EVALUATION OF CONSTRUCTION MATERIAL WASTE MANAGEMENT IN ADDIS ABABA HOUSING PROJECT OFFICE: LIDETA PROJECT BRANCH ARABSA SITE IN FOCUS.

BY:

KIFLIE GEREME

MASTER OF BUSINESS ADMINISTRATION IN CONSTRUCTION MANAGEMENT

ADDIS ABABA SCIENCE AND TECHNOLOGY UNIVERSITY

NOVEMBER, 2018

EVALUATION OF CONSTRUCTION MATERIAL WASTE MANAGEMENT IN ADDIS ABABA HOUSING PROJECT: LIDETA HOUSING PROJECT ARABSA SITE IN FOCUS.

BY:

KIFLIE GEREME

A THESIS SUBMITTED TO

COLLEGE OF NATURAL AND SOCIAL SCIENCES, DEPARTMENT OF BUSINESS AND MANAGEMENT IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF BUSINESS ADMINISTRATION (MBA) IN CONSTRUCTION MANAGEMENT

ADDIS ABABA SCIENCE AND TECHNOLOGY UNIVERSITY

NOVEMBER, 2018

DECLARATION

This thesis is my original work and has not been presented for a degree in any other university, and that all sources of materials used for the thesis have been duly acknowledged.

Name; KIFLIE GEREME MENGISTIE

Signature; ----------

Place: Addis Ababa Science and Technology University

Date of submission: November, 2018

CERTIFICATE

This is to certify that the thesis prepared by Mr. Kiflie Gereme entitled **"Evaluation of construction material wastage management at Addis Ababa Housing Projects: Lideta Housing Project Arabsa Site in focus** " and submitted in fulfillment of the requirements for the Master of Business administration (MBA) in construction management complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

APPROVED BY BOARD OF EXAMINERS

Prof. Belete Kebede	---	---
Adviser	Signature	Date
Solomon Markos (Dr.)	---	---
External Examiner	Signature	Date
Dugasa Mulugeta (Dr.)	---	---
Internal Examiner	Signature	Date
---	---	---
Chair Man	Signature	Date

Abstract

Material waste is defined as the difference between the value of materials delivered and accepted on site and those properly used on specified and accurately measured in the work, after deducting the cost saving of substituted materials transferred elsewhere, in which unnecessary cost and time may be incurred by materials wastage. The main purpose of this study was to assess the current situation of managing and minimizing wastage of construction materials in the housing projects of Lideta branch of Arabsa site by evaluating the causes, impact on the project performance and level of contribution and practice of material wastage minimization strategies. To answer the basic research questions of the study, both primary and secondary sources were used. To this end, the respondents were asked to rank the main sources and causes of construction materials wastage. Out of 174 total populations, the researcher selects 121 total samples. Here both random and non random sampling were used.

The major findings of this study were, among the performance measurement criteria of projects, cost is greatly affected by material wastage at Lideta housing construction branch office of Arabsa site; besides, the planned completion time and quality of project performance criteria also affected by the presence of material wastage at the branch office of Arabsa site. furthermore, the major sources of construction material wastage in the project office are Site management ,design and documentation factors ,procurement , operation (on site, equipment) , materials transportation , handling and storage, site supervision and others (weather, theft) respectively.

According to the study the researcher recommend that the project office should start construction projects after approving design and bill of quantity. Secondly, the way of project management should be changed and supplying materials should be permitted to contractors rather than the government being sole supplier. Finally, the objective of the project office should be free from political interference and managed by professionals who have good project management skills.

Keywords: *housing, construction material wastage,*

ACKNOWLEDGMENT

I would like to express my gratitude to my Advisor, Prof. Belete Kebede for guiding me in writing this thesis. His provision of scholarly guidance, constructive comments and valuable references made it possible for me to complete this thesis.

I want to appreciate Lideta housing construction project branch office employees, contractors and consultant staff for their helpful collaboration in completing the questionnaires used in this study and providing valuable data during data collection process.

My acknowledgment also extends to my wife Etagegn Mengistie, my son Abrak kiflie and my daughter Soliana Kiflie for the time and moral they afford me. Above all, I praise Almighty God who gives me health and endurance until this time.

Table of Contents

Declaration……. II

Certificate……. III

Abstract……. IV

Acknowledgment..... V

Table of Contents….....VI

List of Tables..... IX

List of Acronyms……..……. X

Chapter1.Introduction.....1

1.1 Background of the Study.....1

1.2 Description of the Organization……..……..…….……..…….3

1.3 Statement of the Problem……..……..……....4

1.4.Objective of the Study……..……..……..…….……..….5

1.4.1. General Objective …….....……..……...…….…..5

1.4.2. Specific Objective…….……..……...…….…….6

1.5. Significance of the Study…….…….…….…….6

1.6.Scope of the Study.....6

1.7. Limitation of the Study……..…….……....7

1.8.Organization of the Paper……...….…….……...……7

Chapter 2. Literature Review….....8

2.1 Waste in the Construction Sector……..…….……..……....8

2.1.1 Definition of Waste……..…… ……8

2.2.Types of Waste.....9

2.2.1. Construction Material Waste…....…….…….…….……..9

2.2.2. Time Waste ……..…….…….…….……..10

2.3.Classification of Construction Materials Waste.....11

2.3.1. Based on Nature.....11

2.3.2. Based on Loss.....11

2.4.Sources of Construction Materials Wastage..... 13
2.4.1. Design..... 13
2.4.2. Procurement of Building Materials.....14
2.4.3. Handling and Storage..... 14
2.4.4. Operation.....15
2.4.5. Site Management..... 15
2.4.6. Site Supervision..... 15
2.4.7. Others..... 15
2.5. effect of Material Wastage on Housing Construction Project Performance…..... 16
2.5.1. Effect on Quality of Work.....16
2.5.2. Effect on Cost of Project.....16
2.5.3. Effect on Work Time.....17
2.5.4. Effect on Safety of Workers of a Project.....17
2.5.5. Effect on Environment……18
2.6.Construction Materials Waste Minimization Strategies.....19
2.6.1. Benefits of Construction Materials Waste Minimization.....19
2.6.2. Construction Materials Waste Minimization Strategy in the Housing Construction.....20
2.6.3. Construction Materials Wastage Minimization Hierarchy.....……23
Chapter 3.Research Methodology.....25
3.1.Research design.....25
3.2.Site of the Study……..……..……..……25
3.3.Source of Data and Method of Collection 26
3.4.Sampling Techniques……..……..……26
3.5. Study Population and Sample Size…….....27
3.6.Method of Data Processing……..……..…..……28
3.7. Method of Data Analysis.....28
Chapter 4. Analysis and Discussion of the Study.....30
4.1.Response Rate Analysis of the Study.....30
4.2.Type of Organization.....31

4.3. Effect of Construction Materials Wastage on Project Performance Criteria…...……...…..……31
4.4. Sources and Causes of Construction Material Wastage on Lideta Housing Project Office…….....32
4.4.1. Sources and Causes of Cement Wastage ……..….……..32
4.4.2. Sources and Causes of Aggregate Wastage……..…..……...…36
4.4.3. Sources and Causes of Reinforcement Bar Wastage……..…....39
4.4.4. Sources and Causes of Hollow Concrete Block Wastage……....……....42
4.5. Summary Of Major Sources Of Construction Material Wastage……..…..…...45
4.6. Waste Material Disposal Methods in the Project Office……..…….……46
4.7. Level of Contribution of Waste Minimization Strategies 47
4.8. Level of Practice of Waste Minimization Strategies….……..…….…….…48
4.9. Managers Respond through Interview……..…….50
Chapter 5. Summary Conclusions and Recommendations of the Study.....51
5.1. Summary of finding……...…51
5.2. Conclusion.....54
5.3. Recommendation..... ……...56
REFERENCE.....58
APPENDIX: Questionnaire 61

LIST OF TABLES

Table 3.1 study population data…….27

Table 3.2 sample size data of the study…….....28

Table 4.1. Response Rate analysis of the study.....30

Table 4.2. Type of Organization.....31

Table4.3.responses for the effect of Construction Materials Wastage on Project Performance criteria……...31

Table 4.4.1.1Relative Importance Index and Ranking of Sources of causes of cement wastage……..33

Table 4.4.1.2.Relative Importance Index and Ranking of Major Causes of Cement waste……..34

Table 4.4.2.1 Relative Importance Index and Ranking of Sources of causes of Aggregate wastage……...36

Table4.4.2.2.Relative Importance Index and Ranking of Major causes of Aggregate waste…….....37

Table *4.4.3.1* Relative Importance Index and Ranking of Sources of causes of reinforcement bar wastage….....39

Table 4.4.3.2.Relative Importance Index and Ranking of Major causes of reinforcement bar waste…….……..……40

Table 4.4.4.1 Relative Importance Index and Ranking of Sources of causes of hollow concrete block wastage….....42

Table 4.4.4.2.Relative Importance Index and Ranking of Major causes of hollow concrete block wastage……..…….……..……43

Table 4.5. Summary of relative importance index for major sources of construction material wastage……...45

Table 4.6.Relative Importance Index and Ranking of methods of Waste material disposal 46

Table 4.7.Rank and relative importance index for Level of Contribution of Waste Minimization strategies..... 47

Table 4.8. Rank and relative importance index for Level of Level of practice of Waste Minimization strategies……..48

LIST OF ACRONYMS

1. HCB : Hollow Concrete Block
2. IHDP : Integrated Housing Development Program
3. BOQ : Bill of Quantity
4. JIT: Just- In- Time Delivery
5. AAHCPO : Addis Ababa Housing construction Project Office
6. RII : Relative Importance Index
7. MSE: Micro and Small Scale Enterprise

Appendix 1:

ADDIS ABABA SCIENCE AND TECHNOLOGY UNIVERSITY

COLLEGE OF SOCIAL AND NATURAL SCIENCES

DEPARTMENT OF BUSINESS AND MANAGEMENT

RESEARCH TITLE ON: - EVALUATION OF CONSTRUCTION MATERIAL WASTAGE MANAGEMENT IN ADDIS ABABA HOUSING PROJECTS A CASE OF LIDETA HOUSING PROJECT BRANCH OFFICE OF ARABSA SITE

QUESTIONAIRE FOR CLIENT, CONSULTANT AND CONTRACTOR

Dear respondents, the aim of this questionnaire is to obtain necessary data for the research concerning causes, impacts and ways of material wastage reduction strategies practice in lideta housing construction project branch office of Arabsa site. Therefore, you are kindly requested to contribute to this research work by completing this questionnaire. your identity and that of the company you represent shall remain confidential and all data found from the survey will only be used for an academic purpose. I would like to extend my gratitude for taking your precious time to respond this questionnaire. If you have any questions please contact through the following addresses.

N.B. No need of writing your name and unless required to give brief written answers, rank by number you are kindly requested to put a tick Mark "√ "on the line, table or circle the letter of your choice..

Yours Faithfully; **kiflie Gereme** (Mobile. +251942394092 or +251912071848)

Part One: General Information

1. Type of Organization (Respondents designation)

☐ Client /Owner ☐ Consultant ☐ Contractor

2. Among the project performance measuring parameters ,which one greatly affected by construction material wastage in your site?

