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S C H O O L O FG R A D U A T E S T U D I E S

PERFORMANCE ASSESSMENT OF PUBLIC BUILDING CONSTRUCTION PROJECTS IN ADDIS ABABA

BY

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Abstract

This research analyzes the extent of cost and time performance of public building construction projects in Addis Ababa and tries to identify the critical factors that influence cost and time performance of public building projects in Addis Ababa. Secondary data and questionnaire survey were used to collect relevant information. Secondary data analysis results shows that there is statistically significant variation in the cost and time performance of public building construction projects in Addis Ababa. The outcome of secondary data indicates that 74.3% of public building construction projects in Addis Ababa experienced cost under run and the remaining 25.7% projects were experienced cost overrun. Out of this 74.3% projects, 40% of the projects varies with more than negative 20%. Project time overrun of public projects is a critical problem of the construction industry. The research finding points out 100% of the projects delayed and not completed within the time stated. The minimum and the maximum time overrun is found to be 10% and above 250% respectively. Also to identify critical time and cost performance factors RII (relative importance index) value of each factors was calculated and for each parameters the top five critical factors were identified. Finally based on the findings and results some recommendations were given.

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My Last but not least gratitude goes to my family specially my lovely wife sr. Tigist Misganaw whose patience support and love enabled me to complete this work.

DECLARATION

I declare that this thesis entitled "**Performance Assessment of Public Building Construction projects in Addis Ababa**" is my original work. This thesis has not been presented for any other university and is not concurrently submitted in candidature of any other degree. To the best of my knowledge and belief this thesis contains no materials previously published or written by another person except where due reference is made.

Candidate:

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List of Abbreviations

ANOVA -Analysis of Variables

CCSS-Centre for Construction Strategic Studies

CV-Cost Variance

CPI-Cost performance index

EEA- Ethiopian Economic Association

EVA Earned value Analysis

EPRDF-Ethiopia Peoples' Republic Democratic Front

ETBRC- Ethiopian Building Road Construction.

MPaEC-Ministry of Planning and Economic Cooperation.

NEC-National Engineers and Contractors

PMI-Project Management Institute

RII-Relative Importance Index

SSC-State service commission

SV-Schedule Variance

SPI-Schedule performance Index

TRADE - Training Resources and Data Exchange

USCINRC - U.S. Construction Industry, National Research Council

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Chapter one

1. Introduction

1.1. Background of the Research

The Construction Industry can be described as the sum of all economic activities related to civil and building works: their conception, planning, execution, and maintenance. Such works normally comprise capital investment in the form of roads, railways, airports, ports and maritime structures, dams, power generating stations, irrigation schemes, health centers and hospitals, educational institutions, warehouses, factories, offices and residential premises. It is also defined generally as 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, etc. (Hagos & Shewangzaw, 2009).

In case of Ethiopia, activities covered under the industry are the construction and maintenance activities of: (1) Residential buildings in urban and rural areas, (2) industrial buildings, i.e. factory buildings, ware houses, office buildings, garages, hotels, schools, hospitals, clinics, etc., (3) Other construction works, like roads, dams, dikes, athletic fields, electricity transmission lines.

The construction industry is vital for the development of any nation. In many ways, the pace of the economic growth of any nation can be measured by the development of physical infrastructures, such as buildings, roads and bridges (Takim & Akintoye, 2002). Especially a developing country, like Ethiopia, where consecutive economic growth has been registered, demands high rate of investment and consequently the need for construction of adequate public facilities to serve the development of the country.

The contribution of the sector to the overall economic development of a country is significant (EEA, 2007). It is among the major economic activities for the development of social, political, and economical welfare of the society. Didenko and Konovets (2008) indicated that the construction industry is one of the most used examples of project based industries. It might be characterized as complex, cost and time consuming and risky.

However, construction projects are also dynamic and challenging which attracts capital, new technologies and brilliant brains. Building projects particularly represent one of the largest sectors of the construction industry in the most developing economies of the world .It involves substantial financial and human resources and plays a vital role in the national economy and has a wide range of application to different sectors. Agriculture, industry, health, education, etc. are some of the sectors that directly or indirectly require construction facilities to implement their basic duties.

According to U.S. Construction Industry National Research Council (USCINRC, 2009) the industry is segmented by analysts and practitioners into at least four distinct sectors—residential, commercial, industrial, and heavy construction. These sectors differ from each other in terms of the following:

- The characteristics of project owners, their sophistication, and their involvement in the construction process.
- Complexity of project.
- The source and magnitude of financial capital.
- Required labor skills.
- The use of specialty equipment and materials.
- Design and engineering processes.
- Knowledge and other factors.

Construction is multifaceted in its nature because it contains large numbers of parties as clients, contractors, consultants and regulators. Despite this complexity, the industry plays major role in the development and achievement of society's goals. It is one of the largest industries and contributes about 10% of the gross national product (GNP) in industrialized countries (Navon, 2005).

It also has important contributions to the Ethiopian economy. For instance, the GDP share of the sector is averaged at about 5.2 percent in the period 2009- 2013. The sector has registered relatively higher growth as compared to the growth of GDP during this period. Over this period, there has been increased investment on the development and expansion of various infrastructure projects like roads, airports and residential and non-residential housing units (EEA, 2014)

As Carpenter (2014) described, dramatic changes have affected the construction industry over the past several decades and owners, architects, and contractors alike have been searching for methods to construct projects in a manner that improves performance while reducing risk. The construction industry is an increasingly complex, fragmented, and dynamic industry.

Present-day construction projects involve a lot of stakeholders with dozens of project staff members in decision making capacities of multiple firms and disciplines, each with their own separate focus on project planning, designing and construction.

The quality of life of human beings relies in part on the products of construction industry—houses, office buildings, factories, shopping centers, hospitals, airports, universities, refineries, roads, bridges, power plants, water and sewer lines, and other infrastructure. Construction product such as buildings and infrastructures provide shelter, water, power, and support commerce, education, recreation, mobility and connectivity (USCINRC, 2009).

Building projects are unique in their nature and construction process varies widely because variations in factors such as the physical and the economic environments, the construction team and/or location and time. Internationally distinctive cultural features, traditions and customs present even further obstacles towards performance of construction projects (Xiao and Proverb, 2003).

Due to the uniqueness of projects, there is no one way or method of organizing the resources for all projects. Every construction project is unique and has its own operating environment and sets of technical requirements. As a result, the execution of a construction project is subjected to numerous constraints that limit the commencement or progression of field operation, which have significant impact on project performance.

1.2. Construction Industry in Ethiopia

According to a report of Ethiopian Economic association (2007), the evolution of modern construction industry in Ethiopia is a recent phenomenon and can generally be summarized into four distinct periods. The first period covers the period prior to the year 1968 when most civil works (including roads) were carried out by foreign contractors through international competitive bids. Relevant skilled manpower was also largely employed from abroad.

The second era in the development of the construction industry in Ethiopia was that spanning the period 1968 -1982 when some small domestic contractors started to emerge. In order to build capacity and enhance their competitiveness, the government took initiatives to help contractors to participate in the construction of feeder road projects. In this connection, three domestic contractors can be mentioned: BERTA Construction Company, National Engineers and Contractors (NEC) and the Ethiopian building and road construction (ETBRC).

The third period in the evolution of the industry was the period of the Derg regime which had brought the then evolving domestic private construction companies under state control in 1982. In addition, state-owned construction companies were established. It was regarded as the lost opportunity for the creation of a competitive construction industry in the country (EEA, 2006/7).

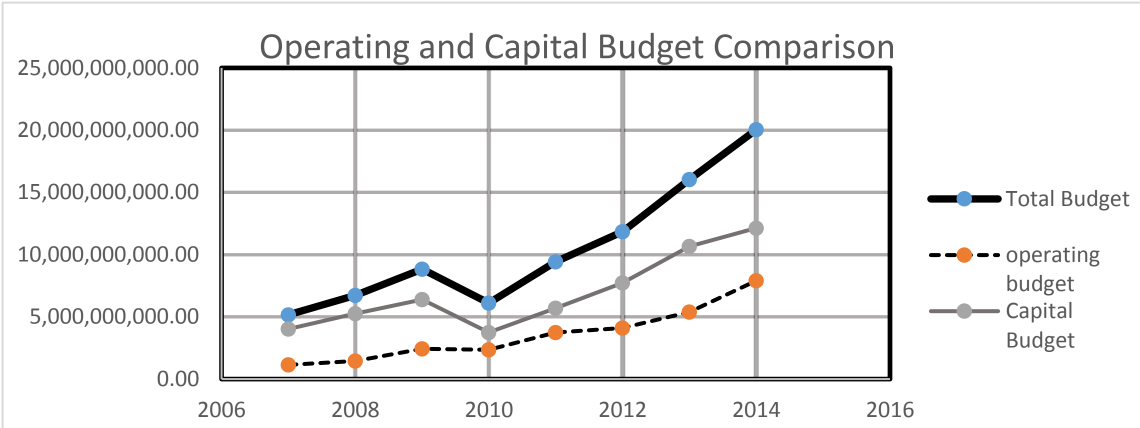
The fourth period begins from the time the EPRDF-led transitional government of Ethiopia took power in May 1991. Economic management has shifted from command to a free market system and various reform measures aimed at promoting the private sector including private construction companies have been introduced. As a result, the role of private contractors in the industry has started flourishing while that of public companies diminishing since 1991(EEA, 2006/7).

Due to implementation of a new market system and development program the share of capital budget has been increasing from year to year. According to a research made by Jekal (2006) on stakeholders and their relationship for public construction projects, during the period of 1997/98 to 2001/02 the share of capital budget is 58.3% of the total annual budget of the country.

Table 1.1: Addis Ababa city administration Annual capital and Operational budget from year 2007 to 2014.

Fiscal Year	Total budget	Operating budget	Capital budget	Capital budget in %
2006/2007	5,166,530,000	1,141,260,000	4,025,270,000	71.91
2007/2008	6,721,150,000	1,454,880,000	5,266,270,000	78.35
2008/2009	8,841,100,000	2,436,380,000	6,404,720,000	72.44
2009/2010	6,112,450,000	2,363,120,000	3,749,330,000	61.34
2010/2011	9,431,540,000	3,744,790,000	5,686,750,000	60.30
2011/2012	11,836,340,000	4,104,410,000	7,731,930,000	65.32
2012/2013	16,040,100,000	5,380,050,000	10,660,050,000	66.46
2013/2014	20,041,110,000	7,904,070,000	12,137,040,000	60.56
Total	84,190,320,000	28,528,960,000	12,137,040,000	66.11

Figure 1.1: Addis Ababa city administration annual capital and operation budget from year 2007 to 2014.



From the table 1.1 and Figure 1.1 above it is understood that, from year 2007 to 2014 the share of capital budget of Addis Ababa City Administration ranges from 60% to 78.35% from year 2007 to 2014 and 8 years average is 66.11%. This indicates that much of the city administration budget has been allocated to capital budget.

Therefore, Construction performance, how well, how quickly, and at what cost buildings and infrastructure can be constructed—directly affects cost of projects and the robustness of the national economy. Construction performance also affect the outcomes of national efforts to renew existing infrastructure systems; to build new infrastructure for power from renewable resources; and to remain competitive in the global market. Changes in building design, construction and renovation, building materials and materials recycling is essential to the success of national efforts to minimize environmental impacts, reduce overall energy use, and reduce greenhouse gas emissions (NSTC, 2008).

Ethiopia is not exceptional. The last two decades are the period that the construction industry has drastically changed. It has great deal of contribution to different sectors, such as manufacturing, agriculture, transportation, education, health etc. Therefore, evaluating the performance of construction projects is a current issue that should be considered as to how it has been done and look for some areas which need improvement to achieve project objectives.

1.3. Statement of the Problem

Construction can be considered as a dynamic industry which is constantly facing uncertainties. Besides these uncertainties, involvement of many stakeholders make the management of cost and time difficult which consequently causes time and cost deviation. Therefore, cost and time overruns are considered one of the most critical issues during the execution of construction projects (Arcila, 2012).

The findings of the study conducted by Memon et al. (2012) revealed that 92% of construction projects of Malaysia were facing time overrun and only 8% of project could achieve completion within contract duration and 89% of respondents agreed that their projects were facing the problem of cost overrun with average overrun at 5-10% of contract price. The same is true for Nigeria and Kenya. The research made by Auma (2014) was an evidence that the performance of the construction in Kenya is poor. Majority of the projects escalated with a magnitude of over 50% and over 50% of the projects likely to escalate in cost with a magnitude of over 20%. Construction projects in Nigeria are also facing the same problem concerning cost and time. According to Akinsiku (2014) 42.3% of construction projects' time and cost performance is between 5-10% of the time scheduled and budgeted cost.

According to a report by Federal Democratic Republic of Ethiopian, Ministry of Urban Development, Housing and Construction (2014) on project performance status evaluation stated that among 14 public building projects under construction 8 projects, i.e. 57%, have failed to meet the planned percentage, (MOUDHD, 2014).

Public and private clients allocate huge amount of budget for the construction of different building and infrastructure projects to achieve their objectives. The objectives of the owners could be financial, social, and political and in which ever the case controlling and monitoring the efficiency and effectiveness of the project is crucial. Therefore, measuring performance is very important to connect industry and project goals and objectives for improvement of process and method of doing things and administering projects. There could be many different ways of doing things and administering projects. In addition to identification of performance success factors, investigation of performance of projects should have to be done in project and industry level along with their respective process and method.

Furthermore, “you can’t improve what you don’t measure” (Cain, 2004). One of the methods used by industries to measure changes in performance is to compare the actual with planed goal.

Performance measures are enablers of innovation and of corrective actions throughout a project’s life cycle. They can help policy and decision makers, and different concerned stakeholders to understand how processes or practices led to success or failure, improvements or inefficiencies, and how to use that knowledge to improve methods, processes, and the outcomes of active projects.

Industry-level measures are needed to determine whether the as a whole is improving or declining over time. Various indicators can be used to track industry trends for several years to identify the root causes of improvement or decline. Project-level measures are needed to contribute to the understanding of how an individual project compares with other similar projects in terms of cost, schedule, cost changes, labor hours, and other factors. Such current measures are of greatest value to owners of multiple projects and to large contractors who are seeking to reduce the costs and delivery time of projects, to improve worker safety, or to initiate some other changes in construction-related processes and practices.

1.4. Research Questions

- To what extent has performance of public building construction projects been achieved in terms of cost?
- To what extent has performance of public building construction projects been achieved in terms of time?
- Which one of the identified factors are critical for cost and time performance of public building construction projects in Addis Ababa?

1.5. Objectives of the Study

1.5.1. General objective

To investigate performance of public building construction projects in Addis Ababa.

1.5.2. Specific objectives

- To assess the current performance state of public building construction projects in Addis Ababa.
- To assess cost and time performance of public building construction projects.
- To identify critical factors that affect cost and time performance of public building construction projects in Addis Ababa.
- To formulate recommendations based of the research findings on performance of construction of public building construction projects.

1.6. Scope of the study

The scope of the study is bounded by five main aspects: geographical, sectoral, project stage, performance measurement parameters and Project years.

Geographical scope: Geographically the research is limited to public building construction projects in Addis Ababa city.

Sectoral Scope: There are various sectors in Construction industry such as road, water works, housing and other public buildings that are managed by different government offices. Hence sectoral scope of this research is Public building projects other than Housing development projects.

Project stage scope: Performance of construction project can be assessed at different stages of projects relating to the objectives of stakeholders particular to the stage. Each stages has its own deliverables that can be reviewed whether the stage's goal is attained or not by using various performance measurement parameters. Investigating performance of construction project at each stages is extensive and needs longer time and is expensive. Therefore, project stage scope of the research is limited to construction stage of the project.

Performance measurement Parameter Scope: There are many parameters that can be used to measure performance of construction projects. The nature, complexity and objectives of the project determine which indicator is much more suitable to assess the performance of a particular project. Time, cost and quality are, however, the three predominant performance evaluation dimensions. Due to time and budget constraints this research focuses on time and cost parameters to measure performance of public building construction projects.

Project Years: Ethiopian Federal government in a new approach prepared a first five years Growth and Transformation plan which considerably changed the construction sector. Mega projects, such as sugar factories, rail way, Renascence Dam are among projects which had been commenced during the first GTP. In addition to these Mega projects, many public building and Housing projects had been constructed than before during this period. Currently the second GTP is underway and it is in its first year duration.

Therefore, as a result of this change the research includes projects that have been started with in the first five years GTP period from year 2010/11 to 2015/16.

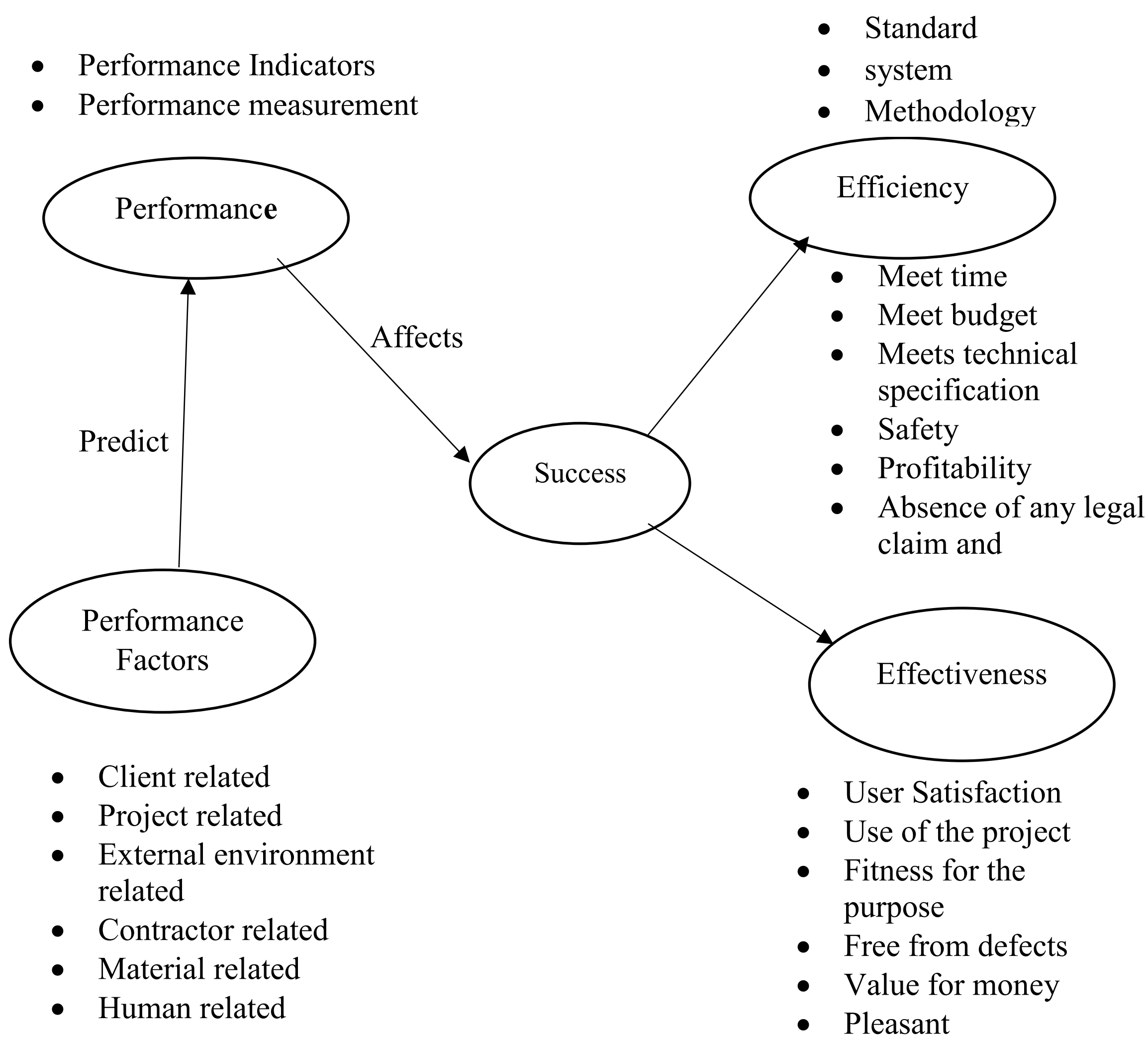
1.7. Significance of the Study

This study is significant to professionals, decision makers, policy designers and practitioners to look for the best policies, methods and process of doing and managing projects and to use and coordinate human, material and other resources efficiently and effectively. Also it will initiate to review the existing practices, methods of work and management system to improve the performance of public building projects in Addis Ababa. It also helps to review existing policies, regulations, and manuals to create conducive environment for effective and efficient coordination and allocation of resources for the achievement of project objectives of stakeholders. Based on the findings, it encourages each stakeholder to play their role for the successful achievement of projects and effective utilization of resources.

1.8. Conceptual Framework

Various conceptual frameworks are developed by different scholars to show the interdependence of variables and their causal relationship.

Figure 1.2: The Relationship between Performance Factors, Project Performance & Project Success.



