CONSTRUCTION WASTE SOURCES, MANAGEMENT PLANNING AND PRACTICES: IN THE CASE OF 40/60 CONDUMINUM AND REAL ESTATES HOUSING IN ADDIS ABABA

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THIS THESIS SUBMITTED TO DEPARTMENT OF PROJECT MANAGEMENT SCHOOL OF GRADUATE STUDENT, ST, MARYS UNIVERSITY FOR PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN PROJECT MANAGEMENT.

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DEPARTMENT OF PROJECT MANAGEMENT

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BY MAHLET ALEM

Advisor Signature Date

Internal Examiner Signature Date

External Examiner Signature Date

DECLARATION

I, Mahlet Alem, declare that this research project entitles" *construction waste source and management planning perceptions and practices in case of housing in Addis Ababa*". Is the outcome of my own effort and study also that all sources of materials used for this study have been acknowledge I have produced it independently with the guidance and suggestion of my research advisor.

This research study has not been submitted for any degree in this university or any other university. It is submitted for the partial fulfilment of the degree of masters of Art in project management.

By Mahlet Alem

Signature: ----------------------

Data: ----------------------------

LITTER OF CERTIFICATION

This is to certify that Mahlet Alem has carried out this research work on the topic entitled *construction waste source and management planning perceptions and practices in case of housing in Addis Ababa*". This work is original in nature and suitable for submission in partial fulfillment of the requirement for the award of master of arts degree in project management and the student has my permission to present it to for assessment.

Advisor Dr Chalachew

Signature------------------

Data-----------------------

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LIST OF ABBRVIATIONA

A. A	Addis Ababa
BREEAM.	Research Establishment Environmental Assessment Method
C	Construction
CFR	Code of Federal Regulation
DW	Demolition Waste
HCB	Hollow Concrete Block
IHDP	Intenerated Housing Development Programmer
LCA	Life Cycle Assessment
MRF	Material Recycling Facilities
OPC	Ordinary Portland Cement
PVC	Polyvinyl Chloride
SWMP	Site Waste Management Plan
UK	United Kingdom
UN	United National

ABSTRACT

In Ethiopia construction industry significantly increase especially in Addis Ababa. In our capital city at this time there are huge construction projects (housing projects) because of this a huge construction material needs for construction process and In property usage of this material or other reasons there are a high amount of construction waste in the site so this waste polluted our environment on account of this waste must be change to use by waste management plan. Therefore, the purpose of this study was to know the source of construction waste and to select the best waste management plan from housing in (40/60 condominium sites and real estate). Establishing the contribution rates of different waste sources Establishing the contribution rates of different waste sources will enhance knowledge-based decision-making in developing appropriate strategy for mitigating construction waste. Quantitative research method, using survey questionnaire, was adopted in this study to assess the frequency and severity of contribution of the sources of waste. The result focused on the 8 source of construction waste and the variables were ranked based on the severity and frequency they contributed. As one of the findings of the study, Operation waste was identified as the highest contributor to construction waste. This study consequently demonstrated that waste has a significant contribution to the cost of construction. Finally, by using the research result possible recommendation was giving to minimize source of the construction waste. Clearly assign and communicate responsibilities: Ensure that those involved in the construction are aware of their responsibilities in relation to the waste management plan, be Clear about how the various element of the waste management plan will be implement and to ensure the plan is being implement.

Keyword: Housing, Source of material waste, construction waste management plan

CHAPTER: ONE

INTRODUCTION

1.1 Background of the study

Waste generated by construction activities, such as scrap, damaged or spoiled materials, temporary and expendable construction materials, and aids that are not included in the finished project, packaging materials, and waste generated by the workforce (Baird, 2016).

Construction and demolition materials are created during the process of creating a new building or structure or they are created when renovating or demolishing an existing building or structure. These materials are usually heavy materials used in large volumes in modern construction, such as concrete, steel, wood, asphalt and gypsum. It is generally known that there is a relatively large portion of the materials being wasted because of different reasons at the sites (Abdulsemee M. Halahla, 2019).

Waste in the construction industry has been the subject of several research projects around the world in recent years. Many of them have focused on the environmental damage coming from materials waste in the process of construction. On the other hand, there have been some studies concerned with the economic aspect of waste in the construction industry (Girma, 2016).

Most previous studies on waste quantification have been focused on waste segregation for specific materials and the volume of waste generated rather than the impacts of the sources that generated the waste. Bossink and Brouwer conducted a waste segregation research on five construction sites in The Netherlands which demonstrated waste components in percentages of the total amount of waste generated and the research showed that between 1% and 10% of each material type delivered to the sites was wasted (O.O. Fadiya, 2013).

In the United States, Gavilan and Bernold subdivided sources of construction waste into six categories: (1) design; (2) procurement; (3) material handling; (4) operations; (5) residuals; and (6) others. These six were supported and similarly regrouped into categories by Ekanayake and Ofori: design, operational, material handling, and procurement. According to Navon and Berkovich, lack of up-to-date information regarding on-site stocks is a typical problem on large construction projects; for lack of information about supply and location of materials on site, the same materials are ordered again resulting in waste. Furthermore, waste can occur at any stage of construction not only because of construction activities but also due to external factors such as theft and vandalism (O.O. Fadiya, 2013).

Now a day building construction industry are boosting globally and consuming huge amount of resource. Building projects are becoming progressively larger and complex in terms of physical size and cost. In Ethiopia construction industry significantly increase especially in Addis Ababa.

In our capital city Addis Ababa at this time there are huge construction projects because this a huge construction material needs for construction process. A property usage of material or other reasons there are a high amount of construction was in the site so this waste polluted our environment because of this waste must be change to use by waste management plan.

Also, in our counter some was conducted, Eskidar Girma (2016) for the Master's thesis on material wastage of 40/60 condominium construction sites, is amongst these academic works. In her survey; questionnaires were spread to 25 supervisor and 56 constructers According to her study, the top three sources of material wastage in building construction are site management, operational, design respectively (Girma, 2016).

A research conducted by Getachew Araya (2009) for the Master's thesis on wastage of materials in building construction sites of Addis Ababa, is amongst these academic works. In his survey; questionnaires were spread to 72 respondents and the result showed that 100 % of the respondents strongly agreed upon the existence of material wastage. According to his study, the top three sources of material wastage in building construction are operational, material handling and design respectively (Getachew, 2009).

Responsible management of waste is an essential aspect of sustainable building. In this context, managing waste means eliminating waste where possible; minimizing waste where feasible; and reusing materials which might otherwise become waste. Solid waste management practices have identified the reduction, recycling, and reuse of wastes as essential for sustainable management of resources (Girma, 2016).

Since 2005 Ethiopia has been implementing an ambitious government-led low- and middle-income housing programmer: The Integrated Housing Development Programmer (IHDP). The initial goal of the programmer was to construct 400,000 condominium units, create 200,000 jobs, promote the development of 10,000 micros and small enterprises, enhance the capacity of the construction sector, regenerate inner-city slum areas, and promote homeownership for low-income households. As the five-year programmed nears completion, documentation of the programmed is timely (Getachew, 2009).

Also study at undergraduate level also pointed out the existence of wastage at the construction site of condominiums and different building projects (Mulualem, Negatu and Tedla, 2012). But these studies do not exhaustively work out the approximate wastage level, the side effect and minimization techniques of materials wastage on condominium sites.

This thesis research uses to identify the source of construction waste and the level of contribution also type of waste management plan is used on housing in Addis Ababa (40/60 condominium and some real estate) construction sites and. Estimating the cost of waste. Finally, based on what data gathered the research was put conclusion and recommendations.

1.2 Statement of problem

The construction industry contributes a large portion of waste to earth. This estimated that on average construction and demolition waste constitutes 15-30% of the total amount of waste that ends up in land fill sites in many countries (Abukhader, 2015). The construction industry is traditionally environmentally unfriendly. Construction cultural practice contributes to waste where trade contractors are rewarded for speed rather than their concern for the environmental impact of their work (Kofoworola, 2009). In Ethiopia effective waste management system is not in place to prevent the negative impact of construction waste. Also, in most of Addis Ababa condominium and real estate the waste is very high. Especially in government construction project like 40/60 condominium (Getachew,2009).

Most of previous studies on source of construction waste have been focused on minimization of the waste, the volume of waste generation and segregation of waste. (Girma, 2016) conduce on minimizing material wastage on 40/60 condominiums sites in Addia Ababa. (C.T.Formoso, 2002) also, observation study of the materials delivered to construction sites in Brazil, materials withdrawn from storage, material movements, and construction processes in order to estimate the amount of waste that would be generated. (O.O. Fadiya, 2013) conduce on Quantitative analysis of the source of construction waste in UK also subdivided sources of construction waste into nine categories: Olusanjo O.Fadiya,Panos Georgakis, and Ezekies Chinyio (1) data error (2) design; (3) material handling; (4) operations; (5)weather ;(6) vandalism;(7)misplacement;(8) residuals; and (9) others.

In the United States, Gavilan and Bernold subdivided sources of construction waste into six categories: (1) design; (2) procurement; (3) material handling; (4) operations; (5) residuals; and (6) others. These six were supported and similarly regrouped into categories by Ekanayake and Ofori: design, operational, material handling, and procurement. According to Navon and Berkovich, lack of up-to-date information regarding on-site stocks is a typical problem on large construction projects; for lack of information about supply and location of materials on site, the same materials are ordered again resulting in waste. Furthermore, waste can occur at any stage of construction not only because of construction activities but also due to external factors such as theft and vandalism (O.O. Fadiya, 2013).

This study decided filled the gap in identifying the source of waste and the severity and frequency contribution and determine or select the waste management plan on ongoing housing in Addis Ababa (40/60 on going condominiums and real estates). In this study source of construction waste subdivided in 8 categories' to conducting the survey in this study. The benefit of addressing this was to use the right number of materials that need to complete their project and to use 3R (reduce, reuse and recycle) techniques.

The purpose of the study is to clearly identify the source construction waste and contribution also to select the best management plan. For this study the data was used from housing in Addis Ababa (40/60 on going condominiums and real estates) and primary and secondary data was used.

1.3 Research Questions

To help achieve the objectives, the following questions were asked

1.What are the major sources construction waste on housing construction sites?

2.Which source of material wastage contribute the large amount of waste?

3.What is the actual level of material wastage occurring on the sites and its cost effect in the project?

4. What are the level of contribution of some waste minimization measures to waste reduction, and the level of practice of such measures in the housing construction site?

1.4 Objective

1.4.1General Objective

The general objective is to know the source of construction waste by their contribution also find out and select the best waste management plan from housing construction sites in Addis Ababa.

1.4.2 Specific Objective

1. Identify the main cause of construction materials waste at the site
2. Identify the largest contribution of the construction waste
3. Estimate the percentage of material wastage and investigate the side effect on the cost of the project
4. Evaluate level of construction of waste minimization measures to waste reduction and levels of practice of same measures in the housing construction sites.

1.5 Significance of the research

Studies on achievements and challenges of housing projects in Addis Ababa city seems scare. Remarkably, inexistence of researches in the area initiated the researcher to contribute something important like this research. Source of construction waste is challenge for the construction housing in Addis Ababa.

The result of this study is believed to be useful for the following reasons:

- It enables the Addis Ababa Housing Development Officials to gain valuable information about the major source of construction waste which affecting the performance of condominium housing projects.
- It suggests possible construction waste management plan options for the improvement of condominium housing projects in to workplace.
- It helps to identify rank of source of waste that influence the housing projects that will help the city administrators.
- It also initiates other researchers to conduct further and detailed studies in housing projects.

1.6 Scope of the Study

Although housing is a nation- wide problem that requires large scale and rigorous study, conditions such as material, financial as well as time constraints forced the researcher to limit the scope of the study in terms of time. The study is limited to cover the year between 2006/7 to 2015/16.

