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M.Sc. Thesis

Behavioral and Attitudes Factors in Construction Waste Management in the Southern West Bank of Palestine

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Date of Defence: 28 /10 / 2010

Dedication

To all of my family, to my home land Palestine that needs all efforts to be built, I dedicate this valuable work.

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I would like to express my sincere thanks and appreciation to my supervisor Dr. Issam Al-Khatib for his guidance throughout this research.

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المستخلص

مع بداية الاهتمام بإدارة النفايات الصلبة في الاراضي الفلسطينية بشكل عام و جنوب الضفة الغربية – الاكثر سكانا" – على وجه الخصوص، فإنه من الضروري البدء بالاهتمام بالنفايات الانشائية بهدف الوصول الى نظام متكامل لادارة النفايات الصلبة، مع الاخذ بعين الاعتبار أن التوجهات و السلوك حجر أساس في إدارة النفايات الانشائية، و فهمها يساهم في حل الكثير من مشاكل إدارة النفايات. و لهذا فإن موضوع البحث يركز على العوامل التي تؤثر على التوجهات، و السلوك، و المعيقات في مجال إدارة النفايات الانشائية، و إمكانية التطوير لهذا القطاع. و من أجل تحقيق هذا الهدف تم استخدام استبيان لجمع المعلومات من المقاولين المصنفين ضمن تخصص الأبنية. و قد أظهرت الدراسة أن تصنيف المقاول، و اتباع وسائل تقليل النفايات، و عدد العمال غير المهرة هي عوامل شديدة التأثير على توجهات المقاولين في إدارة النفايات الانشائية. في حين أن اتباع وسائل تقليل النفايات، و فهم تأثير النفايات الإنشائية على البيئة، و عدد العمال المهرة، و غير المهرة، و تدريب المشرفين الميدانيين هي عوامل تؤثر بشدة على سلوك المقاولين في إدارة النفايات الإنشائية. كما وبينت الدراسة أن قلة مكبات النفايات الانشائية هي المشكلة الرئيسية التي تواجه المقاولين في قطاع إدارة النفايات الإنشائية مع وجود إمكانية التطوير في هذا القطاع، حيث أبدى المقاولون قابلية الدفع مقابل تحسين خدمة الجمع و التخلص، و لكن هذا التطوير بحاجة الى إطار تشريعي قوي. و أخيرا" خلصت الدراسة بالتوصية بتحديث القوانين؛ من أجل خلق نظام متكامل و شامل لإدارة النفايات الإنشائية و ينسجم مع إدارة النفايات الصلبة بشكل عام.

Abstract

By the beginning of taking steps toward solid waste management in Palestine in general, and the south of the West Bank, the largest populated area, in particular, it is an important issue to start focusing on construction waste (CW) for the purpose of integrity in the waste management, taking into account that attitudes and behavior are corner stones in the construction waste management (CWM), and their understanding can contribute to solving many waste management problems. This study focuses on behavioral and attitudes factors, challenges in the CWM and possibilities of development. For this purpose, a structured questionnaire was used for data collection from the local contractors who are classified under the category of buildings construction. The findings showed that contractor size (classification), following waste reduction practices, and number of unskilled labors, are significant factors explaining contractors' attitudes toward waste management; while following waste reduction practices, perception of CW environmental impacts, number of skilled and unskilled labors, and training of field supervisors are significant factors affecting contractors' behavior regarding waste management. The study showed that lack of proper landfills is the main challenging problem in CWM. Also it is concluded that future development in this concern is possible as contractors have the willingness to pay for improvements in waste collection and disposal services; but it needs strong legislation framework. And finally, the study recommends upgrading the current legislations to create integrated and comprehensive CWM system.

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List of Acronyms:

CW:	Construction Wastes.
EMP:	Environmental Management Plan.
EQA:	Environmental Quality Authority.
GDP:	Gross Domestic Product.
LRM:	Logistic Regression Model.
MoEA:	Ministry of Environmental Affairs
MoHPW:	Ministry of Housing and Public Works.
PNA:	Palestinian National Authority.
PCBS:	Palestinian Central Bureau of Statistics
PCU:	Palestinian Contractors Union.
PEL:	Palestinian Environmental Law.
UK:	United Kingdom.
UNEP:	United Nations Environmental Program.
USA:	United States of America.

1. Chapter One: Introduction

1.1 General Background

Construction waste is composed of the residues of materials from construction and demolition activities. It is a complex waste stream, made up of a wide variety of materials such as: excavation materials (earth, gravel, clay, rocks …etc), building materials (concrete, stone, concrete masonry units, cement, steel …etc), roads construction materials (asphalt, gravel, bitumen, curb stones …etc), and other construction materials such as: wood, plastics, metals…etc. These wastes are generated during the project lifecycle that includes construction phase, operational phase and demolition. The amount and type of such wastes depends on factors such as the stage of construction, type of construction, and practices on site (Fatta et al, 2003).

Globally, construction wastes is becoming a serious environmental problem in many large cities in the world (Ferguson et al., 1995; Wong and Tanner, 1997; Shen et al., 2000; Smallwood, 2000; Chen et al., 2002; Shen et al., 2002; cited in Begum et al, 2006a). It frequently makes up 10 – 30% of the waste received at many landfill sites around the world (Fishbein, 1998; Begum, 2006a; Wang et al., 2010). Therefore, construction wastes management became an important issue to reduce the demand on landfill sites, seize the natural resources and reduce environmental pollution.

Construction works include a wide variety of activities that pose negative environmental impacts and create health risks. Such activities include but not limited to: excavations, concrete casting, plastering, welding, wood sawing, steel cutting, cleaning of construction site, isolation works, demolition works, stone cutting, pointing, painting …etc. Since the construction sector is still labor intensive, attitudes and behavior of the workers will affect the generation of the waste.

On the other hand, since the Palestinian National Authority (PNA) ruled over the West Bank and Gaza strip, the construction sector starts developing in parallel to the reconstruction movement after Oslo Accord. New construction companies were established, a lot of development projects were implemented and the contractors union was established to regulate the sector work and to add new legal tint to the contracting companies.

Construction wastes management receives less attention in many countries around the world and especially developing countries due to financial constraints. In Palestine, construction wastes management is totally ignored. The built up mounds of construction wastes along the rural and external roads in Palestine is the best indicator for none taking care of these wastes management. Although the Palestinian community is considered as one of the lowest economical situations in the area and construction wastes management was not a pressing issue in the past, the situations through which the community moves through during the past few years, indicates the importance of construction waste management. Palestine was subjected to home demolition policy, public building destruction, and infrastructure damage by the occupation followed by the reconstruction movement. Moreover, the Israeli's war on Gaza strip in 2008 / 2009 left huge damages in houses, public buildings and other infrastructure sectors. This cycle of destruction and upgrading activities produces large amounts of construction wastes.

All of the above mentioned facts, and especially the output of the Israeli's war on Gaza strip in 2008 / 2009 (large amounts of demolition residue associated with the siege and lack of construction materials), made up the voices to raise in the news calling for making use of the demolition wastes through the reuse of such wastes in reconstruction.. Therefore, it is an important issue to study and understand the situations of the construction wastes, contractors' attitudes and behavior regarding waste management in the construction industry; and Hebron and Bethlehem governorates were selected as a study area for this purpose.

1.2 Research Objectives

1. To determine the impact of contractors attitudes and behavior on construction waste generation and disposal.
2. To assess the challenges toward recycling and reuse of construction wastes and horizon of future development.
3. To find out the factors affecting contractors attitudes and behavior toward construction wastes minimization, proper handling, recycling, reuse, and final disposal.

1.3 Scope and Organization

This research study consists of six chapters. Chapter one titled as introduction and includes general background, research objectives and scope of the study. Chapter two represents the literature review. Chapter three includes description of the study area. Chapter four describes the research methodology. Chapter five includes data analysis, results and discussion. And chapter six provides conclusion and recommendations.

2. Chapter Two: Literature Review

2.1 Construction Waste Generation and Disposal

The generation of construction waste is a result of excavation activities, construction, renovation, and demolition activities (Jaillon et al., 2009; Rocha and Sattler, 2009); and linking directly to the number of projects under implementation. In Catalonia (Spain), the current construction wastes disposed of in landfills occupy a volume which exceeds that occupied by domestic wastes (Ortiz et al., 2010). It has been estimated that the construction waste generation is about 500 – 1000 kg per capita per year (Lauritzen and Hahn, 1992; cited in Kartam et al, 2004). On the other hand, 20 – 50 kg of waste is produced per each constructed squared meter of the building flooring, and 1 – 2 ton per square meter demolished of building flooring (Lauritzen, 1994; cited in Kartam et al, 2004). Construction waste generation in 1996 was 300 kg/cap in Austria, over 500 kg/cap in Denmark, about 2600 kg/cap in Germany and about 900 kg/cap in the Netherlands (Brodersen et al, 2002; cited in Kofoworola and Gheewala, 2009).

Palestine experienced severe political situations that leaded to conflict and resulted in damage of the infrastructure and constructions. According to a study carried out by the National and International Relations of Palestinian Liberation Organization, 13,400 housing units were completely destroyed by the Israeli occupation forces from the year 2000 and until the end of May 2009 (PCBS, 2009b). 20 million squared meter of building have been built between 1994 and 2002 (Ministry of Housing and Public Works – MoHPW, 2009). However, in the last five years, 7,951 houses were totally destroyed and 63,000 houses were partially damaged by the Israeli occupation forces in the Palestine (MoHPW, 2009). In addition, 250,000 housing units are needed to solve the housing problem in Palestine (MoHPW, 2009).

However, quantification of construction waste streams are difficult in general (Zaharieva et al., 2003), and in Palestine in particular is a bit difficult due to the uncontrolled disposal. Up-to-date, there are no published researches or studies about the produced quantities of the construction waste from building and demolition activities in Palestine; moreover; there are no active regulations to control its disposal. Observations indicate that the disposal of the construction waste in Hebron and Bethlehem governorates is taking several forms: in municipal dumpsites, beside roads, on private dumpsites … etc. Both Hebron and Bethlehem governorates contain 17 municipal solid waste uncontrolled dumpsites; some of them are abandoned, while others are active, which are sometimes used for construction waste disposal. Figures 2.1 to 2.4 below show the behavior in construction waste disposal in Hebron and Bethlehem.

Figure 2.1: Random construction waste disposal in Hebron

Figure 2.2: Municipal construction waste disposal site - Hebron Municipality

Figure 2.3: Private construction waste disposal site – Hebron

Figure 2.4: Construction waste disposal at domestic solid waste dumpsite - Al-Daheryyah.

2.2 Construction Waste Related Environmental Impacts

In general, construction wastes are composed of wide range of inert and non-inert materials (Poon et al., 2001; Jaillon et al., 2009) with potential existence of trace amounts of hazardous chemicals, primarily organic compounds or heavy metals. If not properly managed, construction waste flow would result in loss of natural resources and premature filling of available landfill volumes (Zaharieva et al., 2003), and could result in pollution of terrestrial and aquatic environment. Surface water, ground water, air, flora and fauna are susceptible to adverse environmental impacts, where construction waste is disposed in random. Wang et al (2010) stated that the annual huge amount of construction waste generated in various construction activities has long been an environmental problem around the world, and one of the major contributors to the environmental degradation. In China, the majority of the waste has not been well processed that caused severe ecological damage and environmental pollution (Wang et al., 2010). Construction waste also represents a cost to the environment and can threaten the environmental resilience (Kulatunga et al., 2006). Robin and Poon (2009) stated that the construction industry generates a large amount of waste, which pollutes the environment. The environmental effects depend directly on the quantity and quality of the generated wastes, which in turn depend on the type of the construction project (Tam et al., 2007, cited in Begum et al., 2009), and the behavioral of the workers (Lingard et al., 2001, cited in Begum et al., 2009; Begum et al., 2007).

When the construction waste stream contains hazardous chemicals such as paints, tar (Fatta et al., 2003), solvents and additives …etc. surface water is to be polluted through the storm water erosion and carryover these substances to the nearest water course. However, the leaching of such chemicals through the soil strata could reach and pollute the groundwater. In addition, construction waste contains non toxic chemicals such as chloride, sodium, sulphate and ammonia (Townsend and Kibert, 1998); if these chemicals reach the surface water via run-off or groundwater through filtration will result in the degradation of the water quality.

The uncontrolled disposal of construction waste also creates degradation in the air quality through the dust emissions and increase of particulate matter. Respiratory diseases are direct result of the dust emissions from waste mound where it is disposed. However, agriculture and grazing areas will be negatively affected, even by dust emissions or the spread of the waste and reduction of the land area for such purposes. Moreover, uncontrolled disposal creates aesthetic problems and deterioration in the general view of the area. Illegal disposal of construction waste creates severe environmental, social and economic impacts (Sampaio et al., 2009).