1.9. Ethical considerations

The researcher assure the ethical undertaking of the research by adhering to the following ethical standards of doing research. Informed consent, Voluntary participation, Confidentiality and anonymity of respondents. Prior to data collection, letter issued from concerned administrative bodies of Addis Ababa University to different Government and private organizations from where valuable information has been obtained for the research. The public clients and Contractors under the study was also informed about the study and a formal letter was obtained. During data collection, each respondent was informed about the purpose, scope and expected outcome of the research, and appropriate written consents was taken from the respondents. Anyone who was not willing to participate was excluded from the study.

Chapter Two

2. Literature Review

2.1 Project Performance

Performance is a broader concept that covers both the economic and operational aspects of an industry. Performance refers to fineness and includes profitability and productivity among other non-cost factors, such as quality, speed and delivery. "*If you don't know how well you are doing, how do you know you are doing well*?" (TRADE, 1995). In non-construction sectors, know how well you are doing is the primary driver for performance measurement and performance self-assessment as the mechanisms by which firms accurately inform themselves of their true performance in every aspect of their objectives, including the performance of the firms that make up their supply chain.

Performance has been described as the degree of execution of certain task (TRADE, 1995). It is related to the prescribed objectives which form the project considerations. From project management perspective, it is all about meeting stakeholders' needs and expectations from a project. It invariably involves placing consideration on three major project elements i.e. time, cost and quality (PMI, 2004). It has been pointed out that, in today's highly competitive and uncertain business environment, the client who is the major stakeholder, wants speedier delivery of their project with early start of construction work, certainty of performance in term of cost, quality and time, value for money for their investment, minimal exposure to risk and early confirmation of design and price or cost (CCSS, 1998). Although many tend to focus on the elements of cost, quality and time, all others are also important parameters of project performance.

Various literature and researchers have revealed that performance should not be considered only as the achievement of project schedule, time and quality. It is has a broader concept that can be assessed taking different parameter relating to the objective of different stakeholders for a particular project. Customer satisfaction, meeting specifications, health and safety, environmental responsiveness are some of the concerns when evaluating successful achievement of project objectives.

2.2 Performance measurement

Performance Measurement (PM) is a vital tool that can enhance the capturing of knowledge and hence provide improved construction performance, at both corporate and project levels. Measurement is a core activity for sector that is focused on delivering results. Performance is measured primarily allow maximizing the results that are meaningful to organizations by adjusting product or service, using the capabilities and funding available. It enhances the development of a learning organization by capturing and analyzing what is happening in the firms or industry environment, especially through its customers, employees, suppliers, partners and new technologies (Mbugua et al., 1999).

Measurement enables projects and businesses to be compared with each other on the basis of hard information, allowing effective (best) practices to be identified and applied more widely. PM improves management practice. It provides essential information by enabling activities to be monitored, on a regular basis, at several levels within the organization. Performance measurement provides information for strategic evaluation. It also provides a broad / comprehensive/ picture of a business and a strategic focus on critical business issues and on continuous improvement (Mbugua et al., 1999).

Neely et al. (1995) refer to the performance measurement system as *"... a set of metrics used to quantify both efficiency and effectiveness of actions."* Performance measurement has two main aims: to connect company goals and objectives to improvements and to set targets for improvement activity (Grunberg, 2004). Measurement enables increased visibility of the quality and progress of a certain task and helps to justify, manage and evaluate quality and productivity improvement programs at the operations level. The point has been made that proper measurement goals are those that focus as much on communication as on evaluation and targets (Pekuri et al., 2011).

According to a critical review of Deng et al. (2012) performance measurement in construction can be broadly done at three general levels.

1. Industry level: assesses the performance of the industry, both nationally and internationally
2. Business level: measures the performance of the construction organization, including both one-time evaluation and continuous measurement. The spreading and embedding of lessons learnt to generate improvement in project businesses and construction.
3. Project level: evaluate the performance (and success) of construction projects. This may work over the project lifecycle, but most project organizations measure insufficiently to induce improvement opportunities within a project hence potential benefit is to obtain general lesson for spreading and embedding of lessons on other projects.

Mohamed (1996) presented a three-level framework on how the concept of performance measurement could be related and adapted to construction, providing insights as to why and at what level the performance measurement should occur. Internal performance measurement is the examination of an individual organization's current processes and practices for the purpose of identifying improvement targets that relate to how the organization does business and how its customers evaluate their services. Project performance measurement measures the performance of projects in which the organization is involved; its aims are meeting customer requirements, measuring productivity rates, and validating and maintaining its estimating databases. External benchmarking is mainly concerned with the selection and implementation of managerial and technological breakthroughs developed by other industries, in order to generate significant improvement in construction.

Project performance can be measured and evaluated using a large number of performance indicators that could be related to various dimensions (groups) such as time cost, quality, client satisfaction, client changes, business performance, health and safety (Saleh, 2009).

2.3 The goals of performance Measurement

1. **Informing strategy and policy development.** Performance measurement is used to inform Overall strategic planning and direction-setting as well as the ongoing development and implementation of policy and plans. Evidence gained about the difference the agency made through the services it has provided, and the interventions chosen can be used to make informed, targeted changes to policies and plans.

2. **Informing capability and service development.** Performance measures are used to identify areas where capabilities and services need to be developed to enhance core outcomes. For instance, the agency should use performance measurement information to inform workforce planning, recruitment, HR development and organizational planning, which all contribute to enhancing the design, delivery and impact of core services.

3. **Reporting achievements.** Performance measurement should also be used to report coherently and concisely on their achievements. If the performance measurement process is followed it is possible to produce clear, coherent performance stories around the aimed priorities to be achieved. These can clearly explain how one is progressing towards achieving its outcomes (SSC, 2008).

2.4 Construction Project planning

Planning is a fundamental and challenging activity in the management and execution of construction project. Project outcomes, which could loosely be referred as successful or failed, are usually measured by comparing the project with certain pre-defined goals expressed in terms of time, cost and quality (Leung et al., 2003).

The objective of planning in construction is to ensure that the sequence and magnitude of the activities necessary in executing the contract work efficiently are properly understood and identified, their logical relationship established and scheduled to a time duration; and the resources needed for carrying them out well in time, for the entire project to be completed within the overall time schedule and cost, are assessed and made available timely and economically. Economically because to achieve business objective of profit earning.

Construction Project planning involves various aspects and prepared at all phases of project. It is also can be prepared at different levels of management, such as operational, departmental and project levels. For the purpose of determining the project cost and duration, it is necessary to define and quantified the scope of work with the help of tender document. The entire planning will be based on the work so defined and quantified.

2.5 Project control process

In order for a company to succeed, it is critical that the company can control and manage its operations effectively. The better the controllability is, the better the company's ability to react to changes. In order to have good controllability, a company must have access to indications of past, present and future trends from the operative environment (Haapasalo et al., 2006). Opportunities for creating value are shifting from the management of tangible assets to the management of knowledge-based strategies that develop an organization's intangible assets (Anderson & McAdam, 2004). These intangible assets are important elements when developing lead measures for a proactive performance measurement system.

There are four essential elements to correctly control and evaluate the progress and performance of construction projects. These are setting a baseline plan, measuring progress and performance, comparing actual performance against plan, and taking corrective action.

1. *Setting base line:* - The project baseline plan provides the essential features for measuring performance. It begins with identifying and defining scope of each project activities and setting the required output inters of measurable variable. These variables show whether the activity is done according to the established objective the measure the progress and performance of individual activities in turn indicate the achievement of the whole project.
2. *Measuring and monitoring progress and performance*—accurate mechanisms for project measurement are essential prerequisites of effective control systems. The first step in creating them is to establish a control system that measures the ongoing status of various project activities in real time, and provides project managers with relevant information as quickly as possible. The second step is to determine what should be measured. There are both quantitative and qualitative measures for monitoring project progress, and integrating

quantitative measures like time and cost into the control system is relatively easy. On the other hand, qualitative measures like customer satisfaction with product functionality and technical specification can be determined only through on-site inspection or actual use.

3. *Comparing actual performance against plan*—Given that actual project performance is rarely in accordance with the original baseline plan, the next step is to compare the two to measure deviations. This analysis—sometimes referred to as ‘‘gap analysis”—is essential for determining current project status. As a rule, the smaller the deviation between the baseline plan and actual performance, the easier it is to take corrective action.
4. *Taking remedial action*—in cases where the deviations between the plan and actual performance are large and obvious, some form of corrective action is necessary to bring the project back on track. In some cases, the action may be relatively minor; in others, it may require serious and significant remedial steps. In situations where conditions or project scope have changed, the original baseline plan may have to be revised.

2.6 Benefits of Performance measurements

US department of Energy in its book titled “How to measure performance (1995)”, listed seven important benefits of measurements.

1. Identify whether customer requirements have been met.?
2. Helps to understand processes. To confirm what is known or reveal what is not known. Aids to identify where the problems are?
3. Ensures decisions are based on fact, not on emotion. Are decisions based upon well documented facts and figures or on intuition and gut feelings?
4. To show where improvements need to be made. Where can we do better? How can we improve?
5. To show if improvements actually happened. Do we have a clear picture?
6. To reveal problems that bias, emotion, and longevity cover up. If we have been doing our job for a long time without measurements, we might assume incorrectly that things are going well. (They may or may not be, but without measurements there is no way to tell.)
7. To identify whether suppliers are meeting requirements. Do suppliers know if our requirements are being met?

2.7 Performance measurement process

US department of defense (1995), on its book how to measure performance stipulated the process of measuring performance as the following

1. Identify the process flow. This is the first and perhaps most important step. If your employees cannot agree on their processes, how can they effectively measure them or utilize the output of what they have measured?
2. Identify the critical activity to be measured. The critical activity is that culminating activity where it makes the most sense to locate a sensor and define an individual performance measure within a process.
3. Establish performance goal(s) or standards. All performance measures should be tied to a predefined goal or standard, even if the goal is at first somewhat subjective. Having goals and standards is the only way to meaningfully interpret the results of your measurements and gauge the success of your management systems.
4. Establish performance measurement(s). In this step, you continue to build the performance measurement system by identifying individual measures. Identify responsible party(s). A specific entity (as in a team or an individual) needs to be assigned the responsibilities for each of the steps in the performance measurement process.
5. Collect data. In addition to writing down the numbers, the data need to be pre-analyzed in a timely fashion to observe any early trends and confirm the adequacy of your data collection system.
6. Analyze/report actual performance. In this step, the raw data are formally converted into performance measures, displayed in an understandable form, and disseminated in the form of a report.
7. Compare actual performance to goal(s). In this step, compare performance, as presented in the report, to predetermined goals or standards and determine the variation (if any).
8. Are corrective actions necessary? Depending on the magnitude of the variation between measurements and goals, some form of corrective action may be required. Make changes to bring back in line with goal. This step only occurs if corrective action is expected to be necessary. The actual determination of the corrective action is part of the quality improvement process, not the performance measurement process. This step is primarily concerned with improvement of your management system.

9. Are new goals needed? Even in successful systems, changes may need to be revised in order to establish ones that challenge an organization's resources, but do not overtax them. Goals and standards need periodic evaluation to keep up with the latest organizational processes.

2.8 Performance indicators

Performance measures quantitatively tell something important about products, services, and the processes that produce them. They are tools to help us understand, manage, and improve what organizations do. They provide with the information necessary to make intelligent decisions about what to do (TRADE, 1995).

- How well an organization is doing?
- Whether Goals have been met.
- If customers are satisfied.
- If processes are in statistical control.
- If and where improvements are necessary.

A performance indicator is composed of a number and unit of measure. The number gives us a magnitude (how much) and the unit gives the number a meaning (what). Performance measures are always tied to a goal or an objective (the target). Performance measures can be represented by single dimensional units like hours, meters, nanoseconds, dollars, number of reports, number of errors, etc. They can show the variation in a process or deviation from design specifications. Single-dimensional units of measure usually represent very basic and fundamental measures of some process or product (TRADE, 1995).

More often, multidimensional units of measure are used. These are performance measures expressed as ratios of two or more fundamental units. These may be units like Kilometer per Liter (a performance measure of fuel economy), number of accidents per million hours worked (a performance measure of the companies safety program), or number of on-time vendor deliveries per total number of vendor deliveries. Performance measures expressed this way almost always convey more information than the single-dimensional or single-unit performance measures.

According to TRADE (1995); most performance measures can be grouped into one of the following six general categories. However, certain organizations may develop their own categories as appropriate depending on the organization's mission:

1. Effectiveness: A process characteristic indicating the degree to which the process output (Work product) conforms to requirements. (Are right things being done?)
2. Efficiency: A process characteristic indicating the degree to which the process produces the required output at minimum resource cost. (Are we doing things right?)
3. Quality: The degree to which a product or service meets customer requirements and expectations.
4. Timeliness: Measures whether a unit of work was done correctly and on time. Criteria must be established to define what constitutes timeliness for a given unit of work. The criterion is usually based on customer requirements.
5. Productivity: The value added by the process divided by the value of the labor and capital consumed.
6. Safety: Measures the overall health of the organization and the working environment of its employees.

2.9 Key Performance indicators in construction projects.

The purpose of the Key Performance Indicators (KPIs) is to enable measurement of project and Organizational performance throughout the construction industry (UK working group, 2000). Performance of construction projects depends upon on many different factors that are available all the way through consecutive and progressive phases that starts from inception to operation and commissioning stages. The common assessment of the success of construction projects is that they are delivered on time, to budget, to technical specification and meet client satisfaction (Baker *et al.*, 1983). However, the criteria for success are in fact much wider, incorporating the performance of the stakeholders, evaluating their contributions and understanding their expectations (Atkinson et *al.*, 1997).

Traditionally, three indicators have been used to evaluate the success of construction projects: cost, time and quality. Kagioglou et al. (2001) contend that these measures are insufficient, and that many other factors exist that can influence customer satisfaction and the client's willingness to pursue a given procurement route in the future. It has been proposed, for example, that project success should also take into account the project's psychosocial outcomes, which refer to satisfaction of interpersonal relations with project members.

Cost, time and quality are the three common parameters of project performance. It has been stressed that in today's highly competitive and uncertain business environment, clients are demanding for better value from their investment. They want their project to be completed on time, within the estimated cost and with the right quality (Padang; 2006).

The traditional measures known as the "iron triangle" provide an indication of the success or failure of a project, but they do not provide a balanced view of the project's performance. Usually they are apparent only at the end of the project and should therefore be classified as lagging indicators of performance (Kagioglou et al., 2001). The general revolution on performance measurement that has taken place over the past several years has focused on a more comprehensive approach to assess project success. Performance measurement frameworks have been proposed where project success is divided into dimensions, and where project success is considered during the different stages of a project as well as from various perspectives (Chan; 2004).

Since most of the current performance indicators have been product and outcome focused, there is a skeptical attitude towards key performance indicators. However, in recent years, performance indicators related to processes have started to emerge. These indicators include: planned percent complete (PPC), waste, safety and quality process improvement, Habanova and Al-Jibouri (2009) have further identified key performance indicators for the pre-project, design and construction phase of a project. These indicators are likely to improve practices by enabling managers to focus on controlling the main sub-processes and thus increasing the chance of project success measured by the following end-project goals: meeting financial, scheduling and functional requirements, ensuring client satisfaction, health and safety and building quality.

UK Working Group Report on Key Performance Indicator (2000) have identified seven parameters for benchmarking projects, in order to achieve a good performance. These are Time, Cost, Quality, Client Satisfaction, Client Changes, Business Performance, Health and Safety.

2.10. The Level of KPIs

Headline Indicators provide a measure of the overall, rude state of health of a firm. Operational Indicators bear on specific aspects of a firm's activities and should enable management to identify and focus on specific areas for improvement. Diagnostic Indicators provide information on why certain changes may have occurred in the headline or operational indicators and are useful in analyzing areas for improvement in more detail. The indicators are identified as applicable at project and/or company levels. In some cases the company indicator is the average value of that company's project indicators. The indicators are identified as appropriate to the various members of the supply chain to which they could be applied (UKWGR, 2000).

The KPI groups and their associated indicators are shown in the table below

Table 2.1: Key performance indicators

Source: - UK Working Group Report on Key Performance Indicator, 2000.

Indicator group	Indicator	Level
Time	1. Time for Construction	Headline
	2. Time Predictability – Design	Headline
	3. Time Predictability – Construction	Headline
	4. Time Predictability – Design & Construction	Operational
	5. Time Predictability – Construction (Client Change Orders)	Diagnostic
	6. Time Predictability – Construction (Project Leader Change Orders)	Diagnostic
	7. Time to Rectify Defects	Operational
Cost	1. Cost for Construction	Headline
	2. Cost Predictability – Design	Headline
	3. Cost Predictability – Construction	Headline
	4. Cost Predictability – Design & Construction	Operational
	5. Cost Predictability – Construction (Client Change Orders)	Diagnostic
	6. Cost Predictability – Construction (Project Leader Change Orders)	Operational
	7. Cost to Rectify Defects	
Quality	1. Defects	Headline
	2. Quality Issues at Available for Use	Operational
	3. Quality Issues at End of Defect Rectification Period	Operational

Client satisfaction	1. Client Satisfaction Product – Standard Criteria 2. Client Satisfaction Service – Standard Criteria 3. Client Satisfaction – Client-Specified Criteria	Headline Headline Operational
Change Order	1. Change Orders – Client 2. Change Orders – Project Manager	Diagnostic Diagnostic
Business performance	1.Profitability (company) 2. Productivity (company) 3. Return on Capital employed (company) 4. Return on Value Added (company) 5. Interest Cover (company) 6. Return on Investment (client) 7. Profit Predictability (project) 8. Ratio of Value Added (company) 9. Repeat Business (company) 10. Outstanding Money (project) 11. Time taken to reach Final Account (project)	Headline Headline Operational Operational Operational Operational Operational Diagnostic Diagnostic Diagnostic Diagnostic
Health and Safety	1. Reportable Accidents (fatalities) 2. Reportable Accidents (non-fatal) 3. Lost Time Accidents 4. Fatalities	Headline Operational Operational Operational

Table 2.2: Summarized Performance Indicators for Industry Measures by different researchers. **Source**: Adopted from Mbugua *et al.*, (1999) cited in Takim, R and Akintoye, A (2002).

Latham (1994)	**Egan (1998)**	**Construction Productivity Network (1998)**	**Construction Industry Board (1998)**
Client satisfaction Public interest Productivity Project performance Quality Research & development Training and recruitment Financial	Construction cost Construction time Defects Client satisfaction (product) Client satisfaction (service) Profitability Productivity Safety Cost predictability (const.) Time predictability (const.) Cost predictability (design) Time predictability (design)	People Processes Partners Products	Capital cost Construction time Time Predictability Cost Predictability Defects Safety Productivity Turnover & profitability Client satisfaction

According to Atkinson, *et al.*, (1997), Successful construction project performance is achieved, when stakeholders meet their requirements, individually and collectively. However, in order to meet their requirements and continual participation, it is important for the stakeholders to address and distinguish the three orientation criteria that exist in the life cycle of a project: the procurement', the 'process' and the 'result' orientation *(*Takim, R. and Akintoye, A., 2002).

2.11. Definition of success in construction project

The term "Success" implies different meaning for each person. There does not exist an exclusive definition of project success due to the fact that the meaning is different for each person, project team and company. Project success should be assessed based on different criteria, which usually change depending on the eye of the beholder. The most appropriate criteria to measure project success are the project objectives (Arcila, 2012).

These Objectives are also different depending on the person or the company that is assessing them Success is a result much better than expected or normally observed in terms of cost, schedule, quality, safety and participant satisfaction (salleh, 2009). Project success can be also defined as meeting the required expectation of the stakeholders and achieving its intended purpose. Project success requires creating a well-planned project schedule as well as understanding of the key success factors. Project managers would have a clear understanding of which aspects of projects might be critical for their successful completions.

Salleh (2009) cited the work of Sanvido et.at (1992) and defined the success of construction projects as the degree to which project goals and expectations are met. These goals and expectations may include technical, financial, social, and professional aspects. The study covered all the project phase, including design, construction and maintenance.

For a project to be successful, it is essential to understand the project requirements right from the start and go for project planning which provides the right direction to project managers and their teams and execute the project accordingly. For the purpose of this research, successful project is defined as building construction project that is delivered on time and managed within the budget, Time, cost and quality have been recognized as “triple constraint” or important elements of project success ((Babu and Sudhakar 2015).

