Jimma University

Jimma Institute of Technology

School of Civil and Environmental Engineering

Construction Engineering and Management Chair

Assessment of Building Construction Efficiency; Case Study in Addis Ababa

By: Lemlem Temesgen Wubetu

A Thesis Submitted to the School of Graduate Studies of Jimma University in Partial Fulfillment of the Requirements for the Degree of Masters of Science in Civil Engineering (Construction Engineering and Management)

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Approved by Board of Examiners:

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DECLARATION

I declare that this thesis work is work entitled "**Assessment of Building Construction Efficiency; Case Study in Addis Ababa**" is my own original work and has not been presented for a degree in any other university. All sources of material is used for the thesis have been properly acknowledged.

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Date of submission: June, 2016

Place: Jimma, Ethiopia

ABSTRACT:

Construction is generally implemented in the form of one-off projects, which makes it difficult to co-ordinate the process for successful completion. Due to the organization problems created by rigid professional divisions of labour and the one-time nature of construction projects, such disturbances are quite likely, which causes idling in the process and inefficiency of construction in general. Moreover, efficiency of the building construction projects also affected by waste in; time, costs, materials, energy, skills and labor. In recent years, the weight of building construction industry in the national economy of Ethiopia has been increasing. But, still there is inefficiency problems that occurs due to waste that results in the use of equipment, materials, labor or capital in larger quantities than those considered as necessary in the construction of a building and hence, there is a need for strengthening of institutional capacity, adaptation of new technologies and modern project management principles in order to maximize efficiency of the building construction industry. Hence, the main objective of this study is to identify and evaluate the factors affecting the efficiency of building construction projects in Addis Ababa City.

The study period was starting from July, 2015 up to January, 2016. A descriptive and explanatory study was carried out based on literature review. Questionnaire was distributed to the clients, consultants and contractors who are engaged in building construction projects within the city and 84% of questionnaire were received from respondents. Seventy nine (79) factors were identified, categorized into 4 groups, evaluated and ranked from contractors, contractors and client's perceptions. The most important factors contributing to project efficiency were imperfect planning of construction, ordering of materials that do not fulfill project requirements defined on design documents, financial difficulties faced by the contractor, workers' mistakes, fluctuation of prices of materials, poor planning and scheduling of the project by the contractor, damage of materials due to deficient stockpiling and handling of materials and payment delay from the client. Time overrun, cost overrun, poor quality completed project, dispute between parties, and environmental impact were identified as the top five most common and recurrent effects of inefficiency on building construction projects. The practices concerning with the main factors such as time, cost, material, and skill and labour checklists were analyzed in order to formulate strategies to improve efficiency of construction projects in the city of Addis Ababa. Remedial measures such as; Proper site management and frequent supervision, Proper planning and scheduling, Improved job-site efficiency through more effective interfacing of people, processes, materials, equipment, and information, Effective performance measurement to drive efficiency and support innovation, Using updated technology have been identified as top five effective strategies for successful construction performance.

Moreover, it is recommended for construction organizations to have a clear mission and vision to formulate, implement and evaluate their efficiency. The client should facilitate timely payment to contractors. Consultants should provide quality project design where design changes will be minimal. Contractors should have a cost engineer in their projects to control the cash flow of projects. Construction organizations should have different incentive systems in order to improve overall efficiency.

Key words: Addis Ababa, Factors, Building Construction, Efficiency.

ACKNOWLEDGMENT

Above all, I thank the Almighty God and St. Mary, for what they have done to me in my entire life and make me strong and feel patience in committing the tasks in great effort to overcome various challenges and finally come up with accomplishment of this thesis.

I am very grateful to express my deepest appreciation to my advisor, Assistant Professor Yoseph Birru (Doctor Ingenieure), and my co-advisor, Engr. Getachew Kebede (M.Sc.), for their concern and excellent advice which began from the inception of the research work. All my postgraduate instructors deserve great thanks, especially Prof. Emer T. Quezon, since their inputs are worthwhile.

I would like to extend my gratitude to Ethiopian Road Authority (ERA) by sponsoring this scholarship program and giving me the opportunity to complete the requirements leading to the degree of Master of Science in Civil Engineering.

I would like to express my appreciation to all organizations and individuals who contributed directly or indirectly to this thesis and provided the necessary materials and support for realization of this thesis. Many thanks go to Ethiopia Contractor Association staffs and Addis Ababa Housing Development & Construction Bureau for their support throughout my journey. Especial thanks are forwarded to contractors, consultants and client who sacrificed their precious time in filling the questionnaires.

I am deeply grateful to my family for encouraging me to finish the research. Etete (Beliyu Ayinalem) thank you for raising me the way you did. My beloved brothers thank you for always being there for me with your family. My son you are a gift from God as a meaning of your name “Natnael”; thank you for your love. I am also greatly indebted to all my friends who encouraged me in one way or another during my MSc program, especially Dawit G.

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ACRONYMS:

BIM	Building Information Modeling
CADD	Computer-Aided Design and Drafting
CBC	Cumulative Budgeted Cost
CPM	Critical Path Models
CPMIE	Construction Project Management Institute of Ethiopian
EEA	Ethiopian Economic Association
EPD	Environmental Protection Department
ERA	Ethiopian Road Authority
ETB	Ethiopian Birr
FIDIC	Federal International Des Ingenieurs Conseils
GDP	Gross Domestic Product
HR	Human Resource
MoFED,	Ministry of Finance and Economic Development
MoWUD	Ministry of Works and Urban Development
NRC	National Research Council
PERT	Program Evaluation and Review Technique
POP	Plaster of Paris
PPPA	Public Procurement Proclamation Agency
RII	Relative Importance Index
TBC	Total Budgeted Cost
UK	United Kingdom,
US$,	United States Dollar
WAGP	West African Gas Pipeline
WBS	Work Breakdown Structure

CHAPTER 1

INTRODUCTION

1.1 Background

Construction is an industry that has a great impact on the economy of all countries. It is very difficult to think of any development activity that does not involve construction. All infrastructure facilities needed for development, socioeconomic facilities and the very neighborhood we live in are all products of the construction industry. The role the construction industry plays in developing countries is quite significant. For example, in many developing countries, major construction activities account for about 80% of the total capital asset, 10 % of their GDP and; more than 50 % of the wealth invested in fixed assets (Jekale, 2004). Despite the industry's significant contribution, its development and efficiency is relatively low compared to other industries. High project performance and project success are not commonplace in the construction industry, especially those in developing countries (Long et al., 2004). Moreover, in many countries, the productivity of the construction industry is one of the lowest and; its degree of high technology utilization is not comparable with that of other industries. Further, the overall management in the industry is at a low level. The Construction industry's large scale scope and its use of huge capital are in sharp contrast with the low benefit (profit) and inferior management (Guangshe et al, 2008).

The nature and characteristics of the Construction industry and construction projects in developing countries, is different from that of the developed countries in many aspects. According to Jekale (2004), the Construction industry in many developing countries is characterized by "too fragmented and compartmentalized; Public sector dominated (dependency for public construction), and low development of indigenous technology". moreover, the construction industry in developing countries depend on imported input such as construction materials, machinery, and skilled manpower .In addition ,the industry is dominated by foreign construction firms; which execute almost exclusively all the major construction works (Adams, 1997).This is also the case in Ethiopia. Almost all major power projects and most of large road projects are constructed foreign contractors.

In recent years, Ethiopia infrastructure development and urbanization are booming, and the weight of building construction industry in the national economy has been increasing. But, the present state of the construction industry fails in meeting domestic and international quality standards and the performance demand expected from the sector (MoWUD, 2006). Construction projects have problems with construction techniques and management as well as limitation of funds and time. The critical problems are inability to complete the projects on schedule, low quality work, and cost overrun during their execution phase. Therefore, strengthening of institutional capacity, adaptation of new technologies and modern project management principles will be required in order to maximize efficiency of the building construction industry.

In Addis Ababa, the capital city of Ethiopia, a number of modern buildings are constructed some of them are on progress. However, most of these building projects do not perform as expected especially with respect to time, cost and quality standards due to various factors.

Therefore, in this research an attempt was made to identify the factors that influence the efficiency of building construction projects in Addis Ababa City. Following this, the final report has been compiled based on the findings of a survey targeting project owners, consultants and contractors, in an attempt to shed some light on how each project party perceives the relative importance of these factors. Finally, to improve the building construction efficiency in the study area, a number of recommendations have been formulated in order to bridge the gap between the different perceptions.

1.2 Statement of the Problem

According to Karhu (1997), construction is generally implemented in the form of one-off projects, which makes it difficult to co-ordinate the process for successful completion. The situation is further complicated by the fact that the various stages and tasks of building are highly interdependent which creates a vicious circle. Any disturbances are widely reflected on the activities of other parties causing compound effects.

These problems have resulted in high costs of construction and building as well as in end-product quality that does not match the client's needs. As a result of the observed problems on the one hand, and the compulsive strive for competitiveness on the other, each of the parties to the building process has developed the process, but only for his part, while none of the parties has been interested in the comprehensive development of the building process. Due to the synchronization problems created by rigid professional divisions of labour and the one-time nature of construction projects, such disturbances are quite likely, which causes idling in the process and inefficiency of construction in general (Karhu, 1997).

In recent years, Ethiopia infrastructure development and urbanization are booming, and the weight of building construction industry in the national economy has been increasing. But, still there is inefficiency problems that occurs due to waste that results in the use of equipment, materials, labor or capital in larger quantities than those considered as necessary in the construction of a building and hence, there is a need for strengthening of institutional capacity, adaptation of new technologies and modern project management principles in order to maximize efficiency of the building construction industry.

In Addis Ababa, the capital city of Ethiopia, a number of modern buildings are constructed some of them are on progress. However, most of these building projects do not perform as expected especially with respect to time, cost and quality standards due to various factors.

Moreover; personal experience, regarding the efficiency of building construction projects, as a former engineer that who have worked in Building construction projects in different places of Ethiopia and inefficiency of building construction projects noticed in terms of cost, time and quality standards are evidences to select this research topic. In this thesis, therefore, the study attempt was made to identify and evaluate the actual factors influencing the efficiency of building construction projects in Addis Ababa and to propose recommendation that will help to improve the efficiency in the future projects.

1.3 Significance of the Study

It is expected that the findings of the study will be used:

- to recommend the best practice approach/strategies in handling and minimizing inefficiency problems,
- In the future, to use as reference material for students who are willing to pursue related post graduate studies,
- to contribute to the development of construction project management, as well as to the stakeholders and community, and
- to provide knowledge of building construction-related factors that affect the project's efficiency.

1.4 Research Questions

To address the above benefits, the research has the following specific questions.

- What are the factors affecting building construction efficiency?
- How do key stakeholders perceive the effect of each factors affecting efficiency of building construction?
- What are the feasible strategies to be taken to improve efficiency of building construction in the study area?

1.5 Objectives

1.5.1 General Objective

The general objective of the research study is to assess building construction efficiency in Addis Ababa City.

1.5.2 Specific Objectives

The specific objectives of this research are:

- To identify the factors affecting efficiency of building construction.
- To rank perception of key stakeholders on the effect of each factors affecting efficiency of building construction.
- To establish appropriate strategies to improve efficiency of building construction projects.

1.6 Scope and Limitation of the Study

Scope

i. This study was conducted in some selected projects of building construction found in Addis Ababa City.
ii. Due to time limitation, this research was considered only building construction and does not take into account the other categories of construction industry.
iii. This research was focus on assessing the factors affecting efficiency of building construction projects and way of improving.
iv. However there are different analytical and practical issues of efficiency on building construction, the discussions on these issues was limited to building construction efficiency parameters which are listed under independent variable these are time, cost, material, skill and labor.

Limitation

Due to shortage of time and budget, only randomly selected buildings and formally contracted as per PPA procurement regulations has been investigated. Hence the research findings could possibly ignore the performance of small scale building constructions as well as exhaustive evaluation of actual practices.

CHAPTER 2

LITERATURE REVIEW

2.1. INTRODUCTION

2.1.1. Construction

The construction industry is a vital element of the economy and has a significant effect on the efficiency and productivity of other industry sectors. One cannot think of widespread investment in manufacturing, agriculture, or service sectors unless the construction results of infrastructure facilities are in place. In some of the developing countries, the growth rate of construction activity outstrips that of population and of GDP (Chitkara, 2004).

Construction as defined by the United Nations Statistics Division is "an economic activity directed to the creation, renovation, repair or extension of fixed assets in the form of buildings, land improvements of an engineering nature, and other such engineering constructions as roads, bridges, dams and so forth".

In the case of Ethiopia, although the definition adopted by the National Accounts Department of MoFED is similar to that of ISIC, the activities actually covered under the industry are the construction and maintenance of: Residential buildings of urban and rural areas, Non-residential buildings, i.e. factory buildings, ware houses, office buildings, garages, hotels, schools, hospitals, clinics etc. and construction works like roads, dams, athletic fields, electricity transmission lines, telephone and telegraph lines, telephone and telegraph lines etc. (Getaneh, 2011).

Construction projects are understood with the following three major identifying characteristics (Jekale, 2004).

- **Unique**, involving a degree of innovative characteristics depending on the type of projects; and hence employ process-orientation, Management of uncertainty and changes, and flexible approach to its management;
- **Temporary,** for it has a definite beginning and ending constrained by finance and other resources and requirements; and hence, Finite and Constrained; and

- **A component of a certain business or program,** requiring predetermined goals and courses of action; and hence performance-oriented and Constrained.

2.1.2. Construction Industry

Construction is an industry that has a great impact on the economy of all countries. Almost, it is very difficult to think of any development activity that does not involve construction. All infrastructure facilities needed for development such as road, telecom, electricity, power projects, and socioeconomic facilities such as school, hospitals, factories etc.; and the very neighborhood we live in are all products of the construction industry. (Abadir, 2011)

2.1.2.1. Construction Industry in Ethiopia

According to Jekale (2005) in Ethiopia the construction industry has been in the process of transformation, which is based on improving the competitiveness of the construction industry and enhancing its ability to fulfill the national development demands. He presented six distinct development periods based on changes in policies, regulations and management process. Table 1 shows transformation stages of the domestic construction industry cited by Getaneh (2011).

Table 2. 1 Ethiopian construction industry development stages (cited by Getaneh, 2011)

Stage	Year	MEDaC (1999), EEA (2008)	Jekale (2005)
1	Pre 1968	Foreign companies dominated Construction Industry	Foreign companies dominated Construction Industry
2	1968-1982	Small scale domestic construction companies emerged	Small scale domestic construction companies emerged
3	1982-1987	State owned companies Established	Parastatal companies domination
4	1987-1991		Fragmentation between design services & construction works
5	1991-2001	Private construction companies Introduced	Re-emergency of private construction Companies
6	2001-to date		Integration and capacity building

The above table shows that private construction companies are introduced starting from 1991 to date according to MEDaC (1999), EEA (2008). This period, has been used in questionnaire, is important for the context of this research.

2.1.2.2. Classification of Construction Industry

Different approaches are followed by many researchers and authors in classifying the construction industry. According to Halpin, 2006 (cited by Assefa, 2007) construction projects can be broadly classified as:

a. Building construction (includes facilities for residential, institutional, educational, light industrial (e.g. warehouse), commercial, social and recreational purposes),
b. Engineered construction (including highway and heavy (e.g. dams, sewage plant) construction and
c. Industrial construction

The major division of construction industry consists of Building Construction also called ("vertical construction") and Heavy Construction (also called "horizontal construction"). The building construction category sub divided into public and private, residential and non-residential building construction. Heavy construction includes roads, railways, bridges, canals, harbors, dams and other major public works. Other specialty divisions of the construction industry sometimes used includes industrial construction, process plant construction, marine construction and utility construction. The ISIC (Rev. 4, 2008) categorizes construction activity as General Construction and Specialized Construction activities for buildings and civil engineering works. (Getaneh, 2011)

2.2. Building Construction Projects

The existing literature and data sources do very rarely differentiate the building segment from construction in general, which largely includes road construction (outside the scope of this study). Hence, many examples are available on construction rather than solely on buildings. This study focuses exclusively on residential, public and commercial buildings, and as part of the study, deeper analysis was conducted to separate the data and effects of buildings from data and effects of construction (including material extraction and production of building materials) in general.

A building is an assemblage that is firmly attached to the ground and that provides total or nearly total shelter for machines, processing equipment, performance of human activities, storage of human possessions, or any combination of these (Modular Building

Institute, 2010). Among different sector of construction industry building construction also has large contribution for GDP of the country and on reduction of unemployment. The industry is highly fragmented with contractors ranging from a few multinationals that employ hundreds of labour to the majority of contractors that employ less than ten employees. Construction projects as stated by Gilbreath (cited by Oglesby, 1989) represent some of the largest and most complex undertakings known; when completed, a testimony is given of different technological methods adopted and huge consumption of resources such as time, money and people's talent used.

2.3. Building Construction Efficiency

According to Koskela (1992) Construction should adopt the new production philosophy. In manufacturing, the new production philosophy improves competitiveness by identifying and eliminating waste (non-value-adding) activities. Traditionally, construction is viewed and modeled only as a series of conversion (value-adding) activities. For example, waste activities such as waiting, storing inventory, moving material, and inspection are not generally modeled by Critical Path Models (CPM) or other control tools.