2.3 Construction Waste Management

The management of the waste is straight chain starts from the waste generation and ends up with the final disposal. Among the waste management options, in descending order, are: waste reduction, reuse, recycling and disposal (Faniran and Caban, 1998 cited in Begum et al., 2006b). The "3Rs" principle (Reduce, Reuse and Recycle) are collectively representing a waste minimization strategies (Tam, 2009; Wang et al., 2010). However, the most effective method of reducing the environmental impact of the construction waste is primarily preventing its generation and reducing it as much as possible (Esin and Cosgun, 2007). On the other hand, proper construction waste management is reflected from economical and environmental point of view and lead to community benefits. The economical and environmental benefits to be gained from waste minimization are enormous (Guthrie, 1999 cited in Begum et al, 2006a). Waste minimization means efficient use of construction materials as well as reduction in contractors' financial burden, increase the lifetime of the landfills and reduces potential environmental health risks associated with construction waste handling and disposal. Reuse and recycling of construction materials also minimize the amount of waste that is to be land filled and cost of disposal as well. Despite reuse and recycling may have limitations, depending upon reuse function and recovery costs for recycling, 50% - 80% of construction waste is reusable or recyclable (Bossink and Brouwers, 1996 cited in Rodriguez et al., 2007). Reuse and recycling in practice in many countries worldwide, for example, Germany has the highest recovery rate in comparison to Hong Cong, Australia, Japan, USA and UK (Tam and Tam, 2005; cited in Esin and Cosgun, 2007). Recycling in Denmark is more than 80%, in Luxembourg 10%, and 30 – 50% in Germany, the Netherlands, Finland, Ireland and Italy (Brodersen et al., 2002; cited in Kofoworola and Gheewala, 2009). Today, 80% - 90% of the total construction waste amount is economically feasible for recycling (Lauritzen, 1998; cited in Begum, et al., 2006a). In general, to decide which the suitable construction wastes management system, it is very important to assess the feasibility of the above-mentioned options. In addition, to prevent the construction waste generation, it is important to first determine the reasons behind its generation (Esin and Cosgun, 2007).

In developing countries, construction waste management still represents a great challenge. The culture of the construction industry and the resistance to change are significant challenges to effective waste minimization (Teo and Loosemore, 2001; cited in Osmani et al., 2008). Agamuthu (2008) stated that there is still several challenges towards sustainable management of construction waste. First, lack of explicit legislations that can control the whole process of construction waste: generation, reuse, recycling and final disposal. Second, categorization of construction waste, which is still treated as municipal solid waste despite the differences in physical and chemical properties of both; that lead to financial commitments necessary for sustainable waste management. Thirdly, contingency management especially where large amounts of construction waste is produced due to destructive events such as war or earthquake. And finally, reframing construction waste to be used as a source of raw materials, and controlling its disposal in landfills, which lead to conservation of finite natural resources.

Construction waste management can be influenced by several factors. Among these factors: the economic situation of the country, policy restrictions, environmental and health impacts, quantity of the waste, opportunities of source reduction, reuse and recycling. Waste reduction at the source seems to be one of the most important factors, and mostly is influenced by attitudes and behavior of contractors and workers. Attitudes to reuse materials among constructors and consumers as well as the establishment of market place for recycled goods to enable consumers to look for, is a key issue in the construction waste management (Klang et al., 2003). Education and awareness is also another factor, so the high level of construction related education and experience among the employees indicates high level of awareness regarding construction waste management (Begum, 2006c). On the contrary, excessive use of natural resources and production of large amount of construction wastes that is rarely recycled is a result of lack of awareness of resource-efficient construction practices (UNEP, 2000; cited in Nitivattananon and Borongan, 2007).

2.4 Legislation and Policy Framework

There are no public services for the construction waste collection and disposal in Palestine; and the service is out of the scope of local authorities, who are mostly responsible for municipal solid waste management. The current practices are individuals and based on the waste producer is responsible for its collection transport and disposal. Construction waste management regulation is located within the role of the Palestinian Environmental Quality Authority (EQA). The Palestinian environmental law has been issued since 1999, which consisted from 82 articles, is talking about the environment in general; and about the solid waste in articles "7, 8, 9 and 10". Construction waste was mentioned in article 10 as follows: "all agencies and individuals, in conducting any digging, construction, demolition, mining or transportation debris and sands by such activities, shall commit themselves to take all necessary precautions for safe storage and transportation of such materials to prevent any environmental pollution" (EQA, 1999). This statement is general and hasn't been detailed enough or described the ways or procedures through which agencies and individuals can adhere to, to prevent any further environmental pollution. Moreover, the statement is talking about the prevention of pollution only through the storage and transportation of the construction waste and is not giving any attention to construction waste minimization techniques, collection, separation and disposal. However, the law said that the Ministry of Environmental Affairs (MoEA) in cooperation with other specialized agencies shall prepare a comprehensive action plan for solid waste management on the national level. Although the solid waste management programs have been initiated in the West Bank by the construction and operation of Zahret Al-Finjan sanitary land fill for the north, and Al-Minyah sanitary landfill (in the procurement phase) for the south, the construction waste is not included in these programs and is given no attention and still ignored by the competent authorities. In addition, the environmental law remains as it is without any modifications to regulate the ongoing activities; and set down the basis for a comprehensive solid waste management system.

2.5 Attitudes and Behavior in the Construction Industry

Attitude is a feeling toward specific object, which could be positive or negative, and can help the humans to categorize, structure and prioritize the world around them. Attitudes help people to define how they perceive and think about others and how they behave toward them (Wayne State University, 2004; cited in Kulatunga et al, 2006). In terms of attitudes development, there are two thoughts (Wayne State University, 2004; cited in Kulatunga et al, 2006):

a- By changing the environment, in which matters are arranged so that people have to behave in a certain manner, then eventually their attitudes will change in line with that way.

b- By changing attitudes, in which peoples' behavior would change in accordance to the change in their attitudes.

Attitudes refer to an individual's assessment of the advantages and disadvantages of performing a particular behavior (Tudor et al., 2007). Attitude also is based on a person's positive or negative evaluation on consequences of a given behavior and personal beliefs about the consequences as well (Teo and Loosemore, 2001; cited in Wang and Yuan, 2010). Behavior is a positive or a negative action toward specific subject (satisfactory or dissatisfactory), and can be greatly affected by the attitude. Frequently, behavioral decisions are based on attitudes, whether consciously or not (Fabrigar, 2004 cited in Begum et al., 2009). Moreover, the world conservation strategy (1991) stipulate nine principles of the sustainable society, in which changing attitudes and practices represent the 6th item of these principles (Robin and Poon, 2009). Therefore, changing attitudes and behavior of individuals, communities and the public sector is one of the key issues toward achieving sustainable development. In addition, the attitudes and behavior of contractors and workers influence the construction waste generation and considered as one of the most important variable element in the construction waste management. The construction waste generation is mostly depends on the type of the activity, the amount of building materials used and the labor intensity. Labor-intensive nature of construction activities means that behavioral impediments are likely to significantly affect waste level generation (Teo et al., 2000 cited in Begum et al., 2009). Moreover, attitudes and behavior differ from one contractor to another depending on the size of the construction company; and from country to another depending on the economic status and available technology. Begum et al. (2009) concluded that small contractors showed more satisfactory behavior regarding waste management (i.e. more likely to explore waste management) than large contractors.

Attitudes and behavior of contractors in the construction industry are affected by several factors. The important factors that affect contractors attitudes toward waste management include: contractor size, source reduction, reuse and recycling measures, frequency of waste collection, staff training and waste disposal method; on the other hand, employees construction education, contractor experience in construction works, source reduction measures, reuse of materials and waste disposal behavior, are the most significant factors that affect contractors behavior on waste management (Begum et al., 2009). Wang and Yuan (2010) categorized the factors that affect contractors risk attitudes into four groups: knowledge and experience, contractors' character (qualities and features that distinguish contractor from another like values, morals …etc), personal perception, and economic environment (contractors' economic status and external economic conditions).

3. Chapter Three: Description of the Study Area

3.1 The Study area

The area under study is the southern part of the West Bank, which consists of Hebron and Bethlehem governorates in the Palestine. Both governorates were considered and treated as one zone due to short separation distance, contracting inter-relationships and almost similarity in the entire situations as well. In addition, only the sector of building construction was considered, because of its largest intensive labors and different and variability (quantitative / qualitative) of materials involved.

3.2 Location

Hebron and Bethlehem are located in the southern part of the West Bank (see figure 3.1 and 3.2). Bethlehem is located in between Jerusalem and Hebron, at about 10 km south of Jerusalem, and 25 km to the north of Hebron. The total area of the governorate is about 608 km^2 (ARIJ, 2009a), and highest point is at an altitude of 765 meters above sea level (Wikipedia, 2010). In addition, around 35 Palestinian towns and villages are located within the borders of Bethlehem governorate (Wikipedia, 2010).

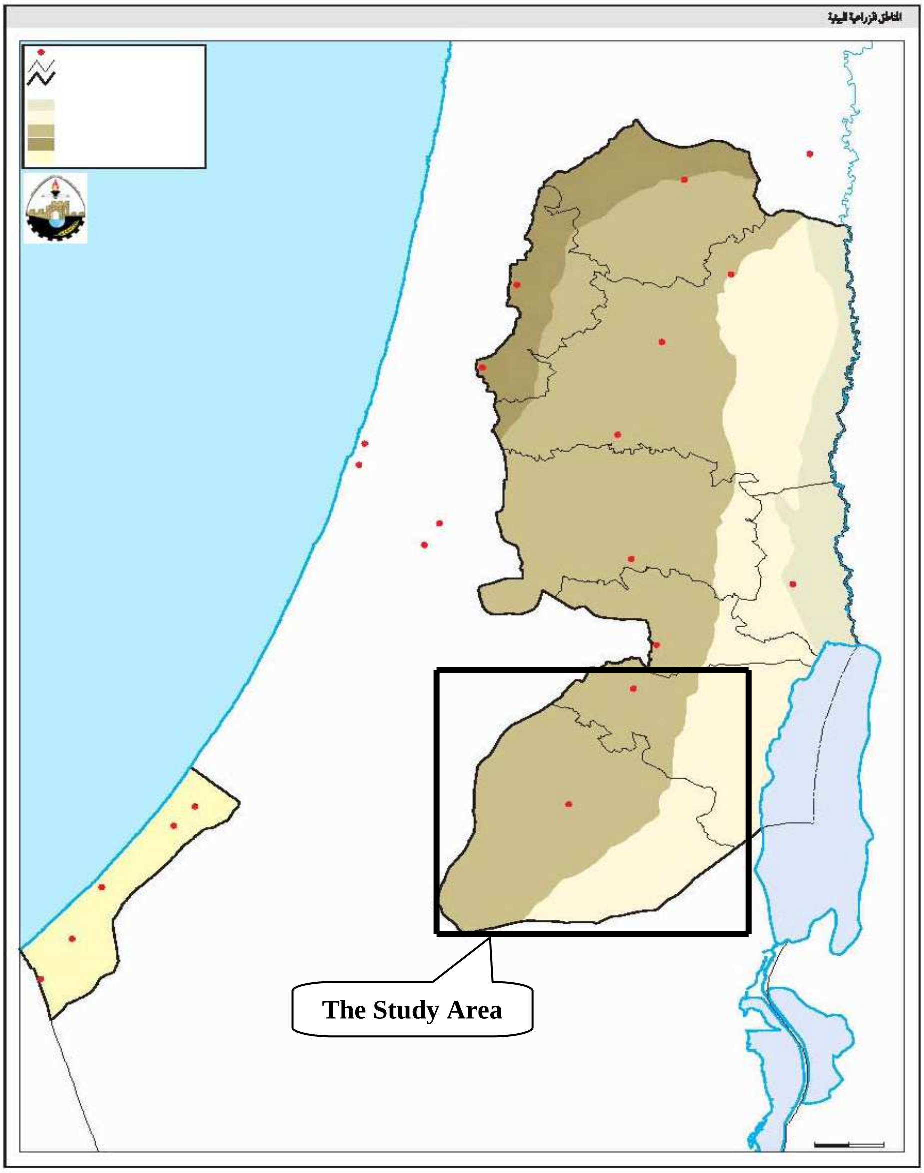

Figure 3.1: The study area within the West Bank
Source: The Joint Services Council for Solid Waste Management for Hebron and Bethlehem Governorates (JSC – H&B).