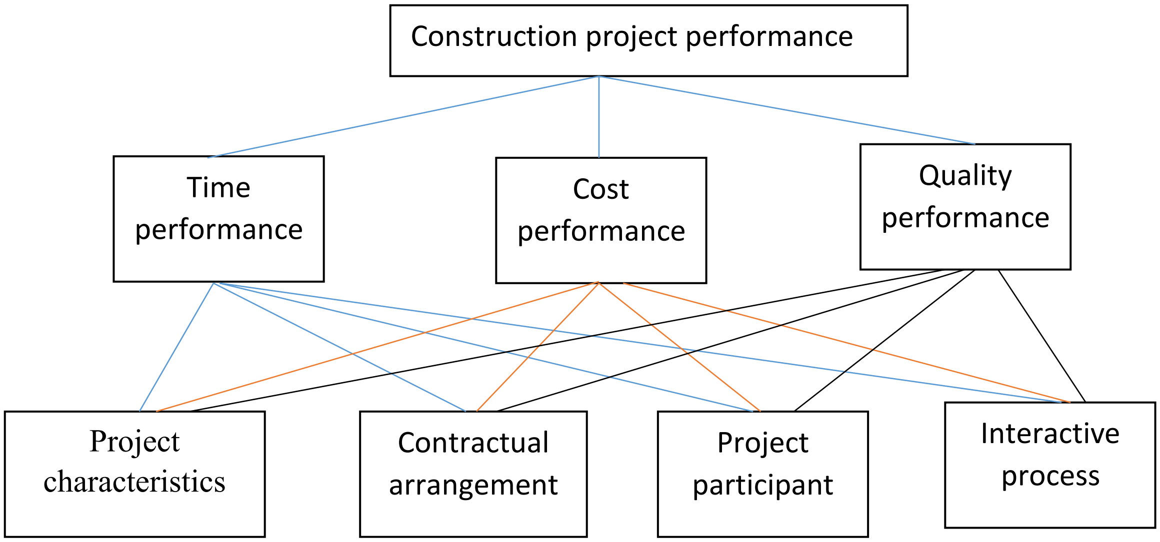
2.12. Success factors

Many literature indicate that without identifying the evaluation criteria, it is not possible to adequately assess the performance of a project (salleh, 2009). Many researches have been conducted to investigate the success factors of construction projects with the aim of providing contract parties with valuable insight into how to consistently achieve superior results for their projects. Although construction projects, by their nature, are repetitive activities, each one has its own characteristics and circumstances. According to its nature and complexity, the factors that affect one project differs from the other. A factor that could affect the success of one project might not affect the other.

Therefore, Identification of the success factors is considered as the key to achieving success in projects. Critical success factors are those inputs to the project management system that directly increase the likelihood of achieving project success.

According to Abraham (2002), the main determinants of project success are budget performance, schedule performance and quality performance.

Figure 2.1: Construction performance factors Model. (Source: (Chau, 1999) Project success model cited in Gaba, (2013).



The level of success in carrying out construction project development activities will depend heavily on the quality of the managerial, financial, technical and organizational performance of the respective parties, while taking into consideration the associated risk management, the business environment, and economic and political stability (Takim & Akintoye, 2002).

Public construction projects involve numerous stakeholders, such as designers, contractors, subcontractors, construction managers, consultants, and specialists from different disciplines. In a multi-agency work environment, it is natural to have clash of objectives and interests among the different stakeholders. The objective of public project management is to ensure the success of a project which not only involves managing the schedule, cost, and quality, generally known as 'the iron triangle', but also satisfying a number of other performance criteria, such as avoiding disputes, and complying with safety norms (Tabish & Jha, 2011).

The researchers identified the success criterial list for each of the contract parties: owner, designer, and contractor. Some of the owner success criterial included being on schedule, being on budget, and return on investment. Examples of the designer success criterial were client satisfaction, quality architectural product, well defined scope, and social acceptability. Finally, contractors' criteria for measuring success included meeting the schedule, profit, being under budget (savings obtained for owner and/or contractor), safety, and client satisfaction (Salleh , 2009).

Furthermore, all three parties held similar viewpoints; for example, all agreed that the financial reality of doing business and achieving an appropriate schedule was a means of measuring the success of a project. On the other hand, there were some unique criteria. For example, the designer was looking for a project that would increases the level of professional satisfaction among their employees. Safety was a high priority for the contractor, and the owner was extremely interested in knowing that the building projects functioned properly for their intended use and were not affected by long-term defects or lingering maintenance problems (Salleh, 2009).

A building project is completed through a combination of many events and interactions, Planned or unplanned, over the life of a facility, with changing participants and process in a constantly changing environment. Certain factors are more critical to a project's success than other. These factors are called critical project success factors. According to Salleh (2009) the term critical success factors in the context of the management of projects was first used by Rockart in 1982 and defined as those factors predicting success on project.

Nguyen et al. (2004) identify and grouped success factors under four categories which are referred to as the 'four COMs', *viz*., comfort, competence, commitment and communication. Comfort component emphasizes that successful projects include the involvement of stakeholders. This includes both primary stakeholders who have a legal relationship to the project (e.g., subcontractors) and secondary stakeholders who do not form a direct part of the project. The competence component identifies the following four aspects as being central to successful project management in the construction industry, i.e. technology, past experience, competent team having comprehensive skills and awarding bids to the right project manager/contractor. Commitment emphasizes the support of top management, commitment to the project, clear objectives and scope, and political support. The support of top management goes beyond the provision of funds and making resources available. Communication plays an important role in leading, integrating people, and taking decisions to make a project a success. There must be shared project vision, where the project manager identifies the interests of all relevant stakeholders and ensures that there is buy-in to the project

Also Chan et al. (2004) reviewed seven international journal and summarized and grouped the factors into five: human-related factors, project-related factors, project procedures, project management actions, and external environment as shown in the table below. Under each group there are a number of identified factors listed which have a direct effect on the success of a project.

Human related factors	Project-related factors	Project procedure	Project management action	External environment
1. Client experience. 2. Nature of client. 3. Size of client's organization. 4. Client's emphasis on low construction cost. 5. Client's emphasis on high quality of construction. 6. Client's emphasis on quick construction. 7. Client's ability to brief. 8. Client's ability to make decision. 9. Client's ability to define roles. 10. Client's contribution for design 11. Clients contribution for construction. 12. Project team leaders' experience. 13 Technical skills of the project team leaders. 14. Planning skill of project team leaders. 15. Organizing skill of project team leaders. 16. Coordinating skill of project team leaders. 17. Motivating skill of project team leaders. 18. Project team leaders' commitment to meet cost, time, and quality. 19. Project team leaders' early and continued involvement in the project. 20. Project team leaders' adaptability to change in the project plan. 21. Project team leaders' working relationship with others. 22. Support and provision of resources from project team leaders' parent company.	1. Type of project. 2. Nature of project. 3. Number of floors of the project. 4. Complexity of project. 5. Size of the project.	1.Procurement method 2. Tendering method	1. Communication system. 2. Control mechanism. 3. Feedback capabilities. 4. Planning effort. 5. Developing an appropriate organization structure. 6. Implementing an effective quality assurance program. 7. Implementing an effective safety program. 9. Control of sub-contractors' work. 7. Overall managerial actions	1. Economic environment. 2. Social environment. 3. Political environment. 4. Physical environment. 5.Industrial relation environment 6. Technology advancement.

Table 2.3: Factors Affecting the Success of a Construction Project: Adapted from Chan et al. (2004).

2.13. Factors Affecting Cost and Time Performance

Salleh (2009) cited the work of Chan and Kumarswamy (1997) and presented the result of a survey undertaken to determine and evaluate the relative importance of the significant factors causing time and cost overrun in Hong Kong construction projects. The factors were grouped into eight major factor categories: project related, client related, design related, contractor related, material, labor, equipment and external factors. The following is a brief description of these categories.

- Project related factors include
    - Project characteristics
    - Necessary variation
    - Communication among various parties
    - Speed of decision making involving all project teams, and
    - Ground conditions.
- Client-related factors include those concerned with
    - Client characteristics
    - Project financing
    - Client Variations and requirement
    - Interim payment to contractors
    - Design-team related factors consist of
    - Design team experience
    - Project design complexity, and
    - Mistakes and delay in producing design document
- Contractor-related factors comprise those related to:
    - Contractor experience in planning and controlling the project
    - Site management and supervision
    - Degree of subcontracting, and
    - Contractor's cash-flow

- Material factors include:
    - Shortage
    - Material changes
    - Procurement programing, and
    - Proportion of off-site prefabrication
    - Human factors encompass:
    - Labor shortage
    - Low skill levels
    - Weak motivation, and
    - Low productivity
- Equipment factors include:
    - Shortages
    - Low efficiency,
    - Breakdown, and
    - Wrong selection
- External factors comprise those such as:
    - Waiting time for approval of drawings and test samples of materials, and
    - Environmental concerns and restrictions.

2.14. Project cost and schedule performance

Earned Value Management (EVM) methodology is commonly defined as a management technique that relates resource planning and usage to schedules and to technical performance requirement. More specifically, EVM can be said to bring cost and schedule variance analysis together to provide accurate status of a project (EunHong et al. 2003).

Schedule variation is determined by (SV) and is the difference between planned and actual duration. A negative SV means the project is late while a positive SV means the project has been completed before scheduled time. Similarly cost variation (CV) is measured as the difference between planned cost and actual cost. A negative CV means over budget or overspent project and a positive CV means an under budget project. Performance can be also determined using SPI (schedule performance index) and CPI (Cost performance index) (Ahsan, 2009).

When the three key parameters are properly recorded along the project life, PMs are able to calculate two types of performance measures. The first type of performance measures are variances which represent the difference between the current status of the project and its baseline. A negative (positive) value points out that more (less) has been spent for the executed activities than what was originally planned. The **Schedule Variance (SV)** is an indicator that provides PMs with a value that represents whether the project is on schedule or not. A negative (positive) value means that the project is behind (ahead of) schedule.

Another type of performance measures are indices, also calculated from the three key parameters of EVM. The indices are again used to display how well the project is performing, now relatively in comparison with the baseline. Again two types of indices can be distinguished. The first type of index is the **Cost Performance Index (CPI)**, which expresses the cost efficiency of the executed work. A CPI of less or more than one means that the project is currently running over or under budget. The second index is the **Schedule Performance Index (SPI)**. The SPI shows whether the project is performing on schedule or not. A SPI of more or less than one means that the project is ahead of or behind.

It is clear that the variances and indices are interrelated. Still it is useful to calculate both performance measures. The variances can give a snapshot of where the project is today (expressed in monetary value) while the indices are rather used to represent the evolution in performance of the project. This is of significant importance to make forecasts about the future of the project.

2.14.1 Cost Considerations

"*It is unwise to pay too much, but it is worse to pay too little*". - John Ruskin.

The relationship of quality to cost is often expressed in the saying that „you get what you pay for.‟ Regardless of Ruskin's advice, cost is a critical factor in most building projects and some clients will seek a low price. Low price and maximum price competition, however, often have negative impacts on quality standards and achieving best value for money overall. In the current economic climate below cost tendering has heightened the risk of contractor insolvency and it may be difficult and expensive to obtain protection from this risk. Unrealistic and inadequate budgets often lead to projects becoming finance driven where cheaper options are preferred to better or more stainable alternatives. Certain clients may have fixed budgets which may not be exceeded in any circumstances. 1n such circumstances the client will expect the quantity surveyor to maintain rigorous cost control during the project in order to deliver the project within budget. Designing to achieve such cost limits might limit the introduction of beneficial features and/or variations which may result in excessive running and maintenance costs later on.

2.14.2. Project Cost Performance

Navon (2005) defined performance measurement as a comparison between the planned and the actual performances. For example, when a deviation is detected, the construction management analyzes the reasons for it. The reasons for deviation can be schematically divided into two groups: (a) unrealistic target setting (i.e., planning) or (b) causes originating from the actual construction process. In many cases the causes for deviation originate from both sources. Navon (2005) stated that performance measurement is needed not only to control current projects but also to update the historic database. Such updates enable better planning of future projects in terms of costs, schedules, labor allocation, etc.

Pheng and Chuan (2006) stated that the measurement of project performance can no longer be restricted to the traditional criteria, which consist of time, cost and quality. There are other measurement criteria such as project management, stakeholder satisfaction, health and safety, defects, etc.

Cost performance (CV) can be computed as (Kuprenas, 2003):

$$CV = \frac{BCWP - ACWP}{BCWP} X100 \text{ .... (Equation 2.1)}$$

$$CPI = \frac{BCWP}{ACWP} \text{..................... (Equation 2.2)}$$

Where:

- BCWP = Budgeted cost of Work Performed
- ACWP = Actual cost of Work performed.
- CPI = cost performance index
- CV –cost variance

CV (Cost variance) provides an indication of the variation of the project costs over the initial award cost of Project, where award cost is the budgeted cost of work performed and Final project cost is the Actual cost of work performed.

- If the value of CV is equal to 0 it means the project is completed on cost.
- If the value of CV is positive it shows the project is completed under budgeted cost of work performed.
- If the value of CV is negative it shows the project is completed over budgeted cost of work performed.

2.14.3 Methods of Project Time Determination

„*Time is money'*. – Benjamin Franklin

Once a decision to build has been reached the client will be anxious to have the building completed as quickly as possible. For many clients, without compromising quality, early completion is the overriding priority. For example where staging a major sporting event is scheduled, or where a client is attempting to establish a market presence ahead of competitors, or to avail of tax incentives. Time is also of the essence in emergency situations such as fire or flood damage or where stabilization works are required to dangerous structures.

Speedy completion is often required on commercial developments. The pressure to achieve early completion intensifies when financing and interest costs associated with acquiring the site begin to mount. Clients seek the early appointment of a contractor in these situations to enable a fast start up on site and favor „fast track" design approaches where the design is developed in parallel with site construction operations. Such approaches risk allowing insufficient time to identify or consider beneficial design options and May on occasion, lead to abortive working and/or losing time. Speedy construction on site often requires accelerated working and/or shift or overtime payments, more intense management presence, and the use of dependable subcontractors and suppliers, all of which add to the cost of the project. Fast track approaches rule out cost certainty and the client will become aware of the eventual cost only at an advanced stage of the project.

Time planning for construction has been practiced for several decades. The conceptual development of time planning can be placed under Four Major development such as Bar chart, Network diagrams,(CPM and PERT), Resource constrained project schedule and Time planning under uncertainty (Jekal & Teshale, 2006). Each Planning techniques is suitable for a different type and size of project. For small and simple project, bar chart can used. Cost, benefit and suitability for the nature of the job should be given due consideration in adopting the technique.

2.14.4 Project Time Performance

Project time performance is measured by comparing actual with the planned project period. This performance metric provides an indication of deviation of schedule between planned Project Time (Duration) over the actual completion duration of the Project.

$$SV = \frac{STWP - ATWP}{STWP} X100 \text{..........(Equation 2.3.)}$$

$$TPI = \frac{STWP}{ATWP} \text{.....................(Equation 2.4)}$$

Where:

- STWP = Scheduled time of work performed
- ATWP = Actual time of work performed.
- TPI= Time performance index
- SV = Schedule Variance

- If the value of SV is equal to 0 it means the project is completed on time.
- If the value of SV is positive it means the project is completed ahead of schedule.
- If the value of SV is negative it means the project is completed behind of schedule.

2.15. Quality Measure

Managing quality in projects must be addressed from two different perspectives: the quality of the product of the project, and the project quality management process. Issues associated with product quality, such as quality metrics and required tools and techniques, are very specific to the nature of the product. For example, the quality issues to be addressed and approaches to be used in building a convention center will be significantly different from those of manufacturing a jet engine. On the other hand, the project quality management process is applicable to a whole spectrum of projects, with wide variation in the nature of the product from project to project. It includes all necessary activities undertaken by the project organization to ensure that the needs of the project and the purpose for which it was initiated are fully met, such as determining quality policies, objectives, and responsibilities. The project quality management process facilitates the implementation of a quality management system through policies, procedures, and the sub processes of quality planning, quality assurance, and quality.

Quality Considerations "Quality is remembered long after the price is forgotten" Sir Henry Royce A project may be completed on time and within budget, but unless it achieves the specified quality or performance criteria it will be considered to be a disappointment or even an outright failure. High profile building failures such as Priory Hall only serve to strengthen the public concern expressed in the *Egan Report*'s findings that 30% of buildings fail to meet the expectations of their owners. Such failures may be prohibitively expensive to rectify, dangerous and can ruin reputations overnight.

The notion of "quality" is multidimensional and includes aspects which may be appraised subjectively. The Latham Report identified a number of quality aspects which clients may seek in a construction project: pleasing to look at; free from defects on completion; fit for the purpose; supported by worthwhile guarantees; satisfactory durability and customer delight Several of these aspects are inherent in the design of the project, while others relate to how successfully the contractor constructs that design on site. The designers will aim to produce an effective and attractive spatial and structural solution to the client's brief. This should provide sufficient, well planned accommodation, using appropriate materials, components, equipment, fittings and furnishings to enable the building to perform effectively and efficiently. Ideally it should generate a sense of delight amongst its users and the public at large.

Chapter Three

Methodology

3.1. Research Design

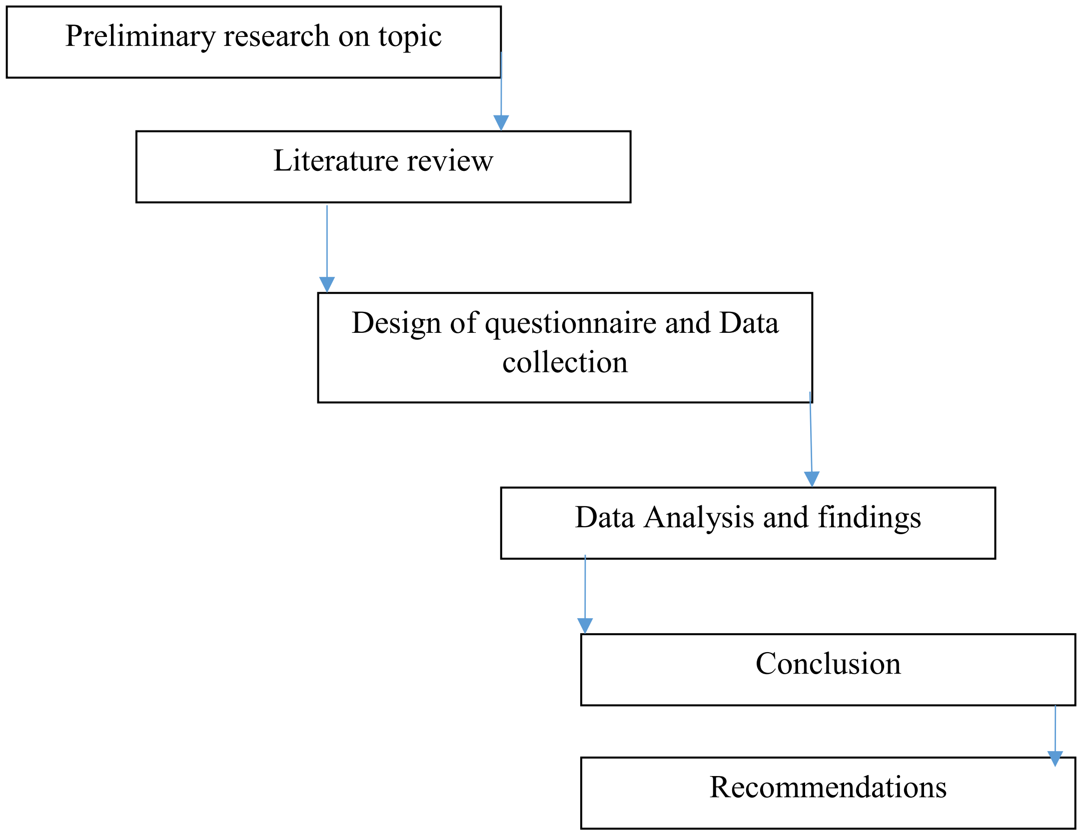
Research methodology should reflect the understanding of the researcher in order to extract valuable results of the study using various methods available, in single or combination form. Methodology is a plan of action that shows how the problems are investigated, what information are collected using which methods, and how this information are analyzed in order to arrive at conclusions and develop recommendations. Research follows some steps and procedures when conducted. Once the problem statement has been formulated, it should clearly portray the kind of data that is required, and the type of analysis that is most appropriate to analyze the data.

This chapter describes research approaches with a view of selecting the most appropriate methodology for the research project, including the research strategy and justification of the methodology: the procedure used and sampling techniques to achieve the objectives of the research.

To undertake this research, both descriptive and quantitative approach were adopted. The objectives of the research is investigating the existing performance of public building construction projects in Addis Ababa and identifying critical factors that affect time and cost performance of projects. Descriptive research studies are those studies which are concerned with describing the characteristics of a particular individual or of a group. The major purpose of descriptive research is description of the state of affairs as it exists at present.

The research followed a sequence of steps illustrated in the Figure below.

Figure 3.1. Research sequence: Adapted from Gaba (2013).



3.2. Research Strategy

There are different research strategies, such as experiments, surveys, action research, grounded theory and case studies, and all of them have advantages and disadvantages. Therefore, there are three different conditions that indicate the type of strategy that should be used in a research. These conditions are: the type of research question, the control that the investigator has in the actual behavioral events and the focus on contemporary events (Saunders et al., 2009)

Therefore, following the three conditions suggested above, to answer the first two research questions, i.e. to what extent performance of public building construction projects have been achieved in terms of cost and time?, a particular research strategy is used. These questions are answered by analyzing secondary data of the selected sample of public building construction projects. Questionnaire survey is the other strategy which is a very popular method of gathering information as it allows input from various source such as client, contractor, and consultant, professional and regulatory bodies. It is commonly used for formal quantitative research.

Data collection was through self-administered questionnaires, which were distributed by hand in the research environment (Addis Ababa). Taking into consideration the characteristics of research environment and limited time available to collect data, hand delivering questionnaires was deemed the most effective as compared to administering them via Internet or face-to-face interviews.