This research was conducted with focusing on the housing construction sites. In our capital city Addis Ababa, the building construction industry is growing rapidly. Also, the ongoing and planned construction housing projects are much greater than other cities.

Therefore, for this study considered on Addis Ababa housing construction projects. And the case study only considers the material waste. Also, different literature review was carried out on material wastage in building sites with a main focus of prior research work.

Moreover, the researcher was working in housing development project and had the experience to the source of construction waste the problem of housing development projects.

1.7 Limitation of the study

- The concept of wastage and waste management is very broad; it is not only about materials wastage but it's beyond that. However, only materials waste is considered in this study since the materials cost covers a great percentage of the project cost so in this study only consider the selection of best waste management plan in housing in Addis Ababa.
- Shortage of time because of stress of work and lesser time.
- Covid-19 effect
- The respondent somewhat careless as they responded and low interest to failed the questionnaires.
- The access to information was likely to be restricted to some extent fearing the biasness that employees in the project.

1.8 Organization of the paper

The study contains five chapter, following this chapter, the first chapter include the introduction part, second chapter incorporates Literature review part, chapter three comprises methodology part, chapter 4 deal about data presentation, Analysis and interpretation and the last Chapter deals with Conclusions and Recommendations

CHAPTER - TWO

LITERATURE REVIEW

2.1 Theoretical Literature

2. 1.1 Definition Construction waste

Waste may be generated during both the extraction and processing of the raw materials and eventual consumption of final products their in. Rubbles and other waste materials arise from construction activity like demolition, renovation of buildings and new construction.
The construction industry is traditionally environmentally unfriendly. Construction cultural practice contributes to waste where trade contractors are rewarded for speed rather than their concern for the environmental impact of their work (Kofoworola, 2009).

Furthermore, construction activities consume a large quantity of materials and energy as well as generating unacceptable level of solid waste. The construction industry consumes 25% of virgin wood and 40% of raw stone, gravel, and sand globally every year. In the US, the production of building components and construction process itself use 40% of extracted material. Construction work leads to land development, land deterioration, resources depletion, waste generation, and various forms of pollution. The construction industry generates about 35% of industrial waste in the world. In the European Union, the construction industry generates a substantial amount of total waste output resulting in between two and five times the quantities of household waste (Kofoworola, 2009).

According to Sir Egan's Rethinking Construction report on the state of UK construction industry, up to 30% of all construction is rework, labor is used to half of its potential efficiency, and at least 10% of building materials for every construction project is wasted. However, the huge waste generated by construction activities creates negative environmental, economic, and social impacts. The environmental impacts include soil and water contamination and deterioration of landscape by uncontrolled landfill.

Material waste significantly contributes additional cost to construction because new purchases are usually made to replace wasted materials; costs of rework, delays, and disposal cause financial losses to the contractor. Also, construction waste has social impacts such as health and safety of workers and societal image of the construction industry.

Construction waste reduction has the highest priority among waste management options which include reduction, recycling, and disposal. Construction management should enhance reduction, reuse, sorting, and recycling of waste before disposal.

Previous studies on construction waste reduction include operatives' attitudes towards waste reduction, direct observation of waste generation and sorting and weighing of waste materials. Recycling plays a crucial role in order to preserve areas for future urban development and to improve, at the same time, local environmental quality. In addition to recycling, inert end-of-life materials can be reused for purposes such as filling materials for land reclamation. Construction waste has a very high recovery potential in which 80% of total waste can be recycled.

Countries such as Denmark, The Netherlands, and Belgium have achieved the aforementioned recycling rate especially given the scarcity of raw materials and disposal sites. However, the vast majority of construction waste still ends up in landfills. In the UK, a total of 89.6 million tonnes of construction and demolition waste were generated in 2005 of which 28 million tonnes were sent to landfills. About 7 million tonnes of construction and demolition waste was disposed at landfills in Australia in 2006-2007 and 42% of total was attributed to construction waste. Also, in Hong Kong, the disposal of construction waste has become a social and environmental problem because there are acute shortages of landfill spaces (Kofoworola, 2009).

2.1.2 Sources of Wastes in Construction

Construction material waste arises from design, logistics, and physical construction processes. In the context of this study, construction wastes are some of the materials delivered to site which have been damaged and meant for disposal, reuse, or recycling. Studies indicate that waste of materials is usually higher than normal figures assumed by construction companies in their estimates. However, while some level of construction waste is unavoidable, the potential benefit of preventing waste generation on site can be substantial. Furthermore, among the objectives of sustainable development is waste reduction which incorporates both reduction at source and recycling so as to reduce quantities and risks there in (Fadiya, 2014).

Most previous studies on waste quantification have been focused on waste segregation for specific materials and the volume of waste generated rather than the impacts of the sources that generated the waste. Bossink and Brouwers conducted a waste segregation research on five construction sites in The Netherlands which demonstrated waste components in percentages of the total amount of waste generated and the research showed that between 1% and 10% of each material type delivered to the sites was wasted. Formosa et al. Conducted an observation study of the materials delivered to construction sites in Brazil, materials withdrawn from storage, material movements, an d construction processes in order to estimate the amount of waste that would be generated (Fadiya, 2014).

The study showed an average waste volume of 27.6% spreading across sources such as lack of quality control, handling, off-cuts, and labor error. In Spain, Solis-Guzman et al. developed a waste quantification model that allows total waste volume to be determined and categorized into demolished, wreckage (from construction processes), and packaging waste.

The model was tested on a typical new construction project and showed that wreckage forms 82% of waste that would be generated from the project. However, while the aforementioned previous studies focus on the volume of waste, this study uniquely measured the severity (in terms of volume) of contribution of the sources and the frequency of their contribution in order to derive the multiplicative impact of the contribution (Formoso et al, 1999).

In order to have adequate record of waste and then develop tools for waste reduction, there is a need to identify the sources of waste and assess their impacts on project outcomes. Despite the fact that considerable research efforts have been done for the identification of the sources of construction waste, there is a need for research targeting the analysis of the identified sources in terms of their waste contribution rates and impacts (Fadiya, 2014).

To be able to reduce the amount of construction waste, the question occurs as to what the main causes of the generation. By identifying the main causes, construction industry players can avoid excessive waste generated. Construction waste originates from various sources in the whole process of implementing a construction project due to one or a combination of many causes. Material waste can be categorized according to its source; namely the stage in which the root causes of waste occur. Different studies in different countries identify these sources which cause building material waste. Bossink and Brouwers (1996) organized the sources of waste during the construction process as: design, procurement, materials handling, operation and residual.

2.1.2.1 Source of Construction Materials Wastage

In addition, in Singapore, Ekanayake and Ofori (2000) organized the sources of construction waste under four categories: design, operations, material handling and procurement. Further, the most common causes of construction waste were identified from past researches by Sasitharan

Nagappan (2011). His study, conducted on causative factors of construction waste existing in construction field activities. The causes of construction waste are matrix and found that 63 wastes

factors existed in construction activities. The waste causes were grouped into seven categories: Design, Handling, Worker, Management, Site condition, Procurement and External.

In this research the sources which cause waste on site were identified after a review of the literature, and placed in seven major categories.

1. Design

2. Procurement

3. Handling and storage

4. Operation

5.Weather

6.Vandalism

7. Others

2.1.3 Types of Construction Waste Materials

Construction is a business that tends to have many different sources of waste. This makes sense considering the many different materials that are used in construction work. There are materials that will need to be disposed of by special environmental services, and then there will be others that can be dumped normally. It is important to also know which materials can be recycled in order to work towards a more sustainable industry. Here, we will look further into the various types of construction waste materials (Lee Chin, 2013).

2.1.3.1 Building Materials

Building materials are some of the most prominent types of materials used in construction. There are many varieties of construction projects. Whether they are basic construction, demolition, restoration, or remodeling projects, there will always be a use of building materials, and with that comes building material waste. Some of the most common examples of these materials are nails, wiring, insulation, rebar, wood, plaster, scrap metal, cement, and bricks. When these materials turn into waste, a lot of times it’s because they are damaged.

In some cases, though, it’s because they were simply unused. The good news about these materials is that a lot of them can be recycled. A specific material that can be reused in many ways is wood. Any time there is wood waste, it can be recovered to be reused for new building projects. Disposal for these kinds of waste is usually pretty basic, but they still need to be disposed of in proper ways. Cement, plaster, and bricks are generally crushed down and can be used in future building projects. As long of the material is contained in a proper dumpster, a recycling or waste management company will come to collect it (Lee Chin, 2013).

2.1.3.2 Dredging Materials

Dredging materials are described as materials that get removed through the preparation of a demolition or construction site. To put it simply, these are parts of nature such as trees, tree stumps, rocks, dirt, and sometimes rubble. These are generally not materials that are considered hazardous, but they should be collected by a waste management company that can provide the proper waste disposal and trash removal for dredging materials. Specific materials that can be reused from this waste such as wood from uprooted trees can be taken to a plant for recycling. Proper recycling and disposal of natural resources are some of the most important aspects of the disposal of dredging materials.

2.1.3.3 Hazardous Waste

Hazardous waste is one of the most important types of construction waste materials you must be able to identify and handle. Not only can this kind of waste be dangerous to those working around and handling it, but it can also present dangers to the general public if not managed properly. Hazardous waste can be produced at sites of construction, demolition, restoration, and remodeling projects. Much of the waste can come from the common material used for building. Some of the most prominent examples of the hazardous waste that comes out of construction are lead, asbestos, plasterboard, paint thinners, strippers, mercury, fluorescent bulbs, and aerosol cans. The proper disposal of these hazardous materials is an area where environmental cleanup companies come in handy. Hazardous material disposal is regulated under strict state and federal laws.

2.1.3.4 Demolition Waste Materials

There are specific types of waste that are prevalent in demolition projects. Due to this, they tend to get broken down into a few sub-types. Asbestos and insulation are major types of demolition waste, and they are also very hazardous materials. Asbestos can increase the risk of lung disease and cancers.

This is because asbestos can produce very fine flakes that can be easily inhaled. However, there is insolation that is not made entirely out of asbestos. The problem is that even if the insolation contains a small amount of asbestos, it' still incredibly hazardous. Another sub-type of demolition waste is non-asbestos- containing materials like concrete, bricks, tiles, and ceramics. Reinforced concrete is very valuable to recycle, as it can be reused to make new concrete.

This kind of material can be crushed up on the site of the project it is being used for. This will keep the costs of transport low as there will be less need for vehicle use. Wood, glass, and plastic fall under a third sub-type of demolition waste materials. Wood from these sites can be disposed of the same way as mentioned above.

Plastic is a major source of the volume of waste created on demolition and construction projects. Part of this is because plastic is mixed into many materials that are used to construct buildings. Many of the plastics that require proper disposal are Styrofoam, PVC siding, and PEX pipes.

2.1.4 Cause of construction waste

2.1.4.1 Steel reinforcement

Steel is used as reinforcement and structural integrity in the vast majority of construction projects. The main reasons steel is wasted on a site is due to irresponsible beam cutting and fabrication issues. The worst sites usually end up being the ones that do not have adequate design details and standards, which can result in waste due to short ends of bars being discarded due to improper planning of cuts. Many companies now choose to purchase preassembled steel reinforcement pieces. This reduces waste by outsourcing the bar cutting to companies that prioritize responsible material use (M, 2019).

2.1.4.2 Premixed concrete

Premixed concrete has one of the lowest waste indices when compared to other building materials. Many site managers site the difficulties controlling concrete delivery amounts as a major issue in accurately quantifying concrete needed for a site. The deviations from actually constructed concrete slabs and beams and the design amounts necessary were found to be 5.4% and 2.7% larger than expected, respectively, when comparing the data from 30 Brazilian sites. Many of these issues were attributed to inadequate form layout or lack of precision in excavation for foundation piles. Additionally, site managers know that additional concrete may be needed, and they will often order excess material to not interrupt the concrete pouring (M, 2019).