Construction has traditionally tried to improve competitiveness by making conversions incrementally more efficient. But judging from the manufacturing experience, construction could realize dramatic improvements simply by identifying and eliminating non conversion (non-value-adding) activities. In other words, actual construction should be viewed as flow processes (consisting of both waste and conversion activities), not just conversion processes.

The method or way of building construction effectively is construction of the building efficiently. Construction efficiency may be determined by solving a number of problems and applying decision methods (Brown, 1991). First, the most efficient site for new construction should be selected and the efficiency of the site for the buildings to be repaired should be determined. Then the investment projects have to be analyzed by multi-criteria methods. According to the project selected, a building is designed on the basis of the effective architectural and constructional decisions made (Leonas, 2004).

2.4. Factors Influencing Efficiency of Building Construction Projects

The construction industry is the most significant industry in the economy and the successful measure with completion within time, budget, accordance with specification and satisfaction of stakeholders. Construction is the process of physically erecting the project and putting construction equipment, materials, supplies, supervision, and management necessary to accomplish the work. Construction projects are complex, with many organizations involved such as clients or owners, architects, engineers, contractors, suppliers and vendors (seller). This includes the heterogeneous and often complex process of producing unique, large and immovable products with a supply of the resources (money, equipment, material, and labour).

The factors influencing efficiency are fluctuating according to and due to the faults and weakness of the client, the contractor, and the consultant. Therefore, it is essential to identify the actual factors influencing efficiency of projects in order to minimize and avoid failures in inefficiency in any construction project.

According to National Research Council (NCR) report, on Improving Construction efficiency and productivity with Modular construction (2010), it defines efficiency improvements as ways to cut waste in:

- time,
- costs,
- materials,
- energy,
- skills and labor.

Koskela (1992) defined waste as "any inefficiency that results in the use of equipment, materials, labor or capital in larger quantities than those considered as necessary in the production of a building. And he also defines waste in terms of Non value-adding activity: Activity that takes time, resources or space but does not add value.

2.4.1. Factors influencing time efficiency

The duration of construction tasks consists of process 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).

Chan and Kumaraswamy (2002) stated that construction time is increasingly important because it often serves as a crucial benchmarking for assessing the performance of a project and the efficiency of the project organization. Several studies have addressed many different factors that influence time efficiency in different types of construction projects. Generally; Construction delay is considered to be one of the most recurring problems in the construction industry and it has an adverse effect on project efficiency in terms of time, cost, quality, and safety.

There are many factors that contribute to causes of delays in construction projects. These range from factors inherent in the technology and its management, to those resulting from the physical, social, and financial environment.

Ahmed et al (2003) and Theodore (2009) identified the following factors causing delays in construction projects. They have categorized the factors that cause delays in the four categories, those are due to:

- Consultant's responsibility: The factors that are related to consultant's responsibility are; absence of consultant's site staff; lack of experience on the part of the consultant; Inadequate experience of consultant; Delay in approving major changes in the scope of work; Mistakes and discrepancies in design documents.
- Owner's responsibility: The factors that are related to owner's responsibility are; Delay to furnish and deliver the site; Lack of working knowledge; Slowness in

making decisions; Lack of coordination with contractors; Change orders by owner during construction; Financial problems; Slowness in decision making process; and Poor communication and coordination.

- Contractor's responsibility: The factors that are related to contractor's responsibility are; Poor qualification of the contractor's technical staff; Shortage of materials on site; Construction mistakes and defective work; Poor skills and experience of labor; Shortage of site labor; Low productivity of labor; Financial problems; Coordination problems with others; Conflicts in sub-contractors schedule in execution of project; Lack of site contractor's staff; Poor site management; and Delays in site mobilization.
- External factors: The factors that are related to external factors are; Delay in obtaining permits from municipality Lack of materials on the market; Lack of equipment and tools on the market; Poor weather conditions; poor site conditions (location, ground, etc.); Poor economic conditions (currency, inflation rate, etc.); Changes in laws and regulations; transportation delays; External work due to public agencies (utilities and public services); and Delay in providing services from utilities (such as water, electricity).

These factors are combined into one uniform list arranged by Ghaleb JS, (2013) in the table below.

Table 2. 2: Factors that influence time overruns (Ghaleb JS, 2013)

No	Time Factors
1	Too many change orders from owner
2	Poor planning and scheduling of the project by the contractor
3	Ambiguities and mistakes in specifications and drawings
4	Slow decision making from owner
5	Poor qualification of consultants, engineers and staff assigned to the project
6	Improper technical study by the contractor during the bidding stage
7	Delay in progress payments by the owner
8	Severe weather conditions on the job site
9	Presence of unskilled labors

No	Time Factors
10	Shortage of technical professionals in the contractor's organization
11	Slow response by the consultant's engineers to contractor inquires
12	Financial difficulties faced by the contractor
13	Delays in contractors claims settlements
14	Poor coordination by the consultant's engineers with the parties involved
15	Insufficient coordination among the parties by the contractor
16	Delay in mobilization
17	Financial constraints faced by the owner
18	Work suspension by the owner
19	Delays in site preparation
20	Delay in the approval of contractor submissions by the engineer
21	Improper handling of the project progress by the contractor
22	Slow response by the consultants engineers regarding testing and inspections
23	Shortage of manpower
24	Modification in material specifications
25	Shortage of equipment
26	Delay in materials delivery
27	Incompetent technical staff assigned to the project
28	Delays by the contractor payments to subcontractors
29	Shortage of materials
30	Insufficient coordination among the parties by the owner
31	Ineffective quality control by the contractor
32	Interference by owner in the construction operation
33	Difficulties in obtaining work permits
34	Materials price regulations
35	Failure of equipment
36	Safety rules and regulations are not followed within the contractor's regulations
37	Unforeseen site conditions

Time inefficiency in Ethiopia projects constitutes a major issue in the construction management field. Besides, dearth of research in this field is the major reason behind this study in which factors influencing efficiency of building construction in the Addis Ababa construction sector will be identified and ranked by professionals in the field.

2.4.2. Factors influencing cost efficiency

A review of literature reveals that there are several factors affecting construction costs efficiency for large buildings. These factors are combined into one uniform list arranged alphabetically in the table below.

Table 2. 3: Construction Cost Factors in alphabetical order (cited by Eshofonie, 2008)

No	Construction Cost Factor	References
1	Absence of construction cost data	Elinwa and Silas (1993)
		AL– Khaldi (1990)
2	Additional work	Mansfield,Ugwu and Doran (1994)
		Elinwa and Silas (1993)
3	Bureaucy in tendering method	Elinwa and Silas (1993)
4	Contractor's cartel	Omole (1986)
5	Contract management	Mansfield ,Ugwu and Doran(1994)
		Ogunlana, Krit and Vithool (1996)
6	Contractual procedures	Elinwa and Silas (1993)
		AL– Khaldi (1990)
7	Cost of materials	Elinwa and Silas (1993)
8	Currency exchange	AL– Khaldi (1990)
9	Disputes on site	Aibinu and Jagboro (2002)
10	Duration of contract period	Aibinu and Jagboro (2002)
11	Economic stability	Elinwa and Silas (1993)
12	Fluctuation of prices of materials	Omoreigie and Radford (2005)
13	Fraudulent practices and kickbacks	Hussain (1999), TELL (2002)
14	Frequent design changes	Asamoah (2002)
15	Government policies	Omole (1986)
16	High cost of labor	Elinwa and Silas (1993)
17	High cost of machinery	Elinwa and Silas (1993)
18	High cost of machinery maintenance	AL– Khaldi (1990)
19	High cost of transportation	Elinwa and Silas (1993)
20	High interest rates charged by banks	AL– Khaldi (1990)

No	Construction Cost Factor	References
21	Inadequate labor availability	Elinwa and Silas (1993)
		AL– Khaldi (1990)
22	Inadequate production of raw materials	Eyo – Ita – Eyo (2001)
23	Incorrect Planning	Elinwa and Silas (1993)
24	Insurance cost	AL– Khaldi (1990)
25	Labour nationality	AL– Khaldi (1990)
26	Lack of coordination between designers and contractors	AL– Khaldi (1990)
27	Lack of productivity standard	AL– Khaldi (1990)
28	Level of competitors	AL– Khaldi (1990)
29	Long period between design and tendering time	Elinwa and Silas (1993)
30	Mode of financing bond and payments	Frimpong and Crawford (2003)
31	Number of competitors	AL– Khaldi (1990)
32	Number of construction going on at the same time	Elinwa and Silas (1993)
33	Previous experience of contractor	AL– Khaldi (1990)
34	Political interferences	Omole (1986)
35	Poor financial control on site	Ogunlana, Krit and Vithool (1996)
36	Relationship between management and labour	Elinwa and Silas (1993)
37	Social and cultural impacts	AL– Khaldi (1990)
38	Supplier and cultural impacts	Manavazhi and Adhikari (2002)
39	Supplier manipulation	Elinwa and Silas 1993)
40	Wrong method of estimation	Mansfield ,Ugwu and Doran (1994)

Some of the factors are highlighted in the following paragraphs:

A. Cost of materials

Material price is subject to supply and demand and is affected by many other things, including quality, quantity, time, place, buyer and seller. Other factors affecting material cost include: currency exchange, low or high demand, material specification, inflation pressure and availability of new materials in the country.

B. Fluctuation of prices of materials

Omoregie and Radfort (2005) surveyed contractors, consultants and public clients and revealed price fluctuation as the most severe cause of project cost escalation in Nigeria. This could be attributed to the limitation in exchange rate which in turn affects construction materials prices and the general price level.

C. Relationship between management and labour

There is always a gap between the project management and labour. This gap should be kept as small as possible, so that the relationship between management and labour may be strengthened. They should work as a team to build a project with minimum cost. If the relationship between management and labour is bad the morale of the laborers will decrease and production will decrease leading to increased project cost.

D. Inadequate production of raw materials by the country

Ogunlana et al (1996) noted that the reason for shortage of materials could be the defective supply of materials occasioned by general shortages in the industry, poor communication amidst sites and head office, poor purchasing planning and materials coordination. Nigeria still imports cement when her cement production potentials surpass any other African country except Egypt and that the 100 % raw materials required for cement production, is readily available in Nigeria (Eyo, 2001)

E. Design Change

This problem arose from inadequate project planning and management of the design process. A quite distinctive example is the progress of West African Gas Pipeline (WAGP). Asamoah (2002) reported that WAGP project has suffered a number of setbacks, culminating in the escalation of its cost from an initial US $500 million. One of the problems includes the changing of the initial plans to lay the pipeline offshore to an onshore configuration. Arise

F. Lack of coordination between designers and contractors

Contractors construct the project according to the project design. Normally, if the design has any mistakes, the contractors may apply the mistakes without knowing there are mistakes or without notifying and coordinating with the designer or the client. Implementing designs with mistakes obviously costs a lot of money.

G. Poor Financial control on site

Controlling the project financially on site is not an easy task .All resources need to be controlled: labour productivity, material availability, material waste, good and effective methods, using effective tools, equipment, good project planning and scheduling. Project

management should therefore be aware of all those factors in order to achieve better financial control on site.

H. Wrong method of estimation

This factor could be attributed to the unpredicted inflationary trend, lack of adequate training and experience at the senior management level, and fraudulent practices Mansfield et al (1994)

I. Additional Work

Additional work is related to design changes, which is due to lack of detailed briefing on the functional and technical requirements of the projects by the clients (Mansfield et al, 1994).

2.4.3. Factors influencing material efficiency

Successful completion of projects requires all resources to be effectively managed. As projects grow in scale, complexity, materials management becomes more difficult, frequently requiring the use of appropriate tools, and techniques to ensure, amongst other things, that materials are delivered on time, stock levels are well managed, the construction schedule is not compromised, and that wastage is minimized. The management of materials in complex construction projects needs adequate consideration due to the various elements involved and the importance of the project. The improper handling and management of materials on construction sites has the potential to severely buildup project performance. The result of improper handling and managing materials on site during construction process will influence the total project cost, time and the quality (Narimah, 2013).

2.4.3.1. Material Waste in the Construction Industry

According to Mahesh (2011) Construction material wastages can be defined as the difference between the value of materials delivered and accepted on site and those properly used as 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.

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.

According to Asmara (2015) wastages of building materials can be divided into two types. One is direct waste and the other is indirect waste. Direct waste is the loss of those materials, which were damaged and could not be repaired and subsequently used, or which were lost during the building process; indirect waste was distinguished from direct waste because it normally represented only a monetary loss and the materials were not lost physically. Such losses arise principally from substitution of materials, from use of materials in excess of quantities allowable under the contract, and from errors. The failure to recognize and record waste from these causes makes accounting for materials meaningless. Therefore, a simple measure of waste on site would be the difference between that used as specified and the quantity of material delivered to site as a percentage of such deliveries (Shen, 2002).

According to Al-Hajj & Hamani (2011) there are many factors; contribute to the generation of material waste. These factors have been under four categories: (1) design; (2) procurement; (3) handling of materials; and (4) operation. They have concluded that most of the causes of waste are due to design issues.

2.4.3.2. Causes of Construction Materials Waste

Many factors contribute to construction waste generation on site. Waste may occur due to one or a combination of many causes.

According to Polat, 2004 (cited by Asmara, 2015) the causes of materials waste in the Turkish construction industry are listed in Table shown below.

Table 2. 4: A causes of materials waste in the Turkish construction industry (Polat, 2004)

Source	Causes of Material Waste	Frequency (%)
Design	Lack of information about types and sizes of materials on design documentations	13
	Design changes and revisions	12
	Error in information about types and sizes of materials on design documentations	10
	Determination of types and dimensions of material without considering waste	3
Procurement	Ordering of materials that do not fulfill project requirements defined on design documents	86
	Over ordering or under ordering due to mistake in quantity surveys	8
	Over ordering or under ordering due to lack of coordination between warehouse and construction crews	4
Material Handling	Damage of materials due to deficient stockpiling and handling of materials	16
Operation	Imperfect planning of construction	61
	Workers' mistakes	32
	Damage caused by subsequent trades	3
Residual	Conversion waste from cutting uneconomical shapes	22
Others	Lack of onsite materials control	23
	Lack of waste management plans	10

Research in Nigeria indicates the three most important factors contributing to construction material waste generation on building sites in Rivers State are "rework due to wrong drawings and specification", "design changes and revisions" and "waste from uneconomical shapes" respectively (Adewuyi, 2013).

2.4.4. Factors influencing efficiency of skill and labor (manpower group)

From previous study managers' skill and manpower group (labor) are stated in factors affecting productivity and efficiency of construction.

- Managerial Factors:

Managers' skill and attitudes have a crucial bearing on productivity. In many organizations, productivity is low even though the latest technology and trained manpower are made available. Low productivity is because of inefficient and indifferent management. Experienced and committed managers can obtain surprising results from average people. Employees' job performance depends on their ability and willingness to work. Management is the catalyst to create both. Advanced technology requires knowledgeable laborers who, in turn, work productively under professionally qualified managers. It is only through sound management that optimum utilization of human and technical resources can be secured (Mahesh, 2012).

- Manpower Group:

Literature shows that a lack of labor experience is the factor which negatively affects labor productivity and proves that, to achieve good productivity, labor plays a significant role. Contractors should have sufficiently skilled laborers employed to be productive. If skilled labor is unavailable and a contractor is required to complete specific task with less-skilled labor, it is possible that productivity will be affected. The absence of any crew member may impact the crew's production rate because workers will, typically, be unable to accomplish the same production rate with fewer resources and with different crew members. Misunderstanding among laborers creates disagreements about responsibilities and the work bounds of each laborer, which leads to a lot of work mistakes and decreases labor productivity. Lack of compensation and increased laborer age negatively affect labor productivity because labor speed, agility, and strength decline over time and reduce productivity (Heizer and Render, 1990)

Based upon the Literature Review, this study extracts various factors affecting skill and labor efficiency in construction from the previous research studies. The following table shows various factors affecting skill and labor efficiency in construction extracted from previous studies.

Table 2. 5: Various factors affecting skill and labor efficiency in construction (Heizer and Render, 1990)

	Factors affecting skill and labor efficiency
A	Management Factors
1	The level of management control
2	Professionalism of the design team
3	Difficulties in employing site supervisor
4	Incompetence of site supervisor
5	Late inspection of completed work
B	Workforce characteristics factors
6	Quality, Experience and Training
7	Disturbance
8	Morality (e.g., alcohol influence)
9	Frequent changes in labors
10	Communication problems
11	Turnover
12	Absenteeism
13	Motivation

Therefore, waste in time, cost, materials, energy, skill and labor are the main groups of factors affecting efficiency of building construction projects in this study.

2.5. Effect of Efficiency Factor in Building Construction

2.5.1. Time Overrun

Time overrun is one of effect of efficiency factor in building construction and it defined as inability to complete a project either by the original planned time or budget, or both, ultimately results in project delay. The social and economic costs of delay can be amazingly high and to a certain extent cannot be absorbed by the industry. When a delay can no longer be absorbed by the client, it will result in the project being abandoned. Thus, it is important to predict and identify problems in the early stages of construction

and diagnose the main causes and implement the most appropriate and economical solutions to prevent further negative impacts of delay.