The governorate of Hebron is located at about 36 km to the south of Jerusalem. Around 182 Palestinian built up areas are located within the governorate, and the total area is about 1,067.0 km^2, with highest point is located at 1,014.0 meter above main sea level (ARIJ, 2009b).

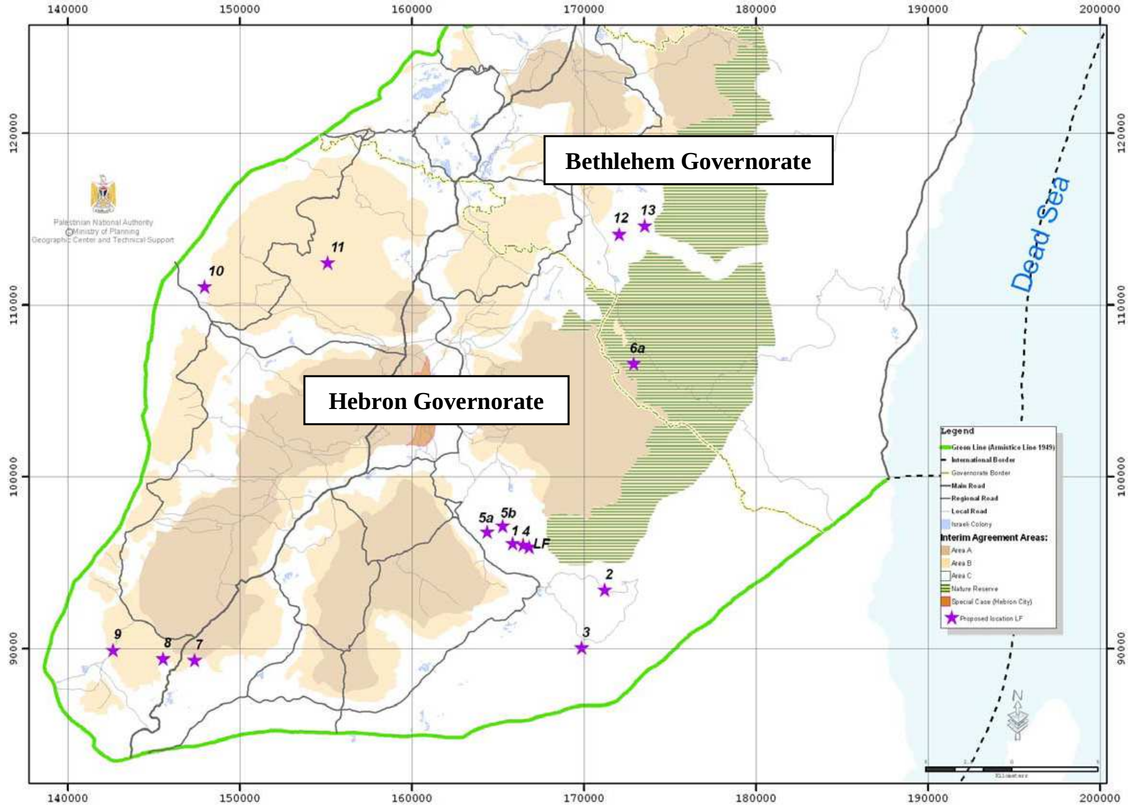

Figure 3.2: Map of Hebron and Bethlehem governorates

Source: The Joint Services Council for Solid Waste Management for Hebron and Bethlehem Governorates (JSC – H&B).

The numbers on the map are related to the preliminary proposed locations for the southern solid waste landfill.

3.3 Demographic Features

Total population of both governorates is 728,399 persons in 2007 (PCBS, 2008); which represent around 31% of the total Palestinians in the West Bank. 176,235 are residing in Bethlehem governorate, while 552,164 are of Hebron residence (PCBS, 2008). The general demographic features in both governorates are nearly similar, denser in cities and low density in villages; with major variation related to the number of population and the size of the towns in each governorate. This is more clearly in the Hebron governorate, so the city of Hebron is surrounded by number of towns with population exceed Bethlehem governorate in total. The large number of population indicates large number of housing units, so Hebron governorate contains 103,086 housing unit; while 38,257 are located within Bethlehem governorates (PCBS, 2008). However, the size of populations reflects the future demand on housing due to the natural growth of the population in both governorates, and specially the Hebron area.

3.4 Economic Situation

The economic situation in both governorates is not largely different from other Palestinian cities. It moves through a fluctuation range and depends, to the large extent, on the stability of the political situations. Both governorates are affected by the closure policy by the Israeli occupation since the beginning of *Alaqsa Intifadah* in 2000. The closure imposed on the West Bank is the biggest challenge that faces the Palestinian businesses by significantly increasing the costs and creating unpredictability in trade flows and market shrinkages (The World Bank, 2007). Now, the situation is a bit more stable than before due to the reduced restriction on movement. The labor force in both governorates is distributed on seven economic activities as shown in table 3.1. Trading, restaurant and hotels is the famous economic activities and the highest job creation in both governorates; so it represents 22.2% in Hebron, and 16.9% in Bethlehem. The existence of holy places in Bethlehem such as the *Nativity Church*, the most holy place for Christians in Palestine, share in the activation of tourism and improvement in the economic conditions as well. In addition, the natural resources such as stone quarrying in Hebron and Bethlehem – the largest in Palestine – are considered as a corner stone in the national economy. However, the old city of Hebron, where *Al-*

Ibrahimi Mosque is located, also participates in tourism activation as well as economic support.

Table 3.1: Labour force distribution by economic activity in the study area.

Economic activity	Hebron Governorate	Bethlehem Governorate
Agriculture, hunting and fishing	19.6	15.2
Mining, quarrying and manufacturing	19.2	14.4
Construction	7.6	11.4
Commerce, restaurant and hotels	22.2	16.9
Transportation, storage and communication	5.0	4.3
Education	11.5	11.6
Health	2.0	6.6

Source: (PCBS, 2009a).

3.5 Construction Sector and Development

Construction sector is one of the leading economic sectors in the Palestine, which is led by the private sector and contributes to sustainable development and improvement of economic situation. Its contribution in the Palestinian Gross Domestic Product (GDP) depends on the political climate and degree of stability; so it reached 23% from 1989 to 1995, and then reduced to 9% in 2004 due to *Alaqsa Intifadah* (Enshassi et al., 2007).

The construction sector occupies an important position among other economic activities. It contributes to 12.9.0% to 14.5% of the labor force in the West Bank from the year 2004 to 2008; and 16% in the third quarter of the year 2009 (PCBS, 2009a). In both governorates, it comes in the fifth level in securing work opportunities; with relatively lower than the total West Bank. Table 3.2 shows the contribution of the construction sector in the work opportunities in the West Bank and Hebron and Bethlehem governorates in particular.

Table 3.2: Contribution of construction sector in work opportunities.

<table>
<tr><th>Area</th><th>Year</th><th>Contribution to labor force employment (%)</th></tr>
<tr><td rowspan="6">West Bank</td><td>2004</td><td>13.0</td></tr>
<tr><td>2005</td><td>14.4</td></tr>
<tr><td>2006</td><td>12.9</td></tr>
<tr><td>2007</td><td>13.6</td></tr>
<tr><td>2008</td><td>14.9</td></tr>
<tr><td>3rd quarter of 2009</td><td>16.0</td></tr>
<tr><td>Hebron</td><td rowspan="2">3rd quarter of 2009</td><td>7.6</td></tr>
<tr><td>Bethlehem</td><td>11.4</td></tr>
</table>

Source: (PCBS, 2009a).

3.6 Development Projects and Reconstruction

Any country in the world involved in war, natural crisis or military disputes, is to be subjected to reconstruction in assistance from the other states, after the end of these crisis. Palestine is still moving in the liberation stage, which is subjected to the war crisis and reconstruction especially after the first and second *Intifadah*. According to the Palestinian Ministry of Housing and Public Works (MoHPW, 2009), around 20 million square meters of building has been built since 1994 up to 2002. In the last 15 years, a large number of construction projects have implemented in the West Bank in general, and in Hebron and Bethlehem in particular; some are funded by international donors, while others were funded by the PNA and investment by the private sector. International and governmental funded construction projects were related to different sectors including but not limited to: education such as schools, health such as hospitals, water such as reservoirs, services such as municipality's buildings …etc. However, the private sector investment were concentrated on income generation and were included but not limited to hotels, restaurants, commercial centers …etc. on the other hand, the PNA strategy pushes toward the sustainable development, at which development projects will continue in progress in parallel to urbanization and population growth.

3.7 Local Contractors and Classifications

Since the Palestinian National Authority (PNA) ruled over the West Bank and Gaza strip, the construction sector has recorded a kind jump in building construction and development. Previously, few local contractors were found due to few projects and occupation restrictions. Moreover, all local contractors were practicing their businesses without any professional regulations. Upon the arrival of the PNA and the start of the reconstruction movement, a lot of projects were started funded by the international community to create appropriate economical environment to cope the stage requirements; and the demand on contractors has increased dramatically. In response to that, many new contractors appeared to carry out the works. In 1994, the contractors union has been established as an association for all contractors in order to organize the contracting works in Palestine, and coordinate with competent authorities for all contracting related issues and disputes (PCU, 2003). The contractors union specified five categories: building construction, roads construction, water and sewage, electro-mechanic and public works and maintenance. Each category includes variety of classifications and is graded from (1 to 5, grade 1 include two grades 1A and 1B). However, the contractor can split within one or more categories and classified into one grade under this category based on specific criteria; i.e. the contractor could be classified in the roads construction category under grade 1A, and at the same time classified under building construction category as grade 2. The grade number reflects the experience and capacity of the contractor, so grade 1A has more experience and higher capacity than grade 1B and so on (PCU, 2003). For more details about building construction classification, see Annex 1: criteria for building construction category.

Hebron and Bethlehem governorates include 112 contractors classified into different specialization and grading categories; 103 of them are specialized in building construction. The participation in bidding depends on the size of the project; and the owner always specify in the tender notice to which category and grade the bid is open to.

4. Chapter Four: Research Methodology

4.1 Survey Design and Sampling

One survey questionnaire was prepared to study the contractors' attitudes and behavior toward construction waste management (see Annex 2). The questionnaire was designed in a way through which the information concerning attitudes and behavior of contractors towards construction waste management can be obtained in an acceptable manner. This questionnaire included information concerning the contractor classification, years of experience, number of implemented projects, number of permanent and temporary workers, employees education and training, waste collection and disposal systems, waste sorting, reduction, reuse, recycling practices, perceptions and attitudes toward construction waste management and disposal, behavior regarding reduction at the source and reuse and recycling of construction waste. In addition, the questionnaire included related information such as challenges and constraints facing local contractors in construction waste management.

On the other hand, and for the purpose of sampling, the contractors were divided into three groups that cover the five grades of classifications under the Palestinian Contractors Union (PCU), so that group (G1) include grades 1A and 1B, group (G2) include grades 2 and 3, and group (G3) include grades 4 and 5. Knowing that the PCU classifies the contractors into five grades based on specific criteria - see Annex 1: contractors classification criteria for building construction specialization

- (PCU, 1994). Then a purposive stratified random sampling method[1] was used for the selection of contractors as specified in the sample size (see Table 4.1).

4.2 Sample Size

For this study, the target population are the contractors who have valid registration with the PCU in the building specialization. Since the number of the contractors who have valid registration up to 1/2/2010 in both governorates is limited, see table 4.1 (PCU, 2009), a random sample was selected to insure a representative from all contractors. The sample was selected according to the following equation (Hogg and Tannis, 1997; cited in Enshassi et al., 2007):

$$m = \frac{Z^2 * P(1-P)}{\in^2} \quad \text{…} \quad (4.1)$$

$$n = \frac{m}{1 + \frac{m-1}{N}} \quad \text{…} \quad (4.2)$$

Where m : Sample size of unlimited population

n : Sample size of limited population

Z : Standardization value correspondent to confidence level (Z = 1.95 for 95% confidence level)

P : Proportional of successes assumed 50%.

$\in$: Maximum error of the point estimate.

N : Total number of population.

[1] Method of sampling used when each group within the population needs to be represented in the sample, so the population is divided into groups (strata) based on specific criteria, and samples are taken from each group in the same proportion as the group has in the population.

So, the number of contractors sample is 83 and distributed between contractors categories as shown in Table 4.1 below:

Table 4.1: Registered contractors, classification and sample size.

Group No.	**G1**		**G2**		**G3**		**Total**
Classification Category	1 A	1 B	2	3	4	5	
No. of Registered Contractors	4	11	31	35	11	11	103
Sample Size	3	9	25	28	9	9	83

4.3 Data Collection

The survey research method was followed for the purpose of data collection. The questionnaire was completed through direct interviews with the targeted contractors. Contractors were represented by their project managers as they were closer to the work site and / or familiar with onsite practices than the contractor himself. However, before the beginning of each contractor survey, all of the contractors were contacted, briefed about the survey and its objectives and a meeting is reserved for the interview and data collection.