Ready -mix concrete is concrete that is manufactured in a batch plan, according to a set engineered mix design. Ready -mix concrete is normally delivered in two ways.

2.1.4.3 Pipes and wires

It is often difficult to plan and keep track of all the pipes and wires on a site as they are used in so many different areas of a project, especially when electrical and plumbing services are routinely subcontracted. Many issues of waste arise in this area of the construction process because of poorly designed details and irresponsible cutting of pipes and wires leaving short, wasted pipes and wires.

2.1.5 Environmental Impacts of Construction and Demolition Waste Management Alternatives

Construction and demolition waste (C&DW) arises mainly as by-products of rapid urbanization activities. C&DW materials have high potential for recycling and reusing. Despite its potential, landfilling is still the most common disposal method. In Malaysia, C&DW practices are principally guided by economic incentives such as low disposal cost or inexpensive virgin material outweighing recycling cost resulting in low recycling rate (A.Rani, 2017).

The purpose of this study is to access the environmental impacts caused by landfilling and the alternatives especially in assessing the damages to human health, ecosystems, and to the resources in the future 10year. It aims to identify the better alternatives in reducing the environmental impacts of landfilling C&DW. Life cycle assessment (LCA) used in this study assessed the environmental impacts associated with all stages, from waste production to end-of-life of waste material. LCA can help to avoid the short-sighted, quick-fix landfilling as the main solution for C&DW by systematically compiling an inventory of energy, fuel, material inputs, and environmental outputs.

The environmental impact of landfilling C&DW is estimated to increase 20.2 % if the business as usual (BaU) landfilling continues to the year 2025. Recycling will reduce 46.0 % of total damages and with the shorter travel distance, the environmental damage is further reduced by 82.3 %. Applying industrial building system (IBS) to reduce waste generation at-site reduced 98.1 % impacts as compared to landfilling scenario. The negative impacts derived from landfilling activity is significantly reduced by 99.5 % (scenario 8) through shifting to IBS, recycling, and shorter the travel distance from construction sites to material recycling facilities (MRF) (A.Rani, 2017).

The what-if scenarios illustrated the alternatives future circumstances, the inclusion of the uncertainty concept, and define the future path of C&DW industry outlook. The outcome of this study is informative and useful to policymakers, particularly in defining the way forward of C&DW industry in Malaysia.

2.1.6. Construction Waste source and management plan

Responsible management of waste is an essential aspect of sustainable building. In this context, managing waste means eliminating waste where possible; minimizing waste where feasible; and reusing materials which might otherwise become waste. Solid waste management practices have identified the reduction, recycling, and reuse of wastes as essential for sustainable management of resources.

Most construction and demolition waste currently generated in the U.S. is lawfully destined for disposal in landfills regulated under Code of Federal Regulations (CFR) 40, subtitles D and C. In some areas all or part of construction and demolition waste stream is unlawfully deposited on land, or in natural drainages including water, contrary to regulations to protect human health, commerce and the environment.

Businesses and citizens of the U.S. legally dispose of millions of tons of building-related waste in solid waste landfills each year. Increasingly, significant volumes of construction related waste are removed from the waste stream through a process called diversion. Diverted materials are sorted for subsequent recycling, and in some cases reused (Zeyad Khaled, 2015).

Volumes of building-related waste generated are significantly influenced by macroeconomic conditions affecting construction, societal consumption trends, and natural and anthropogenic hazards. In recent years, construction industry awareness of disposal and reuse issues has been recognized to reduce volumes of construction and demolition waste disposed in landfills.

Many opportunities exist for the beneficial reduction and recovery of materials that would otherwise be destined for disposal as waste. Construction industry professionals and building owners can educate and be educated about issues such as beneficial reuse, effective strategies for identification and separation of wastes, and economically viable means of promoting environmentally and socially appropriate means of reducing total waste disposed (Zeyad Khaled, 2015).

Organizations and governments can assume stewardship responsibilities for the orderly, reasonable, and effective disposal of building-related waste, promotion of public and industry awareness of disposal issues, and providing stable business-friendly environments for collecting, processing, and repurposing of wastes. Businesses can create value through the return of wastes back to manufacturing processes, promoting and seeking out opportunities for incorporation of recycled materials into products, and prioritizing reduction of building-related wastes through efficient jobsite practices.

Management Plan (SWMP) is a plan that details the amount and type of waste that will be produced on a construction site and how it will be reused, recycled or disposed of. The plan is updated during the construction process to record how waste is being managed and to demonstrate that any materials which cannot be reused or recycled are disposed of at a legitimate site.

2.1.7 Construction material waste minimization

Till the late 1900s, construction waste management has simply been seen as a disposal issue only. It has required a change in the state of mind to include waste reduction and recovery in each stage of the construction project life cycle mainly including design, procurement, construction, and disposal. Recently, the construction waste management approach has been diverged from a traditional to a holistic mindset by emerging a number of new concepts that have led to change in the overall mindset of waste management. These concepts can be summarized as follows (K.Agyekum, 2013). works contribute significantly to pollution of the environment.

Defined waste management as the discipline that encompasses solid waste generation, storage, collection, transport, processing, and disposal by considering the environmental, economic, aesthetics and public concerns. In addition, the management of waste includes monitoring, collection, transport processing and waste disposal. There are many efforts that have been carried out by the Malaysian government to minimize the generation of waste. Nevertheless, many contractors failed in implementing good waste management which led to the mismanagement of construction waste.

There are several approaches to construction waste management. The process of managing construction waste goes far beyond the disposal of the wastes itself. It is encompassing a strategy to effectively utilize construction resources, with the view to reduce the quantity of waste and utilizing the generated waste in the most effective manner.

In Malaysia, disposing the wastes directly to landfill sites is the most common approach in managing construction wastes (K.Agyekum, 2013).

Construction waste management is efficient material handling, reduction, reuse, recycling and disposal of construction waste materials. The practice of waste management for construction activities has been promoted with economic reasons and the recognition that waste from construction and demolition works contribute significantly to the polluted environment (Shen et al, 2002, cited in Shen et al, 2004). According to Coventry and Guthrie (1998), there are two fundamental reasons for reducing, reusing and recycling waste: the economic advantages, and the environmental advantages.

The environmental advantages include the minimization of the risk of immediate and future environmental pollution and harm to human health while the economic advantages include lower project costs, increased business support, lower risk of litigation regarding waste amongst others. The increasing awareness of economic and environmental impacts from construction waste has led to the development of waste management as an important function of construction project management (Shen et al 2004).

There are several approaches to construction waste management. The process of managing construction waste goes far beyond the disposal of the waste itself. It is an all-encompassing strategy to effectively utilize construction resources, with the view to reducing the quantity of waste and utilizing the generated waste in the most effective manner. The most common approach to management of construction waste is dumping in landfill sites. However, decreasing landfill space has led to increasing costs of landfill disposal to the contractor (BIE, 1993, cited in Lingard et al, 2000). In addition, a relatively large number of materials is being wasted because of poor material control on building sites (Poon, et al, 2004). This has prompted the need for alternative approaches and strategies for waste prevention.

2.2 Conceptual literature review

Conceptual framework is a diagram that illustrates the relationships among relevant factors that may influence the successful achievement of goals and objectives. It helps determine which factors will influence and how each of these factors might relate and affect the outcomes.

Various researchers and experts define waste in different ways. Formoso et al. (2002) defined waste as any losses produced by activities that generate direct or indirect costs but do not add value to the product from the point of view of the client. According to the new production philosophy, waste should be understood as any inefficiency that results in the use of equipment, materials, labor, or capital in larger quantities than those considered as necessary in the production process (Koskela, 1992).

Furthermore, Koskela (1992) describes waste includes both the incidence of material losses and the execution of unnecessary work, which generates additional costs but do not add value to the product. In other words, waste in construction is not only focused on the quantity of waste of materials on-site, but also related to several activities such as overproduction, waiting time, material handling, processing, inventories and movement of workers.

Both Formoso et al. (2002) and Koskela (1992) describes waste as a loss created through activities, but do not add value to the construction progress rather adds cost. So, drawing from the views expressed above, the definition of construction waste to be used in this study is any losses in material, time and monetary result of activities but do not add value or progress to the construction.

Construction Waste Categories Besides a clear understanding of the general concept of waste, it is helpful to use a classification of waste in different categories, in order to understand the wide range of possible corrective actions related to its prevention. Construction waste can be categorized into two: material waste and time waste (Al-Moghany, 2006; Ekanayake and Ofori, 2000).

Wasted time is understood as the time that is perceived by the skilled workers as useless, or as wastes use of time. The most common reasons for occurrence of time waste are: shortage of labor, unskilled or unproductive workers, the indecisiveness of clients, accidents on site, the conflict between sub-contractors, poor work flow layout, shortage of materials and inclement weather (Bo Terji, 2010). Time is unnecessarily wasted due to reordering, re-delivery, waiting and handling of additional material.

Therefore, time waste can be viewed as the extra amount of time needed for reordering, re-delivery, waiting and handling of additional material which will lower productivity, delay completion time, raise labor and machinery costs, and bring on extra overhead costs, and hence reduce profit (Formoso et al, 1999). The other type of waste in construction projects is materials waste. Studies in different countries have shown that not all materials procured and delivered to sites are used for the purposes for which they are ordered because of a number of reasons and become wasted (Bossink and Brouwers, 1996; Sagoe, 2011; Al-Moghany, 2006).

2.3. Empirical literature reviewed

2.3.1 Best International Practice on Building Materials Wastage Minimization

While construction and demolition wastes are usually grouped together under the title "C&D waste" in many countries in the world, the minimization strategy also undergone for waste of both processes. Throughout the construction cycle, and especially at the end of a structure's life, large quantities of material waste are produced. The increasing problems associated with construction and demolish waste have led to a complete rethinking in some of the industrialized countries. The current tendency in several industrialized countries is to view wastes as resources or by-products, which become new products that can be used for a variety of useful purposes (Begum et al., 2006; Zebau, Simona, Weisleder and David, 2006). This is because a large proportion of the waste produced on construction sites is recoverable for reuse and recycling.

2.3.1.1 Experience from Germany

Construction and demolition waste management in Germany is a mature and well-integrated sub industry within the broader German construction market. In 2002, German construction and demolition activity generated 214 Megatons of waste composed two thirds of excavated material, nearly another third of building and road demolition waste and a smaller fraction of mixed zxx construction site waste. Despite these high numbers, only 15% of these materials were disposed of in landfills, while the remaining 85% was recovered and reused in further applications or recycled (Zebau, Simona, Weisleder and David, 2006).

Germany's high material and waste disposal costs favor the economics of recovering, reusing and recycling as much construction and demolition waste as possible. Additionally, strong waste management systems have long been required by laws and regulations at all levels of government in order to minimize the impact of construction and demolition waste in the waste stream.

More recent versions of these regulations focus on the complete material cycle, working towards a closed loop substance cycle in construction and demolition. This combination of regulatory pushes from the government and economic pulls from the market have helped Germany establish an effective construction and demolition waste management infrastructure. The disposal of waste is only permitted when recycling is much more expensive

2.3.1.2 Experience from Australia

A number of states, including Victoria, South Australia and Western Australia, have 'towards zero' waste strategy documents. The strategies set state wide targets for waste reduction, resource recovery and littering (Chris and Emily, 2013). Many local councils require waste management plans before granting development consent. They usually require the builder or designer to estimate the total waste stream volumes from both demolition and new construction. In addition, nominate the means of disposal, including the recycling contractor, recycling waste station or landfill site. The site plan is often required to show waste storage facilities on site during construction and provide a schedule for delivery or pickup.

or impossible and the waste is unavoidable. In Germany the following major construction materials are commonly recovered.

