلقة بمكونات النفايات يساعد ايضا في تحسين التخطيط وتحسين ادارة مرافق النفايات الصلبة، مثل تحسين فعالية منشآت اعادة التدوير عندما يتم معرفة مكونات النفايات التي يمكن اعادة تدويرها.

تدور هذه الدراسة حول تطوير نموذج رياضي للتنبؤ بكميات النفايات الصلبة المستقبلية ومكوناتها في فلسطين لكل من المدن و القرى و المخيمات لمحافظتي نابلس و جنين، و لتقييم تخوفات السكان ومواقفهم تجاه منشآت النفايات الصلبة ومرافقها.

تم اعداد استبيان لدراسة تخوفات السكان ومواقفهم استنادا الى ادبيات البحث العلمي، حيث تم توزيع الاستبيان في المحافظتين المذكورتين بعد حساب حجم العينة لكل مناطق الدراسة (الحضر، والريف والمخيمات) على اسس علمية، كما تم جمع معلومات حول كميات النفايات الصلبة للأعوام 2011–2013 و كذلك اعداد السكان، بالإضافة إلى جمع معلومات حول مكونات النفايات الصلبة ونسبها. وتم استخدام برامج الحزم الاحصائية (SPSS) و مايكروسفت اكسل لاستخراج النتائج.

عندما تم تحليل الصفات العامة للمجيبين على الاستبيان وجد ان غالبيتهم كانت رجالا وأن 32.8% منهم كانت تتراوح اعمارهم بين 36–45 سنة، و ان 65.2% تكونت لديهم صورة سيئة حول النفايات و25% منهم لديهم تجربة في زيارة منشئة نفايات صلبة واحدة على الاقل.

وجدت خمسة عوامل رئيسية ذات اعتبار عندما درست العلاقة مع تخوفات السكان وصفت كالآتي الإزعاج، والتلوث، والتخطيط، وادارة المنشأة والسكن. كما اشار التحليل الاحصائي الى الاختلاف في مستويات الوعي حسب العمر والجنس ومكان الإقامة. اظهر تحليل التمايز تضارباً بين الاثار المتوقعة وبين ما يعتقده السكان. اما بالنسبة للعلاقة مع سمات المجيبين على الاستبيان فأظهرت النتائج أن ما بين 67% إلى 69% من الذين كان لديهم توجه رافض لزيارة منشآت النفايات الصلبة لم يزوروا واحدة منها من قبل، بينما تبين أن 51% إلى 56% من الذين كان لديهم توجه لصالح المنشأة كانوا قد

قاموا بزيارة منشئة واحدة على الأقل؛ مما يشير الى ان المواقف تجاه منشآت النفايات الصلبة له علاقة بزيارتها والعكس صحيح.

اشارت الدراسة الى ان متوسط الانتاج اليومي للنفايات الصلبة في منطقة الدراسة كان 0.95 كغم\الفرد\ اليوم. تم اشتقاق سبعة نماذج رياضية من خلال تحليل الانحدار المتعدد لتقدير كمية النفايات الصلبة المتولدة يوميا، واظهرت المؤشرات الاحصائية ان النماذج كانت عالية التنبؤ، وكان عامل التضخم (VIF) اقل من القيمة الحرجة (10)، و كانت قيمتا متوسط الخطأ التربيعي (MSE) و متوسط الخطأ التربيعي المتوقع (MSPR) متقاربتين حيث لم يتجاوز الفارق 0.001، وبالتالي اظهرت المؤشرات السابقة ان النماذج كانت ذات دلالة احصائية عالية. يذكر ان هذا النموذج الرياضي قد يساعد اصحاب القرار لوضع خطط افضل لإدارة النفايات و مرافقها.