Quality of the house ☐ time ☐ cost of the house ☐ environment ☐

3. How the project office dispose waste construction materials?

Methods of material dispose	**High**	**Medium**	**Low**
Re-use within the project office			
Transfer to another construction branches office			
Return back to the supplier			
Sales to another firm			
Donation to other charitable organization			
Doesn't apply any disposal action			

4. Which Sources and Causes have major effect for Material Wastage in lideta housing project branch office ?

The given below are possible sources and causes of construction material waste. Please Rank on a scale of 1-5 which of these waste sources and causes contributes highly to the generation of waste on the project branch 0ffice arabsa site by ticking"√ "the appropriate boxes. **Effects' degree in the generation of waste 1 Not a waste cause 2 Insignificant waste cause 3 Quite a waste cause 4 Significant waste cause and 5 Major waste cause**

Source	Causes	Cement					aggregate					R/bar					HCB				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
design and documentation	Lack of Material plan																				
	Design changes and revisions																				
	Ambiguities, errors, and inconsistencies in drawings																				
	Poor/ wrong specifications (BOQ)																				
Procurement	Poor quality of materials																				
	Poorly schedule to procurement																				
	Mistakes in quantity surveys																				
	Purchased materials that do not comply with specification																				
Transportation Handling and	Improper handling of materials in the client store																				
	Lack of transparency and accountability																				
	Insufficient storage area on site																				

	Inappropriate storage of materials																				
	Damage during transportation																				
	Damage during loading and unloading																				
	Improper storage and handling of materials on site																				
Operation	Rework (chiseling,complete removal and rework…etc.)due to poor monitoring and evaluation																				
	Using excessive quantity of materials than required																				
	Using incorrect type of material																				
	Lack of transparency and accountability																				
	Choice of wrong construction method																				
	Poor construction technology																				
	Lack of coordination among stack holders on site																				
	Poor workmanship																				
Site management	Lack of proper waste management plan and control																				
	Lack of project management capacity																				
	Ineffective planning and scheduling of the project by the contractor																				
	Poor coordination and communication between construction parties																				
	Poor site layout																				
	Lack of a quality management system aimed at waste minimization (kaizen philosophy)																				

Site Supervision	Poor qualification of consultant engineer's staff assigned on the site																				
	Delay in performing inspection and testing by the consultant Engineer																				
	Poor coordination and communication between the consultant engineer, contractor and client																				
	Slow response from the consultant engineer to contractor inquiries																				
Others	Weather condition																				
	Theft																				

Please specify if there are any other possible causes of material waste in your construction site

5. Waste Minimization Measures

Below are possible strategies that contribute to the minimization of material wastes in building construction projects. Rank on a scale of 1-5 first the level of contribution of these strategies for Minimization of material wastage in lideta housing construction project branch Arabsa site.**1= Very low contribution,2= Low contribution,3= Medium contribution,4= High contribution,= Very high contribution**

Waste Reduction Strategy	Level of contribution				
	1	**2**	**3**	**4**	**5**
Design for offsite construction					
Standardization of Design					
Proper detailing during preparation of drawings and specification					
Minimizing design changes					
Use of quality materials					
Correct material planning and ordering					
Careful handling and usage of tools and equipment on site					
Proper storage and handling of materials					
Just in time material delivery					
Improving the skill of the work force by giving training					
Developing waste management plan and hiring site waste manager					
Using low waste building technologies like ready mix and machine spray plastering					
Use of waste aware sub-contractor and right equipment					
Improving the coordination between contractor, consultant Engineer and client					
Re-use of waste materials on site					
Conducting timely monitoring and evaluation and take corrective measures					
Fully implement accountability and responsibility principles					
Disposed unused materials					
Recycling of some waste materials					

Please specify if there are other waste minimization strategies that could have significant Contribution in material waste reduction in lideta housing construction projects branch office in arabsa site .

6. **How do you rank the Practicality of material waste reduction strategies in the project branch office**

Please rank the level of practice of these strategies on your site**.(1= Not practical,2= ,3= Practiced,4= Frequently practiced,5= Most frequently practiced.**

Waste reduction strategies	Level of practice in this project				
	1	**2**	**3**	**4**	**5**
Design for offsite construction					
Standardization of Design					
Proper detailing during preparation of drawings and specification					
Minimizing design changes					
Use of quality materials					
Correct material planning and ordering					
Careful handling and usage of tools and equipment on site					
Proper storage and handling of materials					
Just in time material delivery					
Improving the skill of the work force by giving training					
Developing waste management plan and hiring site waste manager					
Using low waste building technologies like ready mix and machine spray plastering					
Use of waste aware sub-contractor and right equipment					
Improving the coordination between contractor, consultant Engineer and client					
Re-use of waste materials on site					
Recycling of some waste materials					

Please specify if any other waste minimization strategy practiced in your site----------
---

Part two: Open Questioners

7. What is the major source and causes of construction material waste in your project branch office? Please specify it?

Please suggest the ways of waste minimization? ----------

Part three: INTERVIEW QUESTION FOR SUPERVISORS AND PROJECT MANAGER

8. What looks like your construction project branch office material management? is there any exposure to material wastage?

To what extent it affects your project performance?

THANK YOU!!

CHAPTER ONE

Introduction

In this paper, background of the study, description of the organization, statement of the problem, objectives of the study, significance of the study, scope of the study, limitation of the study and organization of the paper are emphasized.

1.1 Background of the Study

Construction industry is an industry, which is involved in the planning, execution and evaluation (monitoring) of all types of civil works. Physical infrastructures such as buildings, communication and energy related construction works, water supply and sewerage civil works are some of the major projects (program) in the construction industry. Currently construction projects are becoming progressively larger and more complex in terms of physical size and cost. Due to this, the building industry is using a considerable amount of material resources. On the other hand, if the life cycle of the materials on site is closely examined, it is generally known that there is a relatively large portion of the materials being wasted because of different reasons at building sites (Getachew, 2009; Mulualem et al, 2012).

Since some degrees of waste materials are inevitable in the construction process, all estimators allow wastage factors in pricing a bill of quantities. Over the years, experience has shown, however, that unless controlling measures are implemented, wastage may frequently exceed often by a larger margin than the figure allowed in the tender document (Al-Moghany, 2006; Bossink and Brouwers, 1996).

As construction is a locomotive sector of the national economy, waste in the construction industry affects the overall national economy. It is important, therefore, to explore measures contributing to construction material waste minimization and assess the level of practice of such measures by the construction industry since cost reduction arising from minimization of waste materials is a direct benefit to all stakeholders.

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.

In 1996, Bossink and Brouwers carried out an intense study in the Netherlands; with a concern of the measurement and prevention of construction waste, based on sustainability requirements stated by Dutch environmental policies. Accordingly, Bossink and Brouwers (1996) estimated 1-10% by weight of the purchased construction materials leave the sites of residential projects as waste in Dutch. Similarly, based on a study of 86 housing projects in the Gaza strip, Al- Moghany (2006) came up with an estimation of the material loss resulting from direct and indirect wastes were about 3.6–11%, which were significantly higher than the values that were normally allowed.

Likewise, there have been a number of studies mostly concerned with the economic aspect of material waste in the construction industry. Skoyles (1987) undertook one of the most extensive studies regarding economic aspect of material waste. He monitored materials waste on 114 building sites, concluding that a considerable amount of waste can be reduced by adopting relatively simple prevention procedures. Storage and handling were identified as major causes of waste. Most problems of materials wastage appeared at building sites are associated with miss material management system and very little with the lack of qualified workers (Skoyles, 1987).

In our country, there were researches undertaken at undergraduate and postgraduate level on the material waste control. A research conducted by Getachew Araya (2009) for his 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).

In addition, other 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 worked out the approximate wastage level, the side effect and minimization techniques of materials wastage on condominium sites. However, to solve the housing problem, which is one of the major problems in Addis Ababa; the city administration has been working on affordable housing projects for the last ten years and starting from 2013 new affordable

housing scheme by all levels of the city dwellers launched. These are 10/90, 20/80 and 40/60 percent payment schemes from the lower income to the middle income residents of the city; therefore, in-depth investigation is vital to identify current condominium building construction materials wastage reduction techniques and the side effect of poor waste reduction practice on the project cost.

In this study, the researcher assesses the sources and causes of material wastage, its impact on performance of the project, level of contribution of waste minimization measures to waste reduction and to what degree the same measures are practice at the sites. Finally, based on the data gathered, the research drew conclusion and suggest how materials waste could be reduced at 20/80 housing construction project sites.

1.2. Description of the Organization

Addis Ababa City administration launched grand low cost condominium housing project through the integrated housing development program (IHDP) in 2006 to minimize housing backlog, slums and to provide decent shelter to middle and low income groups. Since 2005 Ethiopia has been implementing an ambitious government led low and middle income house program. The initial goal of the program was to construct 400,000 condominium units, create 200,000 jobs, promote the development of 10,000 micro and small enterprises, enhance the capacity of the construction sector, regenerate inner city slum areas, and promote homeownership for low income householders (UN- HABITAT, 2010). Addis Ababa housing construction project office has 1 head office and 19 project branch office including agro stone technology center. In 2005 E.C, it announces a new construction program is called 20/80 means 20% value of the house in advance with the remaining 80% expected to be covered by the government long term loan and 10/90 also 10% value of the house in advance with the remaining 90% expected to be covered by the government long term loan. Currently this construction project branch office has 3527 contractors, 39 consultant companies, and 4310 micro and small enterprises participate in different working sectors. This research focuses on lideta housing construction branch offices. it located at bole woreda 11 in arabsa site around 5 km far and viewed south east of bole lemi industrial park. This project has different stockholder and 88 internal employees in the project. Lideta housing construction branch office has built mainly

G+4=147 blocks and G+ 7=23 blocks total 170 blocks and 6065 housing units. Currently the project is completed.

1.3. Statement of the Problem

Now a day's in Ethiopia construction industries are booming due to implementing major infrastructure projects together with many public buildings, commercial building and housing development programs; however, construction materials waste is becoming a serious problem in Ethiopia, especially on housing construction projects at Addis Ababa and no attention is given to such subject. Construction managers often fail to identify and control waste in the construction process, generally, it is accepted that the total cost of materials may be up to 60% or more of the total cost incurred in construction project. Effective construction materials management is a key to success for a construction project K. Harish, (May, 2014).

Waste normally emanates from mismanagement of construction materials. Hence, this thesis assessed the sources, causes and factors incidental to construction material waste and level of contribution and practice of waste minimization strategies. Therefore, this research were determine the current situation in the project office with regard to managing and minimizing construction materials waste in condominium housing projects in Addis Ababa and assess the practicality of the identified waste minimization strategies with a view to seeking for ways to minimize construction materials waste in future construction projects.

It is known that there are some degrees of unavoidable wastes in the building construction process. Due to this, all estimators allow wastage factors in pricing a bill of quantities (BOQ) which is used to increase materials quantity to ensure enough materials are procured to complete the work realistically. But in most Addis Ababa condominium construction sites, the actual materials waste quantity is far higher than the nominal figures assumed by the companies in their cost estimate. However, much of these waste are avoidable (Getachew, 2009; Mulualem et.al (2012).

Since the cost of materials account a great percentage of the total cost of construction projects, construction materials waste has an impact in the overall project cost. This comprises mainly the cost of transporting and disposing of site waste and the material

procurement cost. Tam et *al*. (2007) in a study in the United Kingdom reported an additional cost of 15% to construction project cost overruns as a result of material wastage. It is therefore glaring that the economic losses from construction material waste could pose a great threat to the affordability of houses, sustainability of the housing program, dissatisfaction of the people. Problems concerning construction material wastage may weight rather than other problems show in the housing construction. To summarize, wastage reduction in housing projects needs serious consideration and due attention since the construction industry consumes large amount of (above 60%) materials and the city administration is building and planning to build large amount of condominium houses as being sole supplier of construction materials on the other hand users of condominium houses are crying against the unaffordable costs of houses. Therefore, this research aimed to provide an insight related to materials wastage at Arabsa construction sites of Lideta branch office

Basic Research Questions of the Study

a. What are the causes of construction material wastage in the project office?
b. What are the effects of material wastage on the performance of housing projects?
c. How does the project office dispose waste construction Materials?
d. What are the levels of contribution of waste minimization measures to reduce materials waste in the project office?
e. What are the levels of the practice of such measures in the condominiums construction sites?

1.4. Objectives of the Study

1.4.1 General objective

The general objective of this study was to assess the current situation of managing and minimizing wastage of construction materials in the housing projects of Lideta branch Arabsa site by evaluating the causes, impact on the project cost and level of contribution and practice of material wastage minimization strategies.

1.4.2. Specific Objectives

The specific objectives of the research were:

1. To identify the sources' and major causes of material wastage in housing construction projects in Arabsa Site
2. To assess the effects of material wastage on the performance of housing projects in the construction site
3. To identify the highly exercised methods of material disposal in the project office
4. To assess the level of contribution and level of practice of construction material wastage minimization strategies in the project office.

1.5. Significance of the Study

This research is significant in that it might help the people engaged in the construction industry how they can managing and minimize wastage of construction materials while they produce, transport, operate and stored at construction site. The affordability of the condominium houses become in question, due to high cost of the houses, so the project managers will get information about the cost control system of the office and the impact of material wastage and will take corrective measure in the next projects .In addition, this study intends to provide some framework for the development of policies and rules in the management of construction material waste.

