ADDIS ABABA UNIVERSITY SCHOOL OF GRADUATE STUDIES
ADDIS ABABA INSTITUTE OF TECHNOLOGY(AAIT)
SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING
(CONSTRUCTION TECHNOLOGY AND MANAGEMENT STREAM)

A STUDY ON FACTORS AFFECTING LABOR PRODUCTIVITY ON BUILDING CONSTRUCTION PROJECTS IN ADDIS ABABA, ETHIOPIA

A Thesis submitted to School of Graduate Studies of Addis Ababa University in partial fulfillment of the requirements of the Degree of Master of Science in Civil Engineering (Construction Technology and Management)

By: Mekides Amanuel
Advisor: Abebe Dinku (Prof. Dr.-Ing.)

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June, 2016

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Declaration

I, Mekides Amanuel, declare that this thesis is my own original work and that it has not been presented and will not be presented to other university for a similar or any other degree award.

……..
Mekides Amanuel

Abstract

The objective of the study is to overview the productivity measurement practices in the Ethiopian construction industry. It mainly aims to investigate and rank the critical factors affecting labor productivity in building construction projects according to the rate given by respondents and to compare the investigated critical factors affecting labor productivity in Ethiopia to that of other studies in different countries. Furthermore, it describes approaches suggested by construction practitioners to improve labour productivity on building projects.

The study result indicates that the performances of building construction projects are influenced by the effect of poor labour productivity; however, most of the contractors do not have experience of measuring labour productivity on their projects due to negligence, lack of awareness and believing that measuring productivity is difficult to implement. Hence, contractors are recommended to participate in trainings and workshops to increase their knowledge and level of awareness.

The top ten labour productivity influencing factors rated by their level of effect and frequency of occurrence are rated and ranked as; 1)Shortage of material, 2)Delays in decisions making, 3)Incomplete and Inaccurate drawings, 4) Lack of follow up the work progress, 5) Financial difficulties of the owner/Payment delay , 6)Incomplete facilities (water & power supply, and sanitary facilities), 7)Inspection and Instruction delay, 8)Lack of Motivation, 9)Frequent damage of equipments and 10)Change of work order/Variation. The result indicates that among the top ten ranked critical factors five (50%), four (40%) and 1 (10%) of them lies under the responsibility of Contractors, Consultants and Clients respectively.

Results of the comparative analysis show that the findings of each study are different from the others. These differences indicate that the factors affecting construction productivity change based upon different circumstances.

It is found that; timely supply of Material & Equipments, using work Plan (schedules) and Continuous monitoring of the progress of the project, Acquiring complete drawing & specification, Motivating labours, and Subcontracting works are labour improvement approaches suggested by the respondents in the rank of their effectiveness.

Key words: Construction, Building, Productivity, Labour, Factors,

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Mekides Amanuel

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List of Abbreviations

KPI……..…..Key Performance Indicators

TQM…….Total Quality Management

ILO…….…..International Labour Organization

Yrs…….……...Years

Mill…….……..Million

GC……General Contractor

BC…….……...Building Contractor

RII……...Relative Importance Index

No. ……..….Number

SI……Severity Index

CE……..Critical Effect

HE……..High Effect

ME……..Medium Effect

LE…….……..Low Effect

NE…….…….No Effect

VO…….…….Very Often

O…….…..…..Often

ST……..…….Some Times

NO……..…None

Ex……..….Example

Eq……...Equation

1. Introduction

1.1. Background

Range of construction projects is wide and divided into various segments usually residential buildings, commercial buildings, industrial buildings, road construction, utility construction etc. Construction involves various people, skills, organizations, technologies, contracting methods, financing arrangements and regulatory mechanisms and has different phases such as planning, designing and building, then they are used, maintained, repaired, renovated and eventually demolished or replaced in their life cycle. This diversity of construction projects makes it difficult to manage. In line with this adopt a common productivity measurement system. Now a big question is that how can we measure construction productivity considering all these segments, aspects and phases.

The construction industry remains one of the few most labor intensive industries in the developing countries. It is therefore very important to understand the concept of construction labor productivity. In different researches it was argued that productivity measurement techniques could be perceived as theoretical, difficult and expensive for construction companies to adopt.