A questionnaire survey was used to assess the perception of construction stakeholders. The population consists of contractors, consultant, client, and regulatory body and others professionals who had been participating in one way or other in sample projects of public building construction activity in Addis Ababa.

Besides direct participants of projects, stakeholders who are major contributors of the industry are included in the study. Selection was done by taking into the account the contribution of professionals in decision and policy making and other legal frameworks development for the improvement of construction industry.

24 cost and 29 time factors affecting performance of construction projects were identified. Most of these were obtained from literature review and local experts. These factors are categorized into 4 groups such as project related, contractor related, external environment related and material related based on literature review. These groups can give a comprehensive summary of the critical factors of public building construction projects in Addis Ababa.

3.3. Population

The Federal Democratic Republic of Ethiopian has restructured its state structure at different periods depending on the policies, strategic planning and its implementation to achieve economic, social and political development objectives of the country. In Year 2016, due to the flourishing of construction industry i.e., increasing demand of infrastructure and housing development, the former Ministry of Urban Development and Housing Construction is dichotomized into Ministry of Urban Development and Housing and Ministry of Construction. As a result of this division, the public construction projects are managed by these two Ministries. Each Ministries are Decentralized at regional, Zonal, and Sub-city levels to accomplish their duties.

Major portion of construction of Public Building construction Projects in Addis Ababa are managed by Federal project Office which is under Ministry of Urban Development and Housing construction and Addis Ababa City Administration Construction Bureau. But the Housing projects are administered independently by Addis Ababa Housing Development and Administration Bureau.

Therefore the research needs two types of populations to answer the objectives. The first population is number of public building projects that have been constructed in Addis Ababa city between the years 2010/11 to 2015/16 and the second population is the number of professionals who have been directly participated on the population projects. The first population is used to assess cost and time performance of public building, while the second population was used to identifying critical factors that affects time and cost performance of the project. The total number of public building projects that had been constructed during this period were 71. Out of these projects 24 projects were managed by project office and the remaining 47 projects were administered by Addis Ababa Construction bureau (annex 1).

Professional Sample required to identify critical factors that affect time and cost performance of public building project was based on the number of population projects. Sample of the second population is number of professionals who had been participated on sample projects during construction phase. These professionals were employee who were working for contractors, consultants, clients and regulatory body on a particular projects. Using the sample formula the total of 35 projects were obtained as sample projects and a number of professionals who directly participated on selected sample projects representing each organizations were taken as sample of second population. The table shows number of professional working for each participating organizations on selected sample projects. Four respondent groups participated in the questionnaire survey. These are contractors, consultant, client and regulatory body. The regulatory body represents those personnel who have a role in overall performance of the construction industry and responsible for development of policies, manuals and standards and follow up the general conditions of the industry. The client respondent group indicates those professions who had been participated on a particular sample project representing owner of the project.

Table 3.1: Number of questionnaire distributed with respect to each respondent group.

Organization	Consultants' Employee	Contractors' Employee	Clients' Employee	Regulatory bodies'	Total
Number of Employee	28	52	20	4	104

3.4. Sample Size Determination

This refers to the number of items to be selected from the universe to constitute a sample. It is a major issue before a researcher headed to collection of data. The size of sample should neither be excessively large, nor too small. It should be optimum. An optimum sample is one which fulfills the requirements of efficiency, representativeness, reliability and flexibility. While deciding the size of sample, researcher must determine the desired precision as also an acceptable confidence level for the estimate and hence 95% confidence level is used to calculate the sample size.

Sample size can be calculated as the following equation for 95% confidence level (Assaf et al 2001):

$n = n' / [1 + (n'/N)]$

Where:

N = total number of population

n= sample size from finite population

n' = sample size from infinite population = S^2/V^2; where S^2 is the variance of the population elements and V is a standard error of sampling population. (Usually S = 0.5 and V = 0.06).

1. **Project sample calculation**

   $n = n' / [1 + (n'/N)]$

   $n' = S^2/V^2 = (0.5)^2 / (0.06)^2 = 69.44$

   Population (N) = 71 projects

   $n = 69.44 / [1 + (69.44 / 71)] = 35$

2. **Professionals sample**

The total number of professionals participated on the selected sample projects were 104. To increase the precision and quality of data collected all professionals were allowed to participate in the questionnaire survey.

3.5. Sampling

Broadly there are two sample design methods: Probability and non -probability sampling. Each categories has subdivisions. This research uses random sampling as it is the purest form of probability sampling. Each member of the population have an equal chance of being selected.

3.6. Data collection instrument

There are several instrument of collecting primary data, particularly in surveys and descriptive researches. Important ones are: observation method, interview method, through questionnaires among which a researcher is supposed to select to achieve the objectives of the research. Selection of data collection method depends on different factors such as nature and scope of enquiry, availability of fund, time needed and precision required. The type of research and data needed dictate what type of data collection methods to be used. In a research more than one type of data collection instrument can be used and thus increases the precision of the result by using triangulation method.

Saunders et al. (2009) suggested that Questionnaires tend to be used for descriptive or explanatory research. Descriptive research, such as that undertaken using attitude and opinion questionnaires and questionnaires of organizational practices, enable to identify and describe the variability in different phenomena.

The research have three specific objectives. To achieve each objectives of the research secondary data and questionnaire survey were used. The Archive was used for secondary data collection. Documentation has been considered as a relevant source because it helps to corroborate and increase the evidence from other sources. In addition to secondary data of sample projects, articles from bulletin and internet were used to support the information obtained from the questionnaire. Archival documents were mostly from completed projects, in which contract documents, project reports, correspondence letters and payment certificates were investigated thoroughly which were very important in assessing time and cost performance of public building construction projects in Addis Ababa. Based on the literature review, systematically structured questionnaire were designed to collect information that can help in giving answers for the research questions and to address the identified problem statements.

3.7. Data Collection Procedure

Prior to collecting data using questionnaire and archives, valuable information were obtained from literature review. Based on the acquired facts questionnaire were designed. Also to collect secondary data a comprehensive format was developed which helped to get necessary data to assess time and cost performance of public building projects in Addis Ababa.

A pilot questionnaires were sent to fifteen expertise who have well-regarded experience on the research area to evaluate the quality of questionnaire to check whether the questions are relevant and easily understood by the respondents. The results of the pilot questionnaire significantly helped to improve the quality of the questions and augmented its clarity to be understood by all participants. Based on the obtained result of the pilot questionnaire it was amended and refined to come up with the actual situation of the case.

The questionnaire consisted of two parts. The first part is general background information about the respondent. This includes the demographic questions about the respondents, Years of experience academic qualification, organization and job classification. This information helped the researcher to validate the outcome of the survey, as the research requires involvement of professionals who participated in public building projects.

In the second part professionals who had been working for client, contractor, consultant and regulatory body were asked to rank time and cost factors in general. The evaluation scale was a five-point Likert scale (strongly agree=5, Agree = 4 neutral=3, disagree=2 and strongly disagree=1). At the end respondents were given the opportunity to add information about time and cost performance factors they may have experienced on the projects.

Questionnaires were sent to 104 professionals who had been engaged on the sample projects working on various positions and who have valuable experience in the construction industry.

They are employee of organizations participating on sample projects such as representatives of government ministries and agencies, contractor based organizations that had managed and handled construction projects on construction supervision and execution. They included mainly site engineers, office engineers, architects, builders, project managers, quantity surveyors, construction managers at the top of their careers and who have had immense experience on construction projects. Also professionals who were working for client and consultant were included.

3.8. Validity Test

Validity test indicates the degree to which an instrument measures what it is supposed to measure. There are different ways of testing validity of questionnaire. In the case of this research, content validity test is utilized. Content validity is the extent to which a measuring instrument provides adequate coverage of the topic under study. Validity in relation to questionnaires refers to the ability of questionnaire to measure what is intend it to measure. This means it is concerned that what is find with questionnaire actually represents the reality of what to be measured. This presents with a problem as if the reality of what were measured is actually known (Saunders et al. 2009). This is done by providing adequate coverage of the investigative measurement questions in the questionnaire. Judgement of what is 'adequate coverage' was made through careful definition of the research through the literature reviewed. Also prior discussion was made with others who have good experience in the research area. A panel of individuals was used to assess whether each measurement question in the questionnaire is 'essential', 'useful but not essential', or 'not necessary'.

3.9. Reliability Test

Reliability refers to consistency. Although for a questionnaire to be valid it must be reliable, this is not sufficient on its own. Respondents may consistently interpret a question in questionnaire in one way, when it mean something else. As a consequence, although the question is reliable, it does not really matter as it has no internal validity and so will not enable the research question to be answered. Reliability is therefore concerned with the robustness of questionnaire and, in particular, whether or not it will produce consistent findings at different times and under different conditions, such as with different samples or, in the case of an interviewer-administered questionnaire, with different interviewers.

In this research Internal consistency was used which involves correlating the responses to each question in the questionnaire with those to other questions in the questionnaire. It therefore measures the consistency of responses across either all the questions or a sub-group of the questions from your questionnaire. There are a variety of methods for calculating internal consistency, of which Cronbach's alpha is used in this case.

3.10. Analysis

The term analysis refers to the computation of certain measures along with searching for patterns of relationship that exist among data-groups. Thus, "in the process of analysis, relationships or differences supporting or conflicting with original or new hypotheses should be subjected to statistical tests of significance to determine with what validity data can be said to indicate any conclusions (Kothari, 2004).

Analysis of secondary data was done using gap analysis to compute time and cost variation of projects. Earned Value was used to analyze secondary data. Gap analysis compares budgeted cost of work performed to the actual cost of work performed. Deviations are expressed in birr, days or calculated further as progress, percent completed or a performance index.

Data Collected by questionnaire survey was analyzed by using SPSS percentage, Mean, and correlation. Questionnaire survey was designed for engineering professional engaged in Design project contract administration and construction work. The results were used to identify critical factors for time and cost performance of public building construction projects. The relative importance index method (RII) is used herein to determine owners', consultants' professionals and contractors' perceptions of the relative importance of the identified performance factors. The RII was computed as (Cheung et al. 2004).

$$RII = \frac{\Sigma W}{AxN} \text{............. (Equation 3.1)}$$

Where

W is the weight given to each factor by the respondents and ranges from 1 to 5;

A – The highest weight = 5;

N – The total number of respondents.

3.10.1 Analysis Procedures

Following is a descriptive summary of the statistical analysis procedures that were used for each part of the general survey to examine the correlation of the factors and information obtained from secondary data.

- To summarize the result of secondary data, percentage and gap analysis was used.
- To summarize the responses a background information frequencies and percentages are used to analyze the result.

- Frequencies and percentages are used to summarize background information about respondents. Frequencies, percentages and descriptive statistics (means and standard deviations) are used to summarize respondents' perceptions of the rank of time and cost performance factors on public building projects.

Chapter Four

4. Data Analysis and Discussion

4.1. Introduction

Based on the research approach explained in Chapter 3, this chapter aims to show the results and findings from the secondary and primary data. It is divided into two sections. The first section assesses the quality of data and provides reasons to demonstrate that the information was valid for the research. The second section shows an overview of the results of secondary and primary data. Therefore, this chapter is the basis of the critical discussion and the findings used to confirm or reject the propositions formulated after the review of the literature.

The first two objectives of the research were addressed by secondary data obtained from Addis Ababa city Administration construction bureau and Federal project office. To achieve the third objective of the study, a general questionnaire survey was designed.

As discussed in the methodology section in chapter 3, time and cost variation were calculated using traditional gap analysis method. For both cost and time performance the result was indicated by negative, Zero and positive values. A negative time value indicates time overrun, Zero value indicates project on time and positive value indicates ahead of schedule. The same is true for cost performance.

Analysis of data collected by questionnaire survey was undertaken using statistical analysis software (SPSS). Pearson correlation coefficient and one way ANOVA were used. Pearson correlation coefficient measures the strength and direction of the relationship between two quantitative variable. It ranges from -1 (perfect negative) to +1 (perfect positive). It is a measure of how two random variables move with respect to each other. One-way ANOVA is the statistical methodology for comparing means of several populations. It is called analysis of variance, or simply ANOVA. In this study to compare the mean ratings of the influence of the time and cost performance factors in order to learn which factor demonstrated the most critical.

4.1.1. Data Reliability

According to Saunders (2009) the reliability of an instrument is the degree of consistency which measures the attribute it is supposed to be measure. The lesser the variation an instrument produces in repeated measurements of an attribute, the higher its reliability. Reliability can be equated with the stability, consistency, or dependability of a measuring tool.

Table 4.1 shows the values of Chronbach's Alpha for each fileds of the questionnaire and the entire questionnaire. For the fields, values of Chronbach's Alpha were in the range from 0.771 and 0.891.

Table 4.1: Chronbach's Alpha for each filed of the questionnaire

S.N	Field	N of factors	Cronbach's Alpha
1	Cost	24	0.771
2	Time	29	0.891

This range is considered high; the result ensures the reliability of each fields of the questionnaire. Chronbach's Alpha equals 0.962 for the entire questionnaire which indicates an excellent reliability of the entire questionnaire. There by, it can be said that the questionnaire is valid and reliable.

4.1.2. Data Validity

Validity refers to the degree to which an instrument measures what it is supposed to measure. Validity refers to the degree to which an instrument measures what it is supposed to measure (Pilot & Hungler, 1985). Validity has a number of different aspects and assessment approaches. Statistical validity is used to evaluate instrument validity, which include criterion-related validity and construct validity.

To insure the validity of the questionnaire, two statistical tests were applied. The first test was Criterion-related validity test (Spearman test) which measures the correlation coefficient between each factors. The second test was structure validity test (Spearman test) that is used to test the validity of the questionnaire structure by testing the validity of each factors and the validity of the whole questionnaire. It measures the correlation coefficient between one filed and all the fields of the questionnaire that have the same level of similar scale.

To test criterion-related validity test, the correlation coefficient for each item of the group factors and the total of the field is achieved. The p-values (Sig.) are less than 0.01 for all results, so the correlation coefficients of each field are significant at $\alpha = 0.01$, so it can be said that the each factors are consistent and valid to measure what it was set for.

4.1.3. Pilot study

The piloting was done to test whether the questionnaire was intelligible, unambiguous and easy for respondent to understand and respond to. The professionals participated in this research were from client, contractor, consultant and regulatory body. Pilot study of the questionnaire was conducted by investigating sample questionnaires. 15 questionnaires were distributed to engineers such as projects managers, site engineers, office engineers and organization managers who have a strong practical experience in the industry. Their sufficient experiences are a suitable indication for pilot study. The following are summary of the main results obtained from pilot study:

1. Some factors and sentences should be modified or represented with more details.
2. Some factors were repeated more than one time with the same meaning. So, it should be eliminated.
3. Some factors and sentences should be modified in order to give more clear meaning and understanding.
4. Some local factors should be added as recommended by local experts which affect the performance of public building construction projects.
5. There are some parts of questionnaire required to be regulated well.
6. Some factors should be rearranged in order to give more suitable and consistent meaning
7. There are some questions which are not practical or realistic with respect to local situations of building construction projects. Such questions should be removed or modified to be realistic and fit to practical situations.
8. Factors related to consultant should be added.

Based on the comments obtained from the pilot study, the questionnaire was modified and corrected and as a result the final questionnaire have been made more clearer by replacing ambiguous words with simple and understandable ones.

Total of 104 questionnaires were distributed to employee working for client, contractor consultant and regulatory body. From the total of 104 questionnaires distributed, 87 (84%) were returned out of which 8 (7.7%) were invalid and incomplete and 79 (76%) were analyzed. Based on respondent group 24 (86%), 34 (65%), 18(75%) and 3(75%) questionnaire were returned by consultant, contractor, client and regulatory body employees respectively (Annex 5)

Figure 4.1: Questionnaire distribution for each respondent group

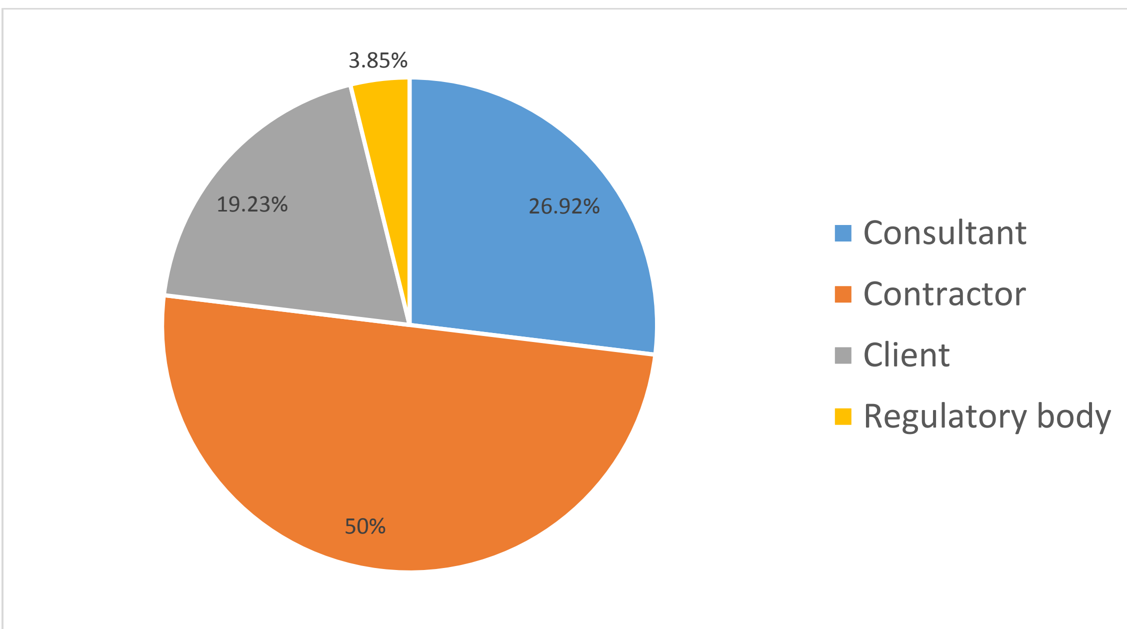


Figure 4.2: Questionnaire Returned by each Respondent Group.

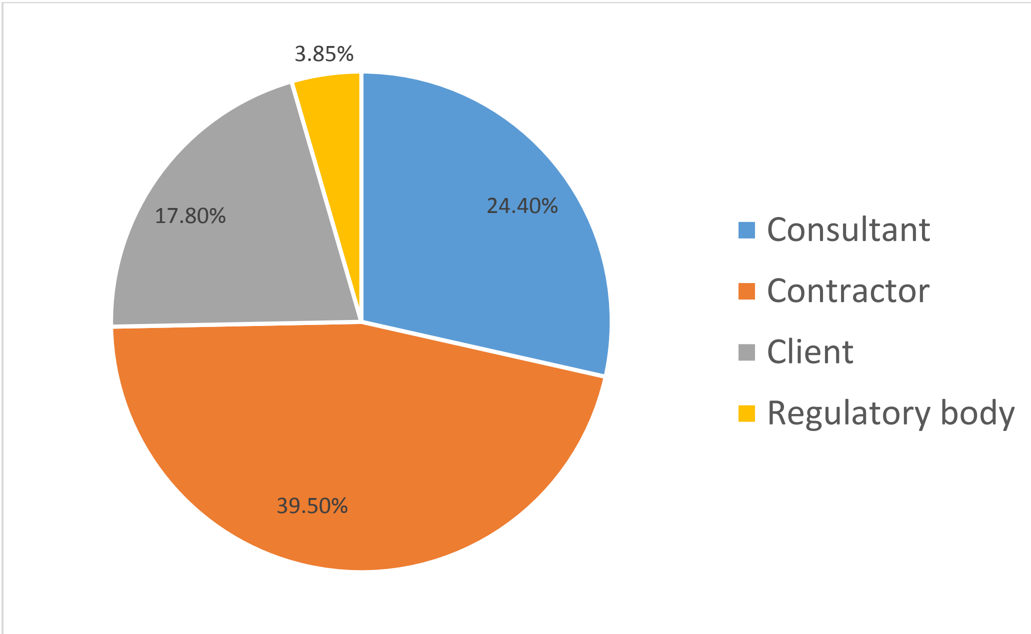
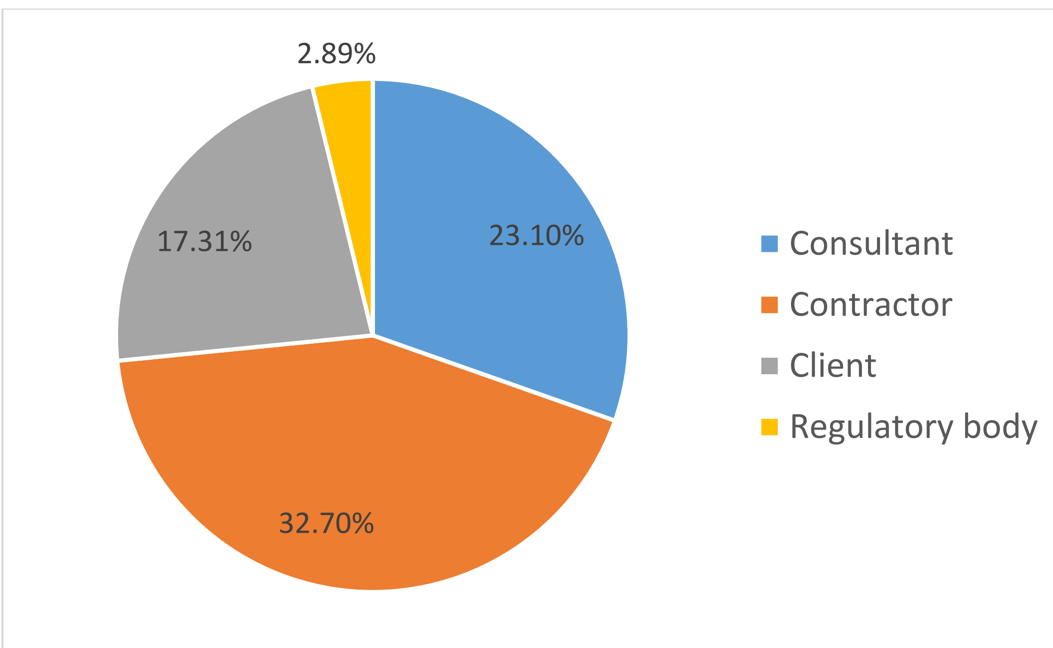


Figure 4.3: Percentage of Questionnaires Analyzed



4.2. Analysis of Secondary Data

This study addresses performance of public building construction projects in Addis Ababa in terms of time and cost parameters. To assess time performance of project, scheduled duration and actual duration of project were used. There are also two common elements to evaluate cost performance of project. These are budgeted cost and actual cost of project and each project cost and time deviation were calculated.