1.6. Scope of the Study

Compared to other parts of the country rapid growth of construction sector is observed in Addis Ababa including housing construction projects; therefore, for this study Addis Ababa condominium construction projects undertaking by government; in particular 20/80 condominium scheme of Lideta Arabsa site constructed by Lideta project branch office. The rationale of this is the government starts this scheme for those low income getting peoples of the city, and currently 20/80 condominium is constructed in a wide range. So, addressing the issue is the concern of many peoples in the city compared to 40/60 scheme. This study was conducted in Addis Ababa; Bole Sub City Woreda 11 Arabsa site. The project site is located around 5 km far from south east of bole Lemi Industry Park.

The concept of wastage is very broad; it is not only about materials wastage, it also covers construction and demolition waste however, only materials waste is considered in this study since the materials cost covers a great percentage of the project cost.

In addition, even though improvement in all kinds of construction materials wastage is necessary, due to resource limitation this research is only undertaken on major building materials used in condominium construction namely, cement, aggregate, reinforcement bar and hollow concrete block. These materials are selected as they accounted the great percentage of the total cost of material

1.7. Limitation of the Study

The focus of this research was to assess the current situation of materials wastage management at Lideta housing construction branch office. In this research, the current trends of the project office in managing waste materials at Arabsa site is investigated, but it is necessary to repeat this research every other site to observe the new trends of construction parties in material waste management.

1.8. Organization of the paper

The study was organized in to five chapters. Following the introductory chapter, chapter two presents a review literature on definition, causes, classification of construction materials waste, effect on performance of construction projects, minimization strategies and to Providing the practical suggestions and recommendations to upgrade the knowledge of managing and minimize the construction materials waste on housing construction project in Lideta branch office. Chapter three tried to discuss the methodology and methods of data collection and analysis. Chapter four deals with data analysis and discussion on the results of the study. Finally, Chapter five presents the conclusion and recommendation of the study respectively.

CHAPTER TWO:

Literature Review

In this section, waste in the construction sector, types of waste, classification of construction materials waste, causes of materials waste, impacts of material wastage on construction project performance and construction materials waste minimization strategies are underlined.

2.1. **Waste in the Construction Sector**

2.1.1. Definition of Waste

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, labour, 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; rather it increases the cost of the project.

Waste has been considered as a major problem in the construction sector. Waste in construction is not only focused on the quantity of waste of materials on site, but also related to time waste. Waste in the construction sector has been the subject of several research projects around the world in recent years. Some of them have focused on the environmental damage those results from the generation of material waste. On the other

hand, there have been a number of studies mostly concerned with the economic aspect of waste in the construction industry (Agyerum, 2012).

All those activities that produce costs, direct or indirect, and take time, resources or require storage but do not add value or progress to the product can be called non-value – adding activities or waste (Al-Moghany, 2006). 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 (Agyerum, 2012). Waste in the construction sector can be also described as the non-hazardous by-product resulting from activities during new construction and renovation. It is generated during the construction process because of factors such as material use, material damage, material non-use, excess procurement and human error (Macozoma, 2002).

The Environmental Protection Department (EPD) of Hong Kong (2000) defines waste as comprising of unwanted materials generated during construction, including rejected structure and materials, materials which have been over ordered or are surplus to requirements, and materials which have been used and discarded. Waste arises from a number of different activities carried out by the contractor during construction and maintenance and may include: wood from formwork and false work, material and equipment wrappings, unusable or surplus cement/ grouting mixes, damaged/surplus/contaminated construction materials (Al-Moghany, 2006).

2.2. Types of Waste

Waste in construction can be classified into two main types; waste of materials and waste of time (Agyerum, 2012). However, this research focuses on materials waste.

2.2.1. Construction Material Waste

According to Ekanayake and Ofori (2000) construction material waste is defined as any material apart from earth materials, which needs to be transported elsewhere from the construction site or used on the site itself other than the intended specific purpose of the project due to damage, excess or non-use. The above definition gives more emphasis on the excess, damage or nonuse materials used in the construction of building component which don't add any value to the building and needs to be transported from the site or

Used for another purpose. Other researchers define material waste as "the difference between the value of materials delivered and accepted on site and those properly used on specified and accurately measured in the work, after deducting the cost saving of substituted materials transferred elsewhere, in which unnecessary cost and time may be incurred by materials wastage" (Enshansi, 1996; McDonald and Smithers, 1997; Pheng and Meng, 1997).

Construction material wastes refer to materials from construction sites that are unusable for the purpose of construction and have to be discarded for whatever reason. Construction material waste is defined as any material apart from earth materials, which needs to be transported elsewhere from the construction site or used on the site itself other than the intended specific purpose of the project due to damage, excess or non-use or which cannot be used due to non-compliance with the specifications, or which is a by-product of the construction process (Agyerum, 2012).

Therefore, the construction materials wastage definition used in this study is excess of materials used than required quantities and the construction materials hauled away generated in the construction site that couldn't be useful for the intended construction.

The extent of wastage varies from site to site. Sites that have high levels of wastage generally have a poor standard of material control. The site conditions are another factor that affects waste generated on the sites. Levels of waste at muddy sites are comparatively higher compared to clean and well drain sites. Other factors such as the size of project, design of the building and method of construction also contribute to difference in waste levels. If the waste level of materials for a particular project is high relative to that of other sites, the performance level would be comparatively lower (Enshansi, 1996).

2.2.2. Time Waste

The second type is time waste. The duration of construction tasks consists of process (and reprocess or rework) time, inspection time, move time, and wait time. Only process time is considered value adding activity. The value adding activity is defined as the activity that converts material and/or information towards that which is required by the customer; non value adding activity (also called waste) as the activity that takes time, resources or space but does not add value. However, all value adding time belongs to process time, not

all process time is value adding. Processes are also subject to wastes resulting from overproduction, wrong construction method, defects, and poor optimization in performance tasks (Al-Moghany, 2006).

2.3. Classification of Construction Materials Wastage

Construction materials waste can be classified based on nature and losses; these are elaborated and discussed below:

2.3.1 Based on Nature

According to Formoso et al, (1999) waste can be classified by nature as unavoidable and avoidable waste in construction projects. It is the wastage that costs more than what is saved if tried to prevent. There is a certain limit up to which, waste of materials can be prevented. Beyond that limit, any action taken to prevent waste will not be viable, as the cost of saving will surpass the value of materials saved. Thus, natural waste is allowed in the tenders. The amount of allowable waste is subjective to the cost effectiveness of the approaches used to manage it (Formoso et al, 1999).

Avoidable waste is when the cost of waste is significantly higher than the cost to prevent it. Such kind of waste represents the waste amount beyond the acceptable level in the site. Therefore, these wastages could be controlled by implementing different waste minimization measures (Formoso et al, 1999).

2.3.2 Based on Loss

Skoyles (1987) classified construction materials waste as direct and indirect waste. Waste that can be prevented and which involves the actual loss or removal and replacement of material is called direct waste. Direct waste consists of a complete loss of materials, due to the fact that they are irreparably damaged or simply lost. In this case, the wastage usually needs to be removed from the site. Therefore, the cost of direct waste does not end up in the cost of material, but followed with the cost of removing and disposing. Thus, by preventing direct waste straight forward financial benefits can be obtained. Direct waste can occur at any stage of the construction process before the delivery of material to the site and after incorporating the materials at the building (Formoso et al, 2002). Forms of direct waste (Skoyles and Skoyles, 1987)

a. **Delivery waste: -**losses during the transportation of materials to the site, unloading and placing in addition to the initial storage. Eg. Bricks, glassing

b. **Cutting and conventional waste:** cutting materials into various sizes and uneconomical shapes. E.g tiles, reinforcement bars

d. **Application and residual waste:** hardening of the excess materials in containers and cans. e.g. Paint, mortar.

e. **Criminal waste:** theft and vandalism eg tiles, cement bags

f. **Management waste:** lack of supervision or incorrect decisions of the management. e.g. throwing away excess material

g. **Waste due to wrong usage:** wrong selection of materials. e.g. rejection of inferior quality marbles, tiles.

Indirect waste occurs when materials are not physically lost; causing only a monetary loss, for example, waste due to concrete slab thickness larger than specified by the structural design. Indirect waste arises principally from the substitution of materials, from use of materials in excess of quantities allowable under the contract, from errors, waste caused by over allocation, where materials are applied in superior quantity of those indicated or not clearly defined in contract documents, and waste caused by negligence, where materials are used in addition to the amount required by the contract due to the construction contractor's own negligence. A large part of these wastes have been hidden, and it has not been perceived as actionable (Skoyles and Skoyles , 1987; Formoso et al, 2002).

According to (Skoyles and Skoyles, 1987), indirect waste have the following Forms:

a. **Substitution waste:** substitution of materials at work, which will incur losses to either to the contractor or client. e.g use of 20cm HCB in place of 10 cm HCB

b. **Production and operational waste:** where materials are used in excess of those indicated or not clearly defined in the contract document. E. g. Additional concrete in trenches, use of excess plaster to rectify uneven surface

c. **Negligence waste:** site errors because of the condemned work or use of additional material. e.g over excavation of foundation resulting in the use of additional concrete.

2.4. Sources and Causes of construction Materials Wastage

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 occurs. 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.

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 Nagapan (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 waste 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. These are Design, Procurement, Handling and storage, Operation, Site management, Supervision and Others.

It is assumed that the importance of these categories will vary not only from project situation to project situation but also from material to material. For example, it is more likely that concrete waste rather than dimensional lumber waste will be created by design error. However, those wastes that are created can usually be attributed to short comings in one of the following areas:

2.4.1. Design

The best opportunities for improving materials resource efficiency in construction projects occur during the design stage. Inadequacy of design and specification and lack of standard manufactured sizes are just some of the waste contributory factors.

Design changes are common as a result of owner demands or requests to meet changing requirements and preferences.

Changes in design decisions while construction is in progress can result in demolition, surplus and redundant materials, demoralization of labor force and reduction of quality of products and in extreme cases, turnover of construction personnel.

Besides, considerable waste is often incurred as a result of design information being incomplete when construction is to begin. There are always cases that the design specifications do not agree with the practical material dimensions causing large amounts of material wastage during construction. If detailed technical information about the construction materials or construction process can be taken into account by the designers, a significant amount of waste can be avoided (Sasitharan, Ismail and Asmi, 2012).

2.4. 2. Procurement of Construction Materials

Errors in ordering and shipping can cause materials wastes in the building construction projects. Procurement mistakes can result in one of three material conditions: over shipment, under shipment, or miss-shipment. They are usually caused by miscommunication either within the builder's organization or between the builder and the vendor (Bossink and Brouwers, 1996).

An enormous amount of waste stems from procurement errors. Ordering errors like ordering significantly more or less will interrupt the pre-planned flow of materials, thus causing deliveries made to redundant and result in additional handling with all its related costs (Sagoe, 2011).

2.4.3. Transportation, Handling and Storage

Wrong materials storage and poor handling are key factor for physical waste generation in the construction projects. Improper handling, may occur at the work site, or before the material arrives at the site. That is, the material may be damaged during fabrication, packaging, loading, or delivery. At the site, construction materials may be damaged due to unnecessary handling or improper storage without appropriate protection. For example, many construction materials are subject to deterioration and bio-degradation due to environmental impacts. Besides, excessive stocks are subject to damage, deterioration, theft and vandalism (Al-Moghany, 2006).Proper handling of materials is dependent on planning, particularly on clear and uninterrupted access from the place of storage to the

place of usage, inclusive of provision of temporary roads and appropriate equipment (Sasitharan, Ismail and Asmi, 2012).

2.4.4 Operation

Operation is one of the major causes for waste generation accepted by many researches. Improper operation procedures are often resulting in high materials wastage. But, raw materials should be fully utilized avoiding wastage. Operational errors like rework, damage to work done by other trade, poor workmanship, using excessive quantity of materials than required are all due to negligence and carelessness or incapability of operatives (Sasitharan, Ismail and Asmi, 2012).

2.4.5 Site Management

Construction management is about planning, coordinating and controlling everything involved in the construction project. Poor planning which is due to lack of planning skills of the management staff lead to the generation of physical waste in building projects. Furthermore, incorrect planning and selection of equipment also cause the work to stop. Thus, proper planning and controlling is the key function that should be used effectively in eliminating material wastage (Sasitharan, Ismail and Asmi, 2012).

2.4.6 Site Supervision

Professional construction supervision specifically tailored to safeguard the successful completion of a construction project. Construction site supervision services can be complemented by compressive quality control services. This guarantees the materials used all equipment's and systems are of good quality, function well and confirm to the standard. Checking and approving all these helps to reduce material wastage on the site (Al-Moghany, 2006).