Good project management in construction must strongly measure and monitor productivity on construction site [1]. Construction productivity has got increased attention from different construction researchers. Researchers and practitioners around the world have provided several contributions on areas related to construction work productivity. In addition, the result of different researches indicated that productivity is a complex issue as many factors influence productivity such as labor, capital, material, equipment, tools and equipments, poor communication or relationship between workers and management, disorganized projects, poor supervision, lack of cooperation and communication between different workers, and unfair workloads are the some of the factors that affect productivity. Technical problems like inadequate designs or incomplete engineering work can also lead to a decrease in construction productivity [2]. The main findings of previous studies indicate that the critical areas affecting

construction productivity were related to materials, tools, equipment availability, and the workers' performance.

Increasing the construction work productivity benefits a contractor in several ways: projects can be completed more quickly, project cost will be lowered, the contractor can submit more competitive bids, the project becomes more profitable and in addition it makes the firm to be capable and also helps to have good will among different stakeholders. Therefore measuring productivity, identifying factors affecting productivity and use productivity improving approaches should be a major and continual concern for construction contractors to increase the probability of projects to be completed as per the budgeted cost and specified time.

1.2. Significance and Application of the Research

Productivity has a great significance in the construction industry. Labor productivity constitutes a significant part of production input for construction projects. In the construction industry, many external and internal factors are never constant and are difficult to anticipate. This factor leads to a continuous variation in labor productivity. It is necessary to bear in mind that a reduction in productivity affects the schedule of the work and causes delays. The consequences of these delays could result in serious money losses. Further, considerable cost can be saved if productivity is improved because the same work can be done with less manpower, thus reducing overall labor cost [3].

Increased productivity in the construction industry benefits the two Contracting parties; the Client and the Contractor of the project. From the Clients's perspective, increased productivity lowers costs, shortens construction schedules and achieves better returns on investments. From the contractor's perspective, increased productivity leads to a more satisfied customer, leads to faster turnover and increased profits.

The conclusions that will be drawn from this study could be used by the construction practitioners of the Ethiopian construction industry to take account of these factors at an early stage in order to minimize the time and cost overrun. Besides the investigated factors can serve as a checklist for construction practitioners to give attention to enhance the productivity of labours so as to make the project to be completed as per the plan.

1.3. Statement of the Problem

In the construction industry productivity loss is one of the greatest and severe problems. Previous researches shown that, from various project-costs components such as labors, materials and equipment's, labor component is considered the most risk. Whereas others components (equipment and material) can be determined by the market price. Labor cost in construction industry is estimated to be about 33%- 50% of the entire project cost [4]. Because labor is more variable and unpredictable than other project-cost components, it becomes necessary to understand the effects of different factors on labor productivity. An increase in productivity can reduce the labor cost in a direct proportion.

1.4. Objective of the Study

The objective of this research is to assess the productivity measurement practices in the Ethiopian construction industry. This research mainly aims to investigate important factors affecting labour productivity in building construction projects. Understanding these factors is helpful for the construction professionals in order to efficiently deliver the project as per the plan. Hence, the main goal of the study is to provide essential information about factors affecting labour productivity to construction professionals to enable the project's to be successful. This study can also be used by other researchers as an input for further studies related to labour productivity on construction projects.

By exploring the real situations in Ethiopian construction industry the following are the specific objectives of the study.

1. To overview the productivity measurement practices in the Ethiopian construction industry
2. To Identify and rank factors affecting labour productivity on construction projects.
3. To propose methods suggested by construction practitioners to improve productivity
4. To compare the critical factors affecting labor productivity in Ethiopia to that of other studies in different countries abroad.

1.5. Scope and limitation of the study

The scope of this research is limited to the study of labour productivity on building construction projects. Low labour productivity affects all contractors of different class and category.

However, the research focus is only on building construction companies and projects due to the fact that construction of buildings uses many labours with various positions.

On the other hand grade three and above building & general contractors are selected by taking in to consideration these contractors have more experience on many projects related to the study area. Besides building projects located in Addis Ababa which are under taking by grade three and above contractors are the targeted projects of the study.

As it is studied by different researches most of construction projects fails to be completed within the contract time and budgeted cost. Low labour productivity is one of the reasons for delay and cost over run for the construction projects. Thus, this research studies mainly the critical factors which affect labour productivity on building projects.

1.6. Organization of the study

This thesis is organized with major five parts. The first chapter describes the basic research information as an introduction part of the research. The second chapter covers the basic literature review on construction productivity related issues to make up the conceptual framework of the study. The third part covers the Research design and methodology. Analyses of findings and discussion on the basis of results are presented in the fourth part. The last part consists of the conclusions made and recommendations forwarded.