In construction delay could be defined as the time over run either beyond completion date specified in a contract, or beyond the date that the parties agreed upon for delivery of a project. It is a project slipping over its planned schedule and is considered as common problem in construction projects. To the owner, delay means loss of revenue through lack of production facilities and rent-able space or a dependence on present facilities. In some cases, to the contractor, delay means higher overhead costs because of longer work period, higher material costs through inflation, and due to labor cost increases. (Abubeker, 2015)

Completing projects on time is an indicator of effectiveness, but the construction process is subject to many variables and unpredictable factors, which result from many sources. These sources include the performance of parties, resources availability, environmental conditions, involvement of other parties, and contractual relations. Stumpf (2000) defined delay as an act or event that extends the time required to perform the tasks under a contract. It usually shows up as additional days of work or as a delayed start of an activity. He showed, in his article, that delay does matter, and that different methods for analyzing schedule delay lead to different results for the owner and contractor. Construction delays became an integral part of the project's construction life. Even with today's advanced technology, and management understanding of project management techniques, construction projects continue to suffer delays and project completion dates still get pushed back (Stumpf, 2000).

2.5.2. Cost overrun

Cost overrun is a very common phenomenon and majority of projects in construction industry are facing this problem. Cost overrun occurs when the final cost or expenditure of the project exceeds the original estimation cost. Wiguna et al (2005), identified three main causes regarding cost overrun that were contractor related problems, material related problem and owner's financial constraints, whereas population and Housing Census of Ethiopia (2007) identified the most critical factors included: high

inflation/increased material price; design change by client; defective design; weather condition; late payment certification on contrast and defective construction work. These all factors will lead to cost overrun on the projects. Angelo and Reina (2002) pointed out that cost overrun is one of the main problems in construction industry. The problem may be found in both developing and developed countries. This problem is quite serious and further study on this issue is needed to reduce the problems.

2.5.3. Effect of Construction materials waste on the building construction efficiency and the environment

Construction waste becomes a global issue facing by practitioners and researchers around the world. Waste can affects efficiency of construction project significantly. More specifically, it has major impact on construction cost, construction time, and productivity and sustainability aspects.

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.

The highest environmental impact of construction materials waste is believed in terms of contamination. Although, construction activities also pollute the soil, the main areas of concern are air, water and noise pollution. Construction activities that contribute to air pollution include land clearing, operation of diesel engines, demolition, burning and working with toxic materials. Construction sites are generating high level of dust (typically from concrete, cement, wood, stone, silica) and this can carry a large distance over a long period. Sources of water pollution on building sites include diesel and oils; paints, solvents, cleaners and other harmful chemicals; and construction garbage and dust.

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 city.

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 tons 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.

2.5.4. Dispute between parties

Disputes are the effects of major causes of poor performance in construction projects such as causes of client related, contractor related, and consultant related and external related that might be arisen during the construction projects among the project parties. Lack of communication may also leads to misunderstandings, conflicts, and disputes.

Hence, it necessitates the project managers to have effective communication skills that are one of the significant soft skills (People skills) with the project parties involving in construction projects. Based on Aibinu et al. (2002), the factors such as lack of communication between the various parties, problem with neighbors, unforeseen site conditions, delay in payments for completed work, improper construction method, delay caused by the subcontractor and discrepancies in contract documents will give rise to disputes between the various parties. Furthermore, if the disputes can't be solved amicably or easily it can lead to arbitration or litigation.

2.6. Strategies of Improving Efficiency

2.6.1. Improving Time efficiency

Mansfield et al (1994) found that construction projects completed on time were a signal of project efficiency. Managing project time is one of strategies to improve efficiency.

PMBOK's (1996) defines project time management as the effective and efficient use of time to facilitate the execution of project, which starts from planning, scheduling and controlling the project to achieve the time objectives. Degoff and Friedman, (1999) defines project time management as the development of a project time schedule, to manage that schedule, and to ensure the project completes within the approved time schedule. Therefore, schedule is important to manage time, which involves defining project activities, sequencing the activities, developing the schedule, executing the schedule and controlling the plans during project execution.

Project time management includes the processes required to ensure timely completion of the project (Duncan, 1990). Overviews of the major processes in project time management are as follows:

- Activity definition; identifying the specific activities that must be performed to produce the various project deliverables.
- Activity sequencing; identifying and documenting interactivity dependencies.
- Activity duration estimating; estimating the number of works periods which will be needed to complete individual activities

- Schedule development; analyzing activity sequences, activity durations, and resources requirements to create the project schedule.
- Schedule control; controlling changes to the project schedule.

Techniques that are usually used in managing project time are as follow:

Critical Path Methods (CPM); The completion of project is delayed when one of the critical path activities is not started on time, not finished within the allotted time, or not finished on time. The focus of CPM is on calculating float in order to determine which activities have the least scheduling flexibility, (Clough, et. Al., 2000).

Program Evaluation and Review Technique (PERT); Although there are surface differences, PERT differs from CPM primarily in that uses the distribution's mean (expected value) instead of money likely estimate originally used in CPM, (PMBOK, 1996).

Bar Chart (Gantt chart); In projects of normal delivery or stable performance, the general contractor creates the bar chart once an award is made and each bar represents the beginning, duration and completion of some designated segment of total project. The Gantt chart is the most widely used method of illustrating project sequences and plans and is still relevant today (Keane et al., 2008).

2.6.2. Improving Cost efficiency

In PMBOK's (1996) defines project cost management as a requirement for financial control of the project, which is accomplished through accumulating, organizing and analyzing data and reporting the cost information. Clough *et. al*., (2000) defines project cost management as the process of determining the total cost of the project, to manage that cost, and to ensure that the project is completed within the approved budget or cost. Keeping within the budget, and knowing when and where the costs are deviating are the keys to efficient and effective cost management and profitable operations.

Project cost management includes the processes required to ensure that the project is completed within the approved budget (Duncan, 1990). Although management discretion may occasionally dictate otherwise, an effort is usually made to achieve gains in time

with the least possible increase in project cost. If project management has to make schedule adjustments at an additional cost, it is necessary to understand how the costs of construction operations vary with time (Clough *et. al*., 2000). Two techniques that are usually used in managing project cost are as follow (Clough *et. al*., 2000):

Cash Flow; One of managing cash flow activities is to make sure that there is still enough money to cover the cost of performing project-employees payment, charges for material, subcontractor invoices and others suitable with the established estimation. The key to manage cash flow is to ensure that cash comes in balance with what goes out. Key effective in cash flow control is aggressively addressing negative cost variance and cost inefficiencies as soon as they are identified, rather than hoping that things will get better as the project goes on. Even when projects have only positive cash flow and cost variances, it is important not to let that flow and variance become worse. A concentrated effort should be made to keep it that way because as stated above it becomes difficult to get back on track.

Cost Plan; Spinner (1997) mentioned that the cost planning starts with the proposal for the project. The cost section of a proposal may consist of tabulations of the contractor's estimated costs for such elements as labors, materials, subcontractors, equipment and others. In addition, the proposal might also include an amount for contingencies, to cover unplanned expenses. It can conclude that cost plan is the task of allocating sums to the various project activities scheme from starting the first task to finishing the last one.

According to Gido and Clement (1999), allocating total project costs for the various elements, such as labor, materials and equipment, to the appropriate work packages in the work breakdown structure (WBS) will establish a total budgeted cost (TBC) for each work package. Once a total budgeted cost has been established for each work package, the second step in the project budgeting process is to distribute each TBC over the duration of its work packages in order to determine how much of money should be spent at any point in time. This amount is calculated by adding up the budgeted costs for each time period up to that point in time. This total amount, known the cumulative budgeted cost (CBC), will be used in analyzing the cost performance of the project. The CBC for

the entire project for each work package provides a baseline against which actual cost and work performance can be compared at any time during the project.

Once the project starts, it is necessary to keep track of actual cost and committed cost so that they can be compared to CBC. After this has been done, the project cost performance can be analyzed by looking at the total budgeted cost, the cumulative budgeted cost, the cumulative actual cost and the cumulative earned value. They are used to determine whether the project is being performed within budget and whether the value of the work performed is in line with the actual cost.

2.6.3. Improving Material efficiency

According to (Al-Moghany, 2006) there are three main strategies used in construction projects waste minimization, these were: Avoiding waste, re-using materials and recycling waste. Avoiding waste refers to any practice or process that avoids, eliminates or minimizes waste at source. Avoiding waste is also referred to as minimization of waste at source. Reusing and recycling waste refers to the re-using and recycling of waste materials, thereby reducing the volume of waste material to be disposed of and discharged into the environment.

Construction Material wastage has been recognized as a major problem in the construction industry that has important implications both for the efficient industry and for the environmental impact of construction projects. Moreover, waste measurement plays an important role in the management of production systems since it is an effective way to assess their performance, allowing areas of potential improvement to be pointed out (Carlos, 2002).

Waste management for construction activities has been promoted with the aim of protecting the environment and the recognition that wastes from construction and demolition works contribute significantly to the polluted environment. The construction industry plays a vital role in meeting the needs of society and enhancing the quality of life. However, the responsibility for ensuring the construction activities and products in consistent with environmental policies needs to be defined and good environmental

practices through reduction of wastes need to be improved. Normally, the best way to deal with material wastes is not to create it in the first place (Shen, 2002).

The building industry is using a considerable amount of resources, but if the life cycle of the material on site is closely examined, it is generally known that there is a relatively large portion of the materials being wasted because of poor material control on building sites (Agyerum, 2012). The potential for minimizing wastage of construction materials is considerable. Practical waste minimization strategies require a detailed understanding of what causes construction waste and examined waste minimization strategies and the relative significance of construction waste sources using survey. The authors found out that a sizeable proportion of the firms did not have specific policies for minimizing waste. Furthermore, while a majority of firms with specific waste minimization policies made efforts to minimize waste at source such as to avoid generating waste in the first place, this minimization was limited to waste generated by site offices and amenities.

The significant contribution to waste reduction in the construction industry is through people changing their wasteful behavior. Waste is an inevitable by-product of construction activity; its management is a low project priority with an absence of appropriate resource and incentives to support it. The availability of local infrastructure and top management supportiveness are the most critical determinant of waste reduction behavior on projects (Agyerum, 2012 cite by Asmara, 2015). Table 12 lists some of the waste minimization methods identified.

Table 2. 6: Methods for Materials Waste managing and Minimization (Agyerum, 2012)

No.	Methods for Materials Waste Managing and Minimization
1	Purchasing raw materials that are just sufficient
2	Good coordination between store and construction personnel to avoid over ordering
3	Adoption of proper site management techniques
4	Training of construction personnel
5	Accurate and good specifications of materials to avoid wrong ordering
6	Proper storage of materials on site
7	Checking materials supplied for right quantities and volumes
8	Employment of skilled workmen

No.	Methods for Materials Waste Managing and Minimization
9	Minimizing design changes
10	Change of attitude of workers towards the handling of materials
11	Accurate measurement of materials during batching
12	Mixing, transporting and placing concrete at the appropriate time
13	Access to latest information about types of materials on the market
14	Vigilance of supervisors
15	Weekly programming of works
16	Careful handling of tools and equipment on site
17	Good construction management practices
18	Adherence to standardized dimensions
19	Waste management officer or personnel employed to handle waste issues
20	Just in time operations
21	Early and prompt scheduling of deliveries
22	Encourage re-use of waste materials in projects
23	Use of low waste technology
24	Recycling of some waste materials on site

2.6.4. Improving skilled and unskilled manpower (labour) efficiency

- Human Resource (HR) Practices

In a 1999 study of over 7500 US workers, Watson and Wyatt International found that HR practices and trust in management had the strongest impact on building commitment (Watson W, 1999). A study conducted from the social exchange theory perspective shows that organizations which exhibit a high level of commitment to their employees through HR practices, are rewarded with increased organizational effectiveness, employee involvement and commitment to the organization (Whitener, 2001). These high commitment HR practices include items such as selective staffing, developmental appraisal, competitive and equitable compensation, and comprehensive training and development activities (Whitener, 2001). Huselid (1995) found nearly one thousand firms, which invest in high performance HR management practices, including: comprehensive employee recruitment and selection procedures, incentive compensation and performance management systems, and extensive employee involvement and training. HR practices can also be classified as control practices. This approach aims to

increase efficiency, reduce direct labor costs and relies on strict work rules and procedures, and bases rewards on outputs (Arthur, 1994).

- Recruitment and hiring:

The first action of HR is the recruitment and hiring of new employees. It is important to be honest with potential hires up front about the expectations of the job that they are applying for. Studies show that realistic job previews (Wanous, 1992) increase the job satisfaction, organizational commitment, and job survival of new hires instead of utilizing an approach of doing whatever it takes to get the employee to accept an employment offer. Why are realistic job previews important? When companies provide accurate information, applicants are better able to determine whether the job will meet their specific needs. By knowing the less desirable aspects of their job, applicants can better prepare for when they occur. Honesty to the applicants, even at risk of losing the potentially valuable employee, may create an impression of trustworthiness (Meyer & Allen 1997).

- Training and development:

When an employee is hired, it is important that they receive acknowledgement and positive support from experienced employees. When a new employee is ignored or discouraged, they become the victim of divestiture. Commitment is likely to be stronger when the organization uses investiture as opposed to divestiture techniques. The more committed the employees were, the more they desired training. New employees, who receive a satisfying training experience, feel better about their ability to perform the tasks expected of them.

- Evaluation and supervision:

Organizational practices that influence the promotion and advancement of employees may also have an influence on their commitment to the organization. In Virginia, promotion is a requirement for continued employment as an Extension agent. Therefore, it can be expected that commitment levels would be higher for those employees who had achieved promotion than for those who had not yet been promoted. Since this study is

directed at newly hired Extension agents, many of whom may not have achieved promotion, commitment due to promotion policies may be the best measure.

- Benefits and compensation:

Researchers often identify compensation among the most important factors for potential employees in considering to accept a job offer, however, what is not so clear is the impact that pay has in regard to retention of the new employee after hire (Barber & Bretz, 2000). This is important as the pay satisfaction of an employee upon their initial hiring does not necessarily mean that they will continue to be satisfied with their pay in the years to come. Currall, Towler, Judge, & Kohn (2005) found that pay satisfaction is significantly associated with the intent to quit in a study of public school teachers. In support of this finding, pay satisfaction has also been associated with increased organizational commitment, job satisfaction, and greater intent to stay in the position (Farrell & Rusbult, 1981). It is evident; therefore, that compensation is an important variable to include in the present study.

- Employee Motivation

Work motivation is defined as a set of energetic forces that originate both within as well as beyond an individual's being, to initiate work-related behavior, and to determine its form, direction, intensity, and duration (Pinder, 2008). When an organization invests time, money, and other resources into employees who are not motivated to learn their job or perform the functions expected of them, that investment is wasted (Latham, 2007).

Generally, according to the NRC Committee the following five breakthroughs are chosen from among dozens of potential ideas, concepts, processes and practices as potentially having the most significant impact on the construction industry efficiency and productivity.

1. Widespread deployment and use of interoperable technology applications, also called Building Information Modeling (BIM). Interoperability is the ability to manage and communicate electronic data among owners, clients, contractors, and suppliers, and across a project's design, engineering, operations, project management, construction, financial, and legal units. Interoperability is made possible by a range of information

technology tools and applications including computer-aided design and drafting (CADD), three– and four–dimensional visualization and modeling programs, laser scanning, cost-estimating and scheduling tools, and materials tracking. Effective use of interoperable technologies requires integrated, collaborative processes and effective planning up front and thus can help overcome obstacles to efficiency created by process fragmentation. Interoperable technologies can also help to improve the quality and speed of project related decision making; integrate processes; manage supply chains; sequence work flow; improve data accuracy and reduce the time spent on data entry; reduce design and engineering conflicts and the subsequent need for rework; improve the life–cycle management of buildings and infrastructure; and provide the data required to measure performance. Barriers to the widespread deployment of interoperable technologies include legal issues, data-storage capacities, and the need for "intelligent" search applications to sort quickly through thousands of data elements and make real-time information available for on-site decision making.

2. Improved job-site efficiency through more effective interfacing of people, processes, materials, equipment, and information**.** The job site for a large construction project is a dynamic place, involving numerous contractors, subcontractors, trades people, and laborers, all of whom require equipment, materials, and supplies to complete their tasks. Managing these activities and demands to achieve the maximum efficiency from the available resources is difficult and typically not done well. Time, money, and resources are wasted when projects are poorly managed, causing workers to have to wait around for tools and work crews' schedules to conflict; when work crews are not on–site at the appropriate time; or when supplies and equipment are stored haphazardly, requiring that they be moved multiple times. Greater use of automated equipment (e.g., for excavation and earthmoving operations, concrete placement, pipe installation) and information technologies, process improvements, and the provision of real–time information for improved management at the job site could significantly cut waste, improve job–site safety, and improve the quality of projects. A primary barrier to more effective use of such technologies is the segmentation and sequencing of planning, design, engineering, and construction processes. Improved job–site efficiency also requires a skilled labor

force with communication, collaboration, and management skills as well as technical proficiencies.

3. Greater use of prefabrication, preassembly, modularization, and off-site fabrication techniques and processes. Prefabrication, preassembly, modularization, and off–site fabrication involve the fabrication or assembly of systems and components at off-site locations and manufacturing plants. Once completed, the systems or components are shipped to a construction job site for installation at the appropriate time. These techniques offer the promise (if used appropriately) of lower project costs, shorter schedules, improved quality, and more efficient use of labor and materials. Various obstacles stand in the way of the widespread use of such technologies, including building codes that hinder innovation as well as conventional design and construction processes and practices.