2.4.7 Others

These wastes may result from a wide variety of sources. This can be due to weather conditions, theft and accident. To reduce material wastage from such causes avoids placing washable materials at sleep slope or near drain and providing security guard at the construction site are advisable (Sasitharan, Ismail and Asmi, 2012).

2.5. Effect of Material Wastage on Construction Projects Performance

Construction site waste management and minimization has great potential to contribute to construction industry performance improvement in addition to waste management problem caused by the construction sector. Wastage of materials in construction projects has an impact on quality of works, project cost, working time, safety and health of the workers (Sagoe, 2011).These effects of material wastage described in detail below.

2.5.1 Effect on Quality of Work

Quality is one of the critical factors in the success of construction projects. Quality problems are considerable in all phases of construction. Achieving good waste minimization on construction projects helps to reduce the quantities of construction waste sent to landfill. Since most of the causes of material wastage are the causes for quality problem in construction projects, minimizing material wastage has a role in the improvement of quality of work. For example, the problem related to labour such as lack of skilled labour, a mistake by the workers, rework, etc. are the causes for material wastage and poor quality of work. Consequently, resolving these causes of materials wastage result also in achieving good quality of work (Sagoe, 2011).

2.5.2 Effect on Cost of Project

Construction material wastage significantly affects the total cost of a project. The true cost of material waste consists of direct and indirect costs. Direct cost consists of the purchase price of the material that ended up as waste and indirect costs consist of:

(i) Cost of transporting the waste off-site

(ii) Missed opportunity of not reclaiming reusable and recyclable material.

(iii) Lost time in terms of labour and management time.

(iv) Loss of ability to win contracts based on bad waste history

A construction company can thus be profitable by reducing the amount of waste it needs to dispose of. Due to this the construction materials wastage has significant influence on the overall project cost (Sagoe, 2011).

2.5.3 Effect on Work Time

The total time of construction project is usually specified prior to the commencement of construction. But construction projects are known to experience time delays due to various reasons. Material waste has a direct impact on the productivity and completion time of project which results in loss of a significant amount of revenue (Sagoe, 2011).

The occurrence of material wastage in construction projects results in an unnecessary works like waste handling processes which are non-value adding activities to the project. This non-value Adding activity consumes a high percentage of overall working time and effort without adding value thus resulting in delay. Therefore, effective minimization of material wastage in construction project results in the avoidance of unnecessary works (Bo Terji, 2010).

2.5. 4. Effect on Safety of Workers of a Project

Another material wastage effect on the building project is lack of safety and health on the workers. Decreasing the amount of waste on site and managing more effectively what remains will lead to cleaner and safer sites. For instance high winds might lift unclear debris such as iron sheeting into the air which could be a potential threat to people (Al-Moghany, 2006). Good waste management on site, which includes, for example, encouraging your workers to think about where they place their waste, will also result in a better site image. More importantly, it could also lead to improved health and safety as there are likely to be fewer accidents if material waste is minimized. This can be achieved by providing:

- Safe access to people and vehicles on site that they can reach the allotted workplace
- Walkway which are free from obstructions of waste materials
- Tidy sites and storing materials in safe places and ensuring that all projecting nails are hammered down flat or removed completely
- Proper arrangement for gathering and disposing of waste materials

2.5.5. Effect on the Environment

Construction waste has a major impact on the environment. With the demands in implementing major infrastructure projects together with many public buildings, commercial building and housing development programs, a large amount of construction waste is being produced by the construction sector. The construction industry is responsible for producing a whole variety of waste, the amount and type of which depends on factors, such as the stage of construction, type of construction work and practices on site.

Thus, waste minimization is an important area of concern in the implementation of construction waste management in the construction industry of Ethiopia, especially in Addis Ababa housing construction projects.

Extra construction materials are usually planned due to the lack of consideration given to waste reduction during the planning and design stage to minimize the generation of waste. The excessive wastage of raw materials, improper waste management and low awareness of the need for waste reduction are common in the local construction sites. Existing works have proposed various waste management approaches.

The large volume of waste in the construction industry contributes to the rapid depletion of natural resources and production of high volumes of air pollution caused during processing. Water pollution will also result from the processing of materials. When material ends up as waste it has the potential to be reused or recycled thereby minimizing its impact on the environment through less processing.

According to (Sagoe, 2011) the construction industry is the biggest consumer of raw material in the UK , 90% of non-energy minerals extracted in Great Britain are used to supply the construction industry with materials 260m tones of material are extracted for use as aggregate and other construction material. The construction of buildings, their materials and the occupant`s use of services is responsible for 50% of the UK CO2 emissions. A push for a more sustainable construction is required as the Government has targets for a 60% reduction in emissions by 2050 below the 1990 levels. Metal, glass and hard wood timber have a high-embodied energy. There re-use and recycling should be given high priority towards waste minimization. By using reclaimed and recycled

materials, 70% of embodied energy can be saved. This could potentially result in cost savings of 40% of the building price.

2.6. Construction Materials Waste Minimization Strategies

Waste minimization is one of the most effective approaches to respond to the waste problem in the construction industry. Waste minimization is defined by the Environmental Protection Agency of USA (2000) as "any method that reduces the volume or toxicity of a waste that requires disposal". Poon and Jaillon (2004) also studied how to reduce building waste at construction sites in Hong Kong, and defined waste minimization as "any technique, process or activity which avoids, eliminates or reduces waste at its source or allows re-use or recycling of the waste". In both sense waste minimization is a method that reduces the amount of waste generated on site.

2.6.1. Benefits of Construction Materials Waste Minimization

The consideration of waste minimization on the construction projects can create mainly financial and environmental benefits.

a. Financial Benefit

For economic reasons people in the construction industry need to have an insight into the financial consequences of construction waste. Substantial savings could be obtained by reducing the amount of construction waste (Begum et al, 2006). The financial benefit gained by waste minimization appreciated over a short term or long-term period. This financial benefit comes from:

- Reduced purchase quantity of raw materials by waste minimization
- Reduced transportation costs for waste materials (less transportation because of less material wasted).
- Reduced disposal costs of waste materials. Less waste generated means less waste taken to landfill, which will reduce landfill fees for disposal.
- Long term benefits through reduction of the occurrence of delay, poor quality, and health and safety problem on the building sites. Due to this the company will get higher profit.

According to Al-Moghany (2006), sending building materials to landfill is like throwing money away. This is because it is already paid for the material, paid someone to deliver it

and then paid someone to collect it and throw it away. However, this argument could be necessarily true when the cost of waste is significantly higher than the cost to prevent it.

2.6.2. Construction Materials Waste Minimization Strategy on Building Construction Sites

Waste minimization is a shared responsibility between all parties of the construction process from the client down to the contractor. The best strategies of construction materials waste minimization identified from past research and discussed below.

a. Design for Offsite Construction

Off-site construction refers to structures built at a different location than the location of use. Offsite construction occurs in a manufacturing plant specifically designed for this type of process. Off-site processes have been proved to decrease waste by optimizing cutting patterns and schedules. Its application also has the potential to significantly change operations on site, reducing the amount of trades and site activities and changing the construction process into one of a rapid assembly of parts that can provide many environmental, commercial and social benefits, including (Shen, Tam and Drew, 2004; Andrew and Richard, 2004):

- Reduce construction related transport and movements;
- Improved workmanship quality and reducing on site errors and re-work, which themselves cause considerable amount of waste on site
- Improved health and safety on site through avoidance of accidents and
- Reduce construction timescales and improved program

b. Standardization of Design

Standardization means to design items with generally accepted and uniform procedures, dimensions or materials. Standardization has the potential to dramatically reduce the current production of construction waste. This is by designing the building size and space to eliminate unnecessary elements, and to reduce off-cuts resulting from the construction process. Standardization of design in building construction ensures compatibility between market supply and specification. For example, by designing room areas and ceiling heights in multiples of standard material sizes a substantial reduction in off-cuts can be achieved (Shen, Tam and Drew,2004; Andrew and Richard, 2004).

c. Proper Detailing During Design

This is perhaps one of the most crucial skills needed in the building design process. This is because the nature and quality of detailing in the design document contribute to how the building is built, what it will look like, what it will cost, and how long it may take to build. Thus, design document should be specified in precise and brief ways so that the contractor can avoid excessive material ordering and estimate properly the possible amount of waste to be generated (Faniran and Caban, 1998; Andrew and Richard, 2004).

d. Correct Material Planning and Ordering

Creating an effective schedule of material ordering, fabrication and delivery of all building materials and components helps to reduce material wastage (Che, Ahmad, Abd and Kasim, 1999). Precise scheduling in building construction enables

- Purchasing raw materials that are just sufficient
- Just-in time delivery of materials, reducing potential for damages
- Good coordination between store and construction personnel to avoid over ordering
- Gives enough time for checking materials supplied for right qualities and volumes

e. Just-in-time Delivery Strategy

Just in time delivery strategy is arranging deliveries to match work stages in order to avoid materials being stored on site longer than necessary. Implementing just-in-time delivery strategy in the construction projects ensure materials arrive on site when they are needed, thereby avoiding damage while stored on site and additional mobilization of materials. Besides, it reduces the potential for over-ordering materials on several projects (Narimah, 2008; Andrew and Richard, 2004).

f. Proper Storage and Handling of Materials

Once what materials need for the project established, there should be work on how those materials will be received and stored on the site. The site manager should plan in advance suitable storage space to protect materials degradation or damage from weathering or moisture (Dennis, 2002). There should be a strategy in place which makes the best use of a central storage area with procedures for moving materials to the workplace as moving materials increases the risk of damage.

Top tips for materials storage on construction projects (Dennis, 2002):

- Designating storage areas for plant, materials, waste, flammable substances separately
- Stored materials shall not spread in an uncontrolled manner on footpaths and other walkways. Further materials do not store where they could obstruct access routes or where they could interfere with emergency escape;
- All storage areas should be tidy, even in the site itself;
- Storage areas should be safe, secure and weatherproof (where required)
- Excess vegetation should be controlled

The use of proper equipment for material handling and advance planning for minimizing multiple handling will result in direct cost reduction and time savings. Careful handling of materials reduces risk of wastage of materials on site. This will begin with the provision of suitable vehicles or delivery plants for transporting material from the storage area in the workplace so as to make the damage to the minimum. In addition, avoid double handling that the points of unloading should be the final position of stacking area (Poon et al. and Jaillon, 2004).

g. Improved the Skill of the Workforce

The construction industry, especially in our country, it is labor-intensive. Thus, the skill and perception of workers influence its progress. It is argued that the causes of construction waste are directly or indirectly affected by the skills of the personnel involved in the construction industry (Andrew and Richard, 2004). As a result, training is absolutely required that the contractor train employees and subcontractors on material wastage minimization practices. In addition, conducting the following methods on the construction sites helps to reduce the amount of material waste due to the ability and perception of the workforce (Al-Moghany, 2006).

- periodic monitoring to ensure compliance
- commending employees that adhere well to site policy and offer advice to those that are not meeting the requirements
- motivating workers by establishing targets and offering bonuses or incentives
- conducting regular meetings to reinforce effective practices.

2.6.3. Construction Materials Wastage Minimization Hierarchy

Three main waste minimization strategies used in construction projects. These are reduction; reuse and recycling collectively called the "3Rs"

a. Reduction

Reduction is defined as any activity that reduces or eliminates the generation of waste at the source, usually within the process. Therefore, Waste reduction or source reduction, means preventing the creation of the waste in the first place (Begum et al., 2006). The biggest opportunity to impact on waste generation through prevention principles is at (Dennis, 2002):

Design: through design for waste reduction, i.e. the design stage will provide plans and specify materials that are prefabricated, recyclable and low waste building technologies.

Operations: through clear communication of the designer to the project team to avoid unnecessary waste through errors and redo.

Procurement: through the engagement of suppliers in delivering quality materials and through take back agreements for unused materials.