This study will contain the major categories as described below;

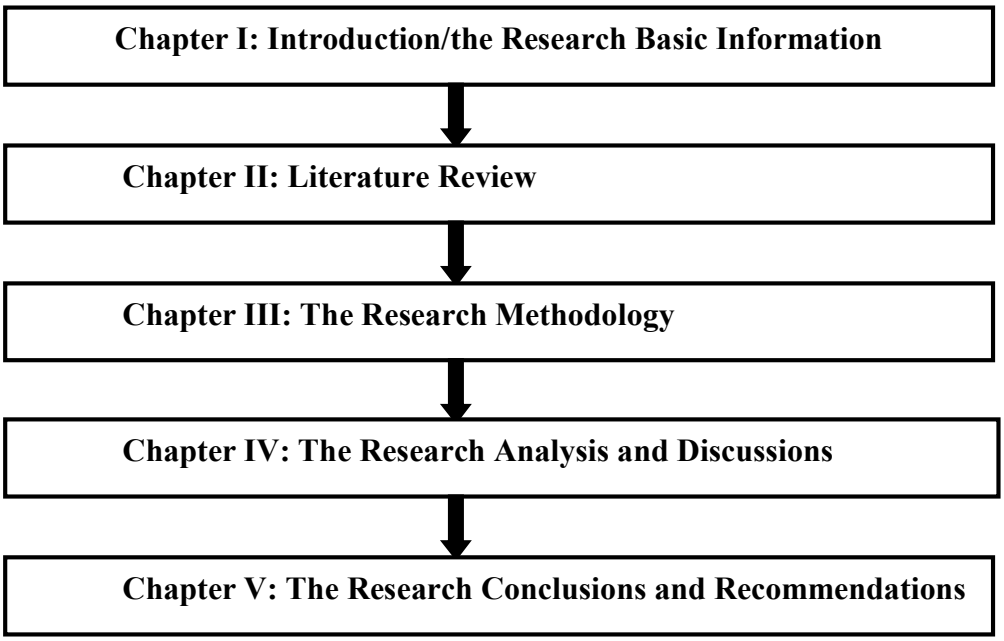

Figure 1-1 Flow Chart of the Research Outline

- **Chapter I; Introduction;** this part contains discussions on background, significance and application, statement of the problem, objective, scope and limitation and organization or contents of the study.
- **Chapter II; Literature Review;** will discuss general descriptions by different researchers about construction productivity based on previous publications. It is divided into different parts containing the concepts of construction productivity.
- **Chapter III; Research Methodology;** covers the research methodology as one chapter. The methodological approach consists of the overall research strategy, the research instrument and the method of data analysis.
- **Chapter IV; Discussions and Analysis;** this part will contain results of the assessment of productivity on Ethiopian construction projects. It is divided into different parts containing findings on factors affecting labour productivity and the suggested approaches to improve labour productivity on building projects. It has also compared the factors affecting construction labor productivity with other countries practice.

- **Chapter V; Conclusions and Recommendations;** at the end based upon the data collected and analyzed during the study period conclusions and recommendations are forwarded.

2. Literature Review

2.1. Construction Project Management

A project means doing something new. In the business world this usually means creating something that someone else wants and is prepared to pay for. According to Namho Kim et al (2007), the construction industry's core business is undertaking projects in generating new buildings or renovating existing ones for a variety of clients.

Since the construction industry is mostly project-oriented, the performance of the construction company is dependent on the performance of projects. Projects have targets, which means they have to be built right, within a cost budget, and finished by a certain date. Project management is simply making sure that all these targets are met.

According to the Project Management Institute, the discipline of project management can be defined as follows: Project management is the art of directing and coordinating human and material resources throughout the life of a project by using modern management techniques to achieve predetermined objectives of scope, cost, time, and quality and participation satisfaction[1].

Therefore project management aims to plan, organize and control to make a project successful.

The simplest way of defining a project as successful is to show that three primary objectives have been met. These might possibly be called the three graces of project management and they are [5];

- Time;-Delivery or completion on or before the date agreed with the customer
- Cost;-Completion within the budgeted cost
- Quality;-A building that meets the set standards of quality.

3.1.1 Delivery or handover of projects on time

Time is often the most important objective of all. Time is an irreplaceable resource. A job that has missed its target date is late and incurs additional cost through time. Costs tend to follow time and grow with time. A project that is finished late usually also overruns its budgets. So,

controlling progress against the plan goes a long way towards controlling the costs of a project[5].