4. Innovative, widespread use of demonstration installations. Demonstration installations are research and development tools that can take a variety of forms: field testing on a job site; seminars, training, and conferences; and scientific laboratories with sophisticated equipment and standardized testing and reporting protocols. Greater and more collaborative use of demonstration installations can be used to test and verify the effectiveness of new processes, technologies, and materials and their readiness to be deployed throughout the construction industry.

5. Effective performance measurement to drive efficiency and support innovation. Performance measures are enablers of innovation and of corrective actions throughout a project's life cycle. They can help companies and organizations understand how processes or practices led to success or failure, improvements or inefficiencies, and how to use that knowledge to improve products, processes, and the outcomes of active projects. The nature of construction projects and the industry itself calls for lagging, current, and leading performance indicators at the industry, project, and task levels, respectively.

CHAPTER 3

RESEARCH METHODOLOGY

3.1. Study Area Setting

The study was conducted in Addis Ababa which is capital city of Ethiopia. The city is located at the geographical center of the country and it lies between $8^0$55'- $9^0$05' north latitude and $38^0$40'-$38^0$50' east longitude. Its average altitude is 2408 meters above the sea level. The highest peak is found at Mount Entoto with 2800 meters. The lower part of the Akaki plain has an altitude of 2200 meters. The Entoto massive in the north surrounds the city. The upper part of the city is characterized by steep slopes with high mountains, flat topped plateau while the lower part is less steep. The city is endowed with numerous streams that start from northwest and northeast running towards the south and draining to the Awash River. The most important streams and rivers are the Kebena, the Ginfle, the Bantyiketu, the Buhe, the Akaki and the Kechene rivers (Region 14 Environmental Protection Bureau, 1997).

The city administration extends over 540 square kilometers with 10 sub-cities and 116 Woredas for administrative purpose. Based on the census data in 2007 the population of the city is 2.7 million and the total administrative area is considered to be urban. (Bogale, 2012)

Figure 3. 1: Administrative Unit of Addis Ababa

3.2. Research Design

Research design is the arrangement considered for the collection and analysis of data to achieve the objectives of the research. A descriptive and explanatory survey design was used in this research. The research was explanatory type because it concerned on gaining information about the factors affecting efficiency of building projects, and it was a descriptive type because it tried to describe the extent of inefficiency and the factors influencing efficiency of building projects in the city of Addis Ababa. The research was conducted first by identification of the factors affecting efficiency of building projects through literature review then from these findings questionnaires were developed and distributed to respondents. The basic methodology and tools which were considered and followed to achieve the objectives of this research are summarized as follows.

Concerning specific objective number one and two; The Relative Importance Index method (RII) was used to determine the most significant efficiency factors and effects of these factors on building projects in the City of Addis Ababa. The relative importance index can be computed by applying the relationship as shown below (Odeh A. and Battaineh H, 2002).

$$RII = \frac{\sum Wi * Xi}{\sum Xi} \quad \text{..... (Equation 1)}$$

Where: i= response category index

Wi = the weight assigned to i^{th} response = 1, 2, 3, 4, 5, respectively.

Xi= frequency of the i^{th} response of the total responses for each factors.

Similarly, to achieve the specific objective three; The practices concerning with the efficiency variable such as time, cost, material, skill and labor checklists were analyzed in order to identify the practical problems of efficiency and then to formulate recommendations to improve efficiency of building construction projects in Addis Ababa.

The figure 3.2 below shows that process of this research paper.

3.3. Population

The population of this research paper is building projects that are under construction in Addis Ababa.

3.4. Sample and Sampling Technique

As the specific number of general population is not known, thus method of random sample selection method is used for sample selection. The sample population stratified under office, commercial, multipurpose, apartments, condominium and bank buildings that are distributed in Addis Ababa. Respondents of this study were contractors, consultants and clients. These parties are main stakeholders and they are engaged fully in the construction process. And also they are the one who decide life cycle process status of the projects, which are scope, time, cost, quality and other major future of the project.

3.5. Study Variables

3.5.1. Dependent variable

- Efficiency of building construction projects

3.5.2. Independent variables

- Cost
- Time
- Wastage of material
- Performance of skill and labor

3.6. Data collection procedure

In this study, identification of factors affecting the efficiency of building construction projects was assessed through literature. Then desk study of Construction Project Management Institute of Ethiopian (CPMIE) and Ethiopian contractor association reports were thoroughly investigated. A designed questionnaire was distributed to evaluate the perceptions of clients, consultants, and contractors on the issue of the factors affecting the efficiency of building construction projects in the city of Addis Ababa. The participants were requested to allocate marks from 1 to 5 (a 5-point Likert's scale): 1-very poor importance; 2-poor importance; 3-average importance; 4-high importance; 5-very high importance to each factor according to their knowledge.

3.7. Data processing and analysis

The collected data from respondents were categorized at the time of data entry. The categorized data were then coded and analyzed using Microsoft Excel software program to determine the severity and frequency occurrence of the factors affecting efficiency of building construction projects in Addis Ababa city. The Relative Importance Index (RII) was calculated using the formula shown in equation 1 above.

Spearman's coefficient of rank correlation was used to test whether there is an agreement or disagreement among each pair of parties in ranking the factors affecting the efficiency of building construction projects in Addis Ababa City.

Spearman's coefficient (ρ) was calculated using the equation shown below.

$$\rho = 1 - \frac{6\sum d^2}{n(n^2 - 1)} \quad \text{..... (Equation 2)}$$

Where: d is the difference between ranks

n is number of subjects or pairs of ranks

3.8. Data Quality Assurance

In order to assure the quality of data, the researcher administered the questionnaires to the relevant respondents in an effort to achieve the necessary information. Moreover, data collectors were trained on the aspects of the questionnaire and how to handle the respondents and the data carefully. During the data analysis, the raw data used in Microsoft excel were checked repeatedly whether the values were exactly the same as the given value by the respondents to avoid any wrong results

3.9. Ethical consideration

Ethical clearance was obtained from Office of Research, Publications, Graduate Studies and Consultancy, Jimma Institute of Technology, Jimma University and Addis Ababa City Roads Authority before the research was done. An official permission was also acquired from stakeholders in order to conduct the research. The data were kept confidential and used only for the research purpose.

3.10. Dissemination Plan

The findings of this thesis work will be presented for School of Civil and Environmental Engineering; and the Office of Research, Publications, Graduate Studies and Consultancy, Jimma Institute of Technology, Jimma University as part of evaluation for the award of the degree of Master of Science and will be publically defended in the presence of examiners.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1. Basic Information on Respondents and Building Projects Efficiency

This section mainly designed to provide general information about respondent's organization, position, experience in building construction projects and building projects efficiency. For this study, the sample population composed of professionals from the clients, consulting firms, and constructing organizations which are engaged in building construction projects within Addis Ababa city. The professional mix includes project managers, site engineers, project coordinators, resident engineers, office engineers, and others.

For the preparation of comprehensive analysis, one hundred (100) questionnaires were distributed to the respondents as follows: 15 to client employees, 25 to consulting firms and 60 to constructing organizations. Out of which, 84 (84%) valid responses were collected as follows: 11 (11%) from client, 21 (21%) from consultants and 52 (52%) from contractors' respondents.

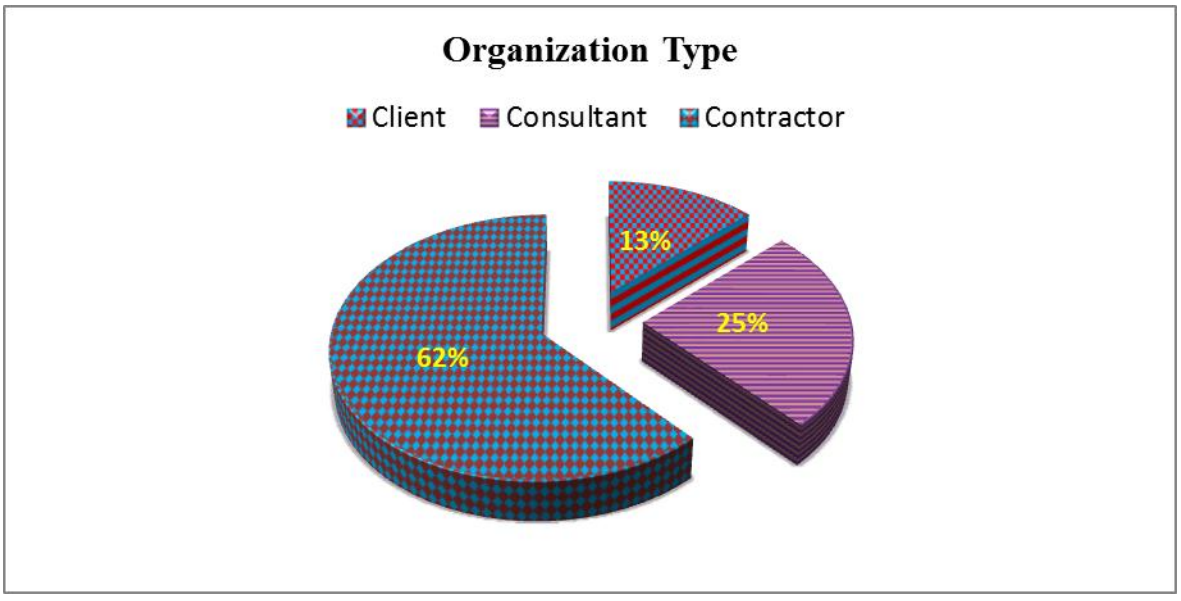

Figure 4. 1: Rate of respondents of each type of organization

Based on the findings from the Figure 4.1 above, 62% (52) respondents of contractors, 25% (21) respondents of consultants and 13% (11) respondents of the client replied a valid questionnaire.

Figure 4.2 below shows the overall experience of the respondents in Addis Ababa building construction projects. In the Figure, 29.25% of the respondents found to possess a work experience of 3 years and below and 38.64% of the respondents had 3-8 years of building work experience. Similarly, the remaining 32.11% of the respondents were found to have a work experience of 8 years and above.

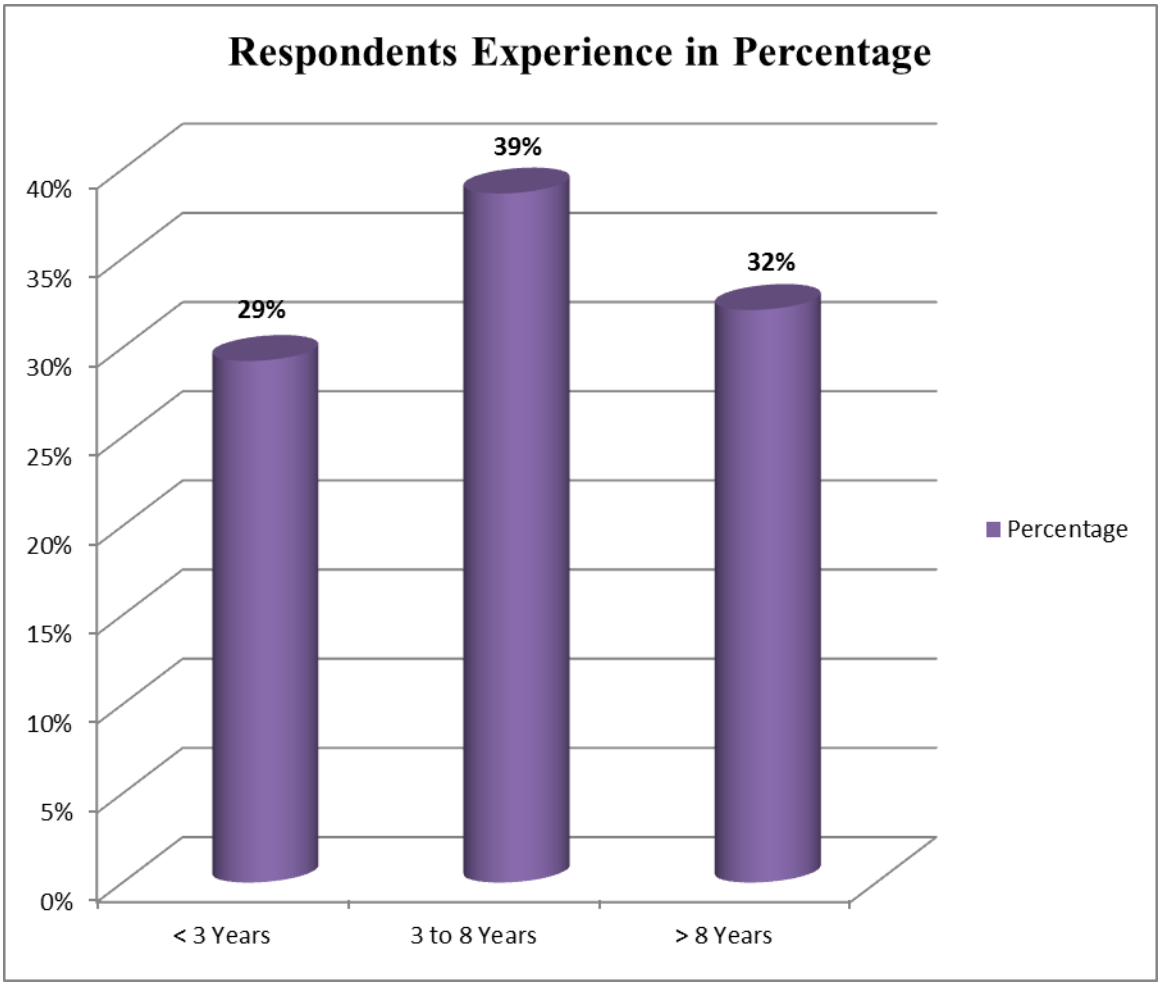

Figure 4. 2: Experience of the respondents in Addis Ababa building construction projects

The number of building construction projects executed by each organizations involved in the study were presented in Table below.

Table 4. 1: Frequency and percent of number of projects executed in each target group

Number of Executed Projects	Contractor		Consultant		Client	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
1 to 5	9	17	-	-	-	-
6 to 10	21	40	1	5	1	9
11 to 15	17	33	5	24	1	9
More than 15	5	10	15	71	9	82
Total	52	100	21	100	11	100

Projects are conceptualized and implemented with the primary aim of timely completion and efficiency. Inefficiency to the project is a failure to implement project management principles. Before identifying the major factors affecting the efficiency of building construction projects and their sever effects, the existence of inefficiency in building projects has to be confirmed first. Hence, the first step in this research was devoted to check whether inefficiency was and still is a problem or not in Addis Ababa building construction projects. Accordingly, the result obtained is presented in Figure 4.3.

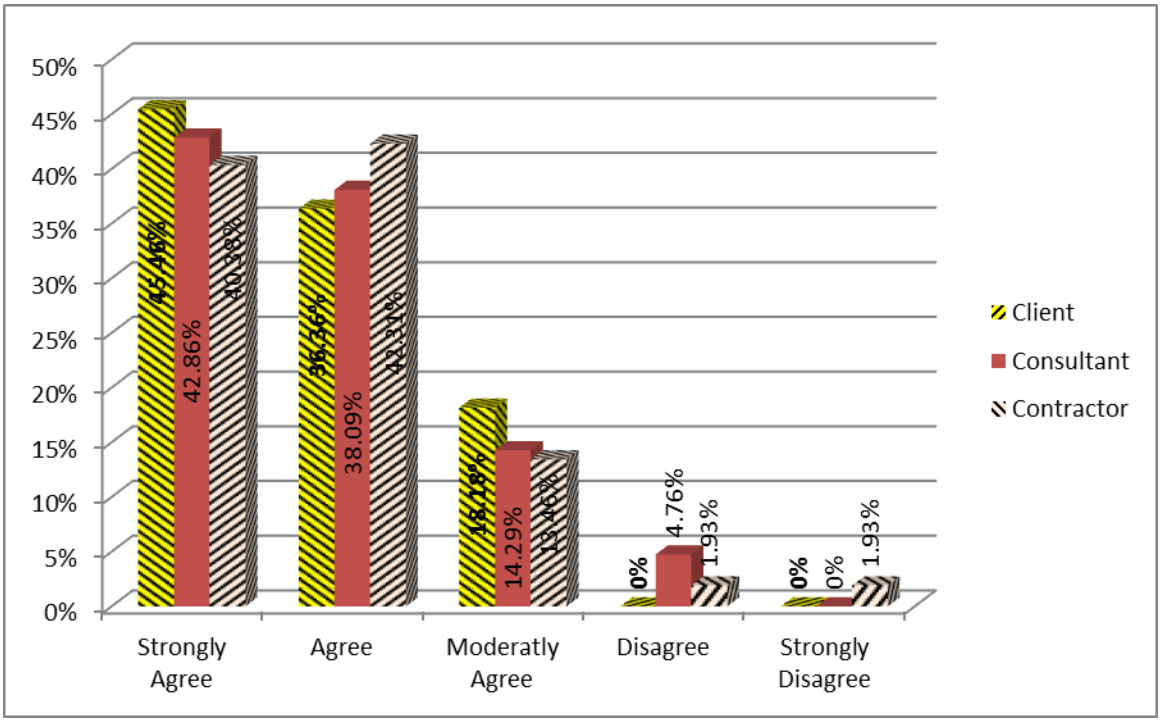

Figure 4. 3: Experience towards inefficiency problems in Addis Ababa building projects

Based on the result shown in the Figure above, out of 84 respondents 81 (96.40%) of them agreed towards the issue based on what they planned and what they performed

physically and financially. Whereas, only 3 (3.60%) of the respondents disagree with the issue. Hence, from the data it can be concluded that inefficiency is the problem of building construction projects in the city of Addis Ababa.