Performance can be measured by both variance and performance index. Performance index indicate whether the project is under or over the budgeted cost and time but it doesn't shows the extent of deviation. In most cases it is used to check whether the project is ahead or behind the schedule at some point in a time. But cost or time variance shows the magnitude of variation between the budgeted and actual cost and duration of project in terms of birr and days. Therefore, in this research time and cost variance was used to analyze the performance of public building construction projects in Addis Ababa.

Data about Project duration and cost was collected from contract documents, schedule and performance related tables, monthly and annual reports. Analysis of numerical data was done in the form of descriptive statistics using charts, tables and discussion.

4.2.1. Project Cost performance

According to equation 2.1 and 2.2 Cost Variance (CV) was calculated. Value of CV zero means the project is completed on budget, value of SV positive means the project is completed under budget and value of SV negative shows the project is completed over budget.

Figure 4.4 indicates the general performance of public building projects in Addis Ababa. 74.3% of projects were completed under budget and the remaining 25.70% were completed with more than planned budget. To see this in some more detailed way projects were sub-grouped in to range of cost variation. The range lies between -20 and +20. These are the minimum and maximum result of cost variance obtained from the study. Categorization was made as shown in the table below.

Figure 4.4: Cost performance of Public Building projects in Addis Ababa.

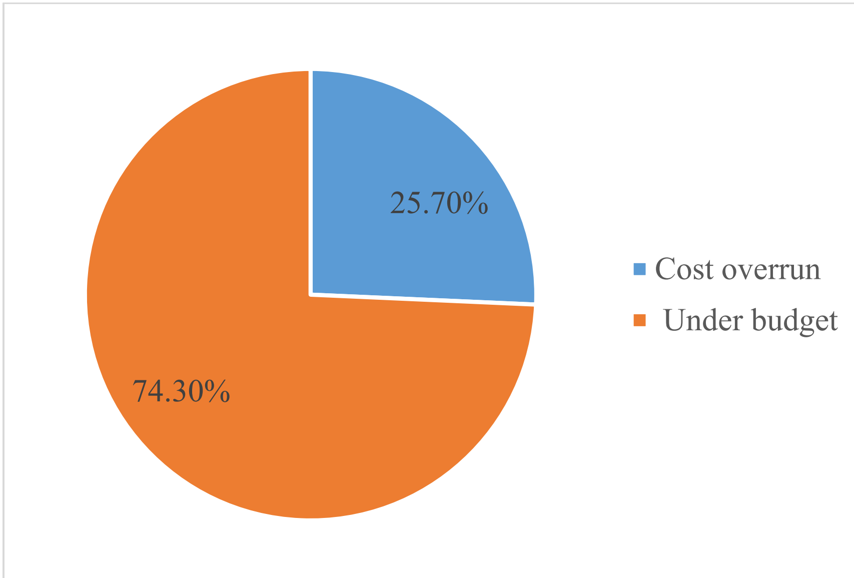
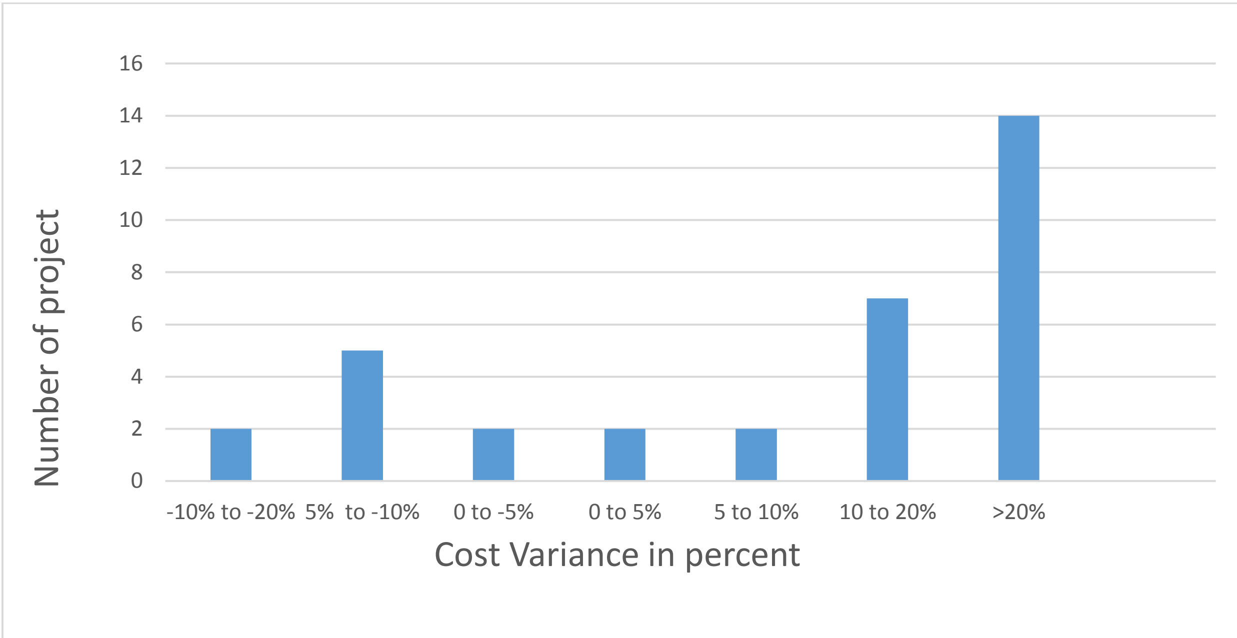


Table 4.2: Cost performance by percentage Range.

Cost Variance	Number of projects	percentage
-10% up to -20%	2	5.71%
-5% up to -10%	5	14.29%
0 up to -5%	2	5.71%
0 up to 5%	2	5.71%
5 up to 10%	2	5.71%
10 up to 20%	7	20%
>20%	14	40%

Figure 4.5 shows cost performance of public building construction projects in Addis Ababa. The result of the analysis of secondary data indicates, out of the total 35 public building construction projects 9 projects (25.7%) were over budget and the remaining 26 (74.3%) project were under budget. 11 projects (31.43%) laid between ± 10% among which 7 projects (20%) are in the range 0 tof -10% and 4 projects (11.43%) were in the range of 0 to +10%. 23 projects (65.71%) showed cost deviation more than ±10% out of these the majority, 14 projects (40%) were completed with a cost of less than 20% of budgeted cost.

Figure. 4.5: Cost Variance in range of percentage.



Clause 52 article 3 of the general condition of contract for civil work gives special consideration for cost variation greater than ± 10% and allows contract amount adjustment. It says, "*If on certified completion of the whole of the Works it shall be found that a reduction or increase greater than 10% (ten percent) other sum named in the Contract excluding all fixed sums, provisional sums and allowances for day works, if any, results from:- (a) the aggregate effect of all Variation Orders, and (b) all adjustments upon re-measurement of the estimated quantities set out in the Bill of Quantities, excluding all provisional sums, and day works but not from any other cause, the amount of the Contract Price shall be adjusted by such sum as may be agreed between the Contractor and the Engineer or, failing agreement, fixed by the Engineer having regard to all material and relevant factors, including the Contractor's Site and general overhead costs of the Contract* (MoWUD, 1994).

This clause infers that cost deviation that ranges between ±10percent is acceptable. According to clause 52 article 3, 65.71% of projects were beyond this acceptable range and subjected to contract amount adjustment.

The research result of Ahsan and Gunawan (2009) exhibited that all projects under the research were under budget. International construction projects in Bangladesh, China, India and Thailand were performed under budget with percentage of 8.44%, 5.41%, 26.14% and 24.95% consecutively. The result of the study conducted by Ahsan and Gunawan (2009) showed all projects were completed under budget whereas the result of this research showed 26 Projects (74.3%) are under budget (annex 4).

A comparative study conducted by Akinsiku and Iyagba (2014) exhibited in both Malaysia and Nigeria projects were cost overrun. Cost overrun in Malaysia ranges from 11 to 31 percent whereas in Nigeria it ranges from 3 to 47 percent. Auma (2014) also indicated with his research construction projects in Kenya are also have the same trends. 50% percent of projects are facing problem of cost overrun with more than 20%.

4.2.2. Project Time performance

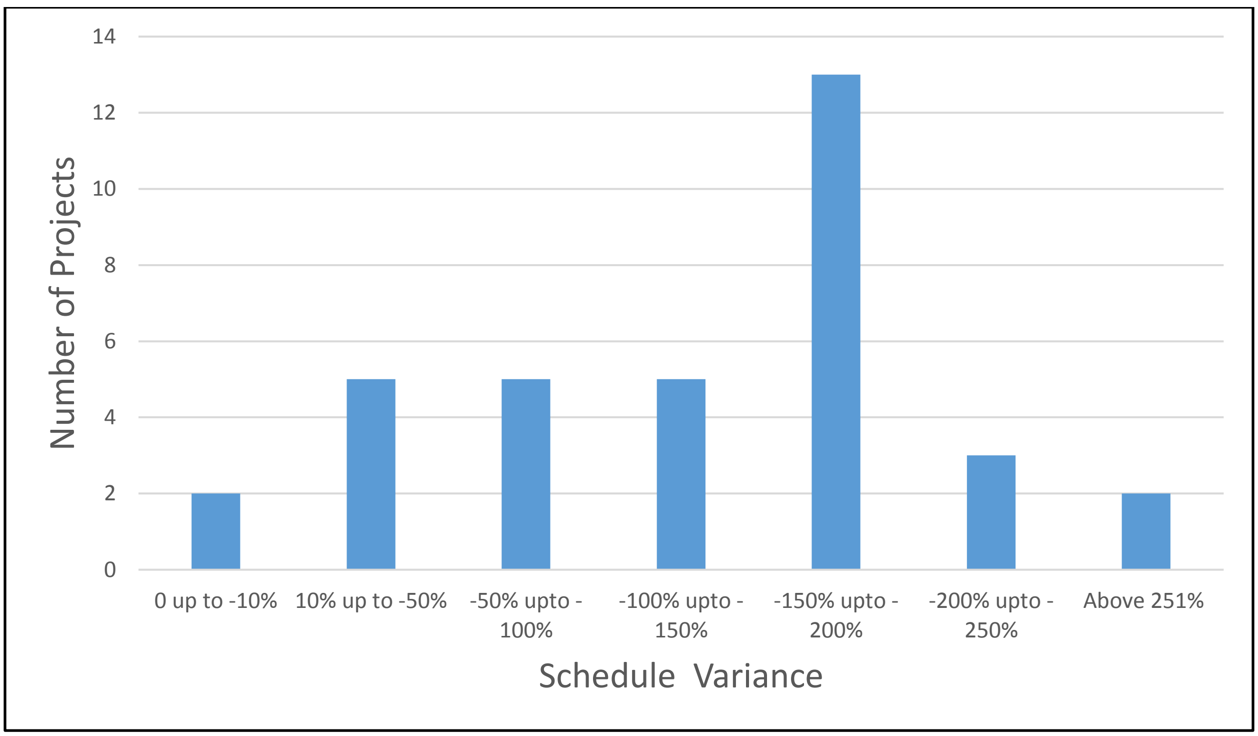
According to equation 2.3 and 2.4 Schedule Variance (SV) was calculated. Value of SV zero means the project is completed on time, value of SV positive means the project is completed ahead of schedule and value of SV negative shows the project is completed behind of schedule.

Table 4.3 and Figure 4.6 show schedule performance of public building construction projects in Addis Ababa. The result of the analysis of secondary date indicates all public building construction projects (100%) experienced time overrun. According to the findings of the research 2 projects (5.71%) experienced time overrun between 0 and -10%, 5 projects experienced schedule overrun between -10% and -50%, 5 projects experienced time overrun between -50% and -100%, 5 projects experienced time overrun between -100% up to -150% , 13 projects delayed between -150% and -200%, 3 projects experienced time overrun between -200% and -250% and the remaining 2 projects experienced cost overrun above -250%. The majority of projects 37.14% experienced cost overrun between -150% up to -200% range.

Table 4.3: Project Time Performance

Time Variance	Number of project	percentage
0 up to -10%	2	5.71%
-10% up to -50%	5	14.29%
-50% up to -100%	5	14.29%
-100% up to -150%	5	14.29%
-150% up to -200%	13	37.14%
-200% up to -250%	3	8.57%
Below 251%	2	5.71%

Figure 4.6: Project schedule variance by range of percentage.



4.3. Analysis of Primary Data

4.3.1 Characteristics of Background Variables

Total of 79 participants working for client, contractor, consultant and regulatory body with percentage 22.8%, 43%, 30.4%, and 3.8% respectively responded in this study. Among the total, almost equal proportion i.e. 26.6% and 27.6% of participants were construction engineers and office engineers respectively. 21.5% were design engineers, 13.9% were project managers while the remaining 10.1% were project engineers. Regarding educational level, the majority of participants, 60.8%, have educational qualification of first degree. 29.1% of participants were having educational level of master Degree whereas the minority of participants, 10.1% have educational level of diploma. 49.4% have work experience greater than 10 years, 26.6% of participants have work experience less than 5 years while the remaining 24.1% have work experience between 5-10 years. Regarding organization, 43% of participants were contractors' employees, 30.4% were consultants' employees, 22.8% were client employees and the minority 3.8% were regulatory bodies' employees.

Figure 4.7: Title of respondent Group.

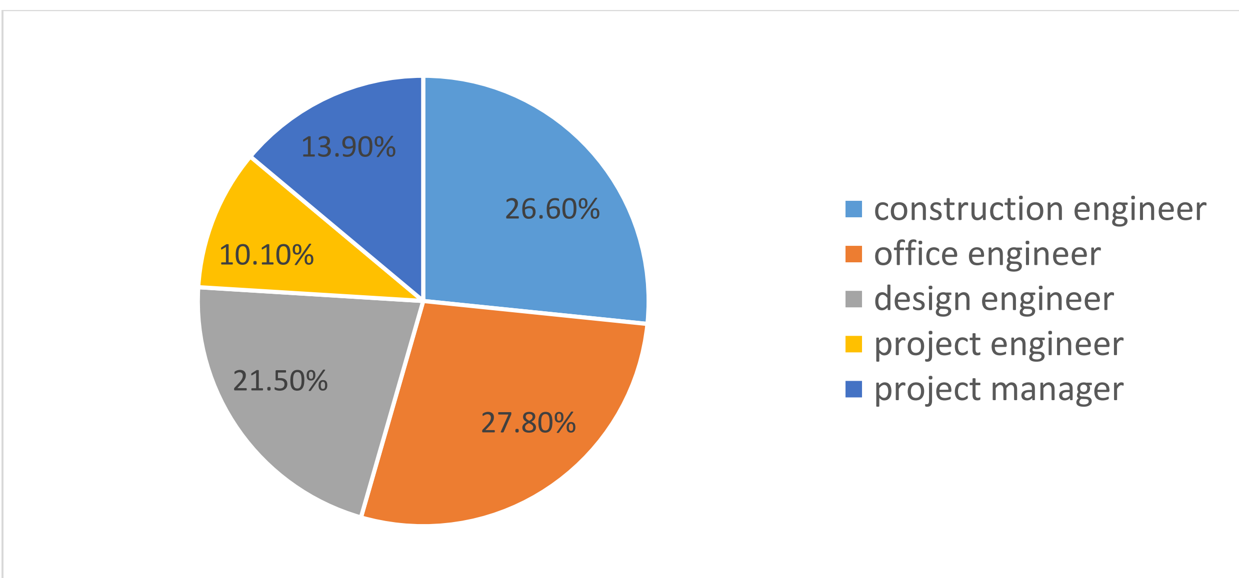


Figure 4.8: Experience of Respondent Group

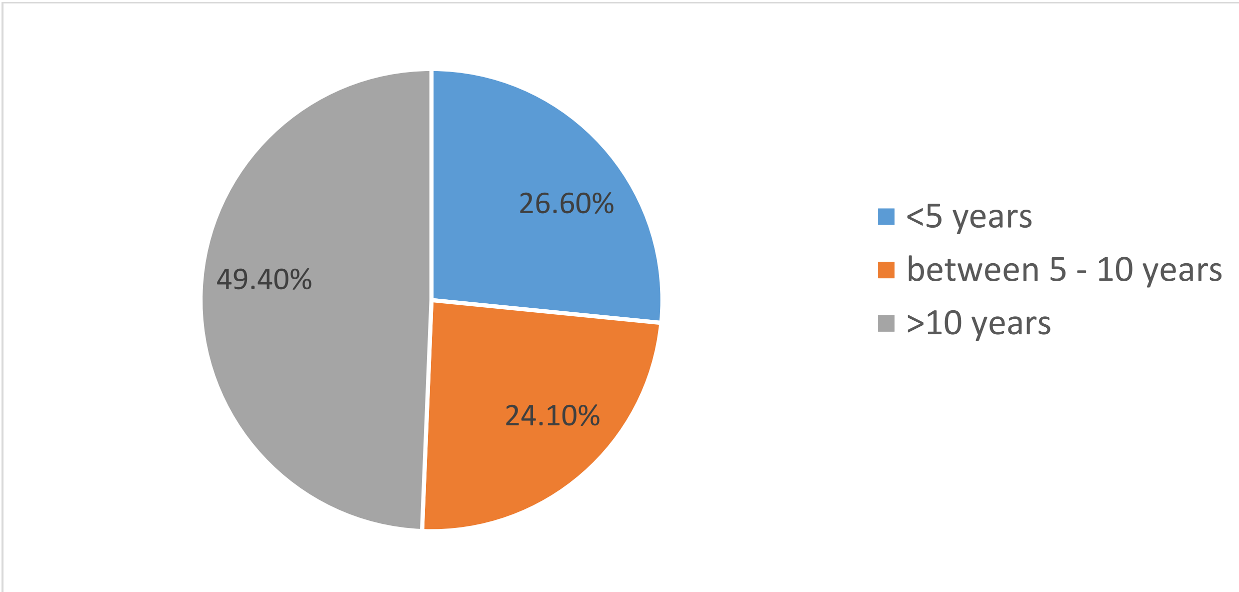


Figure 4.9: Educational Level of Respondent

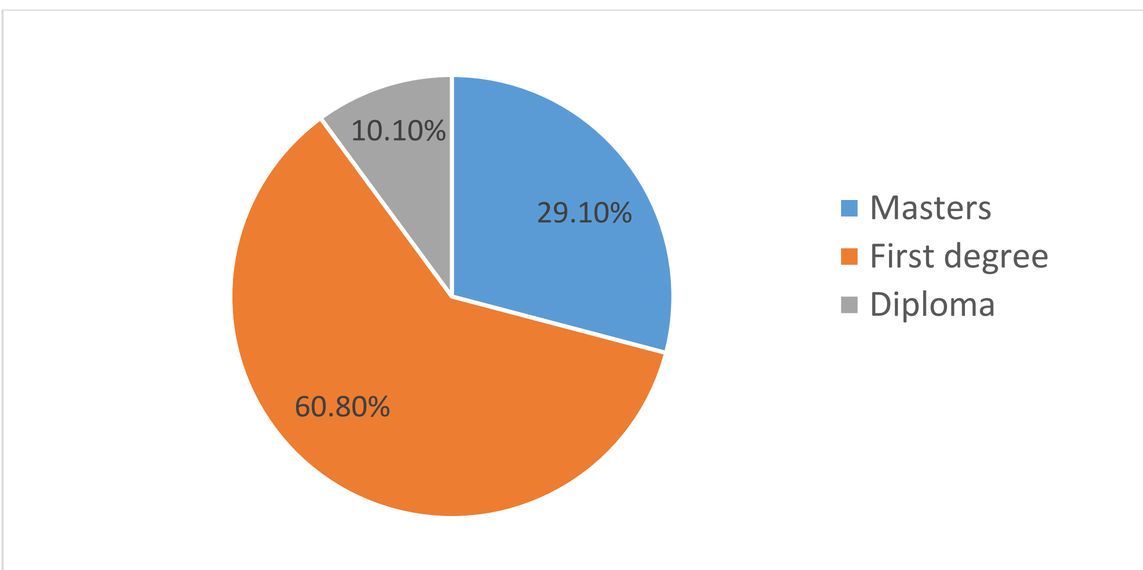
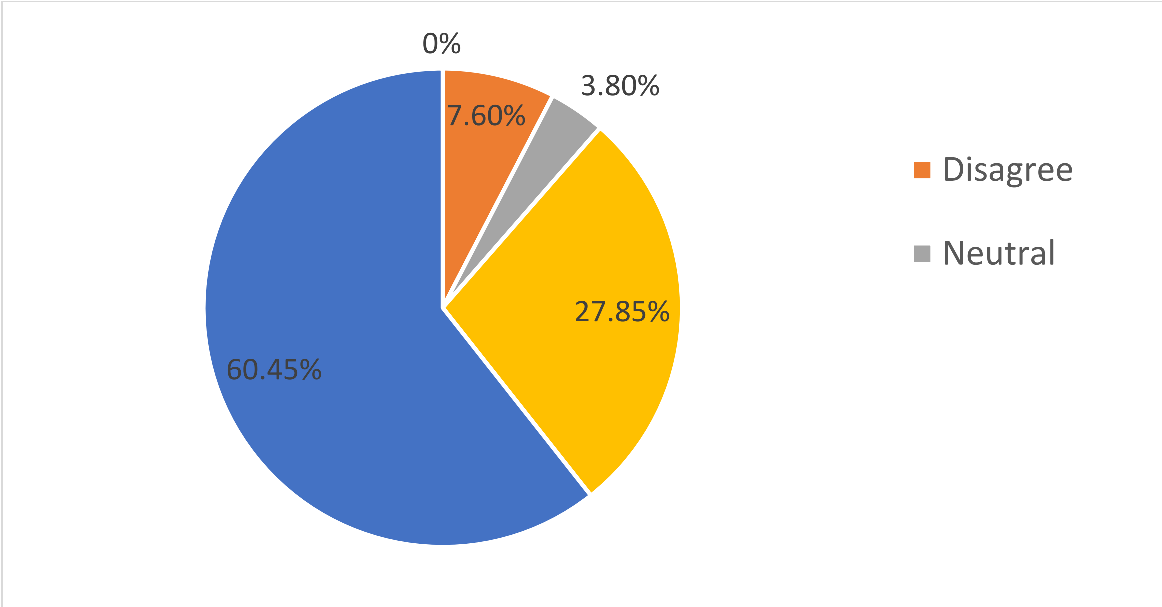


Figure 4.10: Time and cost as performance measurement parameter



4.3.2. Relationship between Background Variables and Cost Factors

A one-way between groups analysis of variance was used to explore the impact of background variables on time and cost performance of public building construction projects in Addis Ababa. Preliminary assumption testing was conducted to check for normality and homogeneity of variance, and there was no serious violation noted.