3.1.2 Budget/Cost

All work should be carried out against budgets. For a small builder this is just a list of jobs executed with their estimated labor and material costs. For larger projects built by some of the bigger contracting companies, budgets will exist not only for jobs, but also for each of the head office departments involved and for other elements of the project and its organization. When actual costs exceed their budgets the contractor's profits are at risk. If the losses are very great, the contractor's business is at risk. The project might even have to be aborted, or restarted with another contractor. A project that costs more than intended might not be a failure. If the contractor can complete the overspent project successfully and stay in business, and if the contract was agreed at a fixed price, then the project owner at least should be satisfied. The contractor should, of course, learn from his mistake [5]. In order to monitor the projects profitability, the contractor is better to have some cost controlling mechanisms.

3.1.3 Quality of the Work

According to Dennis Lock (2004), However the project is big or small, every project must be fit for its intended purpose by satisfying all specifications in respect of performance, appearance, safety and reliability.

3.1.4 Balancing the three primary objectives

The three primary objectives are all interrelated. For example, time is usually related to costs. Project owners sometimes have to decide whether or not more emphasis should be given to one of the objectives, perhaps at the expense of the other two. A special word is needed in this context about quality. Many writers have listed 'quality' as one of the three primary objectives of project management. A good, generally accepted definition of quality is that the object should be fit for its intended purpose. Of course every project must be fit for its intended purpose. So, 'quality' as such is an objective that is not negotiable: it is an absolute requirement and cannot be part of an objectives balancing exercise [5].

2.2. Construction Performance Management

Many construction companies have to manage their business performance in order to achieve their enterprise purpose. A number of companies have managed to make individual goals be coincident with organizational goals in order to maximize effectiveness against the crisis; rapidly changing business environment. To encounter this change, companies have started to bring in Performance Management, in order to accomplish organizational goal, to enhance their competitive power in the marketplace at the same time [6].

In order to have good performance for a company, Slack et al. (2001) offer the following description of high-performance operations that most companies aim to accomplish:

- **Quality;** High-quality operations do not waste time or effort having to re-do things, nor are their internal customers inconvenienced by flawed service.
- **Speed**; Fast operations reduce the level of in-process inventory between micro operations, as well as reducing administrative overhead.
- **Dependability;** Dependable operations can be relied on to deliver exactly as planned. This eliminates wasteful disruption and allows the other micro operations to operate efficiently.
- **Flexibility;** Flexible operations adapt to changing circumstances quickly and without disrupting the rest of the operation. Flexible micro operations can also change over between tasks quickly and without wasting time and capacity.
- **Cost;** Low cost operations lead to higher profits as well as allowing the company to sell their products to a competitive price.

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. Also the absence of criteria related to legal claims has recently been highlighted [7]. The memories of other people involved and

impressions of harmony, goodwill and trust or, conversely, of arguments, distrust and conflict, linger long after financial success or early completion has been attained [8].

The UK best practice programme (cbpp) has launched the 'key performance indicators' (KPIs) for construction [9]. These KPIs give information on the range of performance being achieved on all construction activity and they comprise of:

1. Client satisfaction – product
2. Client satisfaction – service
3. Defects
4. Predictability – cost
5. Predictability – time
6. Profitability
7. Productivity
8. Safety
9. Construction cost
10. Construction time

These KPIs are intended for use as benchmarking indicators for the whole industry whereby an organization can benchmark itself against the national performance of the industry and identify areas for improvement i.e. where they perform badly. It is clear to see that those measures are specific to projects and offer very little indication as to the performance of the organisations themselves from a business point of view apart perhaps from the 'customer perspective'.

Furthermore, none of the measures deals successfully with the 'innovation and learning perspective' apart perhaps from the predictability indicators whose accuracy can illustrate some form of learning from previous projects.

This study mainly deals with construction productivity which is one of the dimensions of performance.

2.3. Construction Productivity

2.3.1. Defining Productivity

Productivity is a multidimensional term, the meaning of which can vary, depending on the context within which it is used. However, there are common characteristics that tend to be embraced by the term. In industrial engineering, productivity is generally defined as the relation of output (i.e. produced goods) to input (i.e. consumed resources) in the manufacturing transformation process [8].

However, there are several variations on this basic ratio, which is often too wide a definition to be useful in practice. Table 2-1 shows a number of these variations, created from examining the term from different perspectives [3].