4.2 Identification of key efficiency indicators of construction projects

This section of the study focuses to identify the most significant key efficiency indicators of construction projects in the city of Addis Ababa. For this study, seventy nine (79) indicators were considered and listed under four groups based on literature review. These groups were believed to give a comprehensive summary of the main key efficiency indicators. The indicators were summarized and collected according to previous studies and others were added as recommended by local experts in the questionnaire.

The ranking of the factors shown in the Table below were done based on rate of occurrence using relative importance index. The Relative Importance Index (RII) for each potential factors influencing building projects efficiency were calculated using equation (1) − section 3.2 of this thesis to rank the factors based on overall factors.

Table 4. 2: RII and rank of group of factors from contractors, consultants, client and overall respondents' point of view

Groups	Contractor		Consultant		Client		Overall	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Time	3.7367	1	3.6484	1	3.9371	1	3.7408	1
Cost	3.3630	3	3.3591	3	3.5606	4	3.3879	3
Material	3.7440	2	3.6607	2	3.7614	2	3.7254	2
skill and labor	3.2663	4	3.3480	4	3.6993	3	3.3434	4

Time group has been ranked by the contractors, consultants and clients respondents in the first position with RII = 3.7367, RII = 3.6484 and RII = 3.7408 respectively. These groups of factors are highly important for the three parties because the parties are concerned with planned time for project completion. Construction time is increasingly

important because it often serves as a crucial benchmarking for assessing the performance of a project and the efficiency of the project organization.

Cost group has been ranked by both the contractors and consultants' respondents in the third position with RII equal 3.3630 and 3.3591 respectively. However, this category has been ranked by the clients' respondents in the fourth position (RII = 3.5606). This group in general, is medium important for all parties because liquidity of organization and project design cost affect the project cost efficiency. Keeping within the budget, and knowing when and where the costs are deviating are the keys to efficient and effective cost management and profitable operations.

Furthermore, material group has been ranked by the entire contractor, consultants and clients' respondents in the second position with RII equal 3.7440, 3.6607 and 3.7614 respectively. This group of factors seems are important for the three parties because the parties are concerned with waste management plan for project efficiency.

The final group, skill and labor group, has been ranked by the clients' respondents in the third position (RII = 3.6993), and by both the consultant and contractors' respondents in the fourth position with RII equal 3.3480 and 3.2663 respectively. It is observed that this group is not as such important for three parties because it is rarely considered through implementation stage of construction projects in the city of Addis Ababa.

4.3 Identification of factors affecting Building Projects Efficiency

This part of the study provides the results and analysis to meet the first objective of the thesis, which focused on with the identification of the factors influencing building projects efficiency. In order to achieve this objective, review of different literatures related to factors influencing building projects efficiency were done.

The literature review focused on the factors influencing building projects efficiency was discussed and the results were presented in chapter two of this study. From the results identified literature review a total list of 79 different efficiency factors were identified and included in the questionnaire for further analysis. Table 4.3 below shows the identified factors influencing building projects performance from the study.

Table 4. 3: The 79 factors identified through literature review.

No	Factors/Groups	No	Factors/Groups
A	Cost Factors	B	Time Factors
1	Cost of Materials	25	Too many change orders from owner
2	Fluctuation of prices of materials	26	Poor planning and scheduling of the project by the contractor
3	High cost of machinery and its maintenance costs	27	Ambiguities and mistakes in specifications & drawings
4	Project financing and payments	28	Slow decision making from owner
5	Payment delay from the client	29	Poor qualification of consultants, engineers and staff assigned to the project
6	High transportation cost	30	Improper technical study by the contractor during the bidding stage
7	Lack of productivity standards	31	Delay in progress payments by the owner
8	Supplier manipulation	32	Severe weather conditions on the job site
9	Economic stability	33	Shortage of skilled &technical professionals in the contractor's organization
10	Level and number of competitors	34	Financial difficulties faced by the contractor
11	Project location	35	Delays in contractors claims settlements and slow response by the consultants engineers regarding testing & inspections (work permit)
12	Previous experience of the contract	36	Poor coordination by the consultant's engineers with the parties involved
13	Relationship between management and labor	37	Insufficient coordination among the parties by the contractor
14	Inadequate production of raw materials by the country	38	Delay in mobilization
15	Frequent design change & lack of coordination b/n designers &contractors	39	Financial constraints faced by the owner
16	Poor financial controls on site	40	Work suspension by the owner
17	Bureaucracy in tendering method	41	Delays in site preparation
18	Weather conditions	42	Improper handling of the project progress by the contractor
19	Number of construction going on at same time	43	Shortage of manpower
20	Absence of construction-cost data	44	Modification in material specifications
21	Wrong method of estimation	45	Shortage of material and equipment
22	Additional work	46	Delay in materials delivery
23	Duration of contract period	47	Delays by the contractor payments to subcontractors
24	Government policies	48	Failure of equipment
		49	Safety rules and regulations are not followed within the contractor's regulations
		50	Unforeseen site conditions

No	Factors/Groups	No	Factors/Groups
C	Material Factors	D	Performance of skilled and labor Factor
51	Unsuitability of materials storage location		Management factor (skilled)
52	Distance of suitable material location from project site	67	The level of management control
53	Lack of waste management plans	68	Professionalism of the design team
54	Lack of information about types and sizes of materials on design documentations	69	Difficulties in employing site supervisor
55	Design changes and revisions	70	Incompetence of site supervisor
56	Error in information about types and sizes of materials on design documentations	71	Late inspection of completed work
57	Determination of types and dimensions of material without considering waste		Workforce Characteristics Factors (labor)
58	Ordering of materials that do not fulfill project requirements defined on design documents	72	Quality, Experience and Training
59	Over ordering or under ordering due to mistake in quantity surveys	73	Disturbance
60	Over ordering or under ordering due to lack of coordination between warehouse and construction crews	74	Morality (e.g., alcohol influence)
61	Damage of materials due to deficient stockpiling and handling of materials	75	Frequent changes in labors
62	Imperfect planning of construction	76	Communication problems
63	Workers' mistakes	77	Turnover
64	Damage caused by subsequent trades	78	Absenteeism
65	Conversion waste from cutting uneconomical shapes	79	Motivation
66	Lack of onsite materials control		

4.3.1. Analysis of factors affecting building projects efficiency

Based on the research methodology described in chapter three, this part of the study is targeted to analyze the severity of the identified factors to rank their importance. In this study, a list of seventy nine (79) potential factors of efficiency found from literatures were considered and categorized under four groups and presented to the respondents to rank and score them. The ranking of the factors were done based on rate of occurrence using relative importance index. The Relative Importance Index (RII) for each potential factors influencing building projects efficiency were calculated using equ. (1) − section 3.2 of this thesis to rank the factors based on overall factors. The results of analysis for each group of efficiency factors as per the view of the three parties were discussed below.

A. Cost Factors

The group consists of twenty four factors considered to affect the cost in construction projects. Table 4.4 summarizes and presents the cost factors and their associated RII and rank.

Table 4. 4: The Relative Importance Index (RII) and rank of cost factors

A. Cost Factors	Contractor		Consultant		Client		Overall	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Cost of Materials	4.1538	3	3.9048	4	4.1818	4	4.0952	3
Fluctuation of prices of materials	4.3462	1	4.0476	3	4.1818	4	4.2500	1
High cost of machinery & its maintenance costs	3.3269	14	3.7619	10	3.3636	14	3.4405	12
Project financing and payments	3.5577	11	4.0952	2	4.3636	3	3.7976	8
Payment delay from the client	4.3269	2	3.9048	4	4.0000	8	4.1786	2
High transportation cost	3.0577	16	2.6667	20	2.4545	23	2.8810	17
Lack of productivity standards	3.8846	5	3.7619	10	4.4545	2	3.9286	5
Supplier manipulation	2.5577	22	2.4286	24	1.8182	24	2.4286	24
Economic stability	3.9615	4	3.6190	12	3.7273	10	3.8452	7
Level and number of competitors	3.5385	12	2.7143	19	3.0000	20	3.2619	15
Project location	2.6731	19	3.0476	16	3.7273	10	2.9048	16
Previous experience of the contract	2.8846	17	2.4762	23	3.3636	14	2.8452	18
Relationship between management & labor	2.5962	21	2.8095	18	2.7273	22	2.6667	22
Inadequate production of raw materials by the country	3.6346	9	3.8571	6	3.7273	10	3.7024	11
Frequent design change & lack of coordination b/n designers &contractors	3.8269	6	4.1429	1	4.6364	1	4.0119	4
Poor financial controls on site	3.8077	7	3.8571	6	4.1818	4	3.8690	6
Bureaucracy in tendering method	3.4808	13	3.4762	13	3.1818	19	3.4405	12
Weather conditions	2.6346	20	2.8571	17	3.2727	16	2.7738	20
Number of construction going on at same time	2.5000	24	2.5714	22	3.2727	16	2.6190	23
Absence of construction-cost data	3.3269	14	3.1429	15	3.2727	16	3.2738	14

A. Cost Factors	Contractor		Consultant		Client		Overall	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Wrong method of estimation	3.6731	8	3.8571	6	4.0000	8	3.7619	9
Additional work	2.8269	18	2.6190	21	2.8182	21	2.7738	20
Duration of contract period	3.5962	10	3.8095	9	4.0909	7	3.7143	10
Government policies	2.5385	23	3.1905	14	3.6364	13	2.8452	18

Cash flow of the project has been ranked by both the contractors and consultants' respondents in the third position and has been ranked by the clients' respondents in the fourth position.

Fluctuation of prices of materials has been ranked by the contractor in the first position. However, this factor has been ranked by the consultants' respondents in the third position and clients' respondents in the fourth position. It is observed that this factor is more important for contractor because fluctuation of material prices affects the cash flow of contractor. Fluctuation in prices has a significant impact on cost increase. Often the contractor estimates prices of the tender according to the present prices at local markets. It's known that the tendering phase and awarding is an early phase of the project, even the awarding process takes long time, so there is a chance of price fluctuation. In case of high prices, the contractor would face the problem of cost overruns at the execution phase.

Payment delay from the client has been ranked by the contractor respondents in the second position. It has been ranked by the consultants' respondents in the fourth position and has been ranked by the clients' respondents in the eighth position. It is remarked that this factor is more important for contractors than for client and consultants.

Frequent design change and lack of coordination b/n designers &contractors has been ranked by the contractor respondents in the sixth position. It has been ranked by the consultants' and clients' respondents in the first position. Frequent design change due to inadequate project planning and management of the design process and lack of coordination, contractors construct the project according to the project design. Normally, if the design has any mistakes, the contractors may apply the mistakes without knowing there are mistakes or without notifying and coordinating with the designer or the client. Implementing designs with mistakes obviously costs a lot of money.

B. Time Factors

The group consists of twenty six factors considered to affect the time in construction projects. Table 4.5 presents the list of factors, their RII and rank.

Table 4. 5: RII and rank of time factors

B. Time Factors	Contractor		Consultant		Client		Overall	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Too many change orders from owner	3.8462	13	3.4762	19	3.9091	14	3.7619	15
Poor planning and scheduling of the project by the contractor	4.3654	1	4.3333	1	3.5455	21	4.2500	2
Ambiguities and mistakes in specifications & drawings	3.9808	9	4.0000	3	4.8182	1	4.0952	4
Slow decision making from owner	3.7115	16	3.5238	17	4.0000	10	3.7024	17
Poor qualification of consultants, engineers and staff assigned to the project	3.8269	14	3.6667	14	4.2727	7	3.8452	12
Improper technical study by the contractor during the bidding stage	4.0000	7	3.9524	4	2.8182	26	3.8333	14
Delay in progress payments by the owner	3.9615	10	3.8095	8	4.0000	10	3.9286	7
Severe weather conditions on the job site	2.8654	25	3.0000	25	3.2727	24	2.9524	26
Shortage of skilled &technical professionals in the contractor's organization	3.8846	11	3.8571	6	3.6364	18	3.8452	12
Financial difficulties faced by the contractor	4.3077	2	4.2381	2	4.6364	3	4.3333	1
Delays in contractors claims settlements and slow response by the consultants engineers regarding testing & inspections	4.0769	3	3.2857	23	4.0000	10	3.8690	10
Poor coordination by the consultant's engineers with the parties involved	4.0000	7	3.7143	11	3.6364	18	3.8810	9
Insufficient coordination among the parties by the contractor	3.7115	16	3.7619	10	3.8182	16	3.7381	16
Delay in mobilization	2.8269	26	3.2857	23	3.4545	23	3.0238	25
Financial constraints faced by the owner	4.0577	5	3.5714	16	4.6364	3	4.0119	5
Work suspension by the owner	3.4423	21	3.4286	20	3.5455	21	3.4524	21

B. Time Factors	Contractor		Consultant		Client		Overall	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Delays in site preparation	3.2692	22	3.0000	25	4.0909	9	3.3095	24
Improper handling of the project progress by the contractor	3.8077	15	3.7143	11	4.3636	5	3.8571	11
Shortage of manpower	3.5385	20	3.6190	15	4.0000	10	3.6190	19
Modification in material specifications	3.2500	23	3.3333	22	3.7273	17	3.3333	23
Shortage of material and equipment	4.0769	3	3.8571	6	4.8182	1	4.1190	3
Delay in materials delivery	4.0385	6	3.7143	11	4.3636	5	4.0000	6
Delays by the contractor payments to subcontractors	3.5769	19	3.4286	20	4.2727	7	3.6310	18
Failure of equipment	3.1346	24	3.8095	8	3.6364	18	3.3690	22
Safety rules and regulations are not followed within the contractor's regulations	3.7115	16	3.5238	17	3.1818	25	3.5952	20
Unforeseen site conditions	3.8846	11	3.9524	4	3.9091	14	3.9048	8

Poor planning and scheduling of the project by the contractor has been ranked by the contractors' and consultants' respondents in the first position with RII = 4.3654 and RII = 4.3333 respectively. But it has been ranked by clients respondents' in the twenty first position with RII = 3.5455. This factor can be considered as more important for consultants and contractors than clients. For the contractor, good planning, organization and control are essential in order to achieve a timely and satisfactory outcome for the client, and to ensure a financial profit.

Financial difficulties faced by the contractor has been ranked by the contractors' and consultants' respondents in the second position with RII = 4.3077 and RII = 4.2381 respectively. But it has been ranked by clients respondents' in the third position with RII = 4.6364. Still, it is observed that this factor is very important for all the three parties involved in building construction projects in Addis Ababa city. This indicates the high importance of cash for the progress of project. Any shortage of cash for the contractor will cause many problems such as slow progress and work decline in productivity. Also the contractors will not be able to purchase the needed equipment for work. More over

the problem of cash also expanded to traders and suppliers, which in turn leads to slow the work, then to occurrence of project's delay.

Shortage of material and equipment has been ranked by the Contractors respondents' in the third position with RII = 4.0769, consultants respondents' in the sixth position with RII = 3.8571 and clients respondents' in the first position with RII = 4.8182. It is remarked that this factor is more important for contractors and clients than consultants.

C. Material factors

This group consists of sixteen factors which affects the construction material. The results obtained are given in Table 4.6.

Table 4. 6: The Relative Importance Index (RII) and rank of material factors

C. Material Factors	Contractor		Consultant		Client		Overall	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Unsuitability of materials storage location	4.1923	4	3.5714	8	3.4545	11	3.9405	5
Distance of suitable material location from project site	4.1154	6	3.3810	9	3.6364	8	3.8690	7
Lack of waste management plans	3.0962	13	3.1905	13	3.2727	13	3.1429	15
Lack of information about types and sizes of materials on design documentations	3.0577	14	3.3333	10	3.4545	11	3.1786	14
Design changes and revisions	3.0385	15	3.2381	11	4.4545	4	3.2738	13
Error in information about types and sizes of materials on design documentations	3.6154	11	3.2381	11	3.7273	5	3.5357	10
Determination of types and dimensions of material without considering waste	3.4808	12	3.1429	14	3.1818	14	3.3571	12
Ordering of materials that do not fulfill project requirements defined on design documents	4.2308	3	4.6190	2	4.8182	1	4.4048	2
Over ordering or under ordering due to mistake in quantity surveys	3.6538	10	3.0000	16	3.0000	16	3.4048	11
Damage of materials due to deficient stockpiling and handling of materials	4.2500	2	4.5238	3	3.7273	5	4.2500	4

C. Material Factors	Contractor		Consultant		Client		Overall	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Over ordering or under ordering due to lack of coordination between warehouse and construction crews	4.1154	6	3.6190	7	3.6364	8	3.9286	6
Imperfect planning of construction	4.2885	1	4.6667	1	4.8182	1	4.4524	1
Workers' mistakes	4.1731	5	4.5238	3	4.5455	3	4.3095	3
Damage caused by subsequent trades	2.7692	16	3.1429	14	3.0909	15	2.9048	16
Conversion waste from cutting uneconomical shapes	3.8269	9	3.7143	5	3.7273	5	3.7857	9
Lack of onsite materials control	4.0000	8	3.6667	6	3.6364	8	3.8690	7

According to contractors, consultants and the client Imperfect planning of construction was the most important material efficiency factor as it has been the first rank among all factors with RII = 4.2885 for contractors, 4.6667 for consultants and 4.8182 for the client. The building contractor may not know the necessary quantity because of imperfect planning. This leads to over- ordering and overfilling of the means of transport.