The time and cost of waste plan preparation is usually recouped through reductions in waste disposal costs or dividends from the sale of salvaged resources. The following list demonstrates some reuse and recycle options in Australia.

2.3.1.3 Experience from South Africa

The C&DW stream in South Africa (SA) alone is estimated at around 5-8 million tons. This shows that there is a massive opportunity for growth in the recycling industry worldwide as well as in SA with regards to the recycling of C&DW. SA still has vast open spaces and natural aggregate resources are still available, therefore it is not surprising that SA is lagging behind in terms of its development of measures to promote the recycling of C&DW. However, as the available area for landfill sites are reduced, natural resources that are depleting and the pressures from global markets increase, such as with the need for ISO 9000 and ISO 14000 requiring more companies to have quality environmental management systems, SA might soon see the need for effective recycling of C&DW.

2.4 Synthesis of summary of the literature review

Generally, development of infrastructural facilities is accompanied by construction, remodeling and demolition of buildings, roads, bridges, flyover, subways, runways, factories and other similar establishments. In most parts of the world, construction industry consumes huge number of natural resources and often generates large quantities of construction waste. A Construction waste consists of unwanted material produced directly or indirectly by the construction industries.

This includes inert and non-biodegradable building materials such as concrete, plaster, wood, metal, broken tiles, bricks, masonry, insulation, nails, electrical wiring, and repair, as well as waste originating from the site. These wastes are heavy, having high density, very often occupy considerable storage space. In general, a very high level of waste is assumed to exist in construction.

Avoiding waste refers to any practice to avoid or minimize waste at source. Re-using and recycling refer to the re-using and recycling of waste materials, and thus, reducing the volume of waste needed to be disposed to the landfills. Minimization of waste at source is given the highest priority, because it is always more efficient to minimize the generation of waste at source than to develop ways for treating or handling the waste.

Therefore, by identifying the main causes, construction industry players can avoid excessive waste generated on construction sites. In addition, there are different studies on effect of material wastage reduction and minimizing strategy, including reusing and recycling on construction projects. From each of the literature reviews on construction waste minimization, different gaps were identified.

The critical gaps will be identified from these studies are lack of clearly knowledge about source of the construction waste and the management plan in housing in Addis Ababa. The source of construction material waste is design changes, rework poor, document etc. Not properly identifying source of construction material waste allowed and actually wasted materials on site. On the other hand, wastage management plan needs serious consideration and due attention since the construction industry consumes large amount of raw material.

Therefore, this research is necessary in order to develop an appropriate construction waste management practice that will set out procedures to fill the knowledge gaps mentioned above.

CHAPTER - THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The research methodology will give the path and choosing a wholly suitable and sound method that is right for the research project. A methodology gives a guideline to achieve the aims and objectives and make the project manageable, smooth and effective. In addition to that it gives the research population, sample size and statistical tools used for data analysis.

3.2 Research Approach

In this study quantitative research approach used in the form of questionnaire sample survey research approach was use to collect the data. Quantitative method is used to test prespecified concepts, constructs, and hypotheses that make up a theory. Quantitative research methods are typically sample survey and experiment. Quantitative research approach was used in this study because of determine the relationship between variable.

3.3 Research Design

The research design used in this thesis was a Descriptive research. Descriptive research aims to accurately and systematically describe a population, situation or phenomenon. It can answer what, where, when and how questions, but not why questions. A descriptive research design can use a wide variety of research methods to investigate one or more variables. The independent variable was the source of construction waste. The severity and frequency of the contribution of these sources using a like scale, which is a multi-item measuring scale where respondent level is anchored with consecutive.

3.3 Research Method

The research method used in this study was mixed methods which include observation, interviews and surveys. Interviews was usually carried out in person. Face-to-face and can also be administered by telephone. The researcher selected these methods because of this approach help me to collect rich information by taking time.

3.3.1 Target Population and Sampling Technique

Target Population means, the entire group of individuals or objects to which researchers are interested in generalizing the conclusions. The target population in this study was employees' of 40/60 condominiums and real estate, who are currently working as project managers, contractors and consultants. 80 The sampling technique used in this study was judgmental or purposive sampling in which the decision to include a sample in the study was made based on the criteria of the person's knowledge of construction, these people are expected to have knowledge about the source of construction waste.

3.3.2 Data collection techniques and procedures

The researcher was used both primary and secondary data collection methods to collect data for the study. The primary data, both qualitative and quantitative will be collect through questionnaire, interviews. Both open and close-ended format questions were designed to obtain information on the situation of construction waste management and source of wastes in the study area, the housing (condominium site and real estate).

=>**The study objectives were achieved by employing the method outlined below.**

Different literature review was carried out on materials wastage in building sites with a main focus of prior research works.

↓

Data gathering was conducted through field observations, questionnaire survey

↓

The collected data was analyzed and discussed.

↓

Finally, conclusion was draw and recommendation on good waste management practice in housing projects has been given.

Figure 3.1 Data collection procedures

3.3.3 Data analysis techniques

The questionnaire responses were analyzes used ordinal regression to derive the probabilities of rating categories (1, 2, 3, 4, and 5) for the severity and frequency of the contribution of the sources of construction waste using SPSS software. The probability of a category is the number of respondents that choose the category divided by the total number of respondents in the sample.

As demonstrated in Fadiya et.al (O.O. Fadiya, 2013) the following formulae were used to derive severity and frequency indices.

$$Sj= \sum_{n=5}^{n=1} wiXi \qquad Xi = n/N \quad wi = i/5$$

Equ (1)

$$Fj= \sum_{n=5}^{n=1} wiYi \qquad Yi = n/N \quad wi = i/5$$

$$\text{Contribution index } (Cj) = Sj \times Fj \qquad \text{Equ (2)}$$

$$\text{Rates} = \frac{Cj}{\sum_{i=1}^{8} Cj} \times 100\% \qquad \text{Equ (3)}$$

Where i is the rating category; mi is number of respondents that chose i for the severity; ni is the number of respondents that chose i for the frequency; N is the total number of responses; wi is the weight of category i; and$j$ is the series of sources of construction waste.

3.3.3.1 Tests of Significant

A test of significance is a formal procedure for comparing observed data with a claim (also called a hypothesis), claim is a statement about a parameter, like the population p or the population mean μ. State the hypothesis. Determine whether the data warrants a one-tailed or two-tailed test. For one-tailed tests, the null hypothesis will be in the form of $\mu > x$ if you want to test for a sample mean that is too small, or $\mu < x$ if you want to test for a sample mean that is too large. The alternative hypothesis is in the form of $\mu = x$. For two-tailed tests, the alternative hypothesis is still $\mu = x$, but the null hypothesis changes to $\mu \neq x$.

Determine a significance level appropriate for your study. This will be the value you compare your final result to. Generally, significance values are at $\alpha = .05$ or $\alpha = .01$, depending on your preference and how accurate you want your results to be. alternative hypothesis is in the form of $\mu = x$. For two-tailed tests, the alternative hypothesis is still $\mu = x$, but the null hypothesis changes to $\mu \neq x$.

3.4 Ethical Considerations

According to Leedy et al (2005), there are a number of key ethical issues that relate to the rights of research participants. These are protection from harm, informed consent, the right to privacy and honesty.

The principle of informed consent requires that respondents should be given full information about the research and their consent be sought to participate in it. The participants in this study were well informed about the nature of the study in writing and orally. The questionnaire described the nature of the study, why it was carried out and notified the respondents that their participation was voluntary. The participants requested for interviews were also orally informed about the nature of the study and that their participation was voluntary and consensual.

3.5 Validity and Reliability

To ensure the quality of research and make it credible for the researcher gave due care to both validity and reliability issues of the data, the research process in general as well as the research output. The researcher used different sources of data from literature, interview, site observation.

A reliability test of Cronbach's Alpha was made for the liker scale type questions on SPSS Cronbach's alpha is a measure used to assess the reliability, or internal consistency, of a set of scale or test items. In other words, the reliability of any given measurement refers to the extent to which it is a consistent measure of a concept, and Cronbach's alpha is one way of measuring the strength of that consistency (Goforth, 2015). A reliability coefficient of .70 or higher is considered "acceptable" in most social science research situations (Bruin, J.2011).

For severity

Reliability Statistics

Cronbach's Alpha	N of Items
.702	8

for frequency

Reliability Statistics

Cronbach's Alpha	N of Items
.707	8

CHAPTER -FOUR

Data Presentation, Analysis and Interpretation

4.1 Introduction

This chapter presents the way the questionnaires are retrieved and subsequent analysis of the data collected from consultant, Contractors and Working for client who are working in housing project in Addis Ababa. The results were duplicated in the form of frequencies, table and percentage.

The main purpose of this survey is to identify the source of construction waste by their contribution also management plan. So, interview was conducted for identifying the source of waste with the project manager of the site.

4.2 Responses Rate

Table 4.1 Respondent Rate of the questionnaire

Respondent	Questionnaires Distributed (N)	In Rate (%)	Filled and returned	Response Rate (%)	Responses from total
Client	**13**	**16.25**	**10**	**76.9**	**16.7**
Contractor	**45**	**56.25**	**30**	**66.6**	**50.0**
Consultant	**22**	**27.5**	**20**	**90.9**	**33.3**
Total	**80**	**100**	**60**	**75**	**100**

With regards to response rate, the questionnaires were distributed to the selected 80 target group. Out of the total 80 questionnaires distribute 60 of the questionnaires are filled and returned. From the respondents are 10 Client, 30 Contractor and 20 Consultant also accordingly from the 60 questionnaires are filled and returned, 75% was collected. 20 were rejecting because of analysis due to many unrepaired questions observed in the questionnaire contained therein. An interview consists of 2 individuals from the contractor and Client. But out of the planned (5) interviews only (3) respondents were interviewed. This was due to the busy schedules of the respondents and absence of time.

The numbers were determined on the basis of the available Engineers employed by the contractors and consultants on the sites.

4.2.1 Characteristics of the Respondents

The demographic characteristics of the responders its surveyed in this research include gender, age, education background experience and professions.

4.2.1.1 Gender distribution

Table 4 .2 Respondent gender distribution

Gender	Number	%
Male	49	81.6
Female	11	18.33
Total	60	100

Concerning the gender 60 of the respondents of the survey are 49 males and 11 of respondents was females. This indicates that the male's participation is higher than females in port construction. The number of male respondents was greater than females‟ may be because of their availability in all positions.

4.2.1.2 Age Distribution

Table 4.3 Age distribution

Age	Number	%
20-35	34	57
36-45	17	28
46-65	9	15
Total	60	100

With reference to age of the respondents the largest proportion of respondents, that is,34(57%) employees were found among the age categories of 20-35 years, while employees, 17(28) respondents were found among the age range of 36- 45 years, The others, 49(15%) employees, were found in the age category of 46- 65 years. The data indicates that most of the respondents of this study were mature enough to know what has been happening in their respective housing projects, and hence were able to provide pertinent and detail information about the achievements and challenges of condominium housing projects.

It can be inferred that majority of staff in the in-construction site are young and therefore experienced.

4.2.1.3 Academic Qualification of Respondents

The education background of the respondents, 50 of the respondents have first degree in fields of Engineering and social sciences whereas 10 of the respondents had masters.

Table 4.4 Academic Qualification of the respondent

Education level	Number	%
Degree	50	83.3
Masters	10	16.6
Total	60	100

summarizes the data regarding educational qualification and work experience. In relation to respondents‟ characteristics in terms of educational qualification, a total of 60 respondent 83.3 % of them had receive a bachelor,16.6% of them had completed Masters. This has a positive influence on performance and quality of condominium housing.