Reduction is at the highest preference on the construction waste minimization hierarchy; it has the most positive environmental impact due to the action having a direct effect. Many design and job site practices can significantly reduce waste and cost of materials while requiring only slight modifications of procedures.

b. Reuse

Reuse means to utilize articles from the waste stream again for a similar or different purpose without changing the form or properties of the article. This includes scrap generated on site and used materials. Reuse extends resource supplies and reduces energy and pollution even more than recycling (Begum et al., 2006). When reusing materials, the contractor should ensure that the material is suitable quality and fit for the intended use.

c. Recycling

Recycling is a process where the separation of a waste from a waste stream for further use and the processing of that separated material as a product or a raw material. According to Ekanayake and Ofori (2000), recycling waste materials is a very important environmental management tool for achieving sustainable development. Recycling, as a minimization strategy generally, requires more technological innovation than those of

reduction and reuse, as the process typically requires the modification of materials through remanufacture. On the other hand, recycling waste without properly based scientific research and development can result in environmental problems greater than the waste itself (Begum et al., 2006).

It is important to understand the principles of waste minimization. The figure below illustrates the waste minimization hierarchy.

CHAPTER THREE

Research Methodology

The methodology used in this study and information about the research strategy, site of the study, sources of information, sampling techniques, sampling size, method of data collection and processing, method of data analysis and interpretation are included in this chapter.

3.1. Research design

The strategy followed in this research was first started with problem identification which has been done through unstructured literature review, archival study and informal discussion with colleagues and professionals in the sector and then the research design were formulated. Then data and information sources were determined based on the formulated research design. On the basis of the data and information sources the research instruments were decided and available documentary sources relevant to the research were reviewed. The review includes thesis, books and journal.

Finally, after an in-depth review of literature, a questionnaire was designed and distributed to client employees, contractors and consultant employees to get their opinion based on their experience. Upon obtaining the desired data, checking and sorting of data has been done. The data's were then analyzed for extracting the information obtained through the overall research work. This was followed by thorough discussions in order to draw a conclusion and to forward recommendations based on the findings of the study.

A descriptive and exploratory survey design was used in this study. It was attempted to collect data from the relevant population (client employees, consultant employees and contractors) to evaluate their perception on the issues of material wastage management system in Arabsa site of Lideta construction branch office.

3.2. Site of the Study

The case study with special reference of Addis Ababa Housing construction project Office (AAHCPO) Lideta Housing Construction Branch Office Arabsa site. In this research, material wastage management system of the project office was assessed. The site is started on March 2012. Besides, the study gave full details to show how the research is going to be carrying out.

3.3. Source of Data and Method of Collection

The data was obtained from primary and secondary data. The former one have been used to collect information from project office employees, consultant firm employees and contractors through questionnaire, interview and through direct observation particularly a questionnaire survey is selected as the research instrument owing to its suitability to the level of information required, cost and time limitations and high number of participants. The secondary data was collected from different thesis's and documents of the organization that includes material management manuals, purchasing manuals, construction manual, property administration directive and annual reports of the project office.

3.4. Sampling Techniques

In this research, both probability and non- probability sampling techniques were used. Stratified Probability sampling is used to determine the number of sample size. The researcher selects Judgmental sampling of non- probability sampling method to obtain information in detail from experienced employees of the owner or client, consultant and contractor of project office. Non- probability sampling technique does not give equal chance that each elements of the population or the study were included in the sample units are selected at the description of the researcher. The reasons behind for selecting such techniques were is that it enables the researcher select any respondent that he/she thinks best to fit the question freely.

3.5. Study Population and Sample Size

The construction sites selected for this study is lideta housing construction project branch office of Arabsa site. Currently the site is completed and the house is transferred to the lucky city dwellers through lot system. The participants of the study include: Client/Owner, Consultant, Contractor,

Table 3.1: Study Populations Data

Site	Client/owner				Consultant staff	Contractors	Total number of population
	Construction department	Property administration department	Purchasing department	Project manager s'			
Arabsa site	**16**	**19**	**8**	**2**	**32**	**97**	**174**
Total	**16**	**19**	**8**	**2**	**32**	**97**	**174**

Source: LHCPBO, November, 2018

To investigate the projects of housing in Addis Ababa in the selected research area, it needed some basic understanding and experience about the current issues of material wastage management in condominium housing, but in order to gather the required information, there were problems of heterogeneity among targeted populations. Then the better alternative way was purposively selected the more profession, experienced, knowledgeable, responsible and volunteer people related to the issue to respond for the questionnaires and interviews.

The sample size of project office was determined using the following formula: **n= N/1+N (e)** ^{2} , Where n is the sample size, N is the population size and e is the desired level of precision (±5%) at 95% confidence interval. we can compute as $174/(1+174(0.05)^{2)}$ =121 Nh=(n*Nh)/N,in strata construction department (121*16)/174=11 ,(121*8)/174=6 ,(121*19)/174=13 ,(121*2)/172=1 ,(121*32)/174=22, (121*97)/174=68

Table 3.2: Sample Size data of the Study

Site	Client/owner				Consultant staffs	Contractor	Total number of population
	Construction department	Property administration department	Purchasing department	Project managers'			
Arabsa site	**11**	**13**	**6**	**1**	**22**	**68**	**121**
Total	**11**	**13**	**6**	**1**	**22**	**68**	**121**

Source: LHCPBO, November, 2018

3.6. Method of Data Processing

After the required data is collected from primary and secondary sources, it was processed and analyzed in accordance with the purpose of the research. The following steps were considered.

Editing: collecting data was examined to detect errors and to assume that the data collected are consistent with other factor.

Coding:the information collected was coded so as to reduce to small classes for efficient analysis.

Classification: row data was classified and grouped to get meaningful relationship. Finally, data was grouped in to similarities "fall" were used to do so and tabulation is used to facilitate analysis.

3.7. Method of Data Analysis

The analysis was carried out after collecting necessary data which was accomplished from both primary and secondary sources. First the data was edited centrally, then the edited data was coated (the response was categorized under limited number of classes finally the coded data is classified based on common characteristics. Then, the already proposed data was arranged orderly in table and other summary format. Percentages were

used to present the relatives to relevant variables so as to compare trend over time among categories.

The analysis was combined in all groups of respondents (clients, consultants, contractors) in order to obtain significant results. Next, data was analyzed by calculating frequencies and Relative Importance Index (RII) as follows (Aibinu and Jagboro, 2002).The collected data was analyzed by evaluating their importance. In order to evaluate the importance of a given answer, the relative importance index is used "RII". The following formula was used to calculate the relative importance index (RII)

RII = ΣPiUi / N (n) ---------- (1)

Where, Pi = participant rate on a given answer, Ui = the weight given to the answer level, N = number of participants, n = maximum score given to an answer

The equation (1) above was calculated to find the RII for the poor construction material management factors and the categories. The indexes were ranked for clients, contractors and consultants. The group index is the average of RII of the poor construction material management reasons in each category.

Besides, the equation (1) above was calculated to find the RII for the construction material wastage sources, causes and contribution and practicality waste minimization strategies. Then, the indexes were ranked for clients, contractors and consultants. The group index is the average of RII of the construction material wastage reasons in each category.

The levels of response are:

1. Major waste cause = 5, significant waste cause = 4, quite waste cause = 3 Insignificant waste cause = 2, not a waste cause =1
2. Very high contribution =5,high contribution =4,medium contribution=3, low contribution=2, very low contribution=1
3. Most frequently practiced=5, frequently practiced=4,practiced=3,not practiced=2,not practical=1
4. High= 1, Medium= 2, Low=3

CHAPTER FOUR

Analysis and Discussion of the Study

The main objective of this study was to assess the current situation of managing and minimizing wastage of construction materials in the housing projects of Lideta branch of Arabsa site by evaluating the causes, impact on the project performance and level of contribution and practice of material wastage minimization strategies. In this part, the respondents were asked to rank the main causes and sources of construction material wastage. Out of 174 total populations (45 client employees, 32 consultant employees and 97 contractors' employees), the researcher selects 121 total sample (31 participants from client, 22 participants from consultant and 68 participants from contractors experienced and more close relation with material management employees of the project office judgmentally. The reason behind for selecting such techniques is that it enables the researcher to be free in selecting any respondent that he/she thinks best to fit the question.

4.1. Response Rate Analysis of the Study

121 questionnaires were distributed and 83 of them were returned. Therefore, 45 contractors, 15 consultant company and 23 clients are participating to response the questionnaires. After the questionnaire survey was carried out, statistical analyses were undertaken on the responses using various methods described in the research methodology. To conduct this research primary and secondary data were used.

Table 4.1 Response Rate of the Survey

No	Project stake holder	Questionnaire distributed		Questionnaire returned		Failed Questionnaire		Analyzed Questionnaire	
		N0.	%	N0.	%	N0.	%	N0.	%
1	Client	31	25.62	23	19	0	0	23	19
2	Consultant	22	18.8	15	12.39	0	0	15	12.39
3	Contractor	68	56.2	50	41.32	5	4.1	45	37.19
Total		121	100	88	72.72	5	4.1	83	68.59

Source : Quesionaire Survey

4.2. Types of Organization (Respondent Designation)

Table 4.2 illustrates that the organizational grouping of the respondents. From the total 83 questionnaires Analyzed, 23 (27.71%) of the respondents were clients 15 (18.07%) were consultant employees while 45(54.2 %) of them were contractors. All parties had direct role in material management and waste reduction.

Table 4.3 respondent's organizational grouping

No.	Organizational grouping	No.	%
1	Clients	23	27.71
2	Consultant	15	18.07
3	Contractors	45	54.2
Total		83	100

Source: Quesionaire Survey

4.3. Effects of Construction Materials Wastage on Project Performance Criteria

Table 4.3: Responses for the Impact of Construction Material Wastage on the Project Performance Criteria

No.	Performance measures criteria	respondents	Percentage
1	Quality	18	21.69
2	Time	31	37.35
3	Cost	34	40.96
4	Environment	0	0
	Total	83	100

The above table shows that 34 (40.96%) of the respondents replied that cost, 31 (37.35%) of the respondents replied that time, 18 (21.69%) of the respondents replied that quality project performance criteria had been affected by material wastage on Lideta housing construction project branch office of Arabsa site construction materials wastage

is the result of mismanagement of material and material constitute a large portion i.e., up to 60-70% of the total cost in construction projects.

The basis of the peoples claim is the increment of the cost of the house, and this is because of existence of high material wastage. Minimizing material wastage benefits all stakeholders of housing construction. Therefore, effective material management decreases the cost of the project and increases the quality, and also helps to complete the project within the time specified as per the plan. Effective construction materials management is a key to success for a construction project Harish (2014).

4.4. Sources and Causes of Construction Material Wastage in Lideta Housing project Branch Office

There are many sources and causes, which contribute to construction material wastage evaluated for the respondents (client, consultants and contractors). Construction material wastage may occur due to one or combination of many sources and causes. The impact of each sources and cause varies from material to material. As discuss in literature review parts, the sources of the identified four main materials wastage classified under 7 categories which are design and documentation, procurement, site management, transportation, handling and storage, operation, site supervision and others and within each source there are many causes that the respondents expected to rank.

4.4.1 Sources and Causes of Cement Wastage

4.4.1.1. Major Sources of Waste

Respondents were asked to rank the listed sources of causes of cement wastage on Lideta housing construction branch office Arabsa site. The relative importance index of all the 7 sources of construction material wastage evaluated for the respondents (client, consultants and contractors,).

Table 4.4.1.1: Relative Importance Index and ranking of sources of cause of cement wastage

	Sources	RII	R
1	Design and documentation	0.68	2
2	Operation (on site, equipment)	0.65	4
3	Site supervisor	0.63	6
4	Site management	0.72	1
5	Transportation , handling and storage	0.66	3
6	Procurement	0.64	5
7	Others	0.56	7

Source: Questionnaire Analysis, 2018

The above table, table 4.4.1.1 shows that site management (0.72), design and documentation (0.68), transportation, handling and storage (0.66) and Operation (on site, equipment) (0.65) respectively are major sources of causes of cement wastage in Lideta housing construction project office Arabsa site.

The result shows that cement was greatly wasted because of problem in site management. Because of inappropriate and insufficient storage area in the contractor site, it is common to observe dry cements. The contractor issued the cement from client store and puts for a long period and become dry. Poor site lay out in the contractor site leads to high wastage of cement. The second source of cement wastage is design and documentation. It categorizes wrong bill of quantity, lack of material plan, design changes and revision and ambiguities, errors, and inconsistencies in drawings. Most of the time bill of quantity prepared by consultants favored the contractor in excess of as built consumption of the building and the excess issued cement becomes wasted.

4.4.1.2. Major Causes of Cement Wastage on Project Office

The questionnaire of this study considered 35 causes which create construction material wastage and the respondents rank the degree of creating cement wastage under the following table.