Ordering of materials that do not fulfill project requirements defined on design documents has been ranked by the contractors', consultants' and client's respondents in the third, second and first positions respectively. This factor is also seems most important factor for the entire parties next to the first one.

Damage of materials due to deficient stockpiling and handling of materials has been ranked by the contractor respondents' in the second position. But it has been ranked in the third and fifth position for consultants' and clients' respondents respectively. Materials are often wasted because they are damaged during storage.

D. Skill and labor factors

This group consists of thirteen factors connected with skill and labor issues. Table 4.7 presents the summary of the result obtained in the study under this group.

Table 4. 7: Summary of the result obtained in the under skill and labor group.

D. Skill and Labor Factors	Contractor		Consultant		Client		Overall	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
The level of management control	2.8462	11	3.0476	9	3.2727	10	2.9524	11
Professionalism of the design team	3.5769	3	3.9048	2	4.3636	2	3.7619	2
Difficulties in employing site supervisor	2.8269	12	2.8571	12	3.3636	8	2.9048	12
Incompetence of site supervisor	3.3462	7	2.9048	10	3.1818	11	3.2143	9
Late inspection of completed work	2.9615	10	3.3333	7	3.7273	6	3.1548	10
Quality, Experience and Training	3.3077	8	3.4762	5	4.4545	1	3.5000	6
Disturbance	3.1538	9	3.5714	4	4.2727	4	3.4048	7
Morality (e.g., alcohol influence)	2.4423	13	2.7619	13	2.8182	13	2.5714	13
Frequent changes in labors	3.6923	2	3.4762	5	3.3636	8	3.5952	3
Communication problems	3.9615	1	4.0952	1	4.1818	5	4.0238	1
Turnover	3.4423	5	2.9048	10	3.0000	12	3.2500	8
Absenteeism	3.4038	6	3.8571	3	3.7273	6	3.5595	5
Motivation	3.5000	4	3.3333	7	4.3636	2	3.5714	4

Communication problems has been ranked by the contractors and consultant respondents in first position but has been ranked by the client respondents in the fifth position. Workers communication needs to be effective for coordinate efforts, leading to improvement in quality of the works.

A frequent change in labors has been ranked by the contractor respondents' in the second position. But it has been ranked in the fifth and eighth position for consultants' and clients' respondents respectively.

Professionalism of the design team has been ranked by the contractors' respondents in the third position but it has been ranked by the consultants and clients respondents' in the second position. However, for consultants and clients, Professionalism of the design team is important than contractors because this factor is mainly affects the two parties.

4.3.2. Ranking of factors affecting building projects efficiency based on general responses of the respondents

Arranging of each efficiency factors by respondents based on efficiency factors' relative importance index is so much essential in order to give a priority for those efficiency factors which have the highest significant impact on building construction projects. For this reason all 79 efficiency factors were ranked as it shown from table 4.8 below based on their RII.

Table 4. 8: Ranking of all types of efficiency factors of building construction projects in Addis Ababa based on all respondents' RII

Factors	Overall Respondents	
	RII	Rank
Imperfect planning of construction	4.4524	1
Ordering of materials that don't fulfill project requirements defined on design documents	4.4048	2
Financial difficulties faced by the contractor	4.3333	3
Workers' mistakes	4.3095	4
Fluctuation of prices of materials	4.2500	5
Poor planning and scheduling of the project by the contractor	4.2500	5
Damage of materials due to deficient stockpiling and handling of materials	4.2500	5
Payment delay from the client	4.1786	8
Shortage of material and equipment	4.1190	9
Cost of Materials	4.0952	10
Ambiguities and mistakes in specifications & drawings	4.0952	10
Communication problems	4.0238	12
Frequent design change & lack of coordination b/n designers &contractors	4.0119	13
Financial constraints faced by the owner	4.0119	13
Delay in materials delivery	4.0000	15
Unsuitability of materials storage location	3.9405	16
Lack of productivity standards	3.9286	17
Delay in progress payments by the owner	3.9286	17
Over ordering or under ordering due to lack of coordination between warehouse and construction crews	3.9286	17
Unforeseen site conditions	3.9048	20

Factors	Overall Respondents	
	RII	Rank
Poor coordination by the consultant's engineers with the parties involved	3.8810	21
Poor financial controls on site	3.8690	22
Delays in contractors claims settlements and slow response by the consultants engineers regarding testing & inspections (work permit)	3.8690	22
Distance of suitable material location from project site	3.8690	22
Lack of onsite materials control	3.8690	22
Improper handling of the project progress by the contractor	3.8571	26
Economic stability	3.8452	27
Poor qualification of consultants, engineers and staff assigned to the project	3.8452	27
Shortage of skilled &technical professionals in the contractor's organization	3.8452	27
Improper technical study by the contractor during the bidding stage	3.8333	30
Project financing and payments	3.7976	31
Conversion waste from cutting uneconomical shapes	3.7857	32
Wrong method of estimation	3.7619	33
Too many change orders from owner	3.7619	33
Professionalism of the design team	3.7619	33
Insufficient coordination among the parties by the contractor	3.7381	36
Duration of contract period	3.7143	37
Inadequate production of raw materials by the country	3.7024	38
Slow decision making from owner	3.7024	38
Delays by the contractor payments to subcontractors	3.6310	40
Shortage of manpower	3.6190	41
Safety rules and regulations are not followed within the contractor's regulations	3.5952	42
Frequent changes in labors	3.5952	42
Motivation	3.5714	44
Absenteeism	3.5595	45
Error in information about types and sizes of materials on design documentations	3.5357	46
Quality, Experience and Training	3.5000	47
Work suspension by the owner	3.4524	48
High cost of machinery and its maintenance costs	3.4405	49
Bureaucracy in tendering method	3.4405	49

Factors	Overall Respondents	
	RII	Rank
Over ordering or under ordering due to mistake in quantity surveys	3.4048	51
Disturbance	3.4048	51
Failure of equipment	3.3690	53
Determination of types and dimensions of material without considering waste	3.3571	54
Modification in material specifications	3.3333	55
Delays in site preparation	3.3095	56
Absence of construction-cost data	3.2738	57
Design changes and revisions	3.2738	57
Level and number of competitors	3.2619	59
Turnover	3.2500	60
Incompetence of site supervisor	3.2143	61
Lack of information about types and sizes of materials on design documentations	3.1786	62
Late inspection of completed work	3.1548	63
Lack of waste management plans	3.1429	64
Delay in mobilization	3.0238	65
Severe weather conditions on the job site	2.9524	66
The level of management control	2.9524	66
Project location	2.9048	68
Damage caused by subsequent trades	2.9048	68
Difficulties in employing site supervisor	2.9048	68
High transportation cost	2.8810	71
Previous experience of the contract	2.8452	72
Government policies	2.8452	72
Weather conditions	2.7738	74
Additional work	2.7738	74
Relationship between management and labor	2.6667	76
Number of construction going on at same time	2.6190	77
Morality (e.g., alcohol influence)	2.5714	78
Supplier manipulation	2.4286	79

Analyzing numerous factors is not effective and the concerned body should be focused on handling main problems facing the construction projects. These factors can be ranked based on their expected values (average values), their standard deviations (or variances) or other methods like sensitivity analysis approaches according to their capacity to change the total cost or schedule. As a rule of thumb, some teams decide to consider only the top 10 or the top 15 risk factors. Others might use other criteria. One such criterion is the Pareto's Law: i.e., 20% of risk items are responsible for 80% of cost increase, so those are the risks that need to be considered" (Touran, 2006).

Based on the idea of Pareto's Law described in the literature above the 20% of the causes were selected as the top sixteen (16) significant factors obtained from the analysis based on their importance. These are imperfect planning of construction (RII = 4.4524); Ordering of materials that don't fulfill project requirements defined on design documents (RII = 4.4048); Financial difficulties faced by the contractor (RII = 4.3333); Workers' mistakes (RII=4.3095); Fluctuation of prices of materials (RII = 4.2500); Poor planning and scheduling of the project by the contractor (RII = 4.2500); Damage of materials due to deficient stockpiling and handling of materials (RII = 4.2500); Payment delay from the client (RII = 4.1786); Shortage of material and equipment (RII = 4.1190); Cost of Materials (RII=4.0952); Ambiguities and mistakes in specifications & drawings (RII = 4.0952); Communication problems (RII = 4.0238); Frequent design change & lack of coordination between designers &contractors (RII = 4.0119); Financial constraints faced by the owner (RII = 4.0119); Delay in materials delivery (RII = 4.0000) and Unsuitability of materials storage location (RII = 3.9405).

4.3.3. Test for agreement in ranking efficiency factors among respondents

In order to evaluate the major efficiency factors by each party independently contractors, consultants and the client data were analyzed separately. This process also facilitated to determine the degree of agreement between each party's responses. The agreement between parties had been addressed in Spearman Rank Correlation Coefficient among ranks of the respondents.

Spearman's coefficient of rank correlation is used to determine whether there was the agreement or disagreement among each pair of parties. The value of Spearman's

coefficient of rank correlation ranges from +1 (perfect positive correlation) to 0 (no correlation) to −1 (perfect negative correlation) and was calculated using equation 2 Odeh, et al., (2002) suggested that if the correlation coefficient value lies between ± 0.5 and ± 1, it is said to have a high degree of correlation. For correlation coefficient value between ± 0.3 and ± 0.5, the degree of correlation is moderate. Low degree of correlation occurs when the correlation coefficient lies between ± 0.1 and ± 0.3. The spearman coefficient and significance level is shown in table 4.9.

Therefore, the results of the agreement with a level of significance of 99% (r=0.01) showed that the relative importance index of efficient building projects between Contractors-consultants, Consultants-client and contractors-client were 0.9690, 0.9638 and 0.9559 respectively.

This result showed that highest agreement value had been found among the entire parties (Contractors-consultants, consultants-clients and contractors-clients) as a result of spearman correlation coefficient shown in the table below.

Table 4. 9: Summary of spearman rank correlation coefficient based on RII for individual respondents success factors

	Contractor Vs Consultant	Consultant Vs Client	Contractor Vs Client
Correlation	0.9690	0.9638	0.9559

The Table above showed that the calculated spearman rank correlation coefficient values for all pair of parties; contractor vs. consultant, consultant vs. client, and contractor vs. client were 0.9690, 0.9638 and 0.9559 respectively.

4.4 Perception of key stakeholders on the effect of each factors affecting efficiency of building construction

Lists of five common effects which are caused by efficiency factor were presented to the respondents to rank and score them. Accordingly, based on the response from each party the Relative Importance Index (RII) for each common potential effect were calculated and the correlation between the rank of the contractor, consultant and client were computed to rank the factors based on overall effect and presented hereunder.

Table 4. 10: Rank of effects of efficiency factor from all Respondents' point view

Effects	Contractor		Consultant		Client		Overall	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Cost overrun	4.3654	2	3.6667	2	3.5455	3	4.0833	2
Time overrun	4.3846	1	3.6190	3	4.0909	2	4.1548	1
Environmental impact	3.0577	5	3.0476	5	3.1818	4	3.0714	5
Loss of quality	3.4808	3	3.7143	1	4.2727	1	3.6429	3
Dispute	3.4808	3	3.4286	4	3.1818	4	3.4286	4

From Table 4.10 it can be concluded that contractors, consultants and clients are in strong consensus with that time overrun, loss of quality and cost overrun are one of the major primary effects of efficiency factors on the city of Addis Ababa building projects. Environmental Impact and disputes are also the effects of efficiency factors that all group reached in strong consensus with each other.

From the results of analysis based on overall respondents, as it is shown from the above Table 4.10, the RII could be categorized into three. The factors with RII value lying between 3.5000 and 4.5000 is categorized under high impact which accounts 60% of the effects from the listed 5 (five) common effects. The factors with RII value lying between 2.5000 and 3.5000 is categorized under average impact which accounts 40% of the common effects listed. Whereas, the factors with RII value lying between 1.5000 and 2.5000 is categorized under minor impact which accounts 0% of the recurrent effects of efficiency factors.

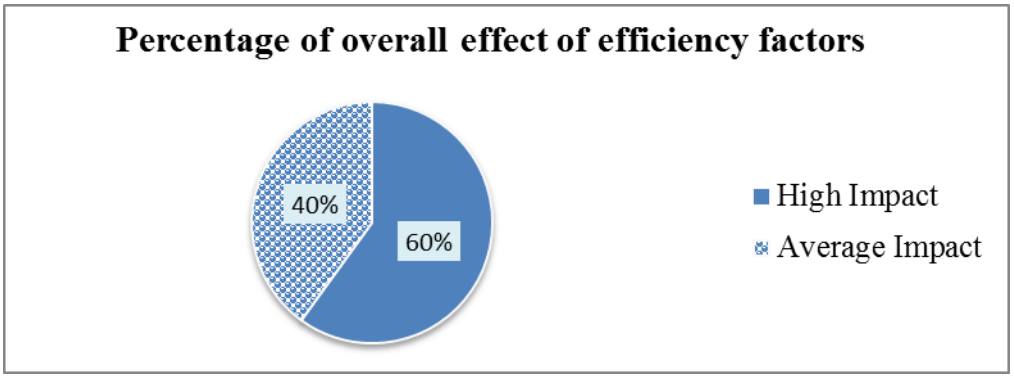

Figure 4. 4: Category for severity of most recurrent effects of efficiency factors.

From the result of overall respondents as indicated in the Figure above, 100 % of the RII values were lying between 2.5 and 4.5 and these values were categorized under high and average level of importance. Thus, time overrun, cost overrun, loss of quality, dispute and environmental impact were among the key effects of efficiency factors on the city of Addis Ababa building projects.

4.5 Practices Concerning Efficiency of building Construction Projects

This part of the research provides the analysis and the results to meet the third objectives of the study, which was focused on formulating strategies to improve the building projects efficiency in the city of Addis Ababa. To achieve this objective, the practices concerning with the key efficiency variables such as time, cost, material, and skill and labor performance checklists were analyzed. The following sub topics presents a summary for the main practices concerning the key efficiency indicators based on the research findings.

A. Cost Management Practice

With regard to cost management practice, questions were addressed to the respondents. Accordingly, the results obtained were discussed in the table below.

The Table below shows, both cost plan and cash flow schedule are found to be the important cost managing system which mostly used by the contractor and client for planning and scheduling. This program enables them to schedule, monitor, update and control project cost and resources. However, with regard to consultant this cost managing system used rarely.

Table 4. 11: Usage of cost plan/cash flow schedule

Do you use cost plan/ cash flow schedule?	**Contractor**		**Consultant**		**Client**	
	Frequency	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
Yes	41	78.85	1	4.76	9	81.82
Sometimes	11	21.15	18	85.71	2	18.18
No	-	-	2	9.52	-	-
Total	52	100	21	100	11	100

The above Table shows, both cost plan and cash flow schedule are found to be the important cost managing system which mostly used by the contractor and client for planning and scheduling. This program enables them to schedule, monitor, update and control project cost and resources. However, with regard to consultant this cost managing system used rarely.

Most consultants and contractors stated that the project delay occurred due to late payment from their client. However, the client respondents stated that sometimes project delay may occur due to late payment as it is the main responsibility of them. Delay in payment from client to contractor lead to delay of contractors' performance and cause problem in cost and time efficiency. This may also lead to disputes and claims between client and contractor of project. The reaction from the respondents has been summarized and presented in Figure below.

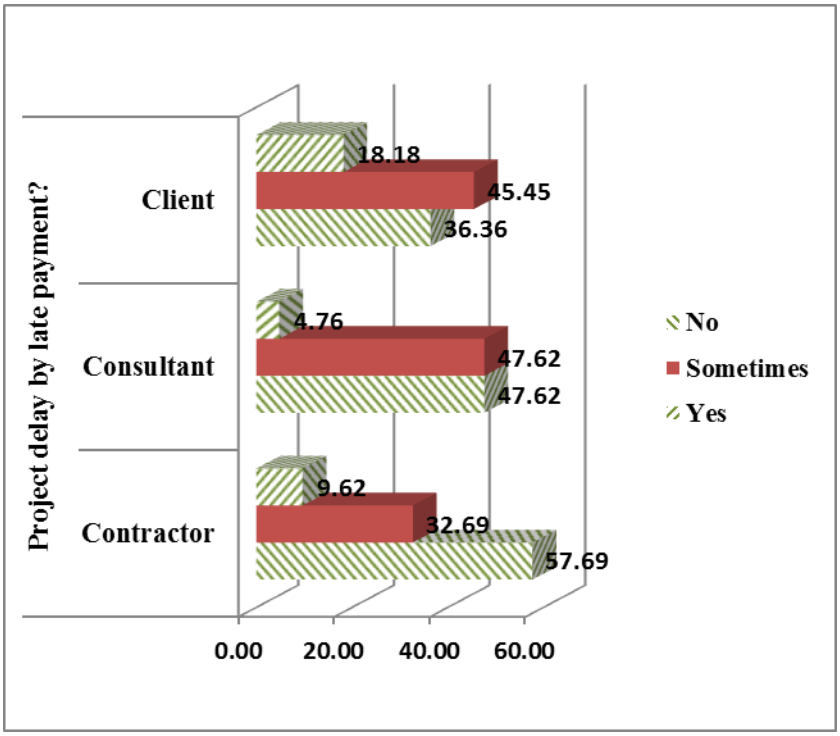

Figure 4. 5: Projects delay by late payment

B. Time Management Practices

With regard to time management practice, different questions were addressed to the respondents. Accordingly, the results obtained and the reaction from the respondents has been summarized and presented in Table shown below.