An interview with the Palestinian Contractors Union (Hebron branch administrator) was held to obtain the required information regarding the contractors' classifications, and to insure whether or not there was any training or capacity building programs for the contractors in construction waste management.

4.4 Statistical Analysis

Analysis of data was carried out using statistical package for social sciences software (SPSS) version 15. Several tests were used to conclude the relationship between different variables, including logistic regression model, cross tabulation and frequencies. For the purpose of identifying the contractors' attitudes and behavior, challenges of the CW management and future development, cross tabulation and frequencies tests were commonly used; while logistic regression model (LRM) was used to identify the factors that best explain contractors' behavior and attitudes toward CW management. Further, evaluation of coefficients, model appropriateness and goodness of fit are used.

4.4.1 Logistic Regression Model (LRM)

The LRM is used to determine the significant factors that affect contractors' behavior and attitudes toward CW management. It is assumed that contractors' attitudes are positive or not, and their behavior is satisfactory or not, and two dependent variables are designated accordingly. In addition, several factors were suggested to affect attitudes and behavior from theoretical point of view, and their significant influence was calculated. The model is as follows (Begum et al., 2009):

$$Log \frac{P_i}{1-P_i} = \beta_0 + \beta iXi + e \qquad \text{(4.3)}$$

Where:

Pi =1 if contractor attitude and behavior toward CW management is positive and satisfactory; Pi =0 otherwise;

Xi : Independent variable;

β_0 : Constant term, assumed to be zero to reduce the standard error of the model;

β_i : Coefficient of the independent variables;

e : The error term;

i : Number of variables in the model = 1, 2 …, n .

The value of the coefficient β_i determines the direction of the relationship between dependent variable (P_i: attitude or behavior) and the independent variable (X_i). When β_i is greater than zero, larger or smaller X_i are associated with larger or smaller values of P_i. In the contrary, if β_i is less than zero, larger or smaller X_i values are associated with smaller or larger P_i.

4.4.2 Method of Estimation

In order to estimate the parameters in the logistic regression model, after transforming the dependent variables into logistic variables, the maximum likelihood method was used (Thomas, 1985; Gujrati, 2003; cited in Begum et al. 2009); and so the probability of certain event occurring is estimated by the logistic regression through calculating the changes in the logarithm of the dependent variable. The likelihood function expresses the values of β in terms of known and fixed values for y (y is related to P) and is derived from the probability distribution of the dependent variable as follows (Begum et al., 2009):

$$L(\frac{\beta}{y}) = \prod_{i=1}^{N} \frac{n_i!}{y_i!(n_i - y_i)!} P_i^{y_i} (1 - P_i)^{n_i - y_i)} \qquad \text{.............................} (4.4)$$

So the values of β that maximize the output of this equation is the max likelihood estimates.

4.4.3 Coefficient Evaluation

The *Wald* test is used to evaluate the significance of each coefficient in the model. The test is defined as follows (Begum et al., 2009):

$$W_i = (\frac{\beta_i}{S.E_{\beta_i}})^2 \quad \text{..} (4.5)$$

Where i is the number of variables = 1, 2 … n, and $S.E$ is the standard error.

4.4.4 Goodness of Fit

Five tests were used to evaluate the appropriateness of the model for the data. These include: the log likelihood, Omnibus test, Cox and Snell R^2, Naglekerke $\check{R}^2$ and Hosmer – Lemeshow test. Cox and Snell R^2 and Naglekerke $\check{R}^2$, which can be treated as supplementary to each other, are more useful evaluative indices such as the overall evaluation of the model and goodness of fit (Peng et al., 2002). The log likelihood function is used to measure how the model fits the data as it provides a measure about the goodness of fit. The function is defined as follows (Begum et al., 2009):

$$Log - likelihood = \sum_{i=1}^{n} [Y_i \ln(\hat{Y}_i) + (1 - Y_i) \ln(1 - \hat{Y}_i)] \quad \text{..........................} (4.6)$$

Where:

Y_i : The actual result

$\hat{Y}_i$: The predicted probabilities of this result.

This term is also quoted as -2log-likelihood because it has an approximate Chi-square distribution, which is defined as follows:

χ^2 = 2[(log-likelihood of bigger model) – (log likelihood of smaller model)]; the smaller the value, the better the model fits the data. However, in order to have statistical relationship indication, calculated χ^2 for the model shall be less than tabulated χ^2 , otherwise there will be no goodness-of-fit.

Furthermore, the coefficients of the model were also tested using Omnibus test, which indicate goodness-of-fit if the observed chi-square is greater than the tabulated one (i.e. the assumption of all coefficients equal zero is refused if the significance value is less than 0.05), which in turn indicate the adequacy of the model for such data type.

In addition, Cox and Snell R^2 is used to evaluate the goodness-of-fit because it determines the proportion of the variation in the dependent variable made by the independent variable of the model. This function is defined as follows (Begum et al., 2009):

$$R^2 = 1 - \left[\frac{L(0)}{L(\beta)} \right]^{2/N} \quad \text{.. (4.7)}$$

Where:

L (0): the likelihood for the model assuming constant only.

L (β): the likelihood of the full model.

N: the sample size.

And since Cox and Snell R^2 cannot achieve a maximum value of 1, Nagelkerke $\check{R}^2$ that is another descriptive measure of goodness-of-fit, is used, which also determines the variation proportion in the outcome made by the independent variables of the model. The function is defined as follows (Begum et al., 2009):

$$\tilde{R}^2 = \frac{R^2}{R^2_{MAX}} \quad \text{……………………………………………………………. (4.8)}$$

Where $R^2_{MAX} = 1 - [L(0)]^{2/N}$ ……………………...……………………….. (4.9)

Moreover, another inferential goodness-of-fit test called Hosmer - Lemeshow test, which provides useful information about the model calibration, is used to check the goodness-of-fit. This test said that the model fits the data well if the significance value corresponding to Chi-square is greater than 0.05 (i.e. the null hypothesis of the model that means there is no difference between observed and predicted values, will not be rejected); as such, the larger the Chi-square, the better the model fits the data.

Also multi-co-linearity between independent variable is investigated using correlation matrix, to insure no evidence of multi-co-linearity (none of any two independent variable have a correlation greater than 0.7).

4.4.5 Summary of the Variables in the Model

All of the variables in the model are summarized in the Table 4.2:

Table 4.2: Summary of the variables in the LRM

Variable No.	Variable description	Variable definition
V5 = (X_1)	Contractor level of education	1 = others, 2 = secondary, 3 = diploma, 4 = university.
V6 = (X_2)	Contractor classification	1 = group 3, 2 = group 2, 3 = group 1
V9 = (X_3)	No. of executed projects by the contractor	1 = less than 5, 2 = from (6 – 10), 3 = from (11 – 20), 4 = from (21 – 30), 5 = from (31 – 40), 6 = more than 40.
V13 = (X_4)	Frequency of waste collection and disposal.	1 = no schedule, 2 = others, 3 = once per month, 4 = twice per month, 5 = once per week.
V21 = (X_5)	Buying durable, refillable and repairable materials.	0 = not practiced, 1 = otherwise.
V22 = (X_6)	Purchasing raw building materials per activity.	1 = that just sufficient, 2 = a bit more than required, 3 = more than required.
V23 = (X_7)	Use of construction materials before expiry date or damage.	0 = not practiced, 1 = otherwise.
V27 = (X_8)	CW has negative environmental impacts.	1 = No, 2 = I don't know, 3 = Yes
V28 = (X_9)	Impact of CW on human health	1 = No, 2 = I don't know, 3 = Yes
V32 = (X_{10})	No. of skilled labors	1 = less than 10, 2 = from (10 – 20), 3 = from (21 – 30), 4 = from (31 – 50), 5 = from (51 – 100).
V34 = (X_{11})	No. of unskilled labors.	1 = less than 10, 2 = from (10 – 20), 3 = from (21 – 30), 4 = from (31 – 50), 5 = from (51 – 100), 6 = from (101 – 200).
V37 = (X_{12})	Most frequent of construction related education among field supervisors.	1 = others, 2 = course certificate, 3 = diploma, 4 = university.
V38 = (X_{13})	Training of field supervisors in CW management.	1 = none of them, 2 = some of them, 3 = all of them.
V39 = (X_{14})	Experience of field supervisors in construction.	1 = low, 2 = medium, 3 = high.

5. Chapter Five: Data Analysis, Results and Discussion

5.1 Construction Waste Quantification

5.1.1 Waste From the Construction Activities

The survey showed that the quantity of CW produced per one squared meter of building floor construction ranges between 17 kg – 81 kg. This range is relatively higher than ranges in other countries like that identified by Lauritzen which was (20 – 50) kg/m^2 of building floor constructed (Lauritzen, 1994; cited in Kartam et al., 2004). The production of wastes depends to the large extent on behavior and experience of workers in the job they are performing; in addition, type of the building, level of labor intensity and available technology, absence of legislations, attitudes and commitment of contractors to source reduction are the major reasons behind this variation.

Respondents to this question reach 46 answers and represent 53.5% as shown Table 5.1 below:

Table 5.1: Respondents to CW quantification

Respondents	
No.	%
47.0	54.7

The obtained data of the building areas and the produced quantities of the CW is plotted and a linear relationship is concluded as shown in Figure 5.1 below:

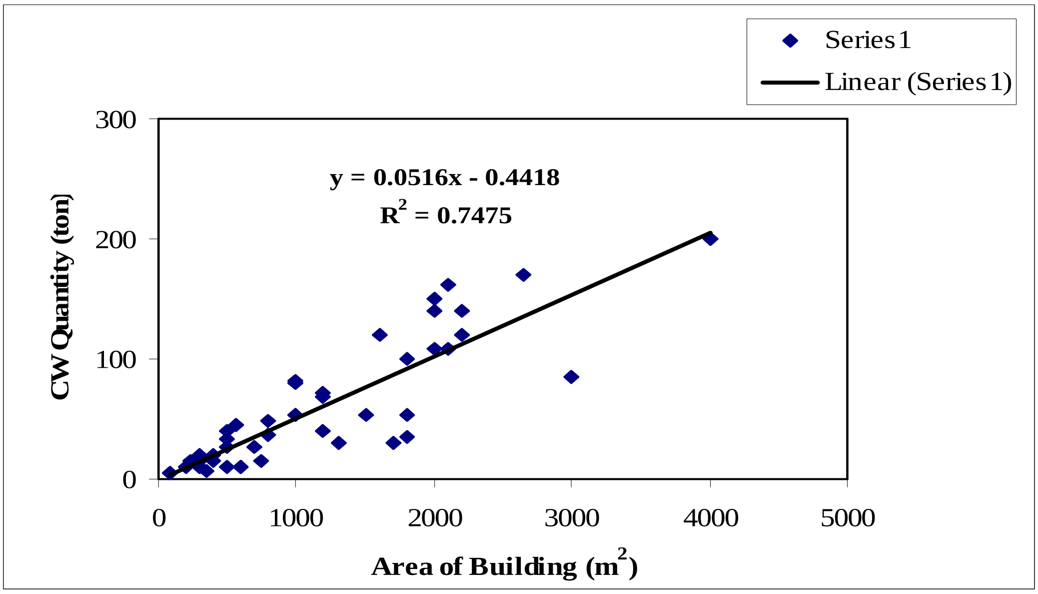

Figure 5.1: Relationship between the area of the building and the produced quantity of CW.

Assuming the produced quantity of waste is *Q* and the area of the building is *A*, then the relationship between area of the building and produced quantity of waste as follows:

$$Q = 0.0516A - 0.4418 \quad \text{(5.1)}$$

Where: $R^2 = 0.7475$

Q is the produced quantity of CW in metric ton.

A is the area of the building in m^2.

The waste included in this model is that produced as a result of the construction activity, and exclude any demolition or surplus wastes. This formula provides an estimation of the CW generated at the worksite with strong relationship between the produced quantities of waste and the area of the building, so 74.75% of the variation in the produced waste quantity is determined by the variations in the building area.