Table: 4.4.1.2 Relative Importance Index and ranking of major cause of cement wastage

No.	Causes of Material wastage on Lideta Housing Construction project Branch Office	Source	RII	R
1	Lack of Material plan	Design	0.68	7
2	Design changes and revisions	Design	0.69	6
3	Ambiguities, errors, and inconsistencies in drawings	Design	0.59	15
4	Poor/ wrong specifications (BOQ)	Design	0.75	2
5	Poor quality of materials	Procurement	0.63	12
6	Poorly schedule to procurement	Procurement	0.68	7
7	Mistakes in quantity surveys	Procurement	0.64	11
8	Purchased materials that do not comply with specification	Procurement	0.62	13
9	Improper handling of materials in the client store	Handling and transportation	0.66	9
10	Lack of transparency and accountability	Handling and transportation	0.67	8
11	Insufficient storage area on site	Handling and transportation	0.63	12
12	Inappropriate storage of materials	Handling and transportation	0.68	7
13	Damage during transportation	Handling and transportation	0.63	12
14	Damage during loading and unloading	Handling and transportation	0.67	8
15	Improper storage and handling of materials on site	Handling and transportation	0.74	3
16	Rework (chiseling, complete removal and rework…etc.)due to poor monitoring and evaluation	Operation	0.68	7
17	Using excessive quantityof materials than required	Operation	0.66	9
18	Using incorrect type of material	Operation	0.67	8

19	Lack of transparency and accountability	Operation	0.64	11
20	Choice of wrong construction method	Operation	0.51	18
21	Poor construction technology	Operation	0.66	9
22	Lack of coordination among stack holders on site	Operation	0.69	6
23	Poor workmanship	Operation	0.73	4
24	Lack of proper waste management plan and control	Site management	0.73	4
25	Lack of project management capacity	Site management	0.72	5
26	Ineffective planning and scheduling of the project by the contractor	Site management	0.75	2
27	Poor coordination and communication between construction parties	Site management	0.73	4
28	Poor site layout	Site management	0.65	10
29	Lack of a quality management system aimed at waste minimization (kaizen philosophy)	Site management	0.76	1
30	Poor qualification of consultant engineer's staff assigned on the site	Site supervision	0.6	15
31	Delay in performing inspection and testing by the consultant Engineer	Site supervision	0.63	12
32	Poor coordination and communication between the consultant engineer, contractor and client	Site supervision	0.68	7
33	Slow response from the consultant engineer to contractor inquiries	Site supervision	0.61	14
34	Weather condition	Others	0.52	17
35	Theft	Others	0.59	16

Source: Questionnaire Analysis, 2018

According to the above table 4.4.1.2 Lack of a quality management system aimed at waste minimization (kaizen philosophy) (0.76) Poor/ wrong specifications (BOQ) (0.75) ineffective planning and scheduling of the project by the contractor (0.75), Improper storage and handling of materials on site (0.74) Poor workmanship (0.73) respectively were the first four major causes of cement wastage on Lideta housing construction branch office.

Mainly cement is wasted because of lack of quality control system for construction work and material in the site. There is no responsible body about the application of kaizen philosophy which is very important to minimize material wastage and increases the

quality of houses. As a result of inappropriate store at the contractor site a lot of cement becomes wasted. But the contractor is not liable. Because the bill of quantity is prepared in the favor of the contractor. Cement standard is greater than as built standard. So, the contractor did not bother about material wastage.

4.4.2 Sources and Causes of Aggregate Wastage

4.4.2.1. Major Sources of Waste

Table 4.4.2.1: Relative Importance Index and ranking of sources of aggregate waste

No.	Sources	RII	R
1	Design and documentation	0.71	2
2	Operation (on site, equipment)	0.68	3
3	Site supervisor	0.66	5
4	Site management	0.73	1
5	Transportation , handling and storage	0.6	6
6	Procurement	0.67	4
7	Others	0.55	7

The above table, table 4.4.2.1 shows that site management (0.73), Design and documentation (0.71) and operation (0.68), procurement (0.67) respectively are major sources of causes of aggregate wastage in Lideta housing construction project office Arabsa site.

Site management problem is the main source of aggregate wastage in Lideta housing project. Poor site layout, design and documentation (wrong bill of quantity) and operation (poor workman ship) make the aggregate to be highly wasted.

4.4.2.2. Major Causes of Aggregate Wastage on Project Office

Table: 4.4.2.2 Relative Importance Index and ranking of aggregate waste cause

	Causes of Material wastage on lideta Housing Construction project Branch Office	Source	RII	R
1	Lack of Material plan	Design	0.71	7
2	Design changes and revisions	Design	0.68	9
3	Ambiguities, errors, and inconsistencies in drawings	Design	0.69	8
4	Poor/ wrong specifications (BOQ)	Design	0.76	2
5	Poor quality of materials	Procurement	0.68	9
6	Poorly schedule to procurement	Procurement	0.68	9
7	Mistakes in quantity surveys	Procurement	0.71	7
8	Purchased materials that do not comply with specification	Procurement	0.6	16
9	Improper handling of materials in the client store	Handling and transportation	0.64	13
10	Lack of transparency and accountability	Handling and transportation	0.72	6
11	Insufficient storage area on site	Handling and transportation	0.48	19
12	Inappropriate storage of materials	Handling and transportation	0.64	13
13	Damage during transportation	Handling and transportation	0.51	18
14	Damage during loading and unloading	Handling and transportation	0.49	19
15	Improper storage and handling of materials on site	Handling and transportation	0.72	6
16	Rework (chiseling, complete removal and rework…etc.)due to poor monitoring and evaluation	Operation	0.66	11
17	Using excessive quantity of materials than required	Operation	0.63	14
18	Using incorrect type of material	Operation	0.67	10
19	Lack of transparency and accountability	Operation	0.69	8
20	Choice of wrong construction method	Operation	0.62	15
21	Poor construction technology	Operation	0.66	11
22	Lack of coordination among stack holders on site	Operation	0.73	5
23	Poor workmanship	Operation	0.74	4

24	Lack of proper waste management plan and control	Site management	0.72	6
25	Lack of project management capacity	Site management	0.77	1
26	Ineffective planning and scheduling of the project by the contractor	Site management	0.74	4
27	Poor coordination and communication between construction parties	Site management	0.72	6
28	Poor site layout	Site management	0.65	10
29	Lack of a quality management system aimed at waste minimization (kaizen philosophy)	Site management	0.75	3
30	Poor qualification of consultant engineer's staff assigned on the site	Site supervision	0.65	12
31	Delay in performing inspection and testing by the consultant Engineer	Site supervision	0.67	10
32	Poor coordination and communication between the consultant engineer, contractor and client	Site supervision	0.65	12
33	Slow response from the consultant engineer to contractor inquiries	Site supervision	0.68	9
34	Weather condition	Others	0.55	17
35	Theft	Others	0.55	17

According to the above table 4.4.2.2., Lack of project management capacity (0.77), Poor/ wrong specifications (BOQ) (0.76), Lack of a quality management system aimed at waste minimization (kaizen philosophy) (0.75) Poor workmanship (0.74) and ineffective planning and scheduling of the project by the contractor (0.74)were the major causes of aggregate wastage on Lideta housing construction branch office respectively.

4.4.3 Sources and Causes of Reinforcement bar Wastage

4.4.3.1. Major Sources of Waste

Table 4.4.3.1**:** RII Result and Ranking of Sources of Cause of Reinforcement bar Wastage

No.	Sources	RII	R
1	Design and documentation	0.72	1
2	Operation (on site, equipment)	0.63	4
3	Site supervisor	0.62	5
4	Site management	0.71	2
5	Transportation , handling and storage	0.61	6
6	Procurement	0.69	3
7	Others	0.59	7

Source: Questionnaire Analysis, 2018

The above table, Table 4.4.3.1 shows that design and documentation (0.72) and site management (0.71), procurement (0.69) and operation (0.63) are major sources of causes of reinforcement bar wastage in Lideta housing construction project office of Arabsa Site respectively.

Design is a major cause for re bar wastage. This problem results from insufficient consideration made during the design stage for optimized cutting of bars. Besides design bill of quantity is also had a greater contribution for rebar wastage. After completion of the project the amount of wastage collected become greater than the expected amount of wastage. This shows there is problem cutting resulted from design and poor work man ship. The contractor forced to issue excess rebar and during completion of the construction the left over rebar returned to the client store. The returned rebar lost its quality and not reused because of problem of storage and handling. Poor site management is also had high contribution for re bar wastage.

4.4.3.2. Major Causes of Reinforcement bar Wastage on Project Office

Table: 4.4.3.2 Relative Importance Index and Ranking of Reinforcement bar waste cause

	Causes of Material wastage on lideta Housing Construction project Branch Office	**Source**	**RII**	**R**
1	Lack of Material plan	Design	0.71	7
2	Design changes and revisions	Design	0.72	4
3	Ambiguities, errors, and inconsistencies in drawings	Design	0.64	11
4	Poor/ wrong specifications (BOQ)	Design	0.79	1
5	Poor quality of materials	Procurement	0.68	8
6	Poorly schedule to procurement	Procurement	0.72	4
7	Mistakes in quantity surveys	Procurement	0.68	8
8	Purchased materials that do not comply with specification	Procurement	0.66	10
9	Improper handling of materials in the client store	Handling and transportation	0.63	12
10	Lack of transparency and accountability	Handling and transportation	0.71	5
11	Insufficient storage area on site	Handling and transportation	0.62	13
12	Inappropriate storage of materials	Handling and transportation	0.67	9
13	Damage during transportation	Handling and transportation	0.53	18
14	Damage during loading and unloading	Handling and transportation	0.52	19
15	Improper storage and handling of materials on site	Handling and transportation	0.62	13
16	Rework (chiseling, complete removal and rework…etc.)due to poor monitoring and evaluation	Operation	0.61	14
17	Using excessive quantityof materials than required	Operation	0.59	15
18	Using incorrect type of material	Operation	0.49	19
19	Lack of transparency and accountability	Operation	0.66	10
20	Choice of wrong construction method	Operation	0.58	16
21	Poor construction technology	Operation	0.68	8
22	Lack of coordination among stack holders on site	Operation	0.69	7

23	Poor workmanship	Operation	0.74	3
24	Lack of proper waste management plan and control	Site management	0.72	4
25	Lack of project management capacity	Site management	0.74	3
26	Ineffective planning and scheduling of the project by the contractor	Site management	0.71	5
27	Poor coordination and communication between construction parties	Site management	0.71	5
28	Poor site layout	Site management	0.63	12
29	Lack of a quality management system aimed at waste minimization (kaizen philosophy)	Site management	0.75	2
30	Poor qualification of consultant engineer's staff assigned on the site	Site supervision	0.7	6
31	Delay in performing inspection and testing by the consultant Engineer	Site supervision	0.38	20
32	Poor coordination and communication between the consultant engineer, contractor and client	Site supervision	0.69	7
33	Slow response from the consultant engineer to contractor inquiries	Site supervision	0.69	7
34	Weather condition	Others	0.56	17
35	Theft	Others	0.61	14

According to the above table 4.4.3.2 Poor/ wrong specifications (BOQ) (0.79), Lack of a quality management system aimed at waste minimization (kaizen philosophy) (0.75) Lack of project management capacity(0.74), Poorly schedule to procurement (0.72) Lack of transparency and accountability (0.71) respectively were the major causes of reinforcement bar wastage on Lideta housing construction branch office. Project management includes material, human and financial resources.

The respondents consider that conversion waste from cutting uneconomical shapes in reinforcement bars as the most significant contributor to this material waste. This problem results from insufficient consideration made during the design stage for optimized cutting of bars. Ekanayake and Ofori (2000) mentioned in their study, lack of attention paid to modular coordination of products was the most significant contributors to site waste.

These problems arise because of the last minutes client requirement or due to unavailability of one size of bars in the market and the need for substitution with another type during the construction activities, poor workman ship and lack of monitoring and evaluation by the consult employees.

4.4.4 Sources and Causes of Hollow Concrete Block Wastage

4.4.4.1 Major Sources of Waste

Table 4.4.4.1: Relative Importance Index and ranking of sources of cause of hollow concrete block wastage

No.	Sources	RII	R
1	Design and documentation	0.71	3
2	Operation (on site, equipment)	0.66	6
3	Site supervisor	0.69	5
4	Site management	0.7	4
5	Transportation , handling and storage	0.72	2
6	Procurement	0.76	1
7	Others	0.58	7

The above table, table 4.4.4.1 shows that procurement (0.76), Transportation, handling and storage (0.72), Design and documentation (0.71) and site management (0.7), respectively are major sources of causes of hollow concrete block wastage. This indicates that the basic source of cause of waste for hollow concrete block is procurement .Therefore; to reduce waste in hollow concrete block working first at the procurement stage is best for housing construction of Lideta branch Arabsa site.