As can be seen in the table 4.4 below, ANOVA result indicated that there was no statistically significant cost means score difference between groups of background variables like title, educational level, work experience and organization, $p > 0.05$.

Table 4.4: Mean difference between Groups of Background Variables on Cost Factors.

Background variable	Categories	N	Mean	SD	Sig.
Title	construction engineer	21	90.71	10.61	0.302
	office engineer	22	87.41	9.70	
	design engineer	17	89.53	7.90	
	project engineer	8	92.25	5.75	
	project manager	11	94.10	5.41	
Educational level	Masters	23	90.26	8.15	0.791
	First degree	48	90.46	9.50	
	Diploma	8	88.13	7.43	
Work experience	<5	21	91.00	8.94	0.836
	5-10	19	90.42	10.51	
	>10	39	89.59	8.13	
Organization	Client	18	92.67	6.35	0.282
	Contractor	34	90.24	10.01	
	Consultant	24	87.71	8.35	
	Regulatory	3	94.00	10.82	

4.3.3. Relationship between Background Variables and Time Factors

A one-way between groups analysis of variance was used to explore the impact of background variables on motivational practice. Preliminary assumption testing was conducted to check for normality and homogeneity of variance, and there was no serious violation noted.

Table 4.5 shows ANOVA result indicated that there was no statistically significant time means scored difference between groups of background variables like title, educational level and work experience. However, there was a statistically significant mean score difference between groups of organization of time score. Post-hoc group comparison using Tukey-HSD is made and the only difference was between contractor and consultant. Contractors' time mean score (M = 120.09, SD = 13.45) was significantly higher than consultants' time mean score (M = 110.08, SD = 11.02).

Table 4.5: Mean difference between Groups of Background Variables on Time Factors

Background variable	Categories	N	Mean	SD	Sig.
Title	construction engineer	21	113.95	13.10	0.469
	office engineer	22	116.18	12.40	
	design engineer	17	115.94	11.73	
	project engineer	8	115.00	14.82	
	project manager	11	122.46	9.50	
Educational level	Masters	23	117.21	11.31	0.807
	First degree	48	116.25	12.47	
	Diploma	8	113.88	15.39	
Work experience	<5	21	115.57	11.18	0.375
	5-10	19	119.74	14.18	
	>10	39	115.00	11.94	
Organization	Client	18	117.67	9.29	0.019
	Contractor	34	120.09	13.45	
	Consultant	24	110.08	11.02	
	Regulatory	3	114.67	8.74	

As shown in the table 4.6, there was a statistically significant difference between groups of back ground variable on time/ cost factor, F = 2.91, df = 3.75, $p < 0.05$. Post-hoc comparison using Tukey HSD showed that the only difference was between participants who reported strongly agree (M= 210.56, SD = 18.32) and disagree (M= 188.67, SD = 12.03).

Table 4.6: Mean difference between Groups of Background Variables on Cost/Time Factors.

Background variable	Categories	N	Mean	SD	df	F	Sig.
Cost/time as PI	Disagree	6	188.67	12.03	3.77	2.91	.040
	Neutral	3	206.33	31.53			
	Agree	22	202.36	19.52			
	Strongly agree	48	210.56	18.32			

4.3.4. Correlation between Cost and Time Factors

According to table 4.7 there was a statistically significant positive strong correlation between cost and time, $r = 0.68$, $p < 0.001$. This strong positive correlation between time and cost implies that as time increases cost also increases and vice-versa.

Table 4.7: Pearson Correlation between Cost Factors and Time Factors

	Cost	Time
Cost	1	0.680**
Significance (P)		.000
Frequency (N)	79	79

Note: **. Correlation is significant at the 0.01 level (2-tailed)

4.3.5. Descriptive of Sub-scales of Cost and Time

Table 4.8 shows that participants' total project related cost factors, Material related cost factors, and Design related cost factors mean score was greater than 3.5. In a 5-point Likert scale and the possible score ranges from 1-5 and 3 become the hypothetical average score. A calculated mean score less than 3, which is hypothetical average, can be considered as low mean score whereas greater than 3 can be considered as high mean score. Consequently, since the calculated mean score of total project related cost factors, Material related cost factors, and Design related cost factors is greater than 3; participants perceived that total project related cost factors, Material related cost factors, and Design related cost factors were very important cost factors in assessing the effectiveness of construction of buildings.

Table 4.8: Mean and Standard Deviation of Sub-scales of Cost.

	N	Mean	Std. Deviation
Project related cost factors	79	3.76	0.40
Material related cost factors	79	3.74	0.58
Design related cost factors	79	4.04	0.56
External environment factors	79	3.40	0.66

However, the mean value of External environment related cost factors was 3.4 mathematically rounded to 3.00. This mean value implies that participants perceived that External environment related Cost factors had moderate or average importance in assessing the cost performance of public building construction project.

As shown in table 4.9 the mean score of Equipment related time factor, Project related time factors and Contractor related time factors was greater than 3.5 which imply that participants perceived that Equipment related time factor, Project related time factors and Contractor related time factors were very important time factors in assessing the effectiveness of construction of buildings.

Table 4.9: Mean and Standard Deviation of Sub-scales of Time

	N	Mean	Std. Deviation
Equipment related time factors	79	3.79	0.64
Project related time factors	79	4.03	0.41
Contractor related time factors	79	4.10	0.48

4.4 Aggregate RII Value and Rank of Cost and Time Factors

This part aims to develop analysis of significance of each time and cost factor in Public building construction projects in Addis Ababa. A final list of factors ordered according to their significance. The results of this part of study provide an indication of the relative importance index and rank of factors affecting time and cost performance of public building construction projects in Addis Ababa.

4.5. Aggregate Relative Importance Index of Cost Factors.

Table 4.10 shows cost factors ranked by their combined value of relative importance index (RII). The first five most important cost factors agreed by all stakeholders are escalation of material price, completeness of design, variation order, and speed of decision making and Initial budget estimate with the value of RII 0.87, 0.85, 0.83, 0.82 and 0.82 respectively. Escalation of material price is the most critical factor for all parities of the project. According to Public procurement Agencies’ manual article 4.2.5.12 escalation is not considered for projects whose project duration is less than 18 months.

Table 4.10: Aggregate RII value and Rank of Cost Factors

Cost factors	RII	Rank
Escalation of material price	0.87	1
Completeness of design	0.85	2
Variation order	0.83	3
Speed of decision making	0.82	4
Initial budget Estimate	0.82	5
Design team experience	0.81	6
Additional or omission work order	0.81	7
Design Changes	0.79	8
delay in producing design document	0.78	9
Information about the project	0.76	10
Method of Contract administration	0.75	11
Ground condition	0.75	12
Material changes	0.74	13
Contract and specification interpretation	0.73	14
Location of project (suitability of location)	0.72	15
Regulatory issues (permits, Utilities, etc.)	0.72	16
Project complexity	0.72	17
Project characteristics (size, type, etc.…)	0.72	17
Natural environment (climate condition)	0.71	19
Relationship between the client and contractor	0.71	19
conflict of Interest	0.71	21
Rate of feedback	0.68	22
Proportion of off-site prefabrication	0.63	23
Environmental concerns and restrictions	0.60	24

Also the result of secondary data indicates 100% of projects facing problem of time overrun and this is caused due to inadequate initial project duration. Public client does not want Project duration to be more than 18 months not to consider escalation of material price on its projects.

The second most critical factor is completeness of design. This result supports the result obtained by the secondary data. The inflated quantities caused the cost of projects to be less than the initial contract amount. 74.30% of projects were completed with lesser cost than its contract amount. Quantity inflation is directly related to quality of design and hence completeness of design is considered the second most critical factor of cost performance of public building construction projects.

Variation was given third place by the respondent as critical factor. Here variation is defined as the deviation of quantity of item of work already specified on the contract document. In Actual usage of the term in construction contract it includes addition and omission of works. But omission and addition of work are considered separately for the sake of this research. Addition and omission are not related to the quality of contract document. It could be initiated by the client to get additional facilities or to modify the existing scope of the work. It is deliberate decision taken by the concerned body. In the context of this research variation is related to completeness of design and computing the actual quality of work related to its design. The research showed that results of questionnaire survey and the secondary data support each other. The result of secondary data showed that 74.3% of projects were completed with cost less than the contract amount due to variation of quantity.

Speed of decision making and initial budge estimate both have 0.82 relative importance index value. Both were given the fourth place in the rank. This showed that the importance of speed of decision making and initial budge estimate. Construction projects mobilizes various resource to its actualization. It requires immediate decision making by all parties participated on the projects. Decision making also can be seen as a way of communication among project parties. For quick decision there should effective system of communication. If the communication system breaks at some point in the communication network it is very difficult to make quick decision. Therefore, quick decision making is directly related to system of communication employed on the project among parties.

The other factor is initial budge estimate. Here initial budget estimate represents the contract amount offered by the contractor. Procurement of Public projects undertakes based on the least price offered by the contractors. Using this system has its own advantages and disadvantages. In most cases contractors coat price to get a job and the fierce competition forced the contractor to reduce their overhead cost and profit margin. As a result projects suffered from insufficient budget and causes default and consequently time and cost overrun.

Table 4.11: Cost Factors Ranked by Contractor

RII Value of Cost factor by Contractor	RII	Rank
Escalation of material price	0.89	1
Completeness of design	0.88	2
Speed of decision making	0.85	3
Variation order	0.84	4
Initial budget Estimate	0.81	5
Design team experience	0.80	6
Design Changes	0.79	7
delay in producing design document	0.76	8
Material changes	0.75	9
Location of project (suitability of location)	0.75	9
Ground condition	0.74	11
Contract and specification interpretation	0.74	11
conflict of Interest	0.74	11
Project complexity	0.74	11
Information about the project	0.73	15
Relationship between the client and contractor	0.72	15
Method of Contract administration	0.72	15
Regulatory issues (permits, Utilities, etc.)	0.72	18
Project characteristics (size, type, etc.…)	0.71	19
Natural environment (climate condition)	0.70	20
Rate of feedback	0.68	22
Proportion of off-site prefabrication	0.62	23
Environmental concerns and restrictions	0.58	24

According to table 4.11 above contractors perceived escalation of material price; RII=0.89, completeness of design; RII=0.88, Speed of decision making; RII=0.85, Variation order; RII=0.84 and Initial budget estimate; RII= 0.81 are the first most critical cost of performance factors.

Consultants perceived that the most important cost performance factors are: Variation order; RII=0.88, Speed of decision making; RII=0.83, Design team experience; RII= 0.83, escalation of material price; RII=0.89, completeness of design; RII=0.88, and Initial budget estimate; RII= 0.81.

Table 4.12: Cost Factors Ranked by Consultant

RII Value of Cost factors by Consultant	RII	Rank
Variation order	0.88	1
Speed of decision making	0.83	2
Design team experience	0.83	2
Escalation of material price	0.82	4
Initial budget Estimate	0.80	5
Design Changes	0.80	5
Completeness of design	0.78	7
Information about the project	0.78	7
delay in producing design document	0.78	7
Method of Contract administration	0.75	10
Ground condition	0.72	11
Material changes	0.71	12
Contract and specification interpretation	0.70	13
Natural environment (climate condition)	0.70	13
Project complexity	0.70	13
Regulatory issues (permits, Utilities, etc.)	0.68	16
Location of project (suitability of location)	0.68	16
Relationship between the client and contractor	0.67	18
Project characteristics (size, type, etc.…)	0.67	18
Rate of feedback	0.66	20
conflict of Interest	0.63	22
Environmental concerns and restrictions	0.59	23
Proportion of prefabrication	0.57	24

Client perceived that the most important cost performance factors are: completeness of design; RII value =0.91, Escalation material price; RII value =0.91, Initial budget estimate; RII value =0.84, Method of contract administration; RII value = 0.8, delay in producing design document; RII value=0.8 and Ground condition; RII value =0.8.

Table 4.13: Cost Factors Ranked by Client

RII Value of Cost factors by client	**RII**	**Rank**
Completeness of design	0.91	1
Escalation of material price	0.91	1
Initial budget Estimate	0.84	3
Method of Contract administration	0.80	4
delay in producing design document	0.80	4
Ground condition	0.80	4
Design team experience	0.78	7
Project characteristics (size, type, etc.…)	0.78	7
Variation order	0.78	7
Regulatory issues (permits, Utilities, etc.)	0.77	10
Additional work order	0.77	10
Information about the project	0.77	10
Relationship between the client and contractor	0.77	10
Material changes	0.77	10
Natural environment (climate condition)	0.77	10
Design Changes	0.76	15
Location of project (suitability of location)	0.76	15
conflict of Interest	0.76	15
Speed of decision making	0.76	15
Proportion of off-site prefabrication	0.74	20
Contract and specification interpretation	0.71	21
Project complexity	0.70	22
Rate of feedback	0.69	23
Environmental concerns and restrictions	0.67	24

The first top five critical cost performance factors perceived by regulatory body are: Information about the project; RII value=0.93, Contract and specification interpretation; RII value=0.93, Design team experience; RII value=0.93, completeness of design; RII value=0.87 and Initial budget estimate; RII value=0.87.

Table 4.14: Cost Factors Ranked by Regulatory Body

RII Value of Cost factors by Regulatory	RII	Rank
Information about the project	0.93	1
Contract and specification interpretation	0.93	1
Design team experience	0.93	1
Design Changes	0.93	1
Completeness of design	0.87	5
Initial budget Estimate	0.87	5
delay in producing design document	0.87	5
Escalation of material price	0.87	5
Method of Contract administration	0.80	9
Regulatory issues (permits, Utilities, etc.)	0.80	9
Speed of decision making	0.80	9
conflict of Interest	0.80	9
Material changes	0.80	9
Ground condition	0.80	9
Project characteristics (size, type, etc.…)	0.80	9
Additional work order	0.73	16
Rate of feedback	0.73	16
Project complexity	0.73	16
Variation order	0.73	16
Location of project (suitability of location)	0.67	20
Natural environment (climate condition)	0.67	20
Relationship between the client and contractor	0.67	20
Environmental concerns and restrictions	0.53	23
Proportion of off-site prefabrication	0.53	23

4.5.1. Comparing Aggregate RII Value of Cost Factors to Respondent Group.

Aggregate RII value of 0.87 indicates that Escalation of material price ranked first. The RII value obtained by respondent group, contractor, consultant. Client and regulatory body, ranked first, fourth, second and eighth respectively. According to the research made by Enthlasis et al. (2009), Escalation of material prices has been ranked by the contractors and client respondents in the first position. However, this factor has been ranked by the consultants' respondents in the second position. Therefore the result of this research supports that escalation is the most important factor for contractor and client. It is observed that this factor is more important for client and contractors because escalation of material prices affects the liquidity of owners and the profit rate of contractors.

Table 4.15: Aggregate RII Value of the top five ranked cost factors

Escalation of material price	0.87	1
Completeness of design	0.85	2
Variation order	0.83	3
Speed of decision making	0.82	4
Initial budget Estimate	0.82	5

Completeness of design has an aggregate RII value of 0.85 and placed at the second rank. The same factor is ranked second by contractor seventh by consultant first by client and fifth by regulatory body. For contractors, next to escalation of material, completeness of design was placed at the second position however for client this factor is the first most ranked factor. It is observed that this factors is very important for client because if requirement of clients was not comprehensively incorporated during design stage there will be a need for modifying a design and consequently there will be variation in quantity. Increase in quantity implies increase in project cost. Therefore, the client need to allocate additional budget for the added amount of work. Completeness of design directly affects the cost of project. For consultant res completeness of design was not considered as the most important factor.

An aggregate value of 0.83 placed variation in the third place. However contractors, consultant, client and regulatory body ranked fourth, first, eighth and sixteenth respectively. For consultant variation is first ranked cost performance factor among all listed cost factors. It has been explained that variation is defined here as the deviation of quantity from the contract amount. It results in increase or decrease of quantity. But the other groups do not consider it as an acute factor of cost performance.

Speed of decision making is ranked fourth with aggregate RII value of 0.82. Contractor ranked third, consultant ranked second, client ranked fifth and regulatory body ranked ninth.

4.6. Aggregate Relative importance index of Time factors.

Tables 4.16 illustrates the top significant factors affecting time performance of public construction projects. It can be inferred from this tables that 5 most critical factors according to the perception of contractor, consultant, client and regulatory body are: contractors' organizational structure, project team experience, project team turnover, test sample of material and labor deployment of contractor.

According to respondents, the first most critical time performance factors is contractors' organizational structure. An organizational structure defines how tasks are formally divided, grouped, and coordinated (Robinson, 1996). Key elements that determine organizational structure are: work specialization, departmentalization, and chain of command, span of control, centralization and decentralization.

Therefore, it determines how project resource are coordinated and information are transmitted among project participants which in turn facilitate decision making and rate of feedback to achieve the objectives of organization in general and projects in particular. The type of organizational structure which can suit to nature of particular projects should be adopted to maintain and achieve project objectives.

Project team experience the second most rated time performance factor with RII value equal to 0.89. Experience is said to be a great teacher (Robinson, 1996). It can also be a great stress reducer. For most of people, the uncertainty and newness of these situations created stress. But as we gained experience, that stress disappeared or at least significantly decreased.

The same phenomenon seems to apply to work situations. That is, experience on the job tends to be negatively related to work stress, two explanations have been offered." First is the idea of selective withdrawal. Voluntary turnover is more probable among people who experience more stress. Therefore, people who remain with the organization longer are those with more stress-resistant traits or those who are more resistant to the stress characteristics of their organization. Second, people eventually develop coping mechanisms to deal with stress. Because this takes time, senior members of the organization are more likely to be fully adapted and should experience less stress (Robinson, 1996). Project team turnover is the third most rated time performance factor in public building construction projects in Addis Ababa. Increased rate of project team turnover results in recruiting new employee to fill the vacant position. Therefore the newly employed worker need some time to adapt himself to the work and the new environment consequently affects the project duration.

It is related to the second critical factor that is project team experience. Decreased rate of turnover mean maintaining experienced workers in the project and in the same token increased rate of turnover mean losing experienced project workers and replacing them with new and unexperienced workers. Test sample of material, labor deployment of contractor and project complexity placed at fourth level. They all have the same value of relative importance index 0.87. Test sample of material takes longer time according to the result obtained from respondent of the research.