4.2.1.4 Year of experience in port construction

Table 4.5 Year of experience

Year of experience	Number of years	%
1-3year	10	16.6
3-5 year	9	15
5-8 year	16	26.6
Above 10	25	41.6
Total	60	100

4.2.1.5 Year of experience in the housing construction site

Table 4.6 Year of experience in the housing construction site

Year of experience	Number of years	%
1-3year	6	10
3-5 year	8	13.3
5-8 year	17	28.3
Above 10	24	40
Total	60	100

The data regarding the respondents‟ years of experience in port construction from 60 respondent 25 are above 10 years, 16 is between 5-8 years,9 is between 3-5 years while 10 are between 1-3

years. experience in condominium (housing) projects. Looking in to the experiences they had, generally, the respondents can be identified as experienced employees, contractors, and MSE.

The next table below shows the respondent's years of experience, the highest years of experience in the construction industry was above 10 years. And the less year of experience in the construction industry was between 3-5 years.

4.3 The Waste Management practice

4.3.1 Source of construction waste

In this part of the result source of construction waste that are gathered from questionnaire survey and site observation are presented and observation are presented and discussed.

Questionnaires were designed to know the severity and the frequency of the source of construction waste material.

The source of construction waste categorized into Eight sources as mentioned before, namely, design, procurement, storage and handling, operation, Vandalism, Weather, Residual and others.

Table 4.7 Source of construction waste frequency scoring for severity

Group		Design	Procurement	Material Handling	Operation	Vandalism	Weather	Residual	Other
Frequency Scoring	1	3	3	6	4	10	10	14	9
	2	9	11	10	2	12	19	19	15
	3	16	21	16	11	17	13	17	18
	4	17	15	16	15	9	14	6	11
	5	15	10	12	28	12	4	4	7
Total		60	60	60	60	60	60	60	60

The Respondents were asked about the source of construction waste on their working site. Majority of the respondents, respond moderate and great for severity contribution.

Sj= $\sum_{n=5}^{n=1} wiXi$ Xi =n/N wi=i/5

Fj= $\sum_{n=5}^{n=1} wiYi$ Yi =n/N wi=i/5

Table 4.8 Analysis result for severity

Source of waste	X1	X2	X3	X4	X5
Design	0.05	0.15	0.27	0.28	0.25
Procurement	0.15	0.18	0.35	0.25	0.16
Material Handling	0.1	0.16	0.26	0.26	0.2
Operation	0.07	0.03	0.18	0.25	0.47
Vandalism	0.16	0.2	0.28	0.15	0.2
Weather	0.16	0.32	0.21	0.23	0.07
Residual	0.23	0.32	0.28	0.1	0.07
Other	0.15	0.25	0.3	0.18	0.12

As a guide, the severity index of design change using the probabilities shown in Table 4.8 was derived as follows:

Sj= $\sum_{n=5}^{n=1} wiXi$ Xi =n/N wi=i/5

$$S\ design=\frac{(1x0.05+2x0.15+0.27x3+0.28x4+0.25x5)}{5}$$

$$=\frac{0.05+0.30+0.81+1.12+1.25}{5}$$

= 0.706

Table 4.9 Severity level

Source of waste	Si
Design	0.71
Procurement	0.51
Material Handling	0.63
Operation	0.80
Vandalism	0.48
Weather	0.45
Residual	0.65
Other	0.38

According to the above table, the severity level for Operation is (0.80) also the highest from other source of waste and Design follows. This indicate that respondent respond that the operation has the highest severity level.

Table 4.10 Source of construction waste frequency scoring for frequency

Group		Design	Procurement	Material Handling	Operation	Vandalism	Weather	Residual	Other
Frequency Scoring	1	0	1	1	1	0	0	1	1
	2	5	17	13	7	25	15	18	15
	3	31	31	36	33	32	35	34	35
	4	18	8	9	10	3	10	7	8
	5	6	3	1	9	0	0	0	1
Total		60	60	60	60	60	60	60	60

The Respondents were asked about the source of construction waste on their working site. Majority of the respondents, respond often and usually for frequency contribution.

Table 4.11 Analysis result for frequency

Source of waste	Y1	Y2	Y3	Y4	Y5
Design	0	0.1	0.52	0.3	0.1
Procurement	0.02	0.28	0.51	0.13	0.05
Material Handling	0.02	0.22	0.6	0.15	0.02
Operation	0.02	0.12	0.55	0.16	0.1
Vandalism	0	0.42	0.53	0.05	0

Weather	0	0.25	0.58	0.16	0
Residual	0.17	0.3	0.56	0.12	0
Other	0.17	0.25	0.58	0.13	0.17

Fj= $\sum_{n=5}^{n=1} wiYi$ Yi =n/N wi=i/5

F design=(1x0+2x0.1+0.52x3+0.3x4+0.1x5)

5

=0+0.2+1.56+1.2+0.5

5

= 0.69

Table 4.12 Frequency level

Source of waste	**Fi**
Design	0.69
Procurement	0.57
Material Handling	0.59
Operation	0.65
Vandalism	0.53
Weather	0.57
Residual	0.58
Other	0.71

According to the above table, the Frequency level for Operation is (0.80) also the highest from other source of waste and Design follows. This indicate that respondent respond that the operation has the highest Frequency level.

Table 4.13 Contribution induce of the source of construction waste

Source of waste	**Fi**	**Si**	**Cj**
Design	0.69	0.71	0.48
Procurement	0.57	0.51	0.29
Material Handling	0.59	0.63	0.37
Operation	0.65	0.80	0.52
Vandalism	0.53	0.48	0.25
Weather	0.57	0.45	0.26
Residual	0.58	0.65	0.37
Other	0.71	0.38	0.27

the contribution index is a measure of significance of each source while severity index is a measure of the extent of contribution and frequency index is a measure of how often a source contributes. Furthermore, the contribution indices were converted to rates according to in order to generate percentages of contribution of the sources to construction waste. Hence, the severity indices, frequency indices, contribution indices, and rates of contribution of the sources of construction waste are shown in Table 4.13. Consider

Contribution index (Cj)=Sj x Fj

Rates=$\frac{Cj}{\sum_{i=1}^{8} Cj}$ x100%

Table 4.14 Rank of the source of construction waste

Source of waste	Rate%	Rank
Design	17.08	2
Procurement	10.3	5
Material Handling	13.1	4
Operation	18.5	1
Vandalism	8.8	8
Weather	9.2	7
Residual	13.2	3
Other	9.60	6

The result show that operation has the highest construction (18.5%). In the second place in term of contribution is design (17.08%) while the source of waste with the minimum contribution is Residual (13.2%). The result of this study is corroborated by existing findings. According these two major contributors as established in this study account for 35.58% of construction waste and are related the project design. Furthermore, the results of Chi-Square test demonstrate the significance of the findings of this study. The p-values of the severity and frequency of the sources of waste were below 0.05 that is, the null hypothesis shows be reject and the results of this study can be accepted as statistically valid.

4.3.2 Construction waste management plans

4.3.2.1 Is there any construction management plan in your site

Table 4.15 Construction waste management plan

	Number of respondents
Yes	**54**
No	**6**

According to the above table, 54 of the respondents respond “Yes” and 6 of the respondents respond “No’’ so this indicate that there is a waste management plan.

4.3.2.2 If you answer 3.1 question “Yes” when what type of construction waste management plan

Table 4.16 Stage of construction

Construction stage	
Pre-construction	26
During construction	31
Post construction	13

The respondents were asked about in which stage of construction is the waste management plan implement then majority of the respondent, respond (31), during construction, (26) pre-construction and (13) post construction.

This implies that, most of the construction waste plan implement during construction stage.

4.3.2.3 Type of construction waste management plan

Table 4.17 Type of construction management plan

Material type	Construction waste management plan		
	Recycled	**Re-use**	**Landfilled**
Concrete			60
Reinforcement bar		60	
Mortal			60
HCB			60
Brick			60
Glass			60

According to the above table, the respondent respond only Reinforcement is re-use (60). The Concrete, Mortal, HCB and Brick are end in the landfilled. So, this show that the generation of waste is very high.

4.3.3 Test the significant of the study

Statistics of severity and frequency of the variable was examined using the Chi-square test. The purpose of the test was to assess the variability of ratings that were assigned to severity and frequency of the source of construction waste by the respondent.

Ho=The percentage of all categories for each source of waste are equal in the underlying population

The sig value was less than 0.05 Model Fitting Information

P<0.05 Statistically significant reject null hypothesis accepted the alternate hypothesis.

Table 4.18 Chi-square and Sig test ststistical for sources of construction waste

Source of waste	Severity		Frequency	
	Chi-square	Sig(p)	Chi-square	Sig(p)
Design	60.00	0.00	45.00	0.00
Procurement	60.00	0.00	60.00	0.00
Material Handling	60.00	0.00	45.00	0.00
Operation	60.00	0.00	60.00	0.00
Vandalism	30.00	0.00	60.00	0.00
Weather	45.00	0.00	60.00	0.00
Residual	60.00	0.00	45.00	0.00
Other	60.00	0.00	45.00	0.00

In addition to that, during my site visit, some waste of concrete was also observed during transportation operations on site. Mostly related to the use of inadequate equipment and overloading of the transporting equipment's.

Besides on most of the sites I had also observed poorly stored reinforcement bars which results in large disorganized stocks.

Also, HCB in which the material put in unsuitable place on site leads to damage.