5.1.2 Surplus Wastes of Excavation Activities

Any building construction requires excavations and site leveling to reach the reduced level on which the foundations of the building can be located adequately without any risk. These excavations are site specific, and depend to the large extent on the nature of the soil, type of the structure and topographical features of the land. The residues of such excavations, which meet the technical specifications of the project, are normally used as filling materials where needed inside the project area or anywhere else; whereas that do not meet the requirements are sent to the disposal sites. This study investigated the waste produced from 85 construction sites and the areas of the constructed building versus the produced quantity of wastes were plotted as shown in Figure 5.2 below:

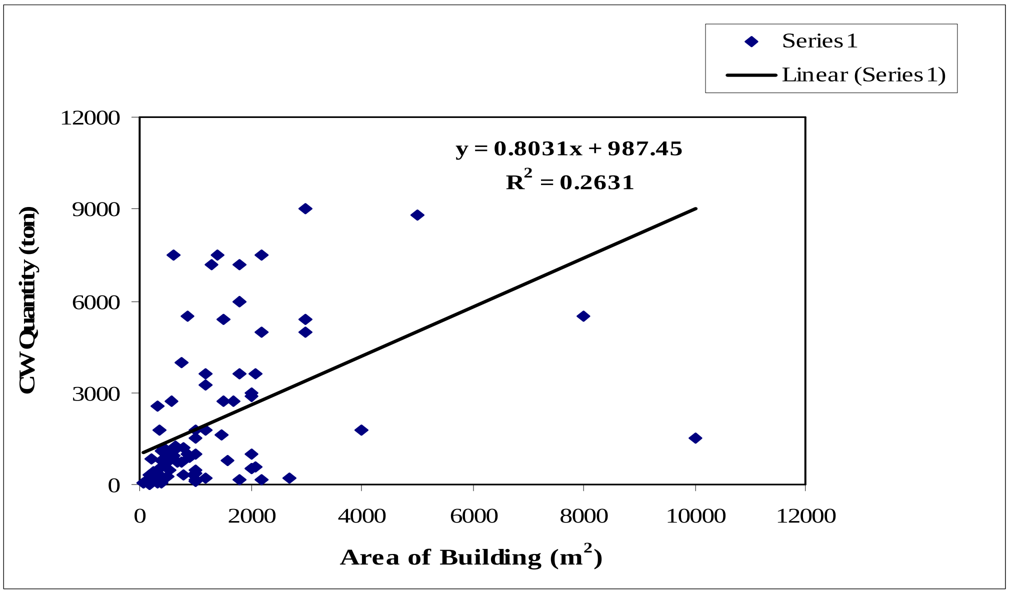

Figure 5.2: Relationship between area of building and the quantity of surplus wastes.

The data is too scattered that makes it difficult to conclude any strong relationship between the area of the building and the produced quantity, so the variation in the building area determines only 26.31% of the variations in the produced quantity of wastes. Moreover, excavation residues are relatively independent from workers behavior since other factors are controlling the situations as mentioned above.

5.2 Attitudes and Behavior Toward CW Management

Through the evaluation of contractors' attitudes and behavior toward CW management, it has been assumed that contractor attitude toward CW management positive or negative and behavior were considered satisfactory or unsatisfactory, and consequently the data was statistically treated to match this objective. The following variables (Table 5.2) were used to determine attitudes toward waste reduction at the source, reuse and recycling:

Table 5.2: Variables of attitues

Reduction at the source		
No.	**Description**	**Label**
V20	Do you follow waste reduction at the source practices?	Yes = (positive attitude), No = (negative attitude)
V21	Do you buy durable, refillable and repairable materials?	Frequently and occasionally = Yes (positive attitude), not practiced = No (negative attitude).
V23	Do you use construction materials before expiry date or damage?	
Reuse and recycling		
V24	Do you use construction materials onsite that can be reused?	Frequently and occasionally = Yes (positive attitude), not practiced = No (negative attitude).
V25	Do you buy materials that have reuse packing?	
V26	Do you use recyclable materials in construction?	

Contractors' behavior toward CW management was determined through the evaluation of onsite waste sorting and waste disposal behavior. The following variables (Table 5.3) were used in the evaluation:

Table 5.3: Variables of behavior

No.	Description	Label
Waste sorting behavior		
V11	Do you sort CW onsite?	Frequently and occasionally = Yes (satisfactory), not practiced = No (unsatisfactory).
Waste disposal behavior		
V14	Which of the following disposal sites you are using?	Municipal domestic solid waste dumpsite, private dumpsite and municipal CW dumpsite = satisfactory behavior, randomly (beside roads … etc.) and others = unsatisfactory behavior.

Moreover, the factors affecting contractors' attitudes and behavior were investigated. Several factors were suggested to affect attitudes and behavior from theoretical point of view and their significant influence was calculated. The findings indicated that contractor experience with respect to the number of executed projects, waste reduction measures and number of unskilled labors are significant factors affecting contractors' attitudes toward CW management. Waste reduction measures, perception of CW environmental impacts, number of skilled labors, number of unskilled labors and training are significant factors affecting contractors' behavior regarding CW management.

5.2.1 Contractors Attitudes Toward Source Reduction, Reuse and Recycling

The study results showed great variations between contractors' positive attitudes (90.7%) and negative attitudes (9.3%) toward waste reduction at the source. This supports the findings that said attitudes toward waste management are generally positive (McDonald and Smithers, 1998; Lingard et al, 2000; Teo et al. 2000; cited in Begum et al., 2009). On the other hand, 86% and 14% of the sample showed positive and negative attitudes toward reuse of waste and use of recyclables materials, respectively. The results are shown in Table 5.4 below:

Table 5.4: Attitudes on source reduction, reuse and recycling

Contractor group	Reduction at the source				Reuse and recycling			
	No.		%		No.		%	
	Yes	No	Yes	No	Yes	No	Yes	No
G1 (grades 1A & 1B)	11	3	78.6	21.4	8	6	57.1	42.5
G2 (grades 2 & 3)	49	5	90.7	9.3	48	6	88.9	11.1
G3 (grades 4 & 5)	18	0	100.0	0.0	18	0	100.0	0.0
Total	**78**	**8**	**90.7**	**9.3**	**74**	**12**	**86.0**	**14.0**
					(Chi-square[2] = 13.024, df[3] = 2, P-value[4] = 0.001)			

It seems that the profit vision of contractors clarifies the positive attitude toward CWM since reduction at the source means efficient use of building materials, reuse of waste materials and use of recyclables could be cheaper than supplying new materials, which in turn maximize the profit of the contractor.

5.2.2 Factors Affecting Contractors Attitudes

The logistic regression model (LRM) was employed to test the significant factors affecting contractor attitudes in the CW management among 8 studied factors. The final model for determining contractors' attitudes toward CW management is as follows:

$$\text{Log}\,(P_i/1\text{-}P_i) = 0.447X_1 - 3.272X_2 + 1.104X_3 + 0.559X_4 - 0.337X_6 + 4.535X_7 - 1.353X_{11} + 1.4528X_{14} \quad \ldots\ldots (5.2)$$

The model summary and other appropriateness and goodness of fit tests are shown in Table 5.5, which shows that the model is appropriate and fits the data well

[2] Chi-square test is used to determine whether there is a significant variation between observed and expected frequencies.
[3] Degree of freedom (df) = (number of rows – 1)*(number of columns - 1)
[4] P-value is the significance measure, if the value is less than 0.05, then the relationship is significant (i. e there is no much difference between observations and expectations).

(refer to the methodology for appropriateness and goodness of fit). The results of analysis showed that three of the studied variables are significant, while other variables have strong relationship with attitudes toward waste management but without any statistically significant. Table 5.6 summarizes the results of the LRM for the whole sample.

Table 5.5: Attitude model summary and other goodness-of-fit tests

Model Summary		
-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
20.910	0.680	0.907
Omnibus Tests of Model Coefficients		
Chi-square	df	Sig.
96.925	8	0.000
Hosmer and Lemeshow Test		
Chi-square	df	Sig.
1.125	7	0.993
Tabulated Chi-square = 90.53		

The model output can be explained as follows:

- The model shows positive relationship between contractor attitude and the level of education, so the higher the education level of the contractor the more positive attitude toward waste management. The reason could be that contractors with higher level of education have good management skills and be able to manage the project cycle, including the waste, in an appropriate manner.
- There is a reverse relationship between contractor classification and attitudes, so small size contractors have more positive attitude toward CW management than medium size and large contractors. This is opposite to Begum et al (2009) who found that large contractors have more positive attitude toward waste management than medium size and small

contractors. This is because small size contractors are usually participating in smaller size projects where the profit margin is normally low, and contractors in such cases are looking forward to reduce expenses and save as much as possible.

- Contractors' attitude toward waste management is more positive for contractors who have more projects execution; contractors with more projects execution are more familiar with cost reduction throughout the construction period.
- The results showed that the lower the frequency of waste collection and disposal, the more positive attitude toward waste management; because low frequency of waste collection and disposal is an indication of following waste reduction measures. This finding agrees with Begum et al. (2009) who found that contractors with low waste collection frequency have positive attitude toward CWM.
- Contractors, who follow source waste reduction such as supplying just sufficient raw building materials per activity, have more positive attitude than those who are supplying more.
- Contractor attitudes toward CW management are more positive for contractors who use construction materials before damage or expiry date; because this is an indication of following waste reduction at the source.
- The findings indicate that the contractors' attitudes are reduced if the number of unskilled labors increased. This could be due to inadequate

field monitoring and absence of incentives by the contractor, low wages, which makes the worker careless regarding wastage of materials.

Table 5.6: Factors of contractors attitudes as estimated by the LRM

Variable	Estimated coefficient (β)[5]	Standard error (S.E)[6]	Wald statistics[7]	df	Significance (P – value)[8]
X_1	0.447	0.765	0.341	1	0.559
X_2	-3.272	1.573	4.326	1	0.038
X_3	1.104	0.613	3.243	1	0.072
X_4	0.559	0.509	1.207	1	0.272
X_6	-0.337	0.921	0.134	1	0.714
X_7	4.535	2.014	5.073	1	0.024
X_{11}	-1.353	0.644	4.419	1	0.036
X_{14}	1.452	0.957	2.300	1	0.129

-2 log-likelihood: initial = 117.835, final = 20.910
X_1: Contractor level of education.
X_2: Contractor classification.
X_3: No. of executed projects by the contractor.
X_4: Frequency of waste collection and disposal.
X_6: Purchasing raw building materials per activity.
X_7: Use of construction materials before expiry date or damage.
X_{11}: No. of unskilled labors
X_{14}: Experience of field supervisors in construction.

- The results provided forward relationship between contractors' attitudes and experience of the field supervisors, so attitudes toward waste management tend to be more positive if the contractors' field supervisors have higher experience in construction related activities. High experience in construction reduces the human errors when locating bench marks and other construction activities related marking, which reduce the probability of errors and waste generation as well. In addition, experienced field supervisors are much familiar about the usage and incorporation of waste

[5] β is the coefficient of the model substituted in equation 5.2; this coefficient is vector and the sign indicates the direction of the relationship in reference to table 4.2.
[6] S.E is the standard error of the coefficient β (i. e $\beta_1 = 0.447 \pm 0.765$).
[7] See the research methodology for the *Wald Test* definition.
[8] The independent variable X_i (X_1, X_2 … etc.) is significant if the P-value ≤ 0.05.

materials into other filling activities and thus reducing the waste production as well.

5.2.3 Contractors' Behavior

In Palestine, observations indicate that behavior in construction waste management is not satisfactory in terms of environmental protection. This is greatly clear from the evidence of waste disposal practices, which is taking place on different inadequate locations. Both waste sorting and disposal behavior have been studied for the three sampled groups of contractors as shown in Tables 5.7 and 5.8, respectively.

Table 5.7: Sorting of CWs materials

Contractor group	No. of respondents		Percentage of respondents	
	Yes	No	Yes	No
G1 (grade 1A & 1B)	7	7	50.0	50.0
G2 (grade 2 & 3)	25	29	46.3	53.7
G3 (grade 4 & 5)	10	8	55.6	44.4
Total	**42**	**44**	**48.8**	**51.2**

The results showed that 51.2% of the contractors do not sort their waste at the construction site compared to 48.8% who do so. In general, there is no large difference between contractors who are practicing sorting of waste materials and those are not practicing although small size contractors (G3) were observed the highest level of onsite sorting of wastes, followed by large size contractors (G1) and finally medium size (G2) who were observed to be the lowest sorting behavior level. Some of the contractors reported that the separation of waste materials refer to two reasons: first, economic reason as some of the waste fractions can be sold such as the metal fraction, which indicate the highest level of sorting behavior among G3. The second, separation of reinforcement steel bars from CW and especially demolition wastes facilitate loading and loading processes.

With respect to waste disposal behavior, the results showed that the majority of the contractors are using private (34.9%) and municipal construction waste dumpsites (27.9%). Because construction waste is still nationally non regulated and absence of sanitary landfills in the area, disposal at both sites in addition to municipal domestic solid wastes dumpsites is the best available option. Unfortunately, the findings showed that 16.3% of the contractors are disposing the wastes in random (on open land, beside roads …etc.) and practiced by all groups of contractors with highest level in G2 and lowest in G3.