Table 4. 12: Usage of planning and scheduling method

Method of Planning	Contractor		Consultant		Client	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Bar chart method	13	25.00	3	14.29	3	27.27
Critical path method	25	48.08	15	71.43	5	45.45
S-curve	12	23.08	3	14.29	2	18.18
Others	2	3.85	-	-	1	9.09
Total	52	100	21	100	11	100

As per the results obtained from the above Table, Critical Path Method (CPM) has been found to be the most important method employed for planning and scheduling by the contractors, consultants and the client. This may be due to the fact that CPM can be used to determine critical activities of project. This will in turn assist these parties to evaluate overall time performance and to identify the effectiveness of critical path on completion date of project. However, bar chart method is found to be moderately important for planning and scheduling method for the entire party because bar chart method can facilitate time performance control for each scheduled activity through project implementation. The S-curve method is found to be rarely used by the Contractor and the client. But it is found to be moderately important as bar chart for the consultant. This may be because of the fact that S-curve method can compare only between actual time and estimated time at any stage through project implementation.

It is difficult to control time performance for each scheduled activity and it is difficult to obtain critical path affecting overall time performance of projects. When the activity time in the project is known, critical path method (CPM) has been demonstrated to be a useful tool in managing projects in an efficient manner to meet this challenge.

The Figure below illustrates the frequency of project team meeting for discussion. It is found out that Contractor and Consultants often meet monthly for discussion. Monthly meeting assist them for monitoring, updating and controlling the project progress and improving future works. Clients often meet weekly for discussion with consultants and contractors.

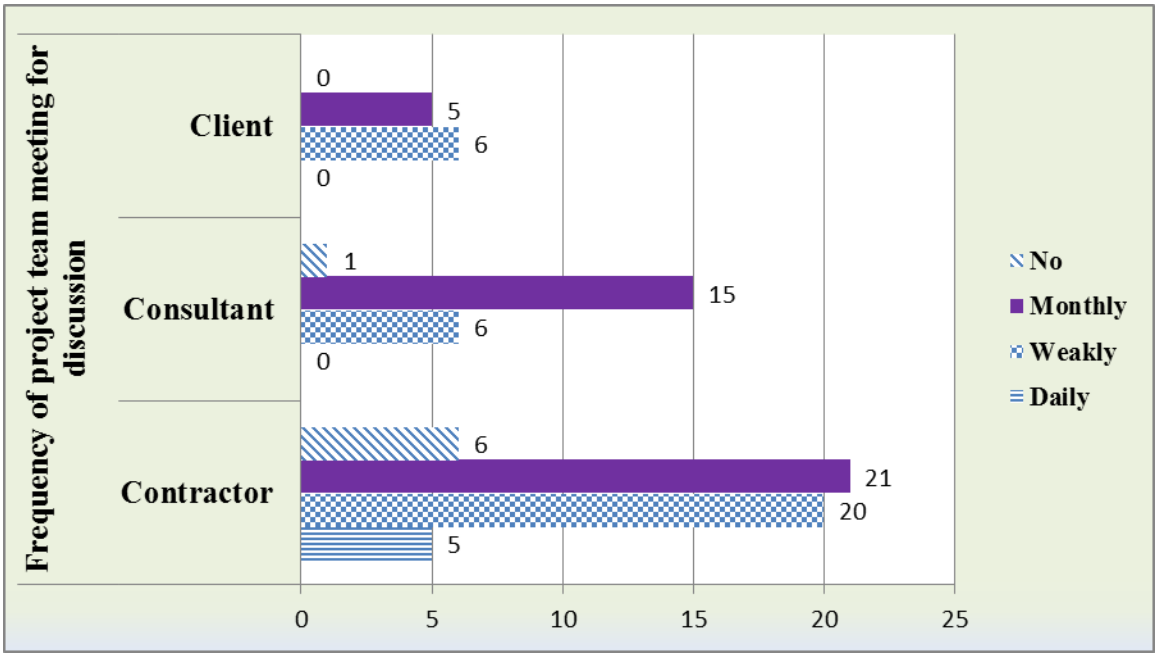

Figure 4. 6: Frequency of project team meeting for discussion

In the Table below, Microsoft project is found to be the most important, famous and easy program software used by contractors for planning and scheduling. This program enables them to schedule, monitor, update and control many criteria of project such as time, cost and resources. However, with regard to clients and Consultants excel sheet is found to be widely used for planning and scheduling processes. This may be due to the fact that they are easy to be used and have different facilities and functions to control time and cost. But, Excel program has some limitation in usage for planning and scheduling. The reaction from the respondents has been summarized and presented in Table below.

Table 4. 13: Applying of software for planning and scheduling

Software Applied	Contractor		Consultant		Client	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Primavera	2	3.85	1	4.76	1	9.09
Ms. Project	31	59.62	9	42.86	2	18.18
Excel Sheet	19	36.54	11	52.38	6	54.55
Others	-	-	-	-	2	18.18
Total	52	100	21	100	11	100

Construction programs with advanced available software can help to accelerate the performance. Information technology management leads to efficiency improvement in the construction industries.

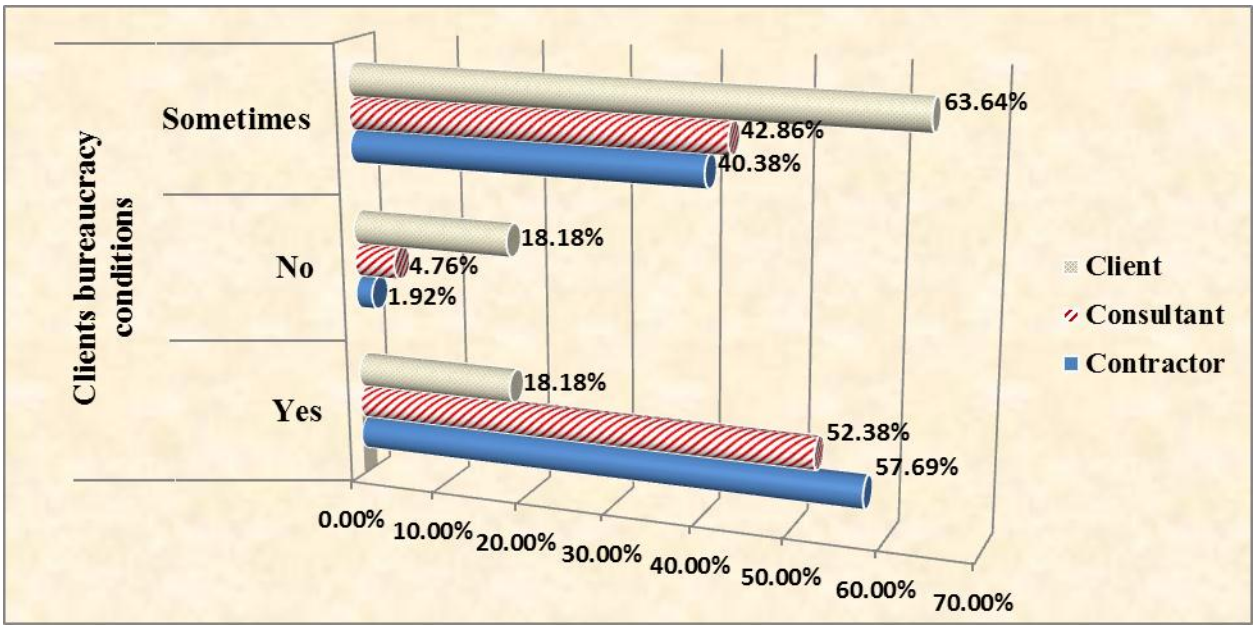

Figure 4. 7: Delay of projects because of Clients bureaucracy conditions

According to the reaction from the respondents summarized and presented in the above figure, most contractors, consultants, and the client respondents agreed that projects were delayed because of clients' bureaucracy conditions. This problem can be considered as an obstacle for time performance of construction projects. All client, consultants and contractors feel with this sensitive problem in their projects. The above Figure shows that construction projects in the city of Addis Ababa completes their project with low efficiency because of bureaucracy in relation to payment problem.

C. Material Management Practice

Practical waste minimization strategies require a detailed understanding of what causes construction waste and examined waste minimization strategies and the relative significance of construction waste sources using survey. The authors found out that a sizeable proportion of the firms did not have specific policies for minimizing waste.

Table 4. 14: RII and rank of strategy for Materials Waste managing and Minimization

Waste Minimization Strategy	Contractor		Consultant		Client		Overall	
	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
Purchasing raw materials that are just sufficient	3.36	6	2.86	9	2.83	9	2.90	9
Good coordination between store and construction personnel to avoid over ordering	3.73	5	3.33	6	2.96	7	3.15	7
Accurate and good specifications of materials to avoid wrong ordering	3.36	6	3.48	4	3.69	2	3.60	3
Proper storage of materials on site	4.36	2	3.90	2	3.58	3	3.76	2
Checking materials supplied for right quantities and volumes	4.18	4	4.10	1	3.96	1	4.02	1
Change of attitude of workers towards the handling of materials	4.45	1	3.48	4	3.31	5	3.50	4
Waste management officer or personnel employed to handle waste issues	4.27	3	3.57	3	3.15	6	3.40	5
Early and prompt scheduling of deliveries	3.18	9	2.90	8	3.35	4	3.21	6
Recycling of some waste materials on site	2.82	10	2.76	10	2.44	10	2.57	10
Accurate measurement of materials during batch	3.27	8	3.05	7	2.85	8	2.95	8

As it can be seen from Table 4.14 Change of attitude of workers towards the handling of materials has been ranked by the contractor in the first position. However, this factor has been ranked by the consultants' respondents in the fourth position and contractors respondents in the fifth position

The significant contribution to waste reduction in the construction industry is through people changing their wasteful behavior. Waste is an inevitable by-product of construction activity; its management is a low project priority with an absence of appropriate resource and incentives to support it. The availability of local infrastructure and top management supportiveness are the most critical determinant of waste reduction behavior on projects (Agyerum, 2012).

D. Skilled and unskilled manpower management practice

Regarding motivation system, it is strategy to increase the speed of construction and so to upgrade the construction time performance. It is remarked that the better training and motivation system can help to accelerate the efficiency. The reaction from the respondents has been summarized and presented in Table 4.15.

Table 4. 15: Usage of incentive system

Incentive System	Contractor		Consultant		Client	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Increase salary	30	57.69	11	52.38	4	36.36
Bonus in position	9	17.31	2	9.52	3	27.27
Training	9	17.31	8	38.10	1	9.09
Others	4	7.69	-	0.00	3	27.27
Total	52	100	21	100	11	100

The above Table shows most Clients, consultants and contractors use increased salary system in order to motivate their workers to improve performance. The client and the consultant sometimes use bonus in position. Increase salary system is more important for employees than bonus in position or training systems because these systems are rarely affect an employee's performance or productivity. Training is rarely required by the contractors according to the nature of project and its duration for the improvement and development of overall performance of an organization. However it is moderately required by the consultant to update their knowledge.

Work motivation is defined as a set of energetic forces that originate both within as well as beyond an individual's being, to initiate work-related behavior, and to determine its form, direction, intensity, and duration. When an organization invests time, money, and other resources into employees who are not motivated to learn their job or perform the functions expected of them, that investment is wasted.

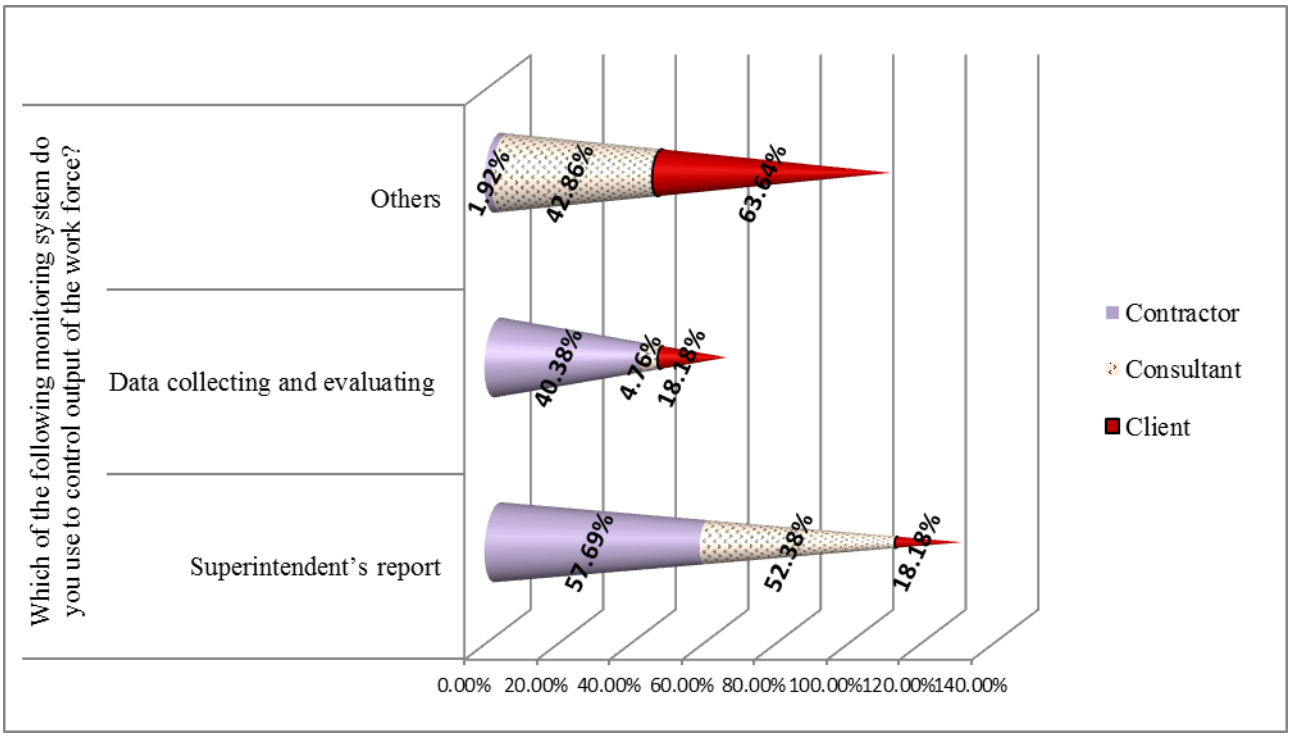

Figure 4. 8: - Monitoring system used to control output of the work force

Organizational practices that influence the promotion and advancement of employees may also have an influence on their commitment to the organization. Commitment and turnover intentions were strongly influenced by the outcome of early career evaluations. Those employees receiving negative feedback became less committed and more likely to consider leaving the company. It can be inferred that those receiving positive feedback became more committed and more likely to remain with the company.

E. Strategies used for Successful efficiency

A questionnaire survey containing eighteen potential strategies/measures for successful efficiency from the literature review and desk study were identified and the percent by respondents was calculated based on the respondents' frequency of reply to each for their effectiveness. Table 4.16 shows the percentage of all factors of remedial measures of inefficiency that have been investigated in this research from contractor, consultant, and client point of views.

Table 4. 16: Strategies used for successful building construction efficiency

Strategies used for successful building construction efficiency	Contractor		Consultant		Client		Overall	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Good communication channel	10	19.23	8	38.10	4	36.36	22	26.19
Knowhow of the practitioners	8	15.38	10	47.62	4	36.36	22	26.19
Proper planning and scheduling	34	65.38	20	95.24	10	90.91	64	76.19
Top management support	8	15.38	5	23.81	3	27.27	16	19.05
Using updated technology	28	53.85	13	61.90	6	54.55	47	55.95
Proper and modern construction equipment	23	44.23	11	52.38	4	36.36	38	45.24
Proper site management and frequent supervision	45	86.54	19	90.48	8	72.73	72	85.71
Creating collaborative working environment in construction	10	19.23	8	38.10	6	54.55	24	28.57
Complete and proper design at the right time	5	9.62	19	90.48	5	45.45	29	34.52
Innovative, widespread use of demonstration installations	8	15.38	18	85.71	6	54.55	32	38.10
Effective performance measurement to drive efficiency and support innovation	24	46.15	18	85.71	9	81.82	51	60.71
Widespread deployment and use of interoperable technology applications	6	11.54	4	19.05	6	54.55	16	19.05
Improved job-site efficiency through more effective interfacing of people, processes, materials, equipment, and information	29	55.77	17	80.95	9	81.82	55	65.48
Recognition of uncertainties	2	3.85	2	9.52	2	18.18	6	7.14
Monitoring and feedback	10	19.23	9	42.86	10	90.91	29	34.52
Reward and punishment	5	9.62	2	9.52	1	9.09	8	9.52
Stakeholder's participation	3	5.77	4	19.05	3	27.27	10	11.90
Greater use of prefabrication	4	7.69	10	47.62	5	45.45	19	22.62

The above Table shows that "proper site management and frequent supervision" was the first most important method for successful performance based on overall percentages. "Proper planning and scheduling" placed in the second position. This result reflects Monitoring and feedback are the second major methods for successful building construction hence by properly planning and scheduling the projects can promote successful efficiency of construction projects.