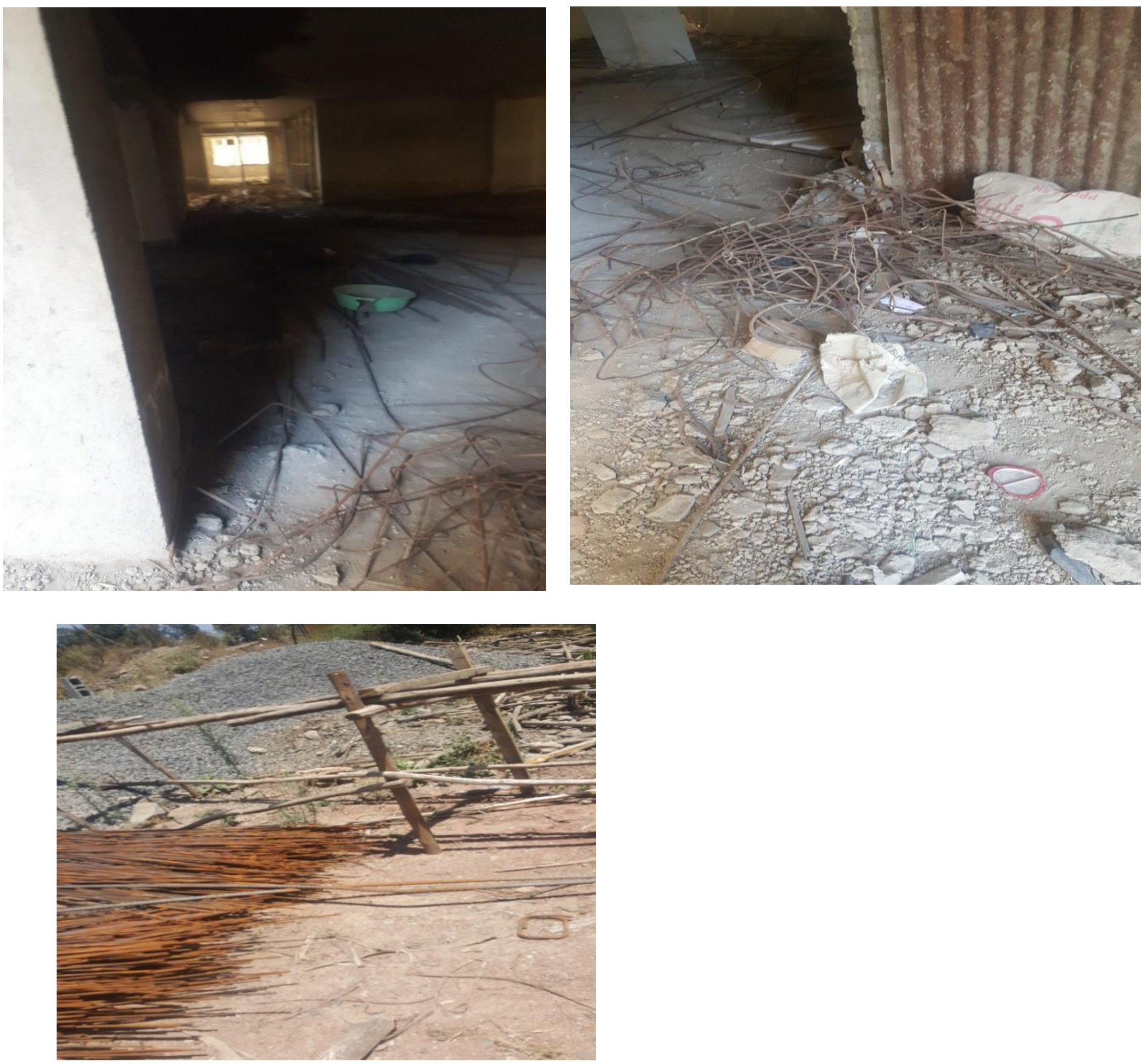

Figure 4.1 Improper handling of Reinforcements bar

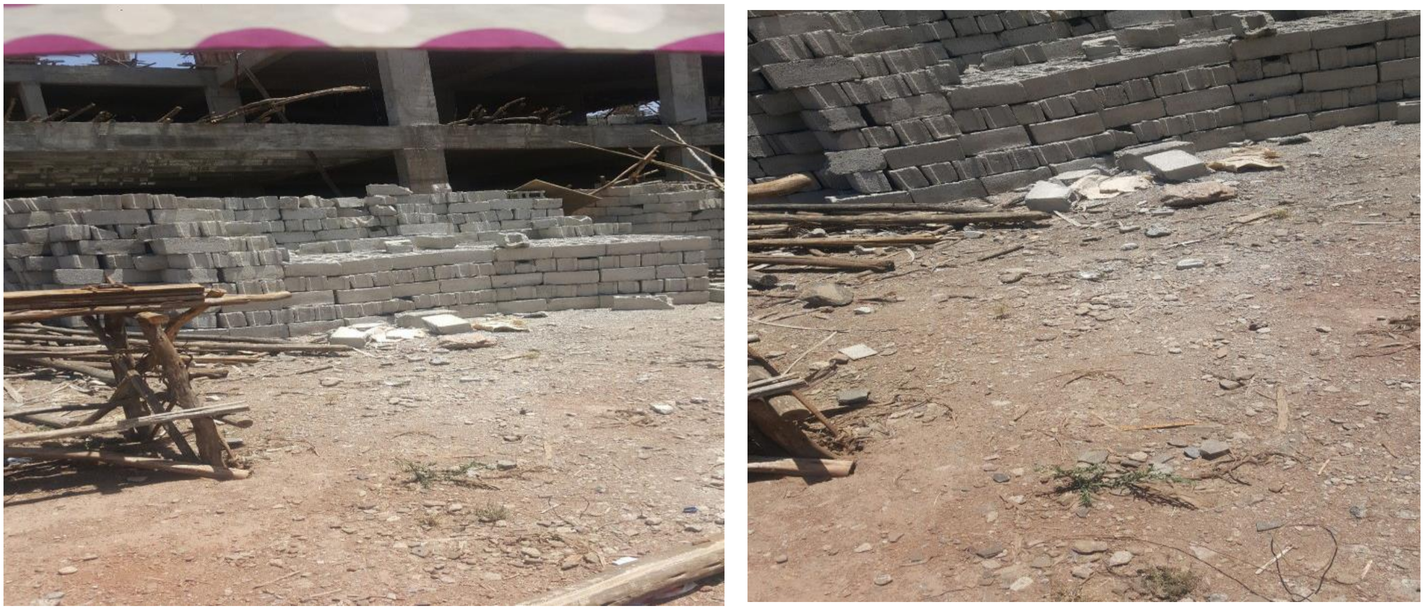

Figure 4.2 Improper storing HCB

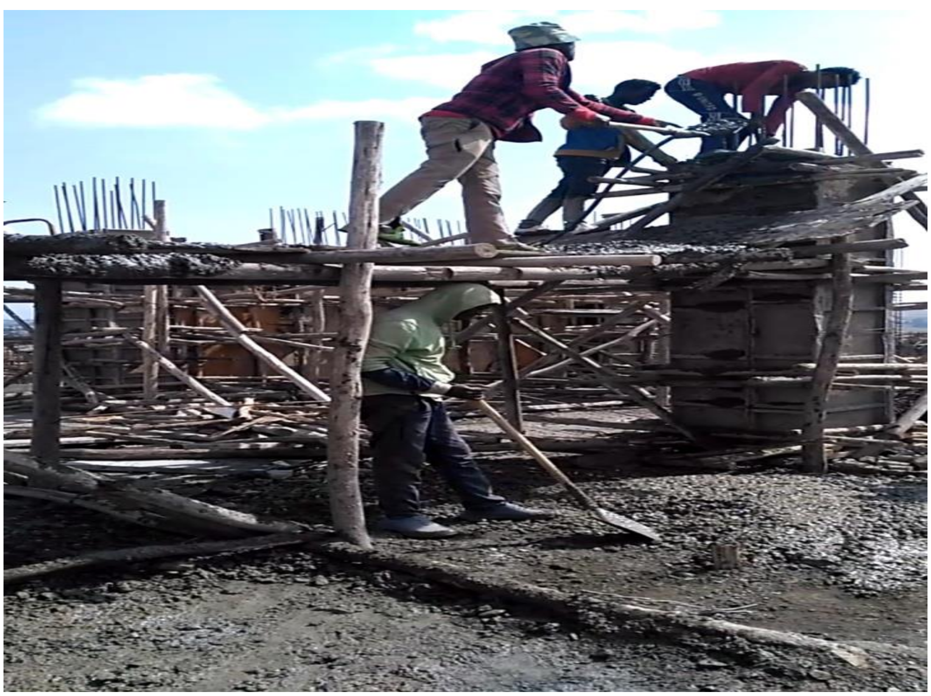

Figure 4.3 Improper transporting of concrete

4.3.4 Case study

The aim of this case study is to illustrate the extent of construction material wastage, reuse and recycling practice and its cost effect.

Site name =Bole Builbula

Type of housing= 40/60 condominium housing construction

No of block =28

Typology of the blocks=2B+G+12

4.19 Estimated Cost of Materia Waste

No	Material			Unit	Quantity	Unit Price	Total cost
1	Cement (OPC)			Qut	2200	560	1,232,000
2	Coarse Aggregate			M^3	700	480	336,000
3	Fine Aggregate			M^3	1000	80	80,000
3	Hollow Concrete	Wall Block	20cm	Pcs	5000	19	95,000
			10cm		4000	17	68,000
		Ribbed slab	22cm	Pcs	4500	22	99,000
			16cm	Pcs	1670	21	35,070
4	Reinforcement bar		8	Kg	450	80.51	36,229.5
			12	Kg	5400	80.71	435,834
			14	Kg	3100	79.18	245,458
			16	Kg	1100	80.64	88,704
			20	Kg	900	75.95	68,355
			24	Kg	200	67.57	13,514
	Total				2,833,164.5birr		

The data was collected by communicate with the contractors and other site worker also the data was estimated because of it was difficult very to measure.

-Total Reinforcement bar in kg=11150kg

-Total Reinforcement bar cost=888094.5birr

-The collected Reinforcement bar in order to sell it to a steel factory at a price of 50 ETB/kg then the cost of saving found by selling these amounts of reinforcement bar from the site.

11150kg X 50 ETB/kg=557500ETB

888094.5-557500=330594.5ETB cost saving found

Rebar recycled and used for new construction project, tools such as rebar cutters and rebar benders can also make it easy to repurpose the stee rods for both functional and decorative purposes. Using the material for art projects, parts for furniture.

Not only bar is reuse but also old concrete was crushed and as recycled aggregate to obtain new concrete (Abdulsemee M. Halahla, 2019).

Also, sand can be partial replace by broken glass (Hana, 2019)

CHAPTER - FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

Construction waste management is required for a country to develop in a sustainable manner. It helps to address issues related to environmental, social and economy. Once the root causes of waste generation are notified, it can either be avoided or minimize to benefit the world for better future.

From this point of view, the purpose of this study was to know source of construction waste by their contribution and a management plan. It is good to assessing the source of the construction waste to create butter world.

The study gives the following conclusions to address based on results gain.

- The rate of construction and corresponding ranking of the source of waste will enhance prioritization of the sources. The first, second and third contributors of construction waste are Operation, Design and Residual as shown in the.
- The survey result show that the general practice of construction waste management plan is very poor. From this study most of housing construction in Addis Ababa remove their waste on land filled except reinforcement bar.
- The reliability of the results of this study justified by the results of Chi-square test (O.O. Fadiya, 2013). The Chi-square value must be less than 0.05. So, the result of Chi-square test for this study questionnaire was less than 0.05 as show in the (Table 4.18). So, it indicates the higher the reliability of the scale of the questionnaire survey and the easier it is to obtain the significant findings. Therefore, the researcher rejects the null hypothesis.
- According to former study (O.O. Fadiya, 2013) the first, second and the third contribution waste was Residual, Design and handling. There is some different between studies because of in our country there are some improper usages and transporting of material during operation.
- Also, the validity of the results of this study and the reliability of the internal consistency of multi-item scales, Cronbach’s alpha estimates of the data the severity and frequency of

the source of construction waste shown in Table 4.19. Table 4.19 show that the alpha value gathers than 0.7 So it is valid and reliable.

- The results of the case study demonstrate that the level of material waste in housing project (40/60 condominium and real estate) construction project is fairly high in all of the assessed construction materials.
- The result of case study showed only reinforcement bar recycles also rebar minimize the cost of material. The case of recycling rebar has contributed to its growing reputation as one of construction's more earth friendly materials. Made completely of steel, most rebar used in new construction came from recycled materials, and after a teardown, most of it will be recycling again. The finding of this study show that waste is major contributor to the cost of construction.

5.2 RECOMMENDATIONS

On the basis of the above-mentioned findings the following point are recommendations to minimize and managing the source of construction waste in housing construction in Addis Ababa.

- To minimize wastage, happen due to operation problem in housing construction sites (40/60 condominium and real estate) by Controlling operation. Controlling operation play crucial roles in preventing waste from the beginning stage through construction completion. By using the following

  1.Clearly assign and communicate responsibilities: Ensure that those involved in the construction are aware of their responsibilities in relation to the waste management plan.

  2.Engate and educate personnel: be Clear about how the various element of the waste management plan will be implement.

  3.Monitor: To ensure the plan is being implement.
- Site supervision and management should be done regularly, the lack of supervision may result in mistakes, reworks, and poor workmanship; Coordination among parties is a key to reducing waste.
- The contractors should pay attention to construction documents and drawings to see any discrepancy and seek advice or answers from the owner or designers prior to construction

and the contractors must try to understand the owner's and designer's intention for the project to mitigate rework

- Zero Avoidable Wast in construction means preventing waste being generated at every stage of a project's lifecycle.
- Higher education institutions should include teachings of sustainable construction in the curriculum of professionals in the construction industry. Also, professional bodies should use conferences and workshops to educate practicing professionals.
- The Addis Ababa city government should introduce specific legislation governing the handling and disposal of construction wastes and follow up with strict monitoring to ensure compliance.
- Incentive schemes should be set up by government to reward firms who embrace construction waste management wholly.
- Creating new job: Since waste can make a good profit from salvaged building parts this will become a vital branch of the building parts, branches of the building industry offering many new jobs firm the sorting and transporting of construction waste.
- The contractors should have sufficient knowledge and expertise. They should gain experience before the construction stage so that they can seek out needed resources. The amount and quality of materials on site should be checked and stored in the proper locations;

5.3 Further research

The following some issues are identified and suggested for future studies.