Most of the time HCB faces quality problem. This comes from low quality of raw materials, problem of ratio and lack of enough storage space in both production and construction sites. Bossink and Brouwers (1996), in their study revealed that choice of low quality products are the main cause of construction wastage.

4.4.4.2. Major Causes of Hollow Concrete Block Wastage on Project Office

Table: 4.4.4.2 Relative Importance Index and Ranking of Cause of Hollow Concrete Block Wastage

	Causes of Material Wastage on Lideta Housing Construction Project Branch Office	Source	RII	R
1	Lack of Material plan	Design	0.67	14
2	Design changes and revisions	Design	0.73	8
3	Ambiguities, errors, and inconsistencies in drawings	Design	0.63	16
4	Poor/ wrong specifications (BOQ)	Design	0.81	3
5	Poor quality of materials	Procurement	0.83	1
6	Poorly schedule to procurement	Procurement	0.75	6
7	Mistakes in quantity surveys	Procurement	0.71	10
8	Purchased materials that do not comply with specification	Procurement	0.73	8
9	Improper handling of materials in the client store	Handling and transportation	0.66	15
10	Lack of transparency and accountability	Handling and transportation	0.72	9
11	Insufficient storage area on site	Handling and transportation	0.66	15
12	Inappropriate storage of materials	Handling and transportation	0.68	13
13	Damage during transportation	Handling and transportation	0.74	7
14	Damage during loading and unloading	Handling and transportation	0.75	6
15	Improper storage and handling of materials on site	Handling and transportation	0.82	2
16	Rework (chiseling, complete removal and rework…etc.)due to poor monitoring and evaluation	Operation	0.7	11
17	Using excessive quantity of materials than required	Operation	0.63	16
18	Using incorrect type of material	Operation	0.57	18
19	Lack of transparency and accountability	Operation	0.69	12
20	Choice of wrong construction method	Operation	0.58	18
21	Poor construction technology	Operation	0.68	13

22	Lack of coordination among stack holders on site	Operation	0.7	11
23	Poor workmanship	Operation	0.76	5
24	Lack of proper waste management plan and control	Site management	0.72	9
25	Lack of project management capacity	Site management	0.74	7
26	Ineffective planning and scheduling of the project by the contractor	Site management	0.73	8
27	Poor coordination and communication between construction parties	Site management	0.71	10
28	Poor site layout	Site management	0.52	20
29	Lack of a quality management system aimed at waste minimization (kaizen philosophy)	Site management	0.78	4
30	Poor qualification of consultant engineer's staff assigned on the site	Site supervision	0.69	12
31	Delay in performing inspection and testing by the consultant Engineer	Site supervision	0.68	12
32	Poor coordination and communication between the consultant engineer, contractor and client	Site supervision	0.71	10
33	Slow response from the consultant engineer to contractor inquiries	Site supervision	0.69	12
34	Weather condition	Others	0.59	17
35	Theft	Others	0.57	19

According to the above table 4.4.4.2, Poor quality of materials (0.83), Improper storage and handling of materials on site (0.82), Poor/ wrong specifications (BOQ) (0.81) Lack of a quality management system aimed at waste minimization (kaizen philosophy) (0.78) respectively were the major causes of hollow concrete block wastage on Lideta housing construction branch office. Project management includes material, human and financial resources. Bossink and Brouwers (1996), in their study revealed that choice of low quality products are the main cause of construction waste.

In housing projects, HCB is produced by micro and small scale enterprises (MSE) with low financial, knowledge and technological capacity. The project office quality control mechanism is too weak and exposed to rent seeking because of this low quality materials are used in the production of HCB. Besides problems regarding ratio, curation period, mold error and attitudinal problems contribute a lot to waste HCB.

On the other hand, compared to other three dominant construction materials, HCB is wasted through transportation, handling and storage. This is because production sheds are outside the construction site and besides unnecessary transportation cost, damage during loading and unloading, lack of enough storage area within the shed leads to wastage of HCB. Additionally, construction and production schedule are not coherent that is most of the time excess product comes first. Then the product kept long period before construction with high exposure to sun light on in appropriate area in the site and finally the product become wasted.

4.5. Summary of Major Sources of Cause of Construction Material Wastage

Table 4.5. Summary of Relative Importance Index and Ranking of Source of Material wastage

No.	Material type	Sources of material wastage						
		Design	Procurement	Transportation, handling and storage	operation	Site management	Site supervisor	others
1	Cement	0.68	0.64	0.66	0.65	0.72	0.63	0.56
2	Aggregate	0.71	0.67	0.6	0.68	0.73	0.66	0.55
3	Reinforcement	0.72	0.69	0.61	0.63	0.71	0.62	0.59
4	Hollow concrete block	0.71	0.76	0.72	0.66	0.7	0.69	0.58
Average RII		0.71	0.69	0.65	0.66	0.72	0.65	0.57
Rank		2	3	5	4	1	5	6

The above table shows that all identified variables have an impact of being sources of construction material wastage in the project office. Based on the RII result site management (0.72), design and documentation (0.71), procurement (0.69) operation (0.66) Transportation, handling and storage (0.65) were taken as sources of material wastage in the project site respectively. Based on the study site management problem contributes more for the existence of construction material.

4.6.Waste Material Disposal Methods in the Project Office

Table: 4.6 Relative Importance Index and Ranking on Methods of Material Disposal

No.	Methods of material dispose	RII	R
1	Transfer to other project office	0.66	1
2	Re-use within the firm	0.55	2
3	Does not apply any disposal action	0.49	3
4	Sales to another firm	0.47	4
5	Return back to the supplier	0.28	5
6	Donation to other charitable organization	0.22	6

The majority of the respondents replied that the project office Transfer to other project branch office(0.66), reuse within the project (0.55) and the rest does not apply any disposal action (0.49) covers the highest portion of material disposal methods respectively.

The result shows that there are many construction materials to be disposed, the practicality of disposal methods indicates the project office did not go through other than the first two methods. during the interview ,the Lideta site manager indicate that ,the existence of wasted material is because of problem of top managers commitment to made timely decision , weak stock management system and lack of accountability and transparency in the project office. The project office kept support from other concerned bodies to decide on actions based on sales to other firm and to donate for other charitable organizations. Once the project office received the material, there is no legal ground to return back to the supplier for recycling or other action. the only material to be recycled is rebar. This situation happens in most branches of the housing project office.

4.7.Level of Contribution of Waste Minimization Measures for Waste Reduction

In this part, the result of the questionnaire survey on the views of respondents on waste minimization measures is presented. The results of the survey provide evidence on the level of contribution of identified 19 waste minimization measures in the Lideta housing construction project branch of Arabsa site.

Table 4.7. Rank and Relative Importance index for Level of Contribution of Waste Minimization Strategies

s.n	Waste minimization measures	RII	Rank
1	Design for offsite construction	0.62	11
2	Standardization of Design	0.81	1
3	Proper detailing during preparation of drawings and specification	0.75	6
4	Minimizing design changes	0.73	7
5	Use of quality materials	0.76	5
6	Correct material planning and ordering	0.77	4
7	Careful handling and usage of tools and equipment on site	0.72	8
8	Proper storage and handling of materials	0.69	9
9	Just in time material delivery	0.75	6
10	Improving the skill of the work force by giving training	0.72	8
11.	Developing waste management plan and hiring site waste manager	0.75	6
12	Using low waste building technologies like ready mix and machine spray plastering	0.69	9
13	Use of waste aware sub-contractor and right equipment	0.73	8
14	Improving the coordination between contractor, consultant Engineer and client	0.79	2
15	Re-use of waste materials on site	0.68	10
16	Conducting timely monitoring and evaluation and take corrective	0.74	7

	measures		
17	Fully implement accountability and responsibility principles	0.78	3
18	Disposed unused materials	0.69	9
19	Recycling of some waste materials	0.68	10

The above table 4.8 illustrates that Standardization of Design with 0.81 RII result have a very high contribution of minimizing wastage of construction materials on Lideta housing construction project office of Arabsa site. In addition, improving the coordination between contractor, consultant Engineer and client, fully implement accountability and responsibility principles, correct material planning and ordering, use of quality materials with 0.79,0.78,0.77,0.76 RII result respectively have high contribution of minimizing the existing material wastage problems of the branch project office.

4.8.Level of Practice of Waste Minimization Strategies in the Project Branch Office

Table 4.8 Rank and Relative Importance Index for Level of Practice of Waste Minimization Strategies

s.n	Waste minimization measures	RII	Rank
1	Design for offsite construction	0.46	10
2	Standardization of Design	0.57	2
3	Proper detailing during preparation of drawings and specification	0.55	4
4	Minimizing design changes	0.55	4
5	Use of quality materials	0.59	1
6	Correct material planning and ordering	0.56	3
7	Careful handling and usage of tools and equipment on site	0.54	5
8	Proper storage and handling of materials	0.54	5
9	Just in time material delivery	0.49	8
10	Improving the skill of the work force by giving training	0.51	6
11	Developing waste management plan and hiring site waste manager	0.5	7
12	Using low waste building technologies like ready mix and machine spray plastering	0.48	9
13	Use of waste aware sub-contractor and right equipment	0.56	3
14	Improving the coordination between contractor, consultant	0.59	1

	Engineer and client		
15	Re-use of waste materials on site	0.5	7
16	Recycling of some waste materials	0.42	11

When we compare the practicality of one strategy from the other strategy use of quality materials and improving the coordination between contractor, consultant Engineer and client getting equal RII, standardization of design, use of waste aware sub-contractor and right equipment and correct material planning with RII result 0.59, 0.57, 0.56 are more practiced in Lideta housing construction project branch office of Arabsa site respectively.

The result shows that the material management situation in Arabsa site of the project office in its main store is improved compared to the situation in the previously constructed sites. Currently, the quality of fabricated construction materials used in the construction of condominium houses assured by the Ethiopian standards agency and different technical and vocational training colleges. Among the 16 identified material waste reduction strategies use of quality materials with 0.59 RII value practiced better than other strategies. But the RII value of the level of contribution of this strategy i.e use of quality materials is 0.76 which is higher than its RII value of level of practicality.

Similarly, the coordination of the three stack holders In the project office also improved compared to the situation in other sites. Improving the coordination between contractor, consultant Engineer and client practiced well with 0.59 RII values still it is below the level of contribution with 0.79 RII value. The second best practiced waste reduction stratedy is standardization of design with 0.57 RII result. Even though the project did not started after having approved design, and varies from site to site the concerned body prepared and send design for each work order. The stockholders decide to implement the contract document.

The result also shows that the project office did not implement the material waste reduction strategies based on the level of contribution of each strategy to achieve effective material management. Concerning recycling only rebar is recycled. The least practiced strategy is recycling construction materials.

Finally, the RII result of all waste minimization strategy practicality is below the RII result of the level of contribution of the strategies. As a result of this the material wastage problem exists and continues in the future. All waste minimization strategies were important for all construction materials.

4.9. Managers Respond through Interview

In addition to the result obtained through the formal questioner the researcher also developed an interview. Here the researcher trid his best to get additional information regarding construction project office material wastage management trends. The researcher also designed one interview question and the respondent in Addis Ababa Housing Development Project Office (AAHDPO) – Lideta Housing Development Branch Office vise branch manager (Ato Awoke).

From the interview the result obtained indicates that there is material wastage in the project office. Regarding the source of wastage MSE produced materials wasted because of quality problem and fabricated materials wasted because of handling and storage. Generally, the activities that did not done during project initiation stage become a base for all material wastage. The project completion time of the project office were too late, is because of poor material supply system or shortage of materials especially electric, sanitary and finishing materials. Currently the person claims that the cost of the house is an affordable and this is resulted from the existence of high material wastage.

The comments and suggestion forwarded by the manager

The project should start construction after having approved design, the project objective should be free from politics, the project should be managed by professionals having best project management skill and experience, the bill of quantity should be prepared by responsible and legally accountable body way of material supply should be transferred to the contractor and the structure of the organization should be revised.