Labor deployment of contractor implies quality and quantity of workers needed for the project. Actually on project site major work is done by contractor and assigning appropriate number and employee having relevant skill and experience is decisive to maintain project objectives.

Table 4.16: Aggregate RII Value of Time factors.

Time factor	**RII**	**Rank**
Contractor's organizational structure	0.93	1
Project team work experience	0.89	2
Project team turn over	0.88	3
Test samples of material	0.87	4
Labor deployment of contractor	0.87	4
Project complexity	0.87	4
Speed of decision making	0.86	7
Rate of feedback	0.84	8
Productivity of labor	0.83	9
Experience of contractor	0.83	9
Contract and specification interpretation	0.83	9
Relationship between the client and contractor	0.83	9
Information about the project	0.83	9
Waiting time for approval of test sample material	0.82	14
Site management	0.82	14
selection equipment	0.81	16
Environmental concerns and restrictions	0.81	17
Equipment Breakdown	0.79	18
Conflict of Interest	0.78	19
Conflict between project parties	0.75	20
Client's unwillingness to help contractor	0.75	20
Contractors' commitment	0.74	22
Initial planning	0.74	22
Design Changes	0.74	22
Method of work	0.73	25
Contractor's financial capacity (cash flow)	0.73	25
Waiting time for approval of drawings	0.72	27
Project team motivation	0.71	28
Low efficiency Equipment	0.66	29

Table 4.17 shows the RII value of time factor ranked by contractor. The result of contractors' response about time performance factors indicated that contractors' organizational structure, project team experience ranked the same as the general responses by project participants. Contractors' organizational structure ranked first and project team

experience was ranked second and have RII value of 0.94 and 0.92 respectively. Test of sample material put in the third rank, labor deployment of contractor in the fourth and project complexity in the fifth place.

Table 4.17: Time Factors Ranked by Contractor.

RII Value of Time factor by Contractor	RII	Rank
Contractor’s organizational structure	0.94	1
Project team work experience	0.92	2
Test samples of material	0.90	3
Labor deployment of contractor	0.89	4
Project complexity	0.89	4
Productivity of labor	0.89	4
Environmental concerns and restrictions	0.86	7
Experience of contractor	0.86	7
Contract and specification interpretation	0.86	7
Rate of feedback	0.86	7
Relationship between the client and contractor	0.85	11
Conflict of Interest	0.85	11
Information about the project	0.85	11
Project team turn over	0.85	11
Waiting time for approval of test sample material	0.84	15
Speed of decision making	0.84	15
Equipment Breakdown	0.84	15
Site management	0.83	18
Conflict between project parties	0.83	18
Design Changes	0.82	20
selection equipment	0.81	21
Client's unwillingness to help contractor	0.80	22
Initial planning	0.76	23
Method of work	0.76	23
Contractors’ commitment	0.75	25
Contractor’s financial capacity (cash flow)	0.75	25
Project team motivation	0.74	27
Waiting time for approval of drawings	0.69	28
Low efficiency Equipment	0.68	29

Compared to a general response by all group of respondent, consultant gave the same rank for contractors' organizational structure, project team experience and project team turn over with RII value of 0.93, 0.88 0.88 respectively. Labor deployment and speed of decision making considered fourth and fifth critical time performance factors by consultant.

Table 4.18: Time Factors Ranked by Consultant.

RII Value of Time factor by Consultant	RII	Rank
Contractor's organizational structure	0.93	1
Project team work experience	0.88	2
Project team turn over	0.88	2
Labor deployment of contractor	0.86	4
Speed of decision making	0.86	4
Rate of feedback	0.84	6
Experience of contractor	0.83	7
Test samples of material	0.83	7
selection equipment	0.83	7
Waiting time for approval of test sample material	0.82	10
Information about the project	0.81	11
Site management	0.81	11
Relationship between the client and contractor	0.80	13
Project complexity	0.80	13
Equipment Breakdown	0.78	15
Productivity of labor	0.78	15
Contract and specification interpretation	0.77	17
Environmental concerns and restrictions	0.73	18
Initial planning	0.71	19
Contractor's financial capacity (cash flow)	0.70	20
Waiting time for approval of drawings	0.70	20
Contractors' commitment	0.69	22
Method of work	0.68	23
Project team motivation	0.65	24
Conflict between project parties	0.64	25
Conflict of Interest	0.63	26
Client's unwillingness to help contractor	0.62	27
Design Changes	0.61	28
Low efficiency Equipment	0.57	29

Correspondingly, clients responded that contractors' organizational structure is the most outweighing factor that can affect time performance of public building construction projects with relative importance index (RII) value equal to 0.97. Contractors, consultant and clients agreed in their response that this factor is the first most factor that affects time.

Table 4.19: Time Factors Ranked by Client

RII Value of Time factor by Client	RII	Rank
Contractor's organizational structure	0.97	1
Project team turn over	0.92	2
Project complexity	0.90	3
Speed of decision making	0.89	4
Project team work experience	0.88	5
Test samples of material	0.87	6
Contract and specification interpretation	0.86	7
Labor deployment of contractor	0.83	8
Conflict of Interest	0.82	9
Relationship between the client and contractor	0.82	9
Site management	0.81	11
Client's unwillingness to help contractor	0.81	11
Productivity of labor	0.81	11
Contractors' commitment	0.80	14
Environmental concerns and restrictions	0.80	14
selection equipment	0.80	14
Rate of feedback	0.80	14
Experience of contractor	0.79	18
Waiting time for approval of test sample material	0.79	18
Low efficiency Equipment	0.79	18
Waiting time for approval of drawings	0.79	18
Information about the project	0.79	18
Method of work	0.77	23
Conflict between project parties	0.76	24
Contractor's financial capacity (cash flow)	0.74	25
Initial planning	0.74	25
Design Changes	0.73	27
Equipment Breakdown	0.73	27
Project team motivation	0.72	29

Next to organizational structure, project team turnover with RII value equal to 0.92, project complexity with RII 0.90 speed of decision making with RII value 0.89 and project team work experience with RII value 0.88 ranked from second to fifth sequentially.

Table 4.20: Time Factors Ranked by Regulatory Body

RII Value of Time factor by Regulatory	RII	Rank
Project complexity	0.93	1
Test samples of material	0.87	2
Labor deployment of contractor	0.87	2
Project team motivation	0.87	2
Rate of feedback	0.87	2
Project team turn over	0.87	2
Information about the project	0.87	2
Contract and specification interpretation	0.87	2
Conflict of Interest	0.87	2
Waiting time for approval of drawings	0.87	2
Project team work experience	0.80	11
Contractors' commitment	0.80	11
Speed of decision making	0.80	11
Contractor's organizational structure	0.80	11
Initial planning	0.80	11
Design Changes	0.80	11
Client's unwillingness to help contractor	0.80	11
Relationship between the client and contractor	0.80	11
Environmental concerns and restrictions	0.80	11
selection equipment	0.80	11
Equipment Breakdown	0.80	11
Productivity of labor	0.80	11
Experience of contractor	0.73	23
Site management	0.73	23
Waiting time for approval of test sample material	0.67	25
Method of work	0.67	26
Contractor's financial capacity (cash flow)	0.67	26
Conflict between project parties	0.67	26
Low efficiency Equipment	0.47	29

The first rank was given by regulatory body to complexity of project having RII Value of 0.93. This differs from the three group of respondents i.e., contractor, consultant and client. The next four ranks were taken by test of sample materials, labor deployment of contractor, Project team motivation and rate of feedback having the same RII value of 0.87.

4.6.1. Comparing Aggregate RII Value of time Factors to Respondent Group.

Surprisingly the rank obtained by aggregate RII value for contractors' organizational structure is the same as the rank given by contractor, consultant and contractor whereas regulatory body ranked it eleventh. Next to contractors' organizational structure, project team experience is given second rank by its cumulative value and comparing this with the respondent group contractor and consultant ranked the same second position client put it at fifth position and regulatory body ranked eleventh.

Table 4.21: Aggregate RII Value of the top five ranked time factors

Time factor	RII	Rank
Contractor's organizational structure	0.93	1
Project team work experience	0.89	2
Project team turn over	0.88	3
Test samples of material	0.87	4
Labor deployment of contractor	0.87	4

Project turnover stood third by it aggregate RII value. Contractor ranked eleventh, consultant ranked third, client and regulatory body placed at second position. Test sample of material is the fourth ranked time factor by its aggregate RII value. Contractor ranked third and the same factor placed seventh by consultant ranked sixth by client and regulatory body positioned at second rank. According to aggregate RII value of time factor labor deployment of contractor ranked fifth and comparing the same factor with the respondent RII value contractor and consultant ranked fourth client ranked eighth and regulatory body ranked second.

To examine the presence of relationship among each time and cost factors, Pearson's correlation was done among 24 factors for time and 29 factors for cost were considered and correlational analysis was done whether there is correlation between these factors.
The result shows that there is correlation between some factors. The SPSS report is attached on the annex for further reference. Among all factors in reference to RII values five critical cost and time factors' correlation is executed.
Furthermore, Pearson's correlation was done among time factors to investigate the presence of correlation in the first top five critical time factors. As exhibited in the table below, it is found that, there is very strong significant correlation between test samples of material and Labor deployment of contractor with (p= 0.002 and r=-.342**), There are also significant correlation between the factors Test samples of material and contractor's organizational structure as well as Labor deployment of contractor and project team work experience which are 0.27 and 0.31 respectively.

Correlation was done for the first top five critical cost factors. As shown in the table below, it is found that, there is no significant correlation among any of the top five critical cost factors.

Table 4.22: Top five Critical Time factors correlations.

		Escalation of material price	Initial budget Estimate	Speed of decision making	Completeness of design	Variation order
Escalation of material price	Pearson Correlation	1	.049	.133	.191	.127
	Sig. (2-tailed)		.667	.243	.091	.266
	N	79	79	79	79	79
Initial budget Estimate	Pearson Correlation		1	.019	.008	-.062
	Sig. (2-tailed)			.866	.944	.585
	N		79	79	79	79
Speed of decision making	Pearson Correlation			1	.087	-.120
	Sig. (2-tailed)				.445	.292
	N			79	79	79
Completeness of design	Pearson Correlation				1	-.060
	Sig. (2-tailed)					.602
	N				79	79
Variation order	Pearson Correlation					1
	Sig. (2-tailed)					
	N					79

Table 4.23: Top five Critical Cost factors correlations.

		Contractor's organizational structure	Labor deployment of contractor	Project team work experience	Test samples of material	Project team turn over
Contractor's organizational structure	Pearson Correlation	1	.103	.015	**.250***	-.051
	Sig. (2-tailed)		.367	.895	**.027**	.658
	N	79	79	79	78	79
Labor deployment of contractor	Pearson Correlation		1	**.242***	**-.342****	.002
	Sig. (2-tailed)			**.031**	**.002**	.987
	N		79	79	78	79
Project team work experience	Pearson Correlation			1	-.023	-.029
	Sig. (2-tailed)				.840	.801
	N			79	78	79
Test samples of material	Pearson Correlation				1	-.037
	Sig. (2-tailed)					.747
	N				78	78
Project team turn over	Pearson Correlation					1
	Sig. (2-tailed)					
	N					79

Chapter Five

Conclusion and Recommendation

5.1 Conclusion

The study carried out an in-depth time and cost performance examination of public construction projects in Addis Ababa. It is in the best interest of project participants to ensure that projects are delivered on schedule and on cost. It can be understood from the study that some key factors are very important in ensuring project performance. It indicates time and cost performance of construction project are very important in achieving project performance .The influence of these two performance metrics determine the success of a project more than any other. A comparison between budgeted cost of work performed versus Actual cost of work performed and scheduled time of work performed versus Actual time of work performed shows projects experienced schedule delay and cost underrun. The analysis has shown that most public building construction projects in Addis Ababa experienced time and cost deviation.

Specific objective 1

<u>To assess cost and time performance of public building construction projects in Addis Ababa.</u>

1.1. To assess cost performance of public building construction projects in Addis Ababa.

Secondary data analysis result shows that there is statistically significant variation in the cost performance of public building construction projects in Addis Ababa. Mostly, projects were delivered under budget. The outcome of secondary data indicates that 74.3% of public building construction projects in Addis Ababa experienced cost under performance and the remaining 25.7% projects completed with higher cost than budgeted. Out of this 74.3% projects 40% of the projects have the Actual cost of work performed varies with more than negative 20%.

Even though scope of the study does not include identification of cost factor particular to each projects in the study that were causing the considerable cost variation of projects, the researcher interviewed professional directly participated in that specific project which have more than 20% cost variance. The result of the interview indicates that inflation of quantity is the major factor for this cost variation.

1.2. To assess time performance of public building construction projects.

Concerning project time performance the result of analysis of secondary data indicates that public building construction projects are not completed within the time duration specified in the contract document. Project time overrun of public projects is a critical problem of the public construction projects in Addis Ababa. The research finding point out 100% of the projects were delayed and not completed within the time stated. The minimum and the maximum time overrun is found to be 10% and above 250% consecutively.

2016 edition of improved contraction process manual of Addis Ababa city Administration construction bureau states how project duration for public construction projects is determined. According to section 10 article 25 of the manual construction project duration for a G+1 building construction set to be 90 days and for G+4 building project duration set to be between 180 days to 360 days. For building projects greater than G+4 building construction project duration is set not to be more than 720 days or 2 years. But the manual does not consider the buildup area and other factors which have significant effect on the time performance of project.

Specific objective 2.

To identify critical factors that affect cost and Time performance of public building construction projects in Addis Ababa.

2.1. To identify critical factors that affect cost performance of public building construction projects in Addis Ababa.

It can be put forward from the study that some factors are very important in ensuring project cost performance. From literature review 24 factors were identified and among these factors the top five ranked was taken as a critical factors. According to statistical analysis result Escalation of material price, completeness of design, Variation, speed of decision making and Initial budget estimate are the most top five critical factors that affect cost performance of public building construction projects in Addis Ababa. The highest RII value of 0.87 was given to Escalation of material price and the least RII value of 0.6 was given to Environmental concern and restrictions factor. The difference between the two extreme values is 0.27. The other 21 factors have a RII value between 0.87 and 0.6.Therefore, in conclusion, all the factors identified from this study should be considered as important factors that affects project cost performance, all efforts should therefore be put to ensure that the identified factors contributes positively to cost performance of public building construction projects in Addis Ababa.

2.2. To identify critical factors that affect time performance of public building construction projects in Addis Ababa.

29 time performance factors were identified from different literatures. Among these factors the result of questionnaire survey indicates that the top five ranked critical factors that affect time performance of public building projects are Contractors' organizational structure, Project team work experience, and project team turn over, Labor deployment of contractor, project complexity and test samples of material. Labor deployment of contractor, project complexity and test samples of materials have the same RII value of 0.87. Out of the 29 time factors contractors' organizational structure has the highest RII value of 0.93 and the least RII value of 0.58 was given to environmental concern and restriction factors. Environmental concern and restriction has got the least RII value as both cost and time performance factor. RII value difference between the highest and the least time affecting factors is 0.35. This variation is higher than the variation between the highest and least value of cost factors

Effort has been made to identify factors critical for each respondent group that affect time and cost performance of public building construction projects Addis Ababa. To identify factors that are considered more critical to contractor, consultant, client and regulatory body, RII value for each cost and time factors was calculated. For contractors the five most important cost factors are escalation of material price, completeness of design, speed of decision making, variation order and initial budget estimate placed from first to fifth consecutively whereas consultants ranked the first five most important cost factors as Variation order, speed of decision making, design team experience, Escalation of material price and initial budget estimate sequentially. Four out of the first five top ranked cost factors, (escalation of material price, speed of decision making, variation and initial budget estimate), are the same for both consultant and contractors.

The other respondent groups are client and regulatory body. Client responded completeness of design is ranked first cost factor and escalation of material, initial budget estimate, method of contract administration, delay in producing design document and escalation of material price are ranked from second to fifth levels. Method of contract administration, delay in producing design document and escalation of material price have the same RII value of 0.80. Information about the project, contract and specification interpretation, design team experience and design change the equal value of RII was given by regulatory body.

In the same way RII value of time factors categorized by respondent group and critical factors of project time performance each group are identified. According to the results obtained from the questionnaire survey contractors were responded that contractor's organizational structure, project team work experience, test samples of material, Labor deployment of contractor and productivity of labor are the most important factors that can affect time performance of public building construction projects in Addis Ababa.

According to the response result of consultant contractor's organizational structure, project team work experience, project team turn over, Labor deployment of contractor and speed of decision making are the most critical time performance factors.

While Client responded contractor's organizational structure, Project team turn over, project complexity, speed of decision making and project team work experience are the most critical time performance factors the response of regulatory body indicates that project complexity take the first position of the list. The other six factor were ranked second with RII value of 0.87. These factors are Labor deployment of contractor, Project team experience, Project team motivation, rate of feedback, project team turn over, information about the project, and conflict of interest.

5.2. Recommendations

Based on the findings of the research this section suggests a number of recommendation and respective roles that should be played by each group of construction industry stakeholders to improve performance of public building construction projects in Addis Ababa. The following recommendations should be put into practice to improve time and cost performance of public building projects in Addis Ababa.

1. Regulatory body of the construction industry is the most top responsible government representative for development of construction industry. Accountable for preparation, improvement and follow up of declarations, policies, manual and overall performance by proving the effectiveness and efficiency of the overall construction environment for the success of public projects. This is not a onetime duty but it is a continuous process and demands application of improved operation and management system and adaptation of up-to-date technological development. Establishment of research and development center is inevitable to conduct up-to- date research on construction industry of the country. The research center should be organized incorporating Client, contractor, consultant, and academician and encouraging participate to actively participate in the reformation of construction industry to achieve a high level of performance in every sector. Committed and visionary participates representing each stakeholder should have part in organizing and coordinating the research center.
2. There should be realistic common standards to set project duration taking into account different variables that can affect project time performance such as environmental related, project related, contractor related, client related and material related factors to avoid biasedness in determining project duration and to fixe adequate duration.

3. Client should develop well defined scope of the project before the design work is commenced. Scope affects the budget to be allocated and consequently the design work of a project. Good scope definition reduces the amount of variation that will occur during construction stage .In practice there are two possibilities for defining scope. Scope can be defined to match with the amount of budget available or budget is fixed after the scope of the project is sufficiently defined. It is vital for completion of projects with in the schedule

and on budget enabling the client to allocate sufficient budget and to determine project duration.

4. In Most case consultant who produces design of projects and bill of quantities should avoid inflation of quantities to minimize variation of work.

5. Contractor should develop well studied organizational structures that enhance its' efficiency and effectiveness to manage the overall activities of the project.

6. Further study should be conducted to investigate other performance parameters, such as quality, stakeholders' satisfaction and health and safety.

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Annex 1:- Sample projects Information

S.N	Project	Duration(days)		Project Cost(Birr)	
		Contract	Actual	Contract	Actual
1	Laboratory Construction (G+3)	180	730	13,482,080.45	14,830,288.50
2	A.A. Environment protection.	485	1760	43,510,203.38	30,457,142.33
3	Bole sub city	558	1760	227,128,479.18	187,989,935.43
4	Government Higher officials and Head of state Residence	240	744	172,610,105.09	95,938,567.76
5	Tegbared polytechnic	365.00	1095	53,977,897.34	37,756,528.09
6	Conference Hall for ministry of Foreign affairs	426	1268	144,621,072.00	113,458,173.68
7	Construction of INSA Head quarter Phase 2	1080	3,210.00	177,728,478.92	142,714,610.13
8	Minilik Hospital	540	1580	183,317,362	75,952,810.31
9	Yekatit 12 Hospital	540	1580	155,200,595.00	175,654,671.00
10	Foreign Affairs and parking & site work	330	940	74,454,888.11	68,343,872.53
11	The Lion Zoo Enclosure	720	2010	91,202,354.29	63,841,648.75
12	Ethiopian Road Authority office	540	1500	39,858,130.42	33,877,082.00
13	Federal Prison Administration Building (G+6)	540	1482	27,616,525.80	30,378,178.38
14	Ministry of science and Technology office building	540	1413	30,556,036.00	33,611,639.60
15	Gulele Rescue Agency	365	949	36,514,891.15	25,560,423.81
16	Federal Ministry of Industry office Building	540	1373	31,982,540.01	32,942,016.21
17	Federal Ministry of Civil Service office Building	540	1367	39,647,492.31	43,612,241.54

S.N	Project	Duration(days)		Project Cost(Birr)	
		Contract	Actual	Contract	Actual
18	Akaki G+4 adm. And Class room	365	856	20,031,759.29	19,489,118.60
19	Federal Main Auditor Office Building	587	1371	32,666,939.	35,933,632.90
20	Entoto Technical collage	180	410	11,084,605	9,300,000.00
21	Addis Ketema	558	1245	228,159,431.4	180,711,601.9
22	Koteb Teaching college (G+4)	180	394	10,336,900	9,367,042.53
23	Addis Ababa education bureau	540	1095	52,472,555	58,929,931.70
24	Yeka sub city building	558	1095	240,606,342.9	9,724,439.88
25	Akaki Kality	558	1095	229,013,805.2	1,309,663.67
26	Gulele sub city bldg.	558	1035	202,757,841	162,930,415.3
27	A.A. Environment protection	485	900	43,510,203.38	40,578,267.50
28	Office Building for Central Statistics Agency	540	885	23,652,160.69	14,146,080.58
29	Justice bureau (G+12)	540	803	66,638,079.39	53,310,463.49
30	Ras Desta Hospital	540	769	19,595,327.45	15,468,749.79
31	Yeka Police	530	720	60,142,451.69	42,099,716.16
32	Kotebe teaching college (G+4)	365	486	32,510,797	28,740,637.26
33	Urban integrated land information system Development	540	660	166,258,403	19,871,016.00
34	Gandi Hospital	365	450	20393,618	24472340
35	Addis ketema Police	530	560	63,966,758.79	44,776,731.08

Source: - Federal Project Office and Addis Ababa Administration Construction Bureau.