- Similar type research to carry out in other areas of country to collect data to implement suitable Construction waste management system.
- Recycling methods for construction waste and to identify marketable products.
- [Further investigation on material wastage of other types of building like commercial industrial and school building projects.

REFERENCES

1.Al-Moghany, S.S. (2006). Managing and Minimizing Construction Waste in Gaza Strip. A thesis submitted to the Islamic University of Gaza- Palestine.

2.Andrew R.J. Dainty and Richard J. Brooke (2204) “Towards improved construction waste minimization” Structural Survey 22(1) 20–29.

3. Begum, R. A., & Siwar, C. (2006). A Benefit-Cost Analysis on the economic feasibility of construction waste minimization: The Case of Malaysia. Resource Conservation & Recycling, 86-98.

4.Bossink BAG, Brouwers HJH (1996). Construction waste: quantification and source evaluation; J. Construction Eng. Manage., 122(1): 55-60.

5.Bo Terje Kalsaass “Work-Time Waste in Construction” 18th Annual Conference, International Group for Lean Construction, Haifa, Israel, July14-16, 2010.

6. Begum, R. A., & Siwar, C. (2006). A Benefit-Cost Analysis on the economic feasibility of construction waste minimization: The Case of Malaysia. Resource Conservation & Recycling, 86-98.

7.Bossink BAG, Brouwers HJH (1996). Construction waste: quantification and source evaluation; J. Construction Eng. Manage., 122(1): 55-60. Bo Terje Kalsaass “Work-Time Waste in Construction” 18th Annual Conference, International Group for Lean Construction, Haifa, Israel, July14-16, 2010.

8.B. Somekh and C. Lewin, Research Methods in the Social Sciences, Sage, London, UK, 2005.

Chris Reardon, Emily Fewster “Waste minimization” Australian Guide to Environmentally Sustainable homes, 2013 C.W.F.

9.Che Wan Putra, A. Ahmad, M.Z. Abd Majid, and N. Kasim, (1999) "Improving material scheduling for construction industry in Malaysia," In Malaysian Science & Technology Congress 99, 6-8, Johor Bahru, Malaysia.

10.Environmental Protection Agency of USA, (2000). Solid Waste and Emergency Response. EPA530-F-00-001. United States.

11.Faniran, O.O and Caban, G. (1998) Minimizing Waste on Construction Project Sites. Engineering, Construction and Architectural Management, Vol. 5, No. 2, pp. 182-188.

12.Formoso, C.T., Isatto, E.L. & Hirota, E.H. 1999. Method for waste control in the building industry. Journal of the University of California, Berkeley, USA.

13.Formoso, C.T., Lucio Soibelman, M., De Cesare, C. and Isatto, E.L. (2002). Materials Waste in Building Industry: Main causes and prevention. Journal of Construction Engineering and Management, 128(4), 316-325.

14.Getachew Araya Kassa, November, 2009 AAU School of Graduate Studies; Master of Science of Civil Engineering, Construction Technology and Management Major Thesis.

15.K.Agyekum, J. a.-K. (2013). minimizing material wastage in construction-A Lean consteuction approach. journal of engineering and applied science, 125.

16.Kidst M. (2014). "Assessment on the Performance of Integrated Housing Development Program with Particular Reference to the Program's Objectives: Focusing on Addis Ababa".

17.K. K Chitkara, Construction Project Management Planning, Scheduling and Controlling – eighth reprint, 2004.

18.Koskela, L. (1992). Application of the New Production Philosophy to Construction. CIFE, Technical Report No. 72, Stanford, USA.

19.Kofoworola, O. F. (2009). Estimation of construction waste generation and management. science direction, 631-738.

20.Lee Chin, I. A. (2013). Classification and quantification of construction waste at housing project site. international journal of zero waste generation, 1.

21.M, A. Y. (2019). Cailding construction projectuse of material wastsge in building construction project. International journal of scientific and engineering research, 1614-1618.

22.McDonald, B. and Smithers, M. (1998), "Implementing a Waste Management Plan during the Construction Phase of a Project: A case study", Construction Management Economics, 16(1), 71 -78.

23.M. M. M. Teo and M. Loosemore, "A theory of waste behaviors in the construction industry," Construction Management and Economics, vol. 19, no. 7, pp. 741–751, 2001.

24.M. Tavakol and R. Dennick, "Making sense of Cronbach's alpha," International Journal of Medical Education, vol. 2, pp. 53– 55, 2011.

25.Mulualem Merid, Negatu Abera & Tedla Belachew, 2012. "The role of construction management professionals in minimizing wastage of material in building construction: the case of Addis Ababa." A thesis submitted in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Construction Technology & Management.

26.Nariah Binti Kasim, January 2008 "improving materials management on construction projects" A Doctoral Thesis Submitted in partial fulfillment of the requirements for the award of Doctor of Philosophy of Loughborough University.

27.National specialist contractor's council (NSCC), "reduce, reuse, recycle managing your waste", London, 2007.

28.Sari Piippo, E. P. (2015). Strategic waste management planning-The organization of municipal solid. an international journal for engineering and information sciences, 146.

29.R. M. Gavilan and L. E. Bernold, "Source evaluation of solid waste in building construction," Journal of Construction Engineering and Management, vol. 120, no. 3, pp. 536–552, 1994.

30.R. Navon and O. Berkovich, "An automated model for materials management and control," Construction Management and Economics, vol. 24, no. 6, pp. 635–646, 2006

31.Shen, L. Y., Tam, W. Y. Vivian, Tam, C. M. and Drew, D., (2004). Mapping Approach for Examining Waste Management on Construction Sites. Journal of Construction Engineering and Management, 130(4), 472-481.

32.Skoyles, E.R. & Skoyles, J.R. (1987). Waste prevention on site. Mitchell Publishing, London. S. Nagapan, et al., "A Review of Construction Waste Cause Factors, in Asian Conference of Real Estate: Sustainable Growth Managing Challenges (ACRE), 2011.

33.Tam C. M., Vivian W. Y. Tam, John K. W. Chan and William C. Y. NG, (2005), Use of Prefabrication to Minimize Construction Waste - a Case Study Approach, The international journal of construction management, 91-101

34.Yu V Borodin, T. A. (2015). waste management through life cycle assessment of products., 3-7. material science and Engineering.

35.Zebau Gmbh, Simona Weisleder and David Nasseri, October 2006 “Construction and Demolition waste management in Germany” Europe aid cooperation office.

36.Zeyad Khaled, B. S.-S. (2015). Development of construction material waste management system. Eng. and Tech Journal, 1717.

APPENDICES

Appendix A Questionnaire

Project Management Department

Assessment of construction waste sources and management planning pactions and practices: housing in Addis Ababa (40/60 condominium)

Questionnaire

This interview is conducted to collect data for research on: construction waste source and management planning pactions and practice: housing in Addis Ababa (40/60 condominium and real estate). The aim of this questionnaires to obtain necessary data for the partial fulfillment of an MSc thesis in project management at St. Mary's university. The information is going to be used as a primary data for this research. Therefor, and your response and participation in the interview will be extremely valuable for the study. All data found from the survey will only be used for an academic purpose. I believe this kind of study will be an input for the development of Ethiopian construction industry. If you want to contact with me, you can use the following address

- Mahlet Alem
- Email: mahletalem091gmail.com
- Post Graduate student at St. Mary's university

You don't need to write your name.

1.General Question

Instruction: The questions below are related to your personal Information. Please indicate your response by marking (√) in the boxes provided in front of each question, and fill the blank spaces as appropriate.

1.1.Respondent Category

(1) Client ☐ (2) Contractor ☐ (3) Consultant ☐ (4)Other ☐

1.2.Gender:

(1) Male ☐ (2) Female ☐

1.3.Age (in yrs.)

(1)20-35 ☐ (2) 36-45 ☐ (3)46-65 ☐ (4) Above 65 ☐

1.4.Education Background:

(1) TVET ☐ (2) Diploma ☐ (3)First Degree ☐ (4)Master's ☐

(5) Degree Ph.D. ☐

1.5. Year(s) of experience in port construction:

(1) <1 year ☐ (2)1-3years ☐ (3)3 -5years ☐ (4) 5-8years ☐
(5)Above10 ☐

1.6Years of experience in the housing construction site

(1) <1 year ☐ (2)1-3years ☐ (3) 3 -5years ☐ (4) 5-8years ☐
(5)Above10 ☐

2. Source of construction waste

No.	Severity Contribution rate	No.	Frequency contribution rate
1	None	1	Never
2	Little	2	Rarely
3	Moderate	3	Often
4	Great	4	Usually
5	Extreme	5	Always

Source of construction waste	Severity Contribution rate					Frequency contribution rate				
	1	2	3	4	5	1	2	3	4	5
Design such as changes to design and contract document errors										
Procurement such as ordering error and supplier's error due to inaccurate data										
Materials handling such as damage during transportation, off-loading, on-site distribution										
Operation such as tradesperson's error and equipment malfunction										
Damage due to **weather** such as temperature and humidity										
Security such as damage on construction site due to **vandalism**										
Residual such as off-cuts from cutting materials to length and packaging										
Materials misplacement on site										

Others such as lack of site materials control and waste management plans										

Please specify if there are any other possible source in your site---------------------------------------
----

3.Construction waste management plan

3.1. Is there any construction management plan in your site?

Yes ☐ No ☐

3.2. if you answer question 3.1 “Yes” In which construction stage it implemented

- Pre-construction ☐
- During construction ☐
- Post construction ☐

3.3 Marke (√) on which type Construction waste management plan used on your site

Material type	**Construction waste management plan**		
	Recycled	**Re-use**	**Landfilled**
Concrete			
Reinforcement bar			
Mortal			
HCB			
Brick			
Glass			

Please specify if there is other type of construction waste management plan that could have significant contribution in material waste reduction in you site--

----

Identify construction methods employed to reduce the a mount of construction and demolition waste generation ---

----

THANK YOU FOR ALL YOU HELP

Appendix B Response

Respondent	Questions					
	Q1	Q2	Q3	Q4	Q5	Q6
1	3	1	1	4	4	4
2	3	1	1	3	3	4
3	1	1	2	3	1	1
4	3	1	2	4	4	4
5	2	1	1	3	3	3
6	1	1	2	4	4	4
7	3	1	1	3	3	3
8	3	1	2	3	4	4
9	2	1	1	3	4	4
10	3	1	3	4	2	2
11	2	1	1	3	3	3
12	3	1	1	3	4	4
13	2	1	2	4	3	3
14	3	1	3	3	4	4
15	3	2	1	4	3	3
16	2	1	1	3	4	4
17	1	1	2	3	2	2

18	2	1	1	3	4	4
19	3	1	3	4	3	3
20	2	1	1	3	4	4
21	2	2	1	3	3	3
22	2	2	3	4	4	4
23	1	1	1	3	1	1
24	2	2	1	3	4	4
25	3	1	1	4	2	2
26	2	1	2	3	4	4
27	3	1	1	3	3	3
28	2	2	2	4	4	4
29	3	1	1	3	1	4
30	1	1	3	3	4	4
31	2	1	1	3	3	3
32	3	1	3	3	4	4
33	2	2	1	3	2	2
34	3	1	3	3	4	4
35	1	1	1	3	4	4
36	2	1	2	3	4	4

37	2	1	1	3	3	3
38	2	1	2	3	4	4
39	1	1	1	3	4	4
40	2	2	1	3	3	3
41	3	2	3	3	3	3
42	2	1	1	3	4	4
43	2	1	3	3	1	1
44	3	2	1	3	3	3
45	2	1	3	3	3	3
46	2	2	1	3	4	4
47	3	2	2	3	1	1
48	2	1	1	3	3	3
49	2	1	2	3	4	4
50	2	1	1	3	3	3
51	3	1	2	3	2	2
52	2	1	1	3	2	2
53	3	1	1	3	4	4
54	2	1	2	3	1	4
55	2	1	1	3	1	1