In conclusion, sorting and disposal behavior of CW is better and more positive for small size contractors (G3) and large size (G1) than for medium size (G2). This result could be due to cost reduction purposes for small contractors, and environmental management plan requirement by donors for large contractors who are mostly involved in large external donated infrastructure projects.

Table 5.8: Contractor CW disposal behavior

Method of waste disposal	**G1**		**G2**		**G3**		**Total**	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Municipal domestic solid waste dumpsite	0	0.0	3	5.6	2	11.1	5	5.8
Private dumpsite	6	42.9	18	33.3	6	33.3	30	34.9
Municipal construction waste dumpsite	5	35.7	13	24.1	6	33.3	24	27.9
Randomly (beside roads...etc)	2	14.3	11	20.4	1	5.6	14	16.3
Others	1	7.1	9	16.6	3	16.7	13	15.1
Total	**14**	**100.0**	**54**	**100.0**	**18**	**100.0**	**86**	**100.0**

5.2.4 Factors Affecting Contractors Behavior

In order to identify the most factors that best explains contractors' behavior toward CW management, the LRM was also selected as the best statistical analysis method for such events. The final model of the contractors' behavior regarding waste management is as follows:

$$\text{Log}\,(P_i/1\text{-}P_i) = -\,1.810X_2 + 0.279X_3 + 2.207X_5 + 2.343X_6 - 2.590X_7 - 2.485X_8 + 1.145X_9 - 1.508X_{10} + 1.415X_{11} + 0.574X_{12} + 3.389X_{13} \quad \ldots\ldots (5.3)$$

Table 5.9 presents the model summary and other appropriateness and goodness of fit tests, which shows that the model is appropriate and fits the data well (refer to the methodology for appropriateness and goodness of fit). The findings indicate that 5^{th} variables among the 11^{th} studied variables are significant (P-value $\leq$ 0.05, see Table 5.10), while other variables have strong relationship with behavior toward waste management but without any statistical significance. The model output of the contractors' behavior regarding waste management for the whole sample is summarized in Table 5.10.

Table 5.9: Behavior model summary and other goodness-to-fit tests

Model Summary		
-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
43.518	0.583	0.777
Omnibus Tests of Model Coefficients		
Chi-square	df	Sig.
74.318	11	0.000
Hosmer and Lemeshow Test		
Chi-square	df	Sig.
5.256	7	0.629
Tabulated Chi-square = 96.22		

The logistic regression model output can be explained as follows:

- The findings shows negative relationship between the contractor group (classification) and behavior regarding waste management, the larger the contractor size, the lower the behavior regarding waste management. Begum et al. (2009) reported negative relationship between contractor category and behavior regard waste management. This result also in complimentary with attitudes toward waste management that correlate negatively with the contractor size.
- Contractors' behavior is more satisfactory for contractors that have more projects execution. The reason could be that experience and knowledge about the benefits of waste sorting and potential impacts of non-sorting of CW during loading and unloading, is higher among contractors who executed more projects. Also those contractors could be experienced difficulties with official authorities due to inadequate waste disposal that pushed them later to use specific disposal sites approved by concerned authorities to protect their reputation and keep their business going on, as such inadequate waste disposal could affect bid awarding for their favor.
- Contractors, that follow waste reduction practices such as buying durable, refillable and repairable materials, have more satisfactory behavior. Because those contractors, who follow such practices, are considered low waste producers, which contribute to environmental protection.
- Behavior is more satisfactory for contractors that do not adhere to some of the waste reduction measures such as supplying raw building materials that are just sufficient. Although supplying more than required materials is

waste generation, contractors that follow such practices tend to have more satisfactory behavior regard waste management. Sometime the time frame of the project implementation is tight and the penalty of delay is relatively high that could exceed the cost of materials wastage; therefore, contractors in such situations are looking to the progress more than expenses reduction of materials. Also some types of imported materials, such as ceramic tiles, is not always available in the market especially the colors, therefore, contractors are forced to supply more than required quantity to cover the maintenance period through which the type could be absent from the market.

- Contractors that follow some of waste reduction measures at the source such as the use of building materials before expiry date or damage; have less satisfactory behavior on waste management. The reason could be that contractors are looking to avoid extra cost more than waste reduction and environmental protection as well.
- Contractors' behavior regarding waste management is less satisfactory for contractors that perceived that CW has no negative environmental impacts. Low awareness regarding environmental impacts of the construction wastes could be the reason behind random waste disposal, which is considered unsatisfactory behavior.
- Contractors' behavior regarding waste management is more satisfactory for contractors that perceived that CW is harmful to the human health. Contractors' perception about the impact of the CW on human health,

which can create health risks, could be the reason that pushes the contractors toward adequate waste disposal.

- Contractors' with more skilled labors have less satisfactory behavior on waste management. Since most skilled labors are working in accordance with unit rate production, onsite sorting of CW could not take place as it takes time, and contractors do not requesting such practices to reduce expenses.
- The higher the number of unskilled labors, the higher the satisfaction level of contractors' behavior. The reason could be that unskilled labors try to make use of the waste fractions such as steel, which improves onsite waste sorting behavior.
- The results showed that the higher the level of construction related education among the field supervisors, the more satisfactory behavior toward waste management. This is contrary to Begum et al. (2009), who reported that contractors with highly educated employee have less satisfactory behavior regarding waste management. Construction related education improves the knowledge of field supervisors regarding the benefit of reuse of some waste fraction, which result in onsite sorting of such wastes and leading to satisfactory waste management behavior.
- The findings provided that contractors whose field supervisors received training in CW management tend to display more satisfactory behavior regarding waste management. Because training improves the knowledge

about the benefits of waste sorting and adequate disposal as well as the impact of random waste disposal and potential environmental degradation.

Table 5.10: Factors of contractors behavior as estimated by the LRM

Variable	Estimated coefficient (β)	Standard error (S.E)	Wald statistics	df	Significance (P – value)
X_2	-1.810	1.013	3.194	1	0.074
X_3	0.297	0.276	1.161	1	0.281
X_5	2.207	1.344	2.697	1	0.101
X_6	2.343	1.003	5.456	1	0.020
X_7	-2.590	1.661	2.430	1	0.119
X_8	-2.485	0.972	6.532	1	0.011
X_9	1.145	0.653	3.072	1	0.080
X_{10}	-1.508	0.602	6.275	1	0.012
X_{11}	1.415	0.638	4.915	1	0.027
X_{12}	0.574	0.407	1.996	1	0.158
X_{13}	3.389	1.531	4.901	1	0.027

-2 log-likelihood: initial = 117.835, final = 43.518.
X_2: Contractor classification
X_3: No. of executed projects by the contractor.
X_5: Buying durable, refillable and repairable materials.
X_6: Purchasing raw building materials per activity.
X_7: Use of construction materials before expiry date or damage.
X_8: CW has negative environmental impacts.
X_9: Impact of CW on human health
X_{10}: No. of skilled labors
X_{11}: No. of unskilled labors
X_{12}: Most frequent of construction related education among field supervisors.
X_{13}: Training of field supervisors in CW management.

5.3 Challenges of the Construction Waste Management

The main challenges and problems that faced the contractors in the construction waste management were assessed within the framework of this research. Eight challenging problems were selected and the contractors' views toward these challenges were generated as shown in Table 5.11. The analysis shows large variations between some of these elements and low variation between others. The lack of landfill sites for CW scored the highest among other challenging problems

(34.9%), and the variation is too large between this element and the rest of the other elements.

Table 5.11: Main challenges in the CW management

Variable	G1		G2		G3		Total	
	Count	%	Count	%	Count	%	Count	%
Careless of workers	2	14.3	11	20.4	1	5.6	14	**16.3**
Low experience of workers	5	35.7	4	7.4	2	11.1	11	**12.8**
Lack of landfills	5	35.7	21	38.9	4	22.2	30	**34.9**
Absence of government incentives	1	7.1	4	7.4	3	16.7	8	**9.3**
Lack of recycling facilities	0	0.0	5	9.5	1	5.6	6	**7.0**
Absence of legislations and polices	0	0.0	5	9.3	3	16.7	8	**9.3**
Lack of financial resources	0	0.0	2	3.7	2	11.1	4	**4.7**
Projects technical specifications	1	7.1	0	0.0	0	0.0	1	**1.2**
Others	0	0.0	2	3.7	2	11.1	4	**4.7**
Total	14	100.0	54	100.0	18	100.0	86	**100.0**

Also, this element represented a challenging problem to all contractors groups: G1 (35.7%), G2 (38.9%) and G3 (22.2%). This indicates that the top priority to be taken by regulatory authorities is to regulate CW disposal service and set down the specifications of sanitary landfills. The second priority as indicated by the data is the careless of workers that scores (16.3%); with relatively lower variations from other problems such as low experience of workers that score (12.8%). The careless of workers indicates that the promotion of CW management principles among the workers as well as contractors in the construction industry is too poor or not non effective by the competent authorities. However, the low experience of workers in the construction waste management indicates that the training of workers for such jobs is not reaching the acceptable level, and this also is supported by the survey since (74.4%) of the contractors stated that none of their workers has received training in the CW management, and 66.3% of them provided that none of their field supervisors has received training in the CW management (see table 5.12). Absence of legislations and policies that score (9.3%) and absent of government incentives that score (9.3%) came in the fourth level. The remaining challenges are of lower importance as indicated by the survey and can be listed in descending order as follows: Lack of recycling facilities, Lack of financial resources, Projects technical specifications.

Table 5.12: Training of labours and field supervisors

Variable	Answer	No. of respondents	Percent
Do labors receive training or awareness in construction waste management?	All of them	3	3.5
	Some of them	19	22.1
	None of them	64	74.4
	Total	**86**	**100.0**
Do they (field supervisors) receive training or awareness in construction waste management?	All of them	4	4.7
	Some of them	25	29.1
	None of them	57	66.3
	Total	**86**	**100.0**

On the other hand, it has been noticed that challenging problems that faces large contractors (G1) in the CW management are slightly differ from small size contractors (G3), while medium size contractors (G3) are ranging between both, sometimes approaching G1 and others approaching G2. Table 5.11 shows full details of these challenges.

5.4 Horizon of Future Development

The successful and sustainability of any development depends largely on the acceptance and response of the target population. Therefore, future development in the CW management shall reflect the views of the contractors as main waste producers, and can contribute to sustainable waste management. However, the majority of the contractors reported that the lack of waste disposal facilities is the main challenge they are facing, which indicates necessary development in CW disposal shall take place. Based on that, the views of different contractors' sizes regarding willingness to pay for improving CW collection and disposal were generated to investigate their responses toward future development.

Table 5.13: Contractors classification by willingness to pay

Contractor Group	**Have you the willingness to pay more for improved construction waste collection and disposal service?**			**Total**
	Answer	**No**	**Yes**	
G1	Count	6	8	14
	%	42.9	57.1	100.0
G2	Count	17	37	54
	%	31.5	68.5	100.0
G3	Count	3	15	18
	%	16.7	83.3	100.0
Total	**Count**	**26**	**60**	**86**
	%	**30.2**	**69.8**	**100.0**

The results showed no statistically significance relationship between contractor group and experience, and willingness to pay. In general, the majority of the contractors (69.8%) have the willingness to pay more for improved CW collection and disposal service. The relationship between contractor size and the willingness to pay is in reverse order: the larger the contractor size (G1), the lower the willingness to pay, and vice versa (see Table 5.13). This result pushes toward establishing collection and disposal system because medium (G2) and small (G3) sizes represent the majority of the contractors.

In addition, the contractors' willingness to pay was studied with respect to their experience in the construction sector. The results showed reverse order relationship between contractor experience and willingness to pay: the lower the years of experience, the higher willingness to pay, except for the very high experience (more than 30 years) that showed 100% willingness to pay, which can't be taken as an indication due to the limited number of this group (see Table 5.14). The findings indicated that the new generations of contractors are more committed to the waste management, and pushes toward regulation of waste collection and disposal practices.

Table 5.14: Contractors experience by willingness to pay

Contractor Experience in Years	**Have you the willingness to pay more for improved construction waste collection and disposal service?**			**Total**
	Answer	**No**	**Yes**	
2-5	Count	2	8	10
	%	20.0	80.0	100.0
6- 10	Count	7	18	25
	%	28.0	72.0	100.0
11 - 15	Count	7	16	23
	%	30.4	69.6	100.0
16 - 20	Count	5	8	13
	%	38.5	61.5	100.0
21 - 30	Count	5	7	12
	%	41.7	58.3	100.0
> 30	Count	0	3	3
	%	0.0	100.0	100.0
Total	**Count**	**26**	**60**	**86**
	%	**30.2**	**69.8**	**100.0**

5.5 Contractors Perception

Contractors' perception of CW management principles were investigated with respect to contractors sizes (Tables 5.15 and 5.16); and perceptions regarding environmental and health impacts of CW with respect to contractors sizes were also evaluated (Tables 5.17 and 5.18).