Table 2-1; Examples of Definitions of Productivity [3]

Definition	**Reference**
Productivity = faculty to produce	(Littre´, 1883)
Productivity is what man can accomplish with material, capital and technology. Productivity is mainly an issue of personal manner. It is an attitude that we must continuously improve ourselves and the things around us	(Japan Productivity Centre, 1958 (from Bjorkman, 1991))
Productivity = units of output/units of input	(Chew, 1988)
Productivity =actual output/expected resources used	(Sink and Tuttle, 1989)
Productivity = total income/(cost + goal profit)	(Fisher, 1990)
Productivity =value added/input of production factors	(Aspe´n et al., 1991)
Productivity is defined as the ratio of what is produced to what is required to produce it. Productivity measures the relationship between output such as goods and services produced, and inputs that include labour, capital, material and other resources	(Hill, 1993)
Productivity (output per hour of work) is the central long-run factor determining any population's average of living	(Thurow, 1993)

Productivity = the quality or state of bringing forth, of generating, of causing to exist, of yielding large result or yielding abundantly	(Koss and Lewis, 1993)
Productivity means how much and how well we produce from the resources used. If we produce more or better goods from the same resources, we increase productivity. Or if we produce the same goods from lesser resources, we also increase productivity. By "resources", we mean all human and physical resources, i.e. the people who produce the goods or provide the services, and the assets with which the people can produce the goods or provide the services	(Bernolak, 1997)
Productivity is a comparison of the physical inputs to a factory with the physical outputs from the factory	(Kaplan and Cooper, 1998)
Productivity= efficiency * effectiveness = value adding time/total time	(Jackson and Petersson, 1999)
Productivity = (output/input) * quality =efficiency * utilisation *quality	(Al-Darrab, 2000)
Productivity is the ability to satisfy the market's need for goods and services with a minimum of total resource consumption	(Moseng and Rolstadas,2001)

Mathematical definitions, on the other hand, can be used as the basis of performance measures, where the major aim is to improve (not to explain) productivity. Since it can be difficult to translate a verbal definition to a mathematical one, mathematical definitions do not always reflect all the characteristics that represent the concept of productivity. Compromises are often made when mathematical definitions are formulated, which in turn means that they usually only show a part of the "true" meaning of productivity.

Broman (2004) suggests that it is necessary to have a clear distinction between a concept and a particular mathematical definition attached to the concept, in order to effectively evaluate the characteristics of the mathematical definition.

Broman (2004) points out the inherent similarities in many definitions of productivity; the basic content seems to be the same. However, Ghobadian and Husband (1990), suggest that, within the similar definitions, there are three broad categorizations:

I. Output/input, the relationship between ratios of output to the inputs used in its production
II. A combination of efficiency and effectiveness
III. Includes any characteristics that makes the organization function better

Most definitions of productivity fall into one of three categories

I. The first is the economist/engineer definition: the ratio of outputs over inputs. An example of productivity under this definition would be the number of refrigerators produced this month.
II. The second definition of productivity is a combination of efficiency (outputs/inputs) and effectiveness (outputs/goals). In this definition a company making refrigerators could measure productivity by a combination of the efficiency measure above plus an effectiveness measure, such as number of refrigerators divided by the objective or goal for the number to be produced that month.
III. The third definition of productivity is the broadest and considers productivity as anything that makes the organization function better. In this definition, productivity would include not only efficiency and effectiveness, but also things like absenteeism, turnover, morale, innovation, etc

The definition in this research is the first approach. That is, productivity is the ratio of outputs over inputs.

Many definitions of the word “productivity” exist. For the basis of this study the Merriam-Webster definition will be used. Merriam-Webster defines productivity as the quality or state of being productive. Labor productivity is typically measured as output per worker or output per labor-hour. Although there are endless definitions for productivity, they all refer to productivity as a comparison of input versus output. Productivity = Output/ Input. Increased productivity occurs when either

1. Output is constant, while input is reduced, and/or
2. Input is constant, while either the quantity or quality of output has been increased or enhanced [9].

2.3.2. Productivity and Related Terms

2.3.2.1. Productivity vs Profitability

Profitability is often confused with productivity. The difference between these concepts is that profitability takes into account monetary effects, while productivity relates to a real process that takes place among purely physical phenomena. Like productivity, profitability is also seen as a relationship between output and input, but the relationship is monetary [10]. In the long run, productivity is considered more suitable than profitability as a measure for monitoring manufacturing excellence since profits are influenced by many factors over the short term that can give a misleading indication of long-term success [10]. Nevertheless, profitability is a crucial indicator for a company because it shows whether the company is making money with its business[11].

Profitability does not have a direct impact on improvement purposes since it is a result of, rather than a contributor to, the actions and processes in operations. However, profitability is a good supplement to performance and productivity measures since it helps to identify the effects of monetary changes and distinguish them from "true" performance and productivity changes [12]. An integrated analysis of profitability and productivity makes the application of productivity theory more practical for managers. Combining those two ratios can help to clarify the true reasons for increased profits (13).