56	3	1	1	3	2	2
57	1	1	2	3	1	1
58	2	1	1	3	2	2
59	3	1	2	3	1	1
60	2	1	2	3	2	3

Respondent	Source of Construction Waste frequency								
No	Design	Procurement	Material Handling	Operation	Vandalism	Weather	Residual	Material misplacement	Other
1	4	3	3	5	3	3	3	3	4
2	3	3	3	3	2	3	3	2	3
3	3	4	3	3	3	3	3	3	3
4	4	3	3	4	3	3	3	3	4
5	3	3	3	3	2	3	2	3	3
6	5	5	4	5	3	3	3	4	5
7	4	3	4	4	3	3	3	3	4
8	4	4	3	3	3	3	3	3	4
9	3	3	3	3	3	3	3	3	3
10	5	4	3	5	3	4	2	3	5
11	3	2	3	3	2	3	3	3	3
12	3	3	3	3	3	2	3	2	3
13	3	2	3	2	2	3	1	3	3
14	3	3	2	3	3	3	2	3	3
15	3	3	3	3	2	3	2	3	3
16	3	2	3	3	2	2	3	3	3
17	4	3	3	3	2	3	4	3	4
18	4	3	3	3	2	3	3	3	4
19	3	3	2	2	3	2	2	1	3
20	4	3	3	5	2	3	4	3	4
21	2	3	1	3	3	2	3	2	2
22	4	3	3	3	2	3	3	3	4
23	3	2	2	3	2	3	3	2	3
24	4	3	3	3	3	4	3	3	4
25	3	2	2	3	3	3	3	3	3
26	4	3	4	5	3	4	3	4	4
27	4	3	3	5	3	3	4	4	4
28	4	3	3	4	3	4	3	3	4
29	3	3	3	3	2	3	2	3	3
30	5	4	4	4	3	2	3	3	5
31	5	3	5	5	2	3	3	5	5
32	5	3	4	4	4	2	2	2	5
33	3	1	3	1	2	3	2	3	3
34	3	2	3	3	3	4	3	3	3
35	2	2	3	3	3	2	4	3	2
36	3	2	3	4	2	2	3	2	3
37	4	4	2	3	3	3	2	2	4

38	2	2	4	4	3	3	3	3	2
39	3	4	2	2	2	2	2	2	3
40	3	2	2	3	3	2	2	2	3
41	2	4	2	3	3	4	3	4	2
42	3	2	3	2	2	3	4	3	3
43	4	3	4	3	3	4	2	3	4
44	2	2	2	2	4	3	3	3	2
45	3	2	4	4	3	2	2	2	3
46	3	2	3	3	2	2	2	4	3
47	3	2	3	2	2	3	2	2	3
48	3	4	2	3	3	3	3	3	3
49	3	2	3	2	3	3	2	3	3
50	3	3	3	3	2	4	3	2	3
51	3	4	2	3	2	3	2	2	3
52	3	3	2	3	3	3	3	3	3
53	5	3	3	4	3	3	3	4	5
54	3	3	3	3	2	4	4	2	3
55	4	3	3	4	3	2	3	3	4
56	3	2	2	3	2	2	4	2	3
57	4	3	3	5	2	4	3	3	4
58	3	3	3	3	2	2	2	3	3
59	4	3	4	3	4	3	2	4	4
60	4	3	3	5	3	3	3	4	4

Respondent	Source of Construction Waste Severity								
No	Design	Procurement	Material Handling	Operation	Vandalism	Weather	Residual	Material misplacement	Other
1	5	2	5	4	3	3	2	3	5
2	3	3	4	3	2	3	2	3	3
3	4	3	5	5	2	4	2	2	4
4	3	1	2	1	1	2	2	3	3
5	4	3	4	3	5	2	3	4	4
6	3	3	1	4	3	1	3	2	3
7	2	4	3	4	4	2	4	4	2
8	4	5	5	5	5	1	3	3	4
9	4	5	4	5	1	2	3	3	4
10	3	5	3	3	2	5	5	2	3
11	2	2	2	4	1	4	1	1	2
12	3	2	2	3	3	4	4	3	3
13	4	5	4	2	2	4	2	4	4
14	5	3	3	3	5	4	1	5	5
15	3	4	2	4	3	2	1	2	3
16	2	5	5	1	1	1	1	2	2
17	3	3	5	5	3	2	3	3	3
18	2	5	4	5	4	2	4	4	2
19	4	3	4	5	5	2	3	4	4
20	3	3	4	5	2	2	5	2	3
21	5	4	5	4	3	2	5	3	5
22	4	2	3	5	4	2	2	2	4
23	2	4	5	4	5	1	3	3	2
24	4	1	3	5	1	3	1	4	4
25	5	3	4	5	3	1	4	4	5
26	3	2	2	5	2	4	2	2	3
27	4	3	3	3	2	1	2	1	4
28	5	3	4	5	1	4	3	5	5
29	3	5	3	5	4	5	1	3	3
30	3	3	2	4	3	2	1	3	3
31	5	2	5	4	2	3	3	4	5
32	5	3	4	5	4	3	2	5	5
33	5	4	4	3	5	3	2	3	5
34	1	4	3	5	3	4	3	3	1
35	5	3	5	3	2	2	4	5	5
36	3	4	3	2	1	2	2	2	3
37	4	4	1	3	2	3	1	1	4
38	2	1	3	4	3	3	1	2	2

39	4	3	3	5	4	2	3	3	4
40	3	3	3	5	1	2	3	1	3
41	4	5	4	4	2	3	2	1	4
42	4	4	2	5	3	4	1	4	4
43	5	3	3	5	1	3	2	1	5
44	3	3	1	4	2	2	2	2	3
45	2	2	1	1	1	1	1	2	2
46	5	4	3	5	3	4	3	4	5
47	2	3	2	5	4	2	4	2	2
48	4	2	4	5	4	3	2	3	4
49	4	3	4	3	2	4	3	1	4
50	5	4	5	5	2	5	2	5	5
51	3	3	2	4	3	3	1	3	3
52	4	4	5	4	4	2	2	4	4
53	5	5	4	5	3	4	2	1	5
54	2	3	2	4	1	1	1	3	2
55	1	2	1	1	1	1	1	1	1
56	5	4	3	5	2	5	2	2	5
57	3	3	3	3	3	3	3	2	3
58	5	4	4	5	3	4	3	4	5
59	1	2	1	4	1	1	2	3	1
60	4	4	5	5	3	4	3	5	4

Appendix C SPSS result

For severity

Design

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	60.000[a]	16	.0
Likelihood Ratio	44.693	16	.0
Linear-by-Linear Association	7.084	1	.0
N of Valid Cases	15		

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	2.000	.000
	Cramer's V	1.000	.000
N of Valid Cases		15	

procurement

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	60.000[a]	16	.00
Likelihood Ratio	44.693	16	.00
Linear-by-Linear Association	.057	1	.81
N of Valid Cases	15		

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	2.000	.000
	Cramer's V	1.000	.000
N of Valid Cases		15	

Material handling

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	60.000[a]	16	.000
Likelihood Ratio	44.693	16	.000
Linear-by-Linear Association	9.366	1	.002
N of Valid Cases	15		

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	2.000	.000
	Cramer's V	1.000	.000
N of Valid Cases		15	

operation

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	60.000[a]	16	.000
Likelihood Ratio	44.693	16	.000
Linear-by-Linear Association	10.082	1	.001
N of Valid Cases	15		

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	2.000	.000
	Cramer's V	1.000	.000
N of Valid Cases		15	

Vandalism

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	30.000[a]	8	.000
Likelihood Ratio	25.826	8	.001
Linear-by-Linear Association	5.765	1	.016
N of Valid Cases	15		

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	1.414	.000
	Cramer's V	1.000	.000
N of Valid Cases		15	

Weather

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	45.000[a]	12	.000
Likelihood Ratio	40.194	12	.000

Linear-by-Linear Association	6.564	1	.010
N of Valid Cases	15		

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	1.732	.000
	Cramer's V	1.000	.000
N of Valid Cases		15	

Residual

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	60.000[a]	16	.000
Likelihood Ratio	44.693	16	.000
Linear-by-Linear Association	11.045	1	.001
N of Valid Cases	15		

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	2.000	.000
	Cramer's V	1.000	.000
N of Valid Cases		15	

Other

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)

Pearson Chi-Square	60.000[a]	16	.000
Likelihood Ratio	44.693	16	.000
Linear-by-Linear Association	2.888	1	.089
N of Valid Cases	15		

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	2.000	.000
	Cramer's V	1.000	.000
N of Valid Cases		15	

For Frequency

Design

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	45.000[a]	12	.000
Likelihood Ratio	40.194	12	.000
Linear-by-Linear Association	1.273	1	.259
N of Valid Cases	15		

a. 20 cells (100.0%) have expected count less than 5. The minimum expected count is .13.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	1.732	.000
	Cramer's V	1.000	.000
N of Valid Cases		15	

Procurement

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	60.000[a]	16	.000
Likelihood Ratio	44.693	16	.000
Linear-by-Linear Association	5.333	1	.021
N of Valid Cases	15		

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	2.000	.000
	Cramer's V	1.000	.000
N of Valid Cases		15	

Material handling

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	45.000[a]	12	.000
Likelihood Ratio	37.962	12	.000
Linear-by-Linear Association	.273	1	.601
N of Valid Cases	15		

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	1.732	.000
	Cramer's V	1.000	.000
N of Valid Cases		15	

Operation

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	60.000[a]	16	.000
Likelihood Ratio	44.693	16	.000
Linear-by-Linear Association	5.091	1	.024
N of Valid Cases	15		

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	2.000	.000
	Cramer's V	1.000	.000
N of Valid Cases		15	

Vandalism

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	60.000[a]	16	.000
Likelihood Ratio	44.693	16	.000
Linear-by-Linear Association	13.466	1	.000
N of Valid Cases	15		

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	2.000	.000

	Cramer's V	1.000	.000
N of Valid Cases		15	

Weather

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	60.000[a]	16	.000
Likelihood Ratio	44.693	16	.000
Linear-by-Linear Association	2.551	1	.110
N of Valid Cases	15		

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	2.000	.000
	Cramer's V	1.000	.000
N of Valid Cases		15	

Residual

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	45.000[a]	12	.000
Likelihood Ratio	40.873	12	.000
Linear-by-Linear Association	6.571	1	.010
N of Valid Cases	15		

Symmetric Measures

		Value	Approximate Significance

Nominal by Nominal	Phi	2.000	.000
	Cramer's V	1.000	.000
N of Valid Cases		15	

Other

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	2.000	.000
	Cramer's V	1.000	.000
N of Valid Cases		15	

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	1.732	.000
	Cramer's V	1.000	.000
N of Valid Cases		15	

For frequency

Reliability Statistics

Cronbach's Alpha	N of Items
.707	8

Item-Total Statistics

Item-Total Statistics	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Design	20.32	7.813	.624	.622
procurement	20.87	9.101	.338	.691
Material handling	20.80	8.841	.435	.670
Operation	20.42	7.027	.668	.602
Vandalism	21.10	10.193	.175	.717
Weather	20.82	9.712	.262	.704
Residual	20.97	10.101	.147	.726
Other	20.85	8.570	.501	.656

For severity

Reliability Statistics

Cronbach's Alpha	N of Items
.702	8

Item-Total Statistics	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted

Design	21.22	22.105	.496	.649
Procurement	21.47	24.558	.302	.691
materialhandling	21.45	20.828	.572	.629
Operation	20.75	22.869	.415	.668
Vandalism	22.08	22.857	.374	.677
Weather	22.03	24.677	.239	.706
residual	22.35	24.367	.306	.690
other	21.90	22.532	.433	.663