Table 5.15: Conractors classification by perception of waste management principles

Contractor Group	Dou you think that waste reduction, reuse and recycling is a key toward construction waste minimization?				
	Answer	**No**	**I don't know**	**Yes**	**Total**
G1	Count	1	1	12	14
	%	7.1	7.1	85.7	100.0
G2	Count	4	6	44	54
	%	7.4	11.1	81.5	100.0
G3	Count	0	1	17	18
	%	0.0	5.6	94.4	100.0
Total	**Count**	**5**	**8**	**73**	**86**
	%	**5.8**	**9.3**	**84.9**	**100.0**

In general, 84.9% of the contractors perceived that waste reduction, reuse and recycling is a key issues toward CW minimization. It was found that there is no statistically significant relationship (P-value > 0.05) between contractor group and perceptions although the smaller size (G3) showed the highest positive perception as shown in Table 5.15.

Table 5.16: Perception of waste reduction at the source

Contractor Group	In your opinion, is reduction at the source is the best option for construction waste minimization?				Total
	Answer	**No**	**I don't know**	**Yes**	
G1	Count	2	1	11	14
	%	14.3	7.1	78.6	100.0
G2	Count	4	8	41	53
	%	7.5	15.1	77.4	100.0
G3	Count	2	2	13	17
	%	11.8	11.8	76.5	100.0
Total	**Count**	**8**	**11**	**65**	**84**
	%	**9.5**	**13.1**	**77.4**	**100.0**

Further, 77.4% of the contractors perceive that waste reduction at the source is the best option toward CW minimization. Also it was found that there was no real variation between contractor classification and perception although the larger the contractor size the higher the positive perception as shown in Table 5.16.

Moreover, 70.9% of the contractors perceive that CW has negative environmental impacts compared to 55.8% who perceived that CW is harmful to the human health. Although the results showed positive perceptions of CW environmental and health impacts, there was no specific relationship between contractor classification and perception as medium size contractors (G2) were the highest positive perception of environmental impacts, and the smaller size (G3) were the highest positive health perception. Full details are shown in Tables 5.17 and 5.18.

Table 5.17: CW environmental impact perception by contractor classification

Contractor Group	**Do you think that the construction waste has negative environmental impacts?**				**Total**
	Answer	**No**	**I don't know**	**Yes**	
G1	Count	4	2	8	14
	%	28.6	14.3	57.1	100.0
G2	Count	10	4	40	54
	%	18.5	7.4	74.1	100.0
G3	Count	3	2	13	18
	%	16.7	11.1	72.2	100.0
Total	**Count**	**17**	**8**	**61**	**86**
	%	**19.8**	**9.3**	**70.9**	**100.0**

Table 5.18: CW health impact perception and contractors classification

Contractor Group	**What is the impact of the construction waste on human health?**				**Total**
	Answer	**Not harmful**	**I don't know**	**harmful**	
G1	Count	0	6	8	14
	%	0.0	42.9	57.1	100.0
G2	Count	12	13	29	54
	%	22.2	24.1	53.7	100.0
G3	Count	5	2	11	18
	%	27.8	11.1	61.1	100.0
Total	**Count**	**17**	**21**	**48**	**86**
	%	**19.8**	**24.4**	**55.8**	**100.0**

In general, contractors' perception of CW management principles, environmental and health impact were more positive and consistent, with no major variations between one contractor group and another. This finding also is in consistency with contractors attitudes toward waste management, which was found to be 90.7% toward reduction at the source and 86% toward reuse and recycling.

5.6 Legislations and CWM Regulations from Contractors Point of View

5.6.1 Construction Waste Management Instructions

The data analysis shows that 84.9% of the contractors have no official instructions to deal with the construction waste compared to 15.1% who have (see Table 5.19). This indicates that there is no systematic and clear procedure and instructions regarding CW generation, reuse, recycling and final disposal. Experience in the construction sector proved that CW management is to the large extent ignored; and instructions stipulated in some contracts are more general such as "suitable material of excavation residues are to be used for the filling places, the none suitable and extra are to be transported and disposed offsite, where these sites are acceptable to the employer" or "the waste surplus should be removed from the site to other places approved and accepted by the official authorities". These instructions remain contract specific and differ from employer to another, and considered as official instructions by some of the contractors in spite of its general form.

On the other hand, employers in the construction industry are always looking for the quality of the work performed by the contractor rather than the waste management. Contracting agencies are restricting the work by top quality through highly qualified workers in the construction activities without any restrictions to the waste production and management skills among the employees; but left as the responsibility of the contractor to decide. The reason behind that could be the absence of restrictions by law as well as to avoid cost implications.

Table 5.19: Instructions for CW management

Variable	Answer	No. of respondents	Percent
Do you have official instructions about how to deal with construction waste	Yes	13	15.1
	No	73	84.9
	Total	**86**	**100.0**

5.6.2 Current Disposal Sites

In Palestine and the study area in particular, where construction wastes disposal is none regulated, the disposal is taking several forms: in solid waste dumpsites, in private dumpsites, on private land and at the abutments along right of ways. Aesthetics, dust emissions, deterioration of agricultural and grazing land are common phenomena of environmental pollution due to the random waste disposal. The current waste disposal sites and contractors' opinion regarding haphazardly waste disposal are shown in the Table 5.20.

The survey results provided that 16.3% of the contractors are disposing the CW in random: on open land, beside roads …etc. This is clearly illegal in reference to the PEL, article (10) that asks agencies and individuals to take necessary precautions for safe storage and transport of construction waste to prevent environmental pollution. This means that waste disposal in public areas, where the environmental impact is significant, is prevented. However, other disposal sites are municipal and private, which are difficult to be classified as legal or illegal due to the absence of regulations by the law. Despite the absence of evaluation reference, disposal in such sites remain limited in specific zones and better than segregation anywhere.

Table 5.20: Current waste disposal sites and contractor openion regarding random disposal

Variable	**Which of the following disposal sites you are using?**							
Contractor Group	**G1**		**G2**		**G3**		**Total**	
Answer	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
Municipal domestic solid waste dumpsite	0	0.0	3	5.6	2	11.1	5	**5.8**
Private dumpsite	6	42.9	18	33.3	6	33.3	30	**34.9**
Municipal construction waste dumpsite	5	35.7	13	24.1	6	33.3	24	**27.9**
Randomly (beside roads...etc)	2	14.3	11	20.4	1	5.6	14	**16.3**
Others	1	7.1	9	16.6	3	16.7	13	**15.1**
Total	14	100.0	54	100.0	18	100.0	86	**100.0**
Variable	**In your opinion, random waste disposal is due to:**							
Contractor Group	**G1**		**G2**		**G3**		**Total**	
Answer	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
Absence of legislation and policies	6	42.9	21	38.9	7	38.9	34	**39.5**
Poor behaviors	5	35.7	9	16.7	1	5.8	15	**17.4**
lack of landfills	0	0.0	18	33.3	7	38.9	25	**29.1**
Others	3	21.4	6	11.1	3	16.7	12	**14.0**
Total	14	100.0	54	100.0	18	100.0	86	**100.0**

Nevertheless, the observations showed that random waste disposal is relatively higher than provided by the statistical analysis of the survey; this could be translated due to sub-contracting of waste disposal through truck drivers, who are the common sub-contractors for this concern, as clarified by several contractors through data collection interviews. In this way, the main contractor is no more liable on the waste disposal, and the truck drivers just exit the borders, where the local authority is responsible for, and dispose the waste randomly at the nearest space.

From contractors' point of view, haphazardly waste disposal is mostly referred to the absence of legislations and policies according to 39.5% of the respondents. The second reason is the shortage in landfills designated for such purposes in accordance with 29.1% of the respondents (see table 5.20). This result supports the investment in CW management through the construction of engineered landfills, upgrading the legislations and establishment of comprehensive waste management system.

5.6.3 Institutional Arrangement and Responsibility

The PEL, article (9) stated that the ministry of environmental affairs in cooperation with other specialized agencies shall determine the standard of the solid waste disposal sites. However, these standards are not determined up to now, and most of the waste disposal sites, including construction waste disposal, are still lacking to any engineering and sanitary requirements. This requires the EQA to fulfill its obligations and coordinate with other actors, ministries and agencies to set down the basis for comprehensive waste management system.

Similarly, from contractors point of view, the data collected showed that municipalities are the first responsible for improving waste disposal 60.5%, the EQA comes in the second position 30.2%; while the overall construction waste management lies within the EQA in coordination with other ministries 46.5% (see Table 5.21).

Table 5.21: CW management responsibility

Variable	Who is the responsible for improving construction waste disposal?						Total	
Contractor Group	G1		G2		G3			
Answer	Count	%	Count	%	Count	%	Count	%
Municipalities	7	50	35	64.8	10	55.6	52	**60.5**
Contractors	1	7.1	2	3.7	1	5.6	4	**4.7**
Regulator authority (EQA)	5	35.7	16	29.6	5	27.8	26	**30.2**
Others	1	7.1	1	1.9	2	11.1	4	**4.7**
Total	14	100.0	54	100.0	18	100.0	86	**100.0**
Variable	**Who is the responsible for the overall construction waste management?**						**Total**	
Contractor Group	**G1**		**G2**		**G3**			
Answer	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
Municipalities	4	28.6	13	24.1	4	22.2	21	**24.4**
Contractors	0	0.0	2	3.7	1	5.6	3	**3.5**
Regulator authority (EQA)	3	21.4	10	18.5	4	22.2	17	**19.8**
EQA in coordination with other PA ministries	7	50.0	27	50	6	33.3	40	**46.5**
Others	0	0.0	2	3.7	3	16.7	5	**5.8**
Total	14	100.0	54	100.0	18	100.0	86	**100.0**

This result strongly supports the role of the regulatory, monitoring and executive authorities. The EQA should communicate and cooperate with other agencies to determine the proper rules and procedures regarding the CW management and promote the public and private sectors and individuals to comply with. Municipalities and other local and national authorities are requested to insure that these rules and procedures are set as a reference to the work contracts, and monitor its implementation. Contractors and other construction sector stakeholders, firms and individuals, shall adopt and comply with the requirements of the regulations to insure clean environment. Kartam (2004) stated that it is the responsibility of the waste creator to insure the competency of the contractor to deal and dispose the waste safely in accordance with the agreed techniques and procedures.

Based on the above-mentioned, it is concluded a gradual responsibility of the CW management, which include in descending order: EQA, local authorities especially municipalities, contractors and individuals. These shared responsibilities are shown in the Figure 5.3 below:

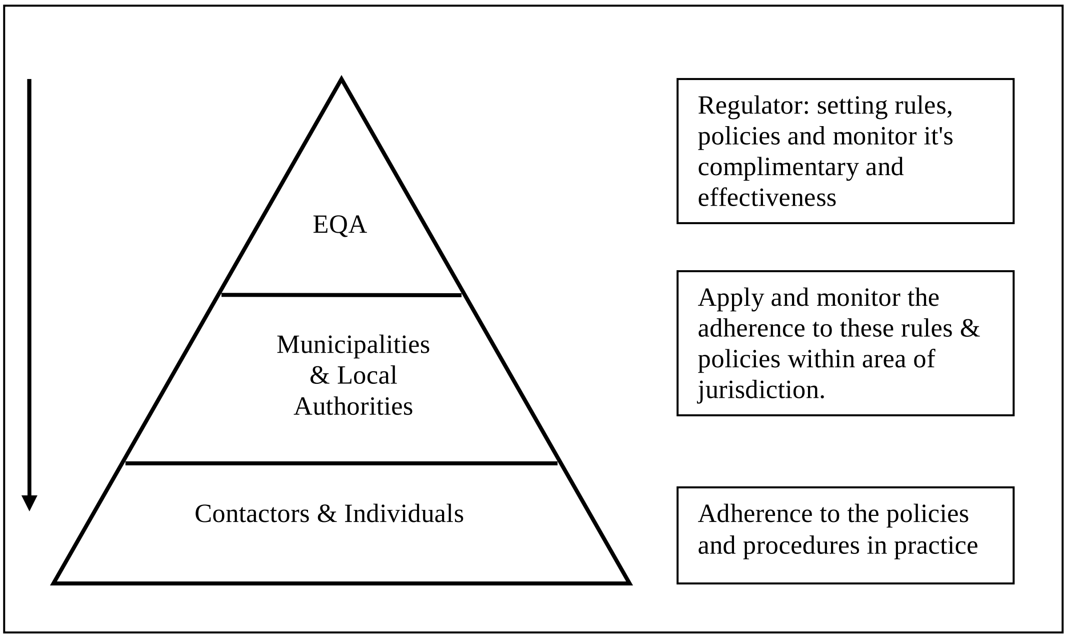

Figure 5.3: Gradual and shared responsibility in comprehensive waste management system

6. Chapter Six: Conclusions and Recommendations

6.1 Conclusions

6.1.1 Attitudes and Behavioral Factors in the Construction Field

It is concluded that contractors' attitudes toward CWM are generally positive: 90.7% positive attitudes toward waste reduction at the source and 86.0% toward waste reuse and use of recyclable construction materials. Moreover, the analysis of waste sorting behavior of contractors showed that 51.2% do not sort the waste at the construction site compared to 48.8% who did that. It is concluded that small size contractors are more committed to onsite sorting of wastes (55.6%), compared to large size contractors (50%) and medium size (46.3%). It is also concluded that medium size contractors are the lowest waste disposal behavior satisfaction among other groups of contractors since 20.4% are disposing wastes beside roads and on open lands without any consideration of environmental concerns. Small size group showed the best satisfactory disposal behavior (5.6%), while large size in between.