2.3.2.2. Productivity vs Performance

Performance is another concept that is often confused with productivity. Whereas productivity is a fairly specific concept related to the ratio between output quantity (i.e. produced products) and input quantity (i.e. resources that are consumed in the operation process), performance is a broader concept that covers both the economic and operational aspects of an industry. Performance refers to excellence, and includes profitability and productivity among other non-cost factors, such as quality, speed, delivery and flexibility. Figure 2.1 explains how all of these concepts relate to one another [11].

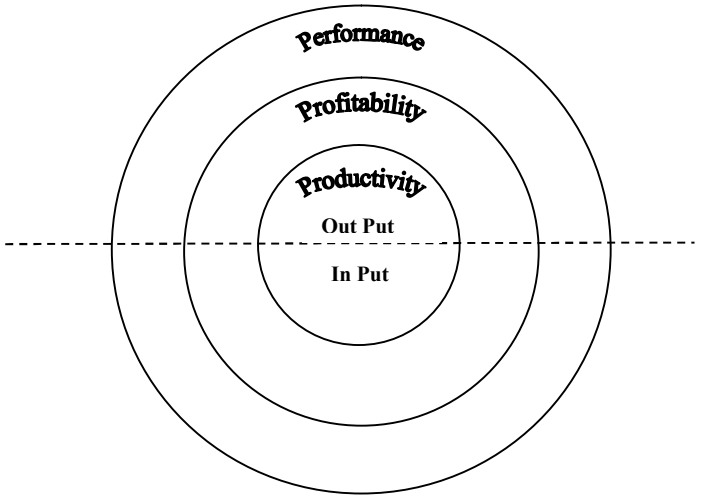

Figure 2-1 Relationships of Performance, Profitability and Productivity[11]

The generic areas of performance that most companies aim to improve are cost, speed and quality [14]. These areas relate to a company's ability to compete and meet customer expectations; they provide some insights into the overall performance of a company [11].

2.4. Productivity Measurement on Construction Site

While each contractor or owner is free to use its own system to measure labor productivity at a site, it is a good practice to set up a system which can be used to track productivity trends over time and in varied locations. Considerable efforts are required to collect information regionally or nationally over a number of years to produce such results. The productivity indices compiled from statistical data should include parameters such as the performance of major crafts, effects of project size, type and location, and other major project influences.

In order to develop industry-wide standards of performance, there must be a general agreement on the measures to be useful for compiling data. Then, the job site productivity data collected by various contractors and owners can be correlated and analyzed to develop certain measures for each of the major segment of the construction industry. Thus, a contractor or owner can compare its performance with that of the industry average [1].

2.4.1. Approaches of Productivity Measures

The basic concept of measuring productivity in construction is the ratio of input to output. According to a research conducted by the Federal Government of United States, there are two

basic approaches to measuring productivity, single factor or partial and multifactor or total productivity measures. Choosing between them usually depends on the purpose of the productivity measurement and the availability of data.

2.4.1.1. Single/Partial Factor Measures

Single/Partial factor measures use only one input in the denominator. Most commonly used single factor measure of productivity is the **labor productivity**, the ratio of output to either employment or labor hours.

Labor Productivity = Output/Labour Input ……. [Eq. 2.1]

Labour can be measured as:

- Persons employed (the most available)
- Hours worked (the most accurate)
- Labour cost

Account also needs to be taken of changes in the quality of labour. Educational attainment is the usual criterion for quality measurement. In construction, this criterion is less reliable, since many skills are acquired through experience.

In this research labor input is measured in hours worked. For example labor productivity is associated with units of product per labor hour, such as cubic meters of concrete placed per hour or squired meters of block works constructed per hour.

High levels of labor productivity may reflect a high efficiency level. In certain situations, other single factor measures might also be useful, such as **capital productivity** (the ratio of output to capital input).

Capital Productivity = Output/Capital Input ……. [Eq. 2.2]

'Capital' refers to physical capital, not investment. Physical capital is machinery and equipment. Physical capital is measured at a depreciated value, which is only an approximation of wear and tear. The 'capital input' is the service provided by a piece of capital in the production of output.

The service is the amount of the capital that is consumed in production as a result of wear and tear.

2.4.1.2. Multi/Total Factor Productivity Measures

Multi/Total factor productivity measures use a weighted average of all inputs in the denominator. The weights usually correspond to each input's share of total expenditures. Multifactor measures reflect the joint impact of all inputs on productivity more accurately than single factor measures because the quantities of all inputs are in effect held constant, whereas only one input is held constant in the single factor approach. Multifactor measures do not seem to be widely used in construction. An increase in total factor productivity implies more output can be produced for a given level of inputs.