The third important factors by overall respondents were "Improved job-site efficiency through more effective interfacing of people, processes, materials, equipment, and information" could be important for successful building construction projects efficiency and helps to finish the project on time with contracted cost.

The results shown in Table 4.16, also illustrates next to the above top three strategies more than 50% of overall respondents agreed "Effective performance measurement to drive efficiency and support innovation, Using updated technology, Proper and modern construction, Innovative, widespread use of demonstration installations and Complete and proper design at the right time" were the most important strategies used for successful building construction projects efficiency in the city of Addis Ababa.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The efficiency of building construction projects is affected by clients, contractors, consultants, regulators, national economies and other stakeholders. The information gathered from the survey was analyzed by using the relative importance index method and correlated using Spearman's rank correlation coefficients for structured part of the questionnaires.

This study is focused on efficiency of building construction projects on randomly selected building projects in Addis Ababa. Based on the results of the analysis of respondents' responses the following conclusions are drawn.

- The first aim was to identify factors affecting efficiency of building construction projects. The questionnaire of this study considered 79 factors which affect efficiency of building construction, and those factors were distributed into four groups namely, Cost, Time, Material and skill and labour. From the results of this thesis 24 cost-related, 26 time-related, 16 material-related and the remaining 13 are skill and labour related factors were identified by the respondents.
- Based on their overall relative importance index as efficiency factors imperfect planning of construction, ordering of materials that do not fulfill project requirements defined on design documents, financial difficulties faced by the contractor, workers' mistakes, fluctuation of prices of materials, poor planning and scheduling of the project by the contractor, damage of materials due to deficient stockpiling and handling of materials, payment delay from the client, shortage of material and equipment, cost of materials, ambiguities and mistakes in specifications & drawings, communication problems, frequent design change and lack of coordination between designers and contractors, financial constraints faced by the owner, delay in materials delivery and unsuitability of materials storage location were the top sixteen most important factors influencing building projects efficiency in the case of Addis Ababa city.

- The second specific objective was to rank perception of key stakeholders on the effect of each factors affecting efficiency of building construction. To identify the most effects of efficiency factors on building construction projects, a questionnaire survey containing five common and recurrent effects of efficiency factors were identified from literatures and ranked by respondents based on the relative importance index value of frequency of occurrence. The result showed that efficiency factors ultimately leads to time overrun, cost overrun, poor quality completed project, dispute between parties, and environmental impact.
- The practices concerning with the key efficiency factors such as time, cost, material, skill and labour checklists were analyzed to formulate remedial measures for successful building projects efficiency in Addis Ababa.
- The third specific objective was to establish appropriate strategies to improve efficiency of building construction projects. A questionnaire survey containing eighteen potential strategies for successful building construction efficiency from the literature review were identified and the percent by respondents were calculated based on the respondents' frequency of reply to each for their effectiveness. The result showed that the following methods will improve the efficiency of construction projects.
  - ✓ Proper site management and frequent supervision
  - ✓ Proper planning and scheduling
  - ✓ Improved job-site efficiency through more effective interfacing of people, processes, materials, equipment, and information
  - ✓ Effective performance measurement to drive efficiency and support innovation
  - ✓ Using updated technology
  - ✓ Proper and modern construction equipment
  - ✓ Innovative, widespread use of demonstration installations
  - ✓ Complete and proper design at the right time
  - ✓ Monitoring and feedback
  - ✓ Creating collaborative working environment in construction

5.2 Recommendation

Based on the findings of the research, the following issues are recommendations to alleviate efficiency problems by respective stakeholders in the city of Addis Ababa building construction projects.

Construction organizations

It is recommended for construction organizations to have proper and continuous training programs about construction projects efficiency to improve performance of building construction projects. In addition, it is preferred to develop capacity building programs for professionals and for firms on the construction industry in the areas of managerial skills, construction project management techniques and processes in order to improve efficiency of construction projects.

Moreover, construction organizations are recommended to evaluate project overtime through project construction in order to enhance and improve time and cost efficiency of projects. Time needed to implement variation orders and to rectify defects should be estimated and scheduled without affecting project time completion. Construction organizations should have different incentive systems in order to improve overall efficiency. All of that will assist organizations to perform building projects successfully.

Client

It is recommended that the client should facilitate timely payment to contractors in order to overcome delay, disputes and claims. All managerial levels should be participated with sensitive and important decision-making. Continuous coordination and relationship between project participants are required through project life cycle in order to solve problems and develop project efficiency. Employees in construction industries should be more interested with belonging to work to quality and time efficient project.

Consultants

Consultants should provide quality project design where design changes will be minimal in order to improve their efficiency and to increase project quality. In addition,

consultants are recommended to check on the master plan and provide quick orders delivered to contractors to obtain time efficient and to minimize disputes and claims.

Contractors

Contractors are recommended to use planned time through project implementation in order to improve time efficiency. They should minimize average delay in claiming to overcome disputes, time and cost efficiency problems. Contractors are also recommended to be more interested with sequencing of work according to schedule. Contractors are recommended to have specific policies for minimizing wastage of material with proper handling and management of materials on construction sites. Contractors should consider business environment risk in their cost estimation in order to overcome delay because of cash flow of project. There should be adequate contingency allowance in order to cover increase in material and equipment cost. Proper motivation systems and training should be established for improvement skill and labor performance of construction projects in the city of Addis Ababa.

For future research

It is recommended similar study should be conducted to cover other projects of the construction industry like road projects, water work projects etc. to improve efficiency of construction projects in Addis Ababa city.

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Appendices

Appendix A: Letter

JIMMA UNIVERSITY
ጅማ ዩኒቨርሲቲ

ቁጥር Ref.No. ፲GRPD/JiT/304/07
ቀን Date 22/11/07

To Whom It May Concern

Dear/ sir/ madam

Lemlem Temesgen is Ethiopian Road Authority (ERA) –Sponsored Post Graduate Student in Construction Engineering and Management at Jimma University Institute of Technology.

Currently she is undertaking MSc research work titled: **Assessment of building construction efficiency in Ethiopia; case study in Addis Ababa**

So we are kindly requesting your cooperation to provide her with all the relevant data necessary for her research work.

We would like to assure you that the findings from the research will be used only for academic purpose.

With Regards!

Dr -Ing Towfik Jemal (PhD)
Postgraduate, Research & Publication Director

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Appendix B: Questionnaire

The aim of this questionnaire is to **assess the factors influencing efficiency of building construction projects in Addis Ababa city**. The research is conducted for partial fulfillment of the requirements for the degree of MSc in construction Engineering and Management at Jimma University. This is required to be filled with exact relevant facts as much as possible.

This questionnaire consists of four parts:

PART ONE: ***General Information***

PART TWO: ***Factors affecting efficiency of building construction***

PART THREE: ***Perception of key stakeholders on the Effect of each factors affecting efficiency of building construction***

PART FOUR: ***Practices Concerning with Factors Influencing Efficiency of Building Construction Projects***

All information provided in this questionnaire will be treated with strict confidentiality and allowed to serve only for the purpose of the academic research under consideration. Interested participants of this study will be given feedback on the overall research results after the completion of the research work.

Investigation Team:

Main Advisor: Dr.-Ing. Yoseph Birru (Assistant Professor)-
Construction Project Management Institute of Ethiopian (CPMIE)CEO
Co-advisor: Engr. Getachew Kebede (MSc.)-
Dean School of Environmental and Civil Engineering
Researcher: Lemlem Temesgen *(+251-921-185772 /lemnat.nael@gmail.com)*

With Kind Regards,

Lemlem Temesgen

PART ONE

A. General Information

Please put (√) and/or fill in the blank space as appropriate

1. Type of Organization:

   ☐ Client ☐ Contractor ☐ Consultant

   ☐ Other, please specify: _____

2. Company size (Number of employees):

   ☐ <10 Employees ☐ 10-25 Employees

   ☐ 25-50 Employees ☐ > 50 Employees

3. Job title in the organization/company:

   ☐ Project Manager ☐ Site Engineer ☐ Project Coordinator

   ☐ Resident Engineer ☐ Office Engineer ☐ Counterpart Engineer

   Other, please specify: _____

4. Years of experience of the building construction projects in Addis Ababa:

   ☐ < 2 years ☐ 2-8 years ☐ > 8 years

5. Number of building construction projects executed:

   ☐ 1–3 projects ☐ 4–6 projects ☐ 7–10 projects ☐ >10projects

6. Estimated value of projects executed: (in ETB)

   ☐ Less than 50 Million ☐ 50–100 Million ☐ 100-150 Million

   ☐ 150-200 Million ☐ More than 200 Million

B. Basic information on Building Construction project efficiency

Inefficiency in Building Construction is a problem in Ethiopia building construction projects in general and that of building construction projects in the City of Addis Ababa.

☐ Strongly Agree ☐ Agree ☐ Moderately Agree

☐ Disagree ☐ Strongly Disagree

PART TWO

Factors affecting efficiency of building construction in Addis Ababa City

Below are lists of factors/groups affecting the efficiency of building construction projects. From your experience, please express/rate your opinion on the importance of the following factors as key building construction efficiency indicators of construction projects in Addis Ababa city. Please tick (√) and scale each representing the following rating in the appropriate box:

Where **(1)** = Very low important, **(2)** = Low important, **(3)** Medium important, **(4)** = High important and **(5)** = Very high important

No	Factors/Groups	Rate of Importance				
		1	2	3	4	5
A	**Cost Factors**					
1	Cost of Materials					
2	Fluctuation of prices of materials					
3	High cost of machinery and its maintenance costs					
4	Project financing and payments					
5	Payment delay from the client					
6	High transportation cost					
7	Lack of productivity standards					
8	Supplier manipulation					
9	Economic stability					
10	Level and number of competitors					
11	Project location					
12	Previous experience of the contract					
13	Relationship between management and labor					
14	Inadequate production of raw materials by the country					
15	Frequent design change & lack of coordination b/n designers &contractors					
16	Poor financial controls on site					
17	Bureaucracy in tendering method					
18	Weather conditions					
19	Number of construction going on at same time					

No	Factors/Groups	Rate of Importance				
		1	2	3	4	5
20	Absence of construction-cost data					
21	Wrong method of estimation					
22	Additional work					
23	Duration of contract period					
24	Government policies					
B	**Time Factors**					
25	Too many change orders from owner					
26	Poor planning and scheduling of the project by the contractor					
27	Ambiguities and mistakes in specifications and drawings					
28	Slow decision making from owner					
29	Poor qualification of consultants, engineers and staff assigned to the project					
30	Improper technical study by the contractor during the bidding stage					
31	Delay in progress payments by the owner					
32	Severe weather conditions on the job site					
33	Shortage of skilled &technical professionals in the contractor's organization					
34	Financial difficulties faced by the contractor					
35	Delays in contractors claims settlements and slow response by the consultants engineers regarding testing and inspections (work permit)					
36	Poor coordination by the consultant's engineers with the parties involved					
37	Insufficient coordination among the parties by the contractor					
38	Delay in mobilization					
39	Financial constraints faced by the owner					
40	Work suspension by the owner					
41	Delays in site preparation					
42	Improper handling of the project progress by the contractor					
43	Shortage of manpower					
44	Modification in material specifications					
45	Shortage of material and equipment					
46	Delay in materials delivery					
47	Delays by the contractor payments to subcontractors					
48	Failure of equipment					
49	Safety rules and regulations are not followed within the contractor's regulations					
50	Unforeseen site conditions					

No	Factors/Groups	Rate of Importance				
		1	2	3	4	5
C	**Material**					
51	Unsuitability of materials storage location					
52	Distance of suitable material location from project site					
53	Lack of waste management plans					
54	Lack of information about types and sizes of materials on design documentations					
55	Design changes and revisions					
56	Error in information about types and sizes of materials on design documentations					
57	Determination of types and dimensions of material without considering waste					
58	Ordering of materials that do not fulfill project req. defined on design documents					
59	Over ordering or under ordering due to mistake in quantity surveys					
60	Over ordering or under ordering due to lack of coordination between warehouse and construction crews					
61	Damage of materials due to deficient stockpiling and handling of materials					
62	Imperfect planning of construction					
63	Workers' mistakes					
64	Damage caused by subsequent trades					
65	Conversion waste from cutting uneconomical shapes					
66	Lack of onsite materials control					
D	**Performance of skilled manpower and labor**					
	Management factor (skilled)					
67	The level of management control					
68	Professionalism of the design team					
69	Difficulties in employing site supervisor					
70	Incompetence of site supervisor					
71	Late inspection of completed work					
	Workforce Characteristics Factors (labor)					
72	Quality, Experience and Training					
73	Disturbance					
74	Morality (e.g., alcohol influence)					
75	Frequent changes in labors					
76	Communication problems					
77	Turnover					
78	Absenteeism					
79	Motivation					

PART THREE

Perception of key stakeholders on the Effect of each factors affecting efficiency of building construction

Objective of the study: - to investigate perception of key stakeholders on the effect of each factors affecting efficiency of building construction.

Please tick (√) in the appropriate box and scale each representing the following rating:

(1) Never, (2) Minor, (3) Average, (4) High and (5) Very High

Questions: From your experience in the sector, what are the effects of these factors (in part two) on building construction project efficiency? Identify from the list and rank them in order of frequency of occurrence?

No	Effects	Frequency/rate of occurrences				
		1	2	3	4	5
1	Cost overrun					
2	Time overrun					
3	Environmental impact					
4	Loss of quality					
5	Dispute					

PART FOUR

Practices concerning with Factors Influencing Building Construction Projects Efficiency

A. Cost Management Practice

Please tick (√) in the appropriate box:

No	Cost Management Practice	No	Sometimes	Yes
1	Do you have the cash flow schedule associated with the estimated time schedule?			
2	Do you apply the actual value and earned value concept in controlling cost for the project?			
3	Do you have a cost engineer who is only responsible for dealing with cost control?			
4	Do you give right and authority for line managers to manage the actual expenses?			
5	Do you apply any software to plan, monitor, and control cost?			
6	If the answer for Q 5 is yes, what is the name of software program you apply?			
7	Did the project delay due to late payment from the client?			

B. Time Management Practice

Please tick (√) in the appropriate box:

1. What kind of method do you use to represent the project planning and scheduling?

   ☐ Bar Chart ☐ Critical path
   ☐ S-Curve ☐ Other, please specify: _____

2. How often the project team does formally meets for discussion of monitoring updating and controlling the progress?

   ☐ Daily ☐ Weekly ☐ Monthly ☐ No

3. Which software do you apply for planning and scheduling the progress of the project?

   ☐ Primavera ☐ MS Project
   ☐ MS Excel sheet ☐ Others, please specify _____

4. Did projects be delay because of the client?

☐ Yes ☐ No ☐ Sometimes

C. Material Management Practice

From your experience, please express/rate your opinion on the importance of the following methods for materials waste managing and minimization of construction projects in Addis Ababa city. Please tick (√) and scale each representing the following rating in the appropriate box:

Where **(1)** = Very low important, **(2)** = Low important, **(3)** Medium important, **(4)** = High important and **(5)** = Very high important

No	Strategy of waste minimization	Rate of Importance				
		1	2	3	4	5
1	Purchasing raw materials that are just sufficient					
2	Good coordination between store and construction personnel to avoid over ordering					
3	Accurate and good specifications of materials to avoid wrong ordering					
4	Proper storage of materials on site					
5	Checking materials supplied for right quantities and volumes					
6	Change of attitude of workers towards the handling of materials					
7	Waste management officer or personnel employed to handle waste issues					
8	Early and prompt scheduling of deliveries					
9	Recycling of some waste materials on site					
10	Accurate measurement of materials during batching					

D. **Skilled and unskilled manpower management practice**

Please tick (√) in the appropriate box:

1. How do you supply the motivation system to enhance the manpower efficiency?

☐ Increase salary ☐ Bonus in position

☐ Training ☐ Others, please specify _____

2. Which of the following monitoring system do you use to control output of the work force?

☐ Data collecting and evaluating ☐ Superintendent's report

☐ Others, please specify _____

E. Strategies to improve efficiency

Which of the following strategies are used in the organization to improve the efficiency of building construction projects? Select all that is applicable.

☐ Good communication channel ☐ Recognition of uncertainties

☐ Knowhow of the practitioners ☐ Monitoring and feedback

☐ Proper planning and scheduling ☐ Reward and punishment

☐ Top management support ☐ Stakeholder's participation

☐ Using updated technology ☐ Greater use of prefabrication

☐ Proper and modern construction equipment

☐ Proper site management and frequent supervision

☐ Creating collaborative working environment in construction

☐ Complete and proper design at the right time

☐ Innovative, widespread use of demonstration installations

☐ Effective performance measurement to drive efficiency and support innovation

☐ Widespread deployment and use of interoperable technology applications

☐ Improved job-site efficiency through more effective interfacing of people, processes, materials, equipment, and information

If others please specify _____

Thank You for Your Cooperation and Support!!