Annex 2: Questionnaire

Questionnaire Survey

Dear respondent",

I am Student of Masters of construction Technology and Management, (CoTM), at Addis Ababa University Institute of Technology. As partial fulfillment of the program, I am undertaking a research on the topic of **Performance Assessment of Public building construction projects in Addis Ababa**. The research result could be used as an input for decision makers, professionals, academician and other interested groups to play their respective role for the achievement of project objectives.

It is believed that your participation in this research will contribute in achieving the objectives of the research. Thus, the quality of your response towards the question items determines the quality of the research results. Therefore, please answer the questions as thoroughly, objectively and honestly as possible according to the instructions contained in the body of the questionnaire. Finally, I want to assure you that all information provided in this survey will be treated with strict confidentiality and allowed to serve only for the purpose of the research under consideration.

Interested participant of this study will be given feedback on the overall research results after the completion of the research work.

Thank You in Advance for your cooperation!!

Part 1: Demographic Profile of respondents.

A) Please encircle only one that represents you most appropriately.

1. What is your title/position?

A) Construction Engineer B) office engineer C) Design Engineer D) Project Engineer E) Project manager

2. What is your highest Educational Level?

A) PhD degree B) Master's degree

C) First degree D) Diploma

3. How many years of Experience do you have (including previous tenure)?

A) Less than 5 years B) 5-10 years C) More than 10 years

4. Type of organization you are working for?

A) Client B) Contractor C) Consultant D) Regulatory

5. Which of the following performance related criteria are in use for the evaluation of public construction projects in your organization? Select all that is applicable.

Cost ◯
- Time ◯
- Quality ◯
- Satisfaction ◯
- Safety ◯

If other please specify: ____

6. In your opinion, how do you understand cost/time as performance criteria? Circle your choices. (Numbers in the bracket indicates points given to each choices)

A) Strongly agree (5) B) Agree (4) C) Neutral (3)

D) Disagree (2) E) strongly disagree (1)

Part Two: Factors Affecting time and cost Performance of Construction Projects

Below are list of factors affecting performance of construction projects? From your experience, please express your opinion on the importance of the following factors that affect public building construction projects in Addis Ababa. (Please put a tick mark in the appropriate column according to their degree of rank).

Rank your response: 1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree and 5= Strongly Agree.

Factors	Degree of Rank				
	5	**4**	**3**	**2**	**1**
(1) Cost factors					
Variation order					
Escalation of material price					
Design Changes					
Project characteristics (size, type, etc.…)					
Ground condition					
Design team experience					
delay in producing design document					
Material changes					
Proportion of off-site prefabrication					
Environmental concerns and restrictions					
Relationship between the client and contractor					
conflict of Interest					
Contract and specification interpretation					
Initial budget Estimate					
Information about the project					
Speed of decision making					
Project complexity					

Completeness of design					
Factors	Degree of Rank				
	5	4	3	2	1
Rate of feedback					
Natural environment (climate condition)					
Location of project (suitability of location)					
Regulatory issues (permits, Utilities, etc.)					
Method of Contract administration					
Additional work order					
(2) Time factors					
Low productivity of labor					
Equipment Breakdown					
Wrong selection equipment					
Waiting time for approval of drawings and test samples of materials					
Environmental concerns and restrictions					
Low efficiency Equipment					
Relationship between the client and contractor					
Conflict between project parties					
Conflict of Interest					
Client's unwillingness to help contractor					
Design Changes					
Contract and specification interpretation					
Initial planning					
Information about the project					
Contractor’s financial capacity (cash flow)					
Contractor’s organizational structure					
Project team turn over					
Site management					
Speed of decision making					
Project complexity					
Rate of feedback					

Factors	Degree of Rank				
	5	4	3	2	1
Project team motivation					
Waiting time for approval of test sample material					
Contractors' commitment					
Labor deployment of contractor					

Annex 3:- Frequency and Percentage of Background Variables

Background variable	Categories	Frequency	Percentage
Title	construction engineer	21	26.6%
	office engineer	22	27.8%
	design engineer	17	21.5%
	project engineer	8	10.1%
	project manager	11	13.9%
Educational level	Masters	23	29.1%
	First degree	48	60.8%
	Diploma	8	10.1%
Work experience	<5	21	26.6%
	5-10	19	24.1%
	>10	39	49.4%
Organization	Client's employee	18	22.8%
	Contractor's employee	34	43.0%
	Consultant's employee	24	30.4%
	Regulatory employee	3	3.8%
Cost/time as PI	Strongly disagree	0	0%
	Disagree	6	7.6%
	Neutral	3	3.8%
	Agree	22	27.85%
	Strongly agree	48	60.45%

Annex 4: project cost performance

Performance	Number of projects	percentage
Cost overrun	9	25.7%
Under budget	26	74.3%
Total	35	100%

Annex 5:- Questionnaire distribution and collection Rate.

organization	distributed	Returned	Invalid	Analyzed	percentage
consultant	28	25	1	24	86%
Contractor	52	40	6	34	65%
client	20	18	0	18	90%
Regulatory	4	4	1	3	75%
Total	104	87	8	79	76%
percentage	100%	84%	7.7%	76%	

Annex 6: Cost factors correlation

		P1	M1	D1	P2	P3	D2	D3	M2	M3	EX1	P4	P5	P6	P7	P8	P9	P10	D4	P11	E2	P12	E3	P13	P14
P1	Pearson Correlation	1																							
	Sig. (2-tailed)																								
	N	79																							
M1	Pearson Correlation	.127	1																						
	Sig. (2-tailed)	.266																							
	N	79	79																						
D1	Pearson Correlation	.091	.029	1																					
	Sig. (2-tailed)	.426	.099																						
	N	79	79	79																					
P2	Pearson Correlation	.069	-.017	-.049	1																				
	Sig. (2-tailed)	.509	.079	.709																					
	N	79	79	79	79																				
P3	Pearson Correlation	.034	.116	-.209	-.000	1																			
	Sig. (2-tailed)	.764	.300	.065	.947																				
	N	79	79	79	79	79																			
D2	Pearson Correlation	-.021	.117	-.041	-.005	.209	1																		
	Sig. (2-tailed)	.051	.305	.717	.969	.079																			
	N	79	79	79	79	79	79																		
D3	Pearson Correlation	.096	.090	.070	-.062	.025	.012	1																	
	Sig. (2-tailed)	.390	.796	.495	.505	.025	.917																		
	N	79	79	79	79	79	79	79																	
M2	Pearson Correlation	.019	-.160	-.017	-.042	-.060	.001	.094	1																
	Sig. (2-tailed)	.069	.199	.079	.712	.599	.999	.412																	
	N	79	79	79	79	79	79	79	79																
M3	Pearson Correlation	.039	.062	-.200	-.067	.102	-.119	.109	.120	1															
	Sig. (2-tailed)	.779	.500	.065	.559	.972	.294	.967	.260																
	N	79	79	79	79	79	79	79	79	79															
EX1	Pearson Correlation	-.144	-.191	-.139	-.060	.210	-.056	.079	.175	.370	1														
	Sig. (2-tailed)	.205	.250	.220	.549	.069	.622	.524	.124	.001															
	N	79	79	79	79	79	79	79	79	79	79														
P4	Pearson Correlation	-.060	.026	-.210	.009	.179	-.015	.049	.162	.319	.242	1													
	Sig. (2-tailed)	.590	.029	.069	.467	.115	.099	.667	.155	.004	.032														
	N	79	79	79	79	79	79	79	79	79	79	79													
P5	Pearson Correlation	-.029	.019	.096	.060	.052	.109	.364	.161	.290	.187	.334	1												
	Sig. (2-tailed)	.049	.912	.750	.590	.651	.096	.001	.157	.095	.349	.003													
	N	79	79	79	79	79	79	79	79	79	79	79	79												
P6	Pearson Correlation	-.004	-.106	-.120	.005	.161	.001	.177	.100	.219	.139	.431	.257	1											
	Sig. (2-tailed)	.459	.359	.299	.450	.156	.479	.119	.097	.060	.249	.000	.022												
	N	79	79	79	79	79	79	79	79	79	79	79	79	79											
P7	Pearson Correlation	-.062	.049	-.396	.190	.274	.046	-.005	-.194	.167	.229	.192	.090	.146	1										
	Sig. (2-tailed)	.505	.667	.000	.226	.014	.690	.965	.290	.142	.040	.091	.742	.190											
	N	79	79	79	79	79	79	79	79	79	79	79	79	79	79										
P8	Pearson Correlation	.091	.000	-.099	.006	-.000	-.009	-.149	.020	.090	.059	.006	.066	.129	-.079	1									
	Sig. (2-tailed)	.429	.401	.307	.961	.949	.901	.210	.007	.792	.649	.454	.569	.201	.490										
	N	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79									
P9	Pearson Correlation	-.120	.199	-.045	.019	-.020	.007	.067	.004	.072	.001	.107	.167	.059	.019	.390	1								
	Sig. (2-tailed)	.292	.249	.694	.300	.009	.949	.556	.974	.527	.390	.099	.140	.640	.066	.000									
	N	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79								
P10	Pearson Correlation	-.262	.054	-.046	.066	.005	.022	.159	-.015	.139	.060	.207	.151	.074	.142	-.011	.765	1							
	Sig. (2-tailed)	.020	.695	.687	.561	.457	.040	.162	.099	.222	.602	.067	.105	.510	.214	.921	.000								
	N	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79							
D4	Pearson Correlation	-.060	.191	-.026	-.141	-.027	.015	.250	.191	.269	.241	.175	.221	.104	.000	-.065	.007	.190	1						
	Sig. (2-tailed)	.602	.091	.019	.215	.010	.094	.026	.251	.019	.099	.129	.050	.111	.944	.571	.445	.254							
	N	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79						
P11	Pearson Correlation	-.027	.152	-.079	-.104	.074	.157	.169	.102	.145	.175	.155	.096	.006	.112	-.017	-.056	-.057	.272	1					
	Sig. (2-tailed)	.011	.100	.529	.104	.597	.167	.196	.372	.201	.129	.171	.400	.451	.325	.000	.626	.610	.015						
	N	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79					
E2	Pearson Correlation	-.097	.006	-.100	-.020	.396	.065	-.126	.075	.142	.290	.255	-.019	.120	.100	.091	.170	.209	.010	.105	1				
	Sig. (2-tailed)	.396	.459	.097	.000	.000	.574	.269	.509	.211	.000	.029	.907	.290	.097	.424	.199	.064	.074	.102					
	N	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79				
P12	Pearson Correlation	-.112	.067	-.241	-.009	.344	.062	-.002	.062	.214	.210	.390	-.210	.225	.116	.007	.176	.220	.024	.296	.300	1			
	Sig. (2-tailed)	.325	.559	.099	.940	.002	.509	.474	.504	.050	.054	.009	.059	.046	.310	.444	.122	.044	.517	.096	.000				
	N	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79			
E3	Pearson Correlation	-.209	.007	-.220	.097	.269	-.099	-.066	.064	.155	.104	.116	.042	.169	.175	.115	.079	.079	.299	.295	.091	.390	1		
	Sig. (2-tailed)	.065	.447	.051	.394	.016	.795	.562	.574	.179	.105	.300	.710	.195	.129	.314	.524	.407	.009	.097	.424	.002			
	N	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79		
P13	Pearson Correlation	.119	-.126	-.074	.014	.245	.006	-.001	.044	.020	.015	-.005	-.022	-.110	.202	-.019	-.001	.029	-.171	-.195	.091	.070	-.011	1	
	Sig. (2-tailed)	.295	.269	.510	.906	.057	.959	.401	.699	.009	.097	.969	.046	.996	.074	.060	.994	.042	.199	.295	.427	.495	.926		
	N	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	
P14	Pearson Correlation	.499	.099	.099	.072	.090	.116	.160	.151	-.019	-.015	-.095	.179	.074	.096	.157	-.021	-.169	-.126	-.090	-.064	-.004	-.009	.150	1
	Sig. (2-tailed)	.000	.799	.779	.591	.492	.307	.159	.104	.070	.095	.761	.114	.510	.399	.167	.056	.152	.269	.296	.596	.974	.977	.186	

Annex 7: Time factors correlation

		LI1	EQI1	EQI2	PI1	Eal2	EQI3	PI2	PI3	PI4	CI5	DI1	PI5	PI6	PI7	Cal1	Cal2	PI8	Cal3	PI9	PI10	PI11	PI12	PI13	PI14	Cal4	Cal5	Cal6	PI15	MI1
LI1	r	1	.495	.150	-.001	.500	.292	.211	.196	.352	.294	.301	.165	-.010	.099	.101	.066	.094	.219	.026	.012	.179	.210	.000	.009	.290	.110	.257	.220	.357
	p		.000	.002	.497	.004	.005	.091	.116	.001	.004	.000	.079	.490	.966	.109	.209	.502	.090	.411	.460	.064	.091	.220	.210	.047	.167	.011	.024	.001
	N	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79
PI1	r		1	.447	.106	.405	.190	.514	.509	.200	.296	.561	.296	.575	.424	.296	.270	.292	.502	.256	.201	.204	.170	.141	.235	.409	.259	.491	.272	.342
	p			.000	.050	.000	.040	.002	.009	.005	.010	.001	.004	.000	.199	.004	.000	.005	.009	.011	.006	.006	.067	.107	.019	.000	.012	.000	.000	.001
	N		79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79
PI2	r			1	.240	.094	.216	.469	.529	.192	.164	.206	.124	.501	.205	.275	.201	.469	.220	.206	.505	.252	.292	.176	.005	.499	.547	.509	.549	.257
	p				.047	.205	.020	.000	.002	.045	.074	.094	.190	.004	.095	.007	.006	.000	.026	.005	.009	.019	.005	.061	.229	.045	.002	.009	.002	.011
	N			79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79
CI5	r				1	.169	.540	.220	.256	.210	.294	.156	-.000	.540	.146	.599	.055	.095	.157	.159	.105	.205	.194	.400	.144	.409	.049	.009	.199	.209
	p					.060	.001	.022	.011	.091	.019	.004	.241	.001	.099	.000	.515	.209	.009	.000	.051	.095	.120	.000	.109	.000	.594	.295	.112	.094
	N				79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79
PI6	r					1	.557	.290	.547	.526	.254	.256	.497	.191	.115	.099	.261	.079	.196	.009	.404	.190	.290	.092	.070	.409	.040	.070	.001	.254
	p						.001	.004	.002	.002	.012	.011	.000	.046	.156	.500	.010	.262	.115	.470	.000	.127	.017	.209	.269	.000	.569	.247	.496	.012
	N					79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79
Cal2	r						1	.591	.447	.592	.469	.297	.250	.294	-.106	.209	.295	.129	.042	.175	.550	.594	-.056	.244	-.095	.242	.049	.149	.207	.109
	p							.001	.000	.001	.000	.004	.019	.004	.176	.005	.004	.120	.556	.062	.001	.000	.575	.015	.500	.091	.554	.095	.094	.050
	N						79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79
PI3	r							1	.560	.109	.240	.270	.250	.156	.161	.256	.429	.215	.110	.190	.269	.260	.244	.056	.160	.200	.277	.519	.507	.559
	p								.000	.047	.091	.007	.019	.005	.070	.011	.000	.020	.150	.047	.000	.010	.015	.577	.079	.099	.007	.002	.009	.001
	N							79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79
PI12	r								1	.595	.526	.467	.205	.455	.077	.594	.275	.249	.070	.164	.400	.472	.001	.242	.196	.520	.524	.171	.199	.205
	p									.000	.000	.000	.005	.000	.250	.001	.007	.014	.271	.075	.000	.000	.497	.016	.115	.002	.002	.066	.121	.095
	N								79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79
Cal4	r									1	.029	.607	.520	.515	.049	.129	.006	.192	.126	.029	.499	.275	.061	.211	.090	.474	.277	.165	.009	.102
	p										.000	.000	.002	.002	.999	.129	.225	.129	.194	.422	.000	.007	.297	.091	.195	.069	.007	.079	.294	.054
	N									79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79
PI15	r										1	.591	.564	.404	.056	.246	.124	.152	.150	.054	.560	.200	-.050	.542	.047	.190	.295	.190	.051	.196
	p											.000	.000	.000	.200	.045	.197	.090	.094	.517	.001	.006	.595	.001	.541	.040	.004	.047	.527	.041
	N										79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79
EQI1	r											1	.500	.290	.149	.276	.054	.122	.111	.072	.206	.559	.194	.220	.197	.549	.140	.160	.254	.177
	p												.000	.004	.056	.007	.510	.149	.164	.264	.005	.001	.120	.022	.115	.002	.109	.000	.012	.059
	N											79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79
Eal2	r												1	.576	.500	-.051	.240	.179	.025	-.099	.569	.179	.104	.050	-.045	.209	.077	-.129	.024	.501
	p													.000	.009	.527	.017	.069	.442	.566	.000	.064	.052	.590	.545	.092	.250	.129	.420	.009
	N												79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79
PI9	r													1	.060	.520	.161	.410	.211	.266	.519	.549	-.029	.209	.017	.240	.207	.016	.172	.009
	p														.250	.002	.070	.000	.091	.009	.002	.001	.401	.059	.442	.027	.054	.445	.065	.259
	N													79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79
DI1	r														1	.229	.000	.122	.094	-.126	.152	.042	.207	.210	.201	.267	.014	-.015	.099	.104
	p															.024	.471	.142	.504	.195	.090	.556	.005	.052	.006	.009	.452	.449	.507	.052
	N														79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79
PI7	r															1	.155	.500	.274	.256	.227	.559	.197	.512	.161	.270	.060	.516	.195	.070
	p																.007	.009	.000	.012	.022	.001	.041	.000	.079	.000	.501	.002	.042	.247
	N															79	79	79	79	79	79	79	79	79	79	79	79	79	79	79
PI8	r																1	.440	.196	.419	.459	.259	.267	.011	.029	.190	.599	.209	.276	.290
	p																	.000	.042	.000	.000	.012	.009	.469	.599	.046	.001	.006	.007	.021
	N																79	79	79	79	79	79	79	79	79	79	79	79	79	79
PI10	r																	1	.574	.491	.521	.510	.262	.152	.149	.169	.270	.104	.279	.140
	p																		.000	.000	.002	.009	.010	.090	.104	.060	.006	.052	.007	.110
	N																	79	79	79	79	79	79	79	79	79	79	79	79	79
PI13	r																		1	.577	.212	.277	.109	.252	.219	.419	.026	.426	.100	.259
	p																			.000	.050	.007	.047	.005	.026	.000	.410	.000	.057	.012
	N																		79	79	79	79	79	79	79	79	79	79	79	79
Cal5	r																			1	.274	.555	.149	.077	.124	.266	.099	.569	.527	.099
	p																				.007	.001	.095	.249	.149	.009	.209	.000	.002	.209
	N																			79	79	79	79	79	79	79	79	79	79	79
MI1	r																				1	.519	.110	.205	.001	.407	.292	.127	.060	.214
	p																					.009	.167	.095	.490	.000	.020	.199	.275	.025
	N																				79	79	79	79	79	79	79	79	79	79
EQI2	r																					1	.212	.151	.274	.596	.091	.569	.199	.100
	p																						.091	.092	.007	.001	.219	.000	.099	.040
	N																					79	79	79	79	79	79	79	79	79
EQI3	r																						1	.265	.276	.475	.207	.519	.260	.200
	p																							.009	.007	.062	.094	.009	.000	.009
	N																						79	79	79	79	79	79	79	79
PI4	r																							1	.111	.272	-.001	.175	.105	.152
	p																								.166	.000	.490	.062	.170	.122
	N																							79	79	79	79	79	79	79
PI5	r																								1	.205	.175	.469	.244	.205
	p																									.095	.061	.000	.015	.009
	N																								79	79	79	79	79	79
Cal1	r																									1	.020	.546	.121	.540
	p																										.404	.001	.144	.001
	N																									79	79	79	79	79
Cal3	r																										1	.519	.105	.515
	p																											.002	.051	.002
	N																										79	79	79	79
PI11	r																											1	.544	.524
	p																												.002	.002
	N																											79	79	79
PI14	r																												1	.500
	p																													.000
	N																												79	79
Cal6	r																													1
	p																													
	N																													79