Total Factor Productivity = Construction Output/Resources Used ……. [Eq.2.3]

2.4.2. Three Dimensions of Construction Productivity: Task, Project, and Industry Level

According to Allison L. Huang et al, the nature of the construction process points to a need for measures of construction productivity at three levels: (1) task; (2) project; and (3) industry. Tasks refer to specific construction activities such as concrete placement or structural steel erection. Projects are the collection of tasks required for the construction of a new facility (e.g., the construction of a new commercial office building) or renovation (i.e., additions, alterations, and major replacements) of an existing constructed facility. Industry measures are for the construction sector and represent the total range portfolio of projects.

The basic concept underlying construction industry productivity measures is a comparison of the output of a task, project, or industry with the corresponding factors of production (inputs) required to generate that output. The output and inputs of production thus constitute the basic components of every productivity measure. Typically, productivity measures are formulated as a ratio of output to one or more inputs. If only one of the inputs is used, then the ratio is a single factor productivity measure. A common example of this type of measure is output per labor hour. If all of the inputs are used, then the ratio is a multifactor productivity measure [15].

2.4.2.1. Task Level Productivity Measures

Tasks in construction refer to specific construction activities such as concrete placement or structural steel erection. Task-level measures are widely used within the construction industry. Most task-level metrics are single factor measures and focus on labor productivity. Typical task-level productivity measures published by R.S. Means estimate how much a given output is produced by a designated crew in a normal 8-hour day. In this case, the denominator is the number of hours associated with a designated "crew day." Thus, for a designated crew day, higher output is better. In this case higher output equates to higher task labor productivity. For some tasks, equipment may be involved, in such cases, R.S. Means provides estimates of output that is produced by a designated crew in an 8-hour day along with the equipment they use, and these measures can be considered multifactor.

Goodrum and Haas examined productivity measures for 200 construction activities over a 22-year period. They found that average activity productivity has increased. Furthermore, studies by Goodrum and Haas show that activities that experienced a significant change in equipment technology (i.e., hand tools and machinery) generally also witnessed substantially greater long-term productivity improvements. Activities that experienced a significant change in material technology in terms of modularization, reduction in unit weight, or installation flexibility, also experienced greater productivity improvements.

2.4.2.2. Project Level Productivity Measures

Projects are the collection of tasks required for the construction of a new facility (e.g., the construction of a new commercial office building) or renovation (i.e., additions, alterations, and major replacements) of an existing constructed facility. Since a project is a collection of tasks, project level productivity Measures are more complicated as compared to task level productivity measurement. The inputs and outputs for a given task, say concrete placement, differ from those of another task, say structural steel erection. Thus, it is not possible to aggregate the individual raw task productivity metrics into a project productivity metric unless adjustments are made.

One way to make these adjustments is to use a reference data set to calculate baseline values for each task. Information is still needed, however, to calculate a meaningful project level productivity metric. For instance, information yielding the task weight (share that it represents to

the overall project) is required, as is an understanding of the task flows. Because some tasks are completed in parallel, while other in series, the composition of the task flows affects overall project productivity. Therefore, each component of the project productivity metric contains: (1) the task weight; (2) the raw task productivity baseline value in the denominator; (3) the raw task productivity value for that project in the numerator; and (4) a measure of the task mix (in parallel versus in series task flows). The project productivity index value is a function of the individual components[15].

The project level productivity metric just described is useful in measuring how an individual project compares to the overall average in the reference data set. In addition, data from all projects can be compiled into a distribution. Further analyses can then be conducted to identify characteristics associated with the best performing or worst performing projects.

A related measure of productivity on project level is cost per square footage data for a particular type of building. R.S. Means produces a square footage model that requires limited inputs, such as building type, exterior wall type, structural system, and square footage, and yields rough estimates for the overall cost of a project.

2.4.2.3. Industry Level Productivity Measures

At the industry level productivity, the amount (or value) of output produced per unit of input—provides a measure of industrial efficiency. Industry level productivity measures can be developed for different building types or infrastructure types. For each building or infrastructure type, productivity measures can be created, and these productivity measures can serve as benchmarks for practitioners who engage in such projects.

Industry level productivity measures can be either single factor (labor) productivity or multifactor productivity. Increases in labor productivity may be due to increases in labor quality or labor efforts. However, it can also increase simply due to other factors such as technology, even when labor quality and worker efforts are held constant.