Also the factors that best explain contractors' attitudes and behavior regarding CW management are identified. Contractor experience size (classification), following waste reduction practices and the number of unskilled labors are significant factors influencing contractors' attitudes toward CW management. On the other hand, following waste reduction practices, perception of CW environmental impacts, number of skilled labors, number of unskilled labors and training of field supervisors in CWM, are factors significantly affecting contractors' behavior.

6.1.2 Policy Frame Work and Challenges of CWM

It is generally concluded that the CWM sector is still unregulated. The PEL is poor and lack to the waste management principles and is not be able to provide a base for comprehensive waste management system, which open the door toward the use of different waste disposal sites including municipal domestic and construction waste disposal sites, private sites as well as haphazardly waste disposal. The lack of CW landfills and low experience of workers are the major problems facing the contractors in CWM. The solution of these challenging problems is out of the reach of the contractors' hands as the regulation of such activities is the responsibility of the government. It has been concluded that the development is viable since the core principles of successful development are insured: willingness to pay that insure sustainability of the service, and positive perception regarding CWM principles, health and environmental impacts that insure adherence to the laws with low awareness efforts.

6.2 Recommendations

Due to the absence of legislations regarding CW management and general positive attitudes and behaviors regarding CW management, it is highly recommended to regulate this sector through upgrading of the PEL and establishment of comprehensive management system including the following milestones:

1. Waste management 3R principles: legislation shall prioritize options in the CW management starting from reduction at the source, reuse and recycling.

The purpose is to reduce the quantity of wastes that to be sent to landfills and cost of waste disposal as well.

2. Integration and comprehensive: the system shall be part of the waste management system in order to use some of the fraction in domestic wastes landfills as covering materials. Also it should be comprehensive to deal with all types of CW.
3. Technically adequate: the system shall include provision regarding waste disposal sites especially for waste fraction that can't be disposed at domestic waste landfills. The provision shall specify the main requirements of the waste disposal sites and lead to engineered CW landfill.
4. CW transportation shall be environmentally regulated to avoid any negative impacts during waste transportation.
5. The shared responsibilities regarding CW management shall be clarified and allocated, so there will be no conflict and every party will be committed to its obligations.
6. The system shall include punishment provision to push toward adherence to the system.

The current problems that face the contractors such as the lack of landfills and low experience of workers in CWM shall be solved. There shall be incentives for local authorities and the private sector to construct engineered landfills for CW in different locations; these shall undergo licensing system to insure meeting the legislations requirements. In addition, there shall be coordination between the EQA, PCU and Labor Association to hold training and awareness for workers in the construction sector. The training shall be intensive by the beginning of the process, and then can be held on regular basis.

The environmental management plan (EMP)[9] shall be made part of the classification criteria at the PCU. Each contracting company shall have EMP and integrated with the comprehensive waste management system.

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[9] EMP can be defined as a set of procedures created by companies to provide framework for dealing with the pollution risks associated with their activities and improve onsite management. It includes:

- A description of activities carried out on site;
- Pollution risk identification;
- Pollution risk management (structural and procedural controls);
- Roles and responsibilities;
- Staff training and awareness;
- Emergency preparedness and response;
- Inspections, maintenance, monitoring and mitigation;
- Improvements and review.

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8. Annex 01: Contractor's classification criteria for building construction specialization.

Category	Classification Requirements											
	Capital	Experience (executed Projects)		Professional license	Engineers			Accountant		Administrator	Office		
1 A	JD 400,000.0	Total projects JD 6.0 million	One project of JD 2.0 million; or two projects each of JD 1.5 million.	Yes	Office engineer	Technical manager of 10 years experience	Quantity surveyor	BSc. Degree with 2 years experience; or diploma with 5 years experience	Work contract	BSc degree in business	Area of $150m^2$	Rent contract	drawing
1B	JD 250,000.0	Total projects JD 3.0 million	One project of JD 650,000; or two projects each of JD 500,000.	Yes	Office engineer	Technical manager of 10 years experience	Quantity surveyor	BSc. Degree with 2 years experience; or diploma with 5 years experience	Work contract	BSc degree in business	Area of $125m^2$	Rent contract	drawing
2	JD 100,000.0	Total projects JD 3.0 million	One project of JD 333,000; or two projects each of JD 250,000.	Yes	Office engineer	Technical manager of 8 years experience	Quantity surveyor	BSc. Degree with 2 years experience; or diploma with 5 years experience	Work contract	BSc degree in business	Area of $100m^2$	Rent contract	drawing
3	JD 75,000.0	Total projects JD 0.5 million	One project of JD 166,000; or two projects each of JD 125,000.	Yes	Office engineer	Technical manager of 6 years experience		BSc. Degree with 2 years experience; or diploma with 5 years experience	Work contract	BSc degree in business	Area of $75m^2$	Rent contract	drawing
4	JD 30,000.0	Total projects JD 150,000	One project of JD 65,000; or two projects each of JD 50,000.	Yes	Technical manager of 4 years experience			BSc. Degree with 2 years experience; or diploma with 5 years experience	Work contract	-	Area of $50m^2$	Rent contract	drawing
5	JD 30,000.0	-	-	Yes	-	-	-	-	-	-	Area of $30m^2$	Rent contract	drawing

9. Annex 02: Contractors' Questionnaire

Questionnaire ID in the Sample ☐

		General Information:
V1	☐	**What is your district?** a- Bethlehem b- Hebron
V2	☐	**Where do you live?** a- Village b- City or town c- Refugee camp
V3	☐	**How old are you?** a- Between 20 – 30 years b- Between 30 – 40 years c- Between 40 – 50 years d- Between 50 – 60 years e- More than 60 years
V4	☐	**How could you rate your monthly income?** a- Very high b- High c- Intermediate d- Low e- Very low
V5	☐	**What is your level of education?** a- University b- Diploma c- Secondary d- Others ___________
		Classification and Experience:
V6	☐	**What is the classification of your company?** a- Category 1 A b- Category 1 B c- Category 2 d- Category 3 e- Category 4 f- Category 5
V7	☐	**What is the type of the company?** a- Public company b- Private limited company c- Others: _______
V8	☐	**How many years of experience do you have in the building construction?** a- 2–5 years b- 6- 10 years c- 11 – 15 years d- 16 – 20 years e- 21 – 30 years f- More than 30
V9	☐	**How many projects you have executed?** a- Less than 5 b- From 5 to 10 c- From 11 to 20 d- From 21 to 30 e- From 31 to 40 f- More than 40
		Attitudes and Behaviors:
V10	☐	**How do you collect the waste inside the project area?** a- In steel containers b- In special zone within the project area c- Anywhere within the project area d- Others: _______________
V11	☐	**Do you sort construction waste onsite?** a- Frequently b- Occasional c- Not practiced
V12	☐	**Why you do not sort the wastes?** a- Useless b- Costly c- It takes time d- Others: ________

<table>
<tr><td>V13</td><td>☐</td><td>What is the frequency of waste collection and disposal?
a- Once per week b- Once per month
c- Twice per month d- Others: ________________________</td></tr>
<tr><td>V14</td><td>☐</td><td>Which of the following disposal sites you are using?
a- Municipal domestic solid waste dumpsite b- Private dumpsite
c- Municipal construction waste dumpsite d- Randomly (beside roads...etc) e- Others: ___________________________</td></tr>
<tr><td>V15</td><td>☐</td><td>How much waste per project you are disposing?
a- Small amount b- Medium amount c- Large amount</td></tr>
<tr><td>V16</td><td>☐</td><td>How much tons of waste per project you are disposing (except excavations)?
<table>
<tr><th>Project Type</th><th>Project Area (m2)</th><th>Amount of Waste (Ton)</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>V17</td><td>☐</td><td>How much tons of excavations waste per project you are disposing?
<table>
<tr><th>Project Type</th><th>Project Area (m2)</th><th>Amount of Waste (Ton)</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
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<tr><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>V18</td><td>☐</td><td>Do you think that waste reduction, reuse and recycling is a key toward construction waste minimization?
a- Yes b- NO c- I Don’t know</td></tr>
<tr><td>V19</td><td>☐</td><td>In your opinion, is reduction at the source is the best option for construction waste minimization?
a- Yes b- NO c- I Don’t know</td></tr>
<tr><td>V20</td><td>☐</td><td>Do you follow waste reduction practices at the source?
a- Yes b- NO</td></tr>
<tr><td>V21</td><td>☐</td><td>Do you buy durable, refillable and repairable materials?
a- Frequently b- Occasional c- Not practiced</td></tr>
<tr><td>V22</td><td>☐</td><td>How much raw materials do you purchase per activity?
a- That are just sufficient b- A bit more than required c- More than required</td></tr>
<tr><td>V23</td><td>☐</td><td>Do you use construction materials before expiry date or damage?
a- Frequently b- Occasional c- Not practiced</td></tr>
</table>

V24	☐	**Do you ruse construction materials onsite that can be reused?** a- Frequently b- Occasional c- Not practiced
V25	☐	**Do you buy materials that have reuse packing?** a- Frequently b- Occasional c- Not practiced
V26	☐	**Do you use recyclable materials in construction?** a- Frequently b- Occasional c- Not practiced
V27	☐	**Do you think that the construction waste has negative environmental impacts?** a- Yes b- NO c- I Don't know
V28	☐	**What is the impact of the construction waste on human health?** a- Not harmful b- Harmful c- I Don't know
V29	☐	**Do you have environmental management plan?** a- Yes, for all projects b- Yes, for some projects c- NO
V30	☐	**Have you the willingness to pay more for improved construction waste collection and disposal service?** a- Yes b- NO
V31	☐	**What is the main challenge you are facing in the construction waste management?** a- Careless of workers b- Low experience of workers c- Lack of landfills d- Absence of government incentives e- Lack of recycling facilities f- Absence of legislations and polices g- Lack of financial resources h- Projects technical specifications i- Others: ______________________________________
Workers and Education:		
V32	☐	**How many skilled labors do you have? ____**
V33	☐	**How many field supervisors do you have? ____**
V34	☐	**How many none skilled labors do you have? ____**
V35	☐	**Do labors receive training or awareness in construction waste management?** a- All of them b- Some of them c- None of them
V36	☐	**What is their experience in construction related activities?** a- Low b- Medium c-High
V37	☐	**Could you please specify most frequent of the construction related education of the field supervisor employees?** a- University b- Diploma c- Course certificate d- Others _____

V38	☐	**Do they receive training or awareness in construction waste management?** a- All of them b- Some of them c- None of them
V39	☐	**What is their experience in construction related activities?** a- Low b- Medium c-High
		<u>Legislations:</u>
V40	☐	**Do you have official instructions about how to deal with construction waste?** a- Yes b- NO; if yes, go to V41; if NO, go to V42
V41	☐	**Who is the source of these instructions?** a- Municipality b- EQA c- Others: ____________________
V42	☐	**In your opinion, random waste disposal is due to:** a- Absence of legislation and policies b- Poor behaviors c- lack of landfills d- Others: _______________
V43	☐	**Who is the responsible for improving construction waste disposal?** a- Municipalities b- Contractors c- Regulator authority (EQA) d- Others: ____
V44	☐	**Who is the responsible for the overall construction waste management?** a- Municipalities b- Contractors c- Regulator authority (EQA) d- EQA in coordination with other PA ministries e- Others: ____