CHAPTER FIVE

Summary of findings, Conclusions and Recommendations of the Study

5.1. Summary of findings

The general objective of this study is to assess the current situation of managing and minimizing wastage of construction materials at Addis Ababa housing construction projects of Lideta branch of Arabsa site by evaluating the causes, impact on the project performance criteria and level of contribution and practice of construction material wastage minimization strategies. The results of the study are summarized as below.

- Among the performance measurement criteria of projects, cost is greatly affected by material wastage on Lideta housing construction branch office of Arabsa site. The planned completion time and quality of project performance criteria also affected by the presence of material wastage Lideta housing construction branch offices of Arabsa site. Effective construction materials management is a key to success for a construction project (Harish, 2014).
- According to the respondents' response, the frequency of waste material disposal methods in the project branch office is ranked as transfer to other project branch office (0.66), reuse within the project (0.55) and the rest does not apply any disposal action (0.49) respectively.
- This study has outlined the seven major sources construction material wastage based on RII. The site management (0.72) ,design and documentation factors (0.71), procurement (0.69), Operation (on site, equipment) (0.66), materials transportation , handling and storage (0.65), site supervisor (0.63) and others (0.61) (weather ,theft) had an impact on construction material wastage in Lideta housing construction project branch of Arabsa site respectively.
- Based on the nature of the four dominant materials (cement, aggregate, reinforcement bar and HCB) the researcher has outlined seven group of sources of causes of material wastage based on RII.
- In this study, the first four major source of cause of cement wastage site management (0.72), design and documentation (0.68), transportation, handling and

storage (0.66) and operation (on site, equipment) (0.65) in Lideta housing construction project office of Arabsa site are identified respectively.

- ☞ The study has identified the first four major cause of cement wastage Lack of a quality management system aimed at waste minimization (kaizen philosophy) (0.76) Poor/ wrong specifications (BOQ) (0.75) ineffective planning and scheduling of the project by the contractor(0.75), improper storage and handling of materials on site (0.74) poor workmanship (0.73 on Lideta housing construction branch office respectively.
- ☞ The first four major source of cause of aggregate wastage site management (0.73), design and documentation (0.71) and operation (0.68), procurement (0.67)) at Lideta housing construction project office of Arabsa site has been identified respectively.
- ☞ The study identified the first four major cause of aggregate wastage lack of project management capacity (0.77), Poor/ wrong specifications (BOQ) (0.76), lack of a quality management system aimed at waste minimization (kaizen philosophy) (0.75) Poor workmanship(0.74) and ineffective planning and scheduling of the project by the contractor(0.74) on Lideta housing construction branch office. Project management includes material, human and financial resources respectively.
- ☞ The study identified first four major source of cause of reinforcement bar wastage design and documentation(0.71) and site management (0.71), procurement (o.69) and operation (0.63) , Site supervisor (0.62) on Lideta housing construction project office of Arabsa site respectively.
- ☞ The study identified first four major cause of reinforcement bar wastage Poor/ wrong specifications (BOQ)(0.79), Lack of a quality management system aimed at waste minimization (kaizen philosophy) (0.75) Lack of project management capacity(0.74), Poorly schedule to procurement (0.72) Lack of transparency and accountability(0.71) on Lideta housing construction branch office. Project management includes material, human and financial resources respectively.
- ☞ The study identified first four major source of hollow concrete block wastage procurement (0.76), transportation, handling and storage (0.72), Design and documentation (0.71) and site management (0.7) on Lideta housing construction branch office Arabsa site respectively.

- The study identified top four major cause of hollow concrete block wastage Poor quality of materials(0.83), improper storage and handling of materials on site(0.82), Poor/ wrong specifications (BOQ) (0.81) lack of a quality management system aimed at waste minimization (kaizen philosophy) (0.78) respectively on Lideta housing construction branch office. Project
- Based on RII result, standardization of design with (0.81) have a very high contribution of minimizing wastage of the four materials on Lideta housing construction project office of Arabsa site. In addition, improving the coordination between contractor, consultant Engineer and client, fully implement accountability and responsibility principles, correct material planning and ordering, use of quality materials with 0.79,0.78,0.77,0.76 RII results have high contribution minimizing the existing material wastage problems of the branch project office respectively.
- Regarding the practicality of one strategy from the other, the RII varies and the respondents ranked as Improving the coordination between contractor, consultant Engineer and client, standardization of design, use of waste aware sub-contractor and right equipment practiced on Lideta housing construction project branch office of Arabsa site respectively, but the RII result of each waste minimization strategy practicality is below the RII result of the level of contribution of the strategies. As a result of this, the material wastage problems exist and continue in the future. All waste minimization strategies were important for four key materials.

5.1 Conclusions

In this study, the major sources of construction material wastage in the project office are Site management, Design and documentation factors, procurement , Operation (on site, equipment) , Materials transportation , handling and storage, site supervision and others (weather, theft) respectively.

Among the project performance criteria cost of the house was highly affected by existence of construction material wastage in the branch office. Next to this, time and quality were also affected respectively.

The extent of presence of waste material is very high in the project office. The project office practiced the method of disposal ranked as Transfer to other project branch office, reuse within the project and the rest does not apply any disposal action respectively. The nature of the wasted materials needs more of selling. The materials become waste due to change in design and it should be disposed with selling or preparing design suitable for the materials.

Based on the analysis, all the identified waste minimizing strategies have high contribution, but the practicality of the strategies is below their importance level. Recently the project office try to solve the design fluctuation problems, the coordination between stakeholders starts to strengthen, accountability and responsibility starts to practice and material quality assurance is made by Ethiopia standardization agency which starts to solve quality problems. Because the level of practicality of waste reduction strategies is very low to the accumulation of waste material in the project is still high. The result of level of contribution and level of practicality is similar for cement, aggregate, reinforcement bar and hollow concrete block. The mitigation measures practiced for reducing construction materials wastage in constructing industry are, use of quality materials, improving coordination between contractor consultant engineer and client, standardization of design, use of waste aware subcontractor and right equipment ,minimizing design changes and proper detailing during preparation of drawings and specification to avoid over-ordering and proper storage and handling of materials on site.

The major causes of cement wastage are Lack of a quality management system aimed at waste minimization (kaizen philosophy), problem of bill of quantity (BOQ), problem of planning and scheduling by the contractor, improper storage and handling problem on site and Poor workmanship participating in the construction work. To minimize wastage of cement, the project first should solve the above listed findings of the study.

The major causes of aggregate wastage are lack of project management capacity , Poor/ wrong specifications (BOQ), lack of a quality management system aimed at waste minimization (kaizen philosophy), poor workmanship, and ineffective planning and scheduling of the project by the contractor, respectively on Lideta housing construction branch office.

The major causes of reinforcement bar wastage are Poor/ wrong specifications (BOQ), lack of a quality management system aimed at waste minimization (kaizen philosophy), lack of project management capacity, poorly schedule to procurement and lack of transparency and accountability. The problem of bill of quantity either surplus or shortage creates material wastage. Most of the time reinforcement bar had been purchased through international bid as bulk and the contractor issues excess of the building demand then the rebar exposed to unnecessary wastage by un skilled bar benders.

The major causes of hollow concrete block wastage are Poor quality of materials, improper storage and handling of materials on site, poor/ wrong specifications (BOQ) , lack of a quality management system aimed at waste minimization (kaizen philosophy). Products of MSE (HCB, riser, terrazzo, half ditch and precast) wasted because of low quality in the production stage and transportation, handling and storage. Because the production site is located far away from the construction site. For example MSE is producing at jemo for Arabsa site. This forced the project to incur high transportation cost. As a result, the cost of the house increases.

5.3 Recommendations

The result of this study had concluded that there is great material wastage and the project that did not practice waste minimization strategies equivalent to the degree of the problems. The following recommendations have been made to improve the application of material management principles to minimize construction materials problem in the project office.

- The project office should be start construction projects after having approved design and bill of quantity.
- The way of project management should be changed. Example the material supplying should be permitted to contractors rather than the government being sole supplier.
- The objective of the project office should be free of political interference and managed by professionals who develop project management skill.
- Problem of coordination among stakeholders must be solved with strong monitoring and evaluation system.
- Construction materials produced by MSE shall be produced in the construction site. As a result the project office could easily control quality problems and reduce cost of transportation.
- The project organization should incorporate quality control department (kaizen team leader) in all project branch office.
- To manage projects as per the performance measurement criteria, project managers should have been expected high commitment of giving appropriate and timely decision for problems solving to improve the performance of the project.
- Give training for construction parties about scientific project management principles, construction material wastage reduction strategies which is appropriate for each materials and apply at building construction sites should emphasized by concerned bodies. (consultants, contractors, MSE and the project staff)
- The project head office should apply all alternatives of waste disposal methods and use the time as turning point for minimal wastage.
- Transportation and storage facility on the sites should be improved by planning the details of material delivery and their storage space on site.

- Contractors should develop waste management plans and hire site waste manger to address material wastage problem and to enjoy the likely benefit.
- Optimization should be done to use resources during the design of the project.

Recommendation for Future Studies

This study will serve as the basis for future researches in the same field. The following are suggested research areas.

1. Study the Type of Contract Applied in the Housing Construction Projects.
2. Study on Feasibility of Reusing and Recycling as Minimizing Measures of Construction Materials Waste in Condominium Construction Projects
3. It is Necessary to repeat this Research every New Site to Observe the Degree of Material Wastage in the Construction Site.

REFERENCES

Agyerum, K. (2012).Minimizing Materials Wastage at the Construction Stage of a Project through the Implementation of Lean Construction. A Thesis submitted to the Department of Building Technology, Kwame Nkrumah University of Science and Technology, pp, 11-12

Al-Moghany, S. S. (2006). Managing and Minimizing Construction Waste in Gaza strip. A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Construction Management The Islamic University of Gaza – Palestine.

Andrew R.J. Dainty and Richard J. Brooke (2204) "Towards Improved Construction Waste Minimization" Structural Survey 22(1) 20–29

Ayarkwa, J, K. Agyekum and E. Adinyira, (n.d), "Exploring Waste Minimization Measures in the Ghanaian Construction Industry" College of Architecture and Planning, Kwame Nkrumah University of Science and Technology Kumasi, Ghana

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

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

C.W.F. 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 Construction Waste Minimization: The Case of Malaysia. Resource Conservation & Recycling, 86-98.Development Program United Nations Human Settlements Program: Nairobi

Dennis S. Macozoma (2002) "Construction site waste management and minimization"

Ekanayake, L.L. & Ofori, G. (2000).Construction material waste source evaluation, Proceedings of the 2nd South African Conference on Sustainable Development in the Built Environment, Pretoria, South Africa.

Enshassi, A. (1996), "Material Control and Waste on Building Sites", Building Research Information. 24(1), 31-34.

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.

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.

Getachew Araya Kassa, November, 2009 AAU School of Graduate Studies; Master of Science of Civil Engineering, Construction Technology and Management Major Thesis. International council for research and innovation in building and construction.

k. Harish, (May, 2014) A Study of Materials Management in Existing Constructions at Coimbatore Global journal of Engineering Science and Researches M.E, Department of Civil Engineering, Anna University/R.V. S Technical Campus Coimbatore, TN, India ISSN 2348 – 8034 Harishkv38@ymail.com

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

Macozoma, D. S. (2002). Construction Site Waste Management and Minimization. International Council for Research and Innovation in Building and Construction (CIB)/(CSIR) Building and Construction Technology, Report No.BOU/C361, Pretoria, South Africa Management professionals in minimizing wastage of material in building construction: the case Management, 130(4), 472-481.

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.

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.

Narimah 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

Pheng, L.S. and Meng,C.Y (1997), Managing Productivity in Construction, England, Ashgate Publishing Limited.

Poon, C. S.,Yu, A. T. W. and Jaillon, L. (2004). Reducing Building Waste at Construction Sites in Hong Kong. *Journal of Construction Management and Economics*, 22: 461– 470.

Sagoe, A. (2011). Managing Waste and Cost in the Construction Industry: A case study of the Road Construction industry in Ghana. A thesis submitted to the Institute of Distance Learning, Kwame Nkrumah A thesis submitted to the Institute of Distance Learning, Kwame Nkrumah requirements for the degree of common wealth executive masters of Business Administration

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.

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

UN-HABITAT (2010) the Ethiopia Case of Condominium Housing: The Integrated Housing

Enviro-nmental Protection Agency of USA, (2000). Solid Waste and Emergency Response. EPA-530-F-00-001. United States.