Multifactor productivity is often a preferred measure compared to labor productivity. This is because labor productivity measures are more open to misinterpretation. Increases in labor productivity may reflect increases in the capital-labor ratio, rather than increases in labor quality

and efforts. Additionally, a unit of production may achieve high levels of labor productivity, but the overall productivity may be compromised because the underlying capital-labor ratio may not be optimal. Similarly, low labor productivity might be efficient in the sense that low wages induce contractors to adopt more labor intensive practices and save on capital costs. Labor productivity measures are limited in the sense that they do not reveal a complete picture and are prone to misinterpretation. While labor productivity is often a less preferred measure of productivity compared to multifactor productivity, it is calculated with much more precision with fewer assumptions. Obviously, the data requirement for labor productivity calculation is also significantly less compared to multifactor productivity calculation.

2.4.2.4. Does Task-Level Productivity Reflect Industry-Level Productivity?

Construction projects tend to be unique and are increasingly more complex. Task-level productivity does not capture project-level uniqueness and complexity. The trend of increasing project complexity could partly explain productivity decline at the industry level. High productivity at the task level also does not necessarily translate into high productivity at the project level. A project level success depends on managerial coordination and planning, which task-level productivity does not capture. For instance, idle time is not included in task-level productivity measurement, but it certainly can hinder progress and productivity at the project level. Regulation is sometimes cited as one reason for low productivity in the construction industry. Regulation does not generally apply to task-level productivity, but it does affect project-level and therefore industry-level productivity.

This paper focuses on a single factor productivity measurement at task level, rather than multifactor productivity.

Task/Lower-level measures are more useful for monitoring individual activities, while higher-level measures may be more convenient for developing industry-wide standards of performance [1].

By measuring productivity and its changes during construction projects, you can identify problem areas and resolve them more quickly, resulting in better productivity on job sites.

2.5. Factors affecting productivity on construction site

Identification and evaluation of factors affecting labor construction productivity have become a critical issue facing project managers for a long time in order to increase productivity in construction [16]. Understanding critical factors affecting productivity of both positive and negative can be used to prepare a strategy to reduce inefficiencies and to improve the effectiveness of project performance.

Knowledge and understanding of the various factors affecting construction labor productivity is needed to determine the focus of the necessary steps in an effort to reduce project cost overrun and project completion delay, thereby increasing productivity and overall project performance.

This study aimed to identify factors affecting or contributing to the delay of projects completion in Indonesia through a survey. The results will be useful information to improve construction productivity in Ethiopia [17].

There are a wide range of factors that influence the productivity of construction industry. Much has been published about the factors that affect construction productivity and several key factors are usually cited in the literatures. Based on past researches, supervision, resource availability, project uniqueness, organization of the work, labor availability, changes in technology, management (poor or good), labor organizations, wages, training of workers, motivation, training of the work force, weather conditions, uncertainty, location, monitoring of performance and others have been identified as factors affecting construction labor productivity.

Different researchers have studied the factors that affect construction productivity and the key factors are summarized and categorized based on their characteristics as stated bellow;

According to Carl T. et al., 1999, the factors are summarized and categorized in to five groups according to their characteristics, namely: 1. Project Uniqueness, 2. Technology, 3. Management, 4. Labor Organization, 5. Real Wage Trends and 6. Construction Training.

David Stiedl, 1998, groups the factors as; 1.Motivation and experience of the workforce, 2.Organization of the work, 3. Type and condition of tools and equipment provided to the worker, and 4.Continual monitoring of performance.

Allison L. et al., 2009, categorizes the factors as: 1. Skilled labor availability, 2. Technology utilization, 3. Offsite fabrication and modularization and 4. Use of industry best practices.

The casual factors for low productivity is critically reviewed from the above researches and in this research the factors are summarized and categorized in to twelve groups according to their characteristic; 1. Design related factors, 2. Work/Execution plan related factors, 3. Material related factors, 4. Equipment and Technology related factors, 5. Labor related factors, 6. Health and safety related factors, 7. Supervision related factors 8. Project related factor factors, 9. Quality of work related factors, 10. Leadership, coordination and organization related factors, 11. Owner and/or consultant related factors, 12. External factors. These factors are discussed in the following sections;

2.5.1. Design Related Factors

Generally, projects come across some design, drawings and specification changes during construction. If drawings or specifications are with errors and unclear productivity is expected to decrease since laborers in the field are uncertain about what needs to be done. As a result, task may be delayed, or have to be completely stopped and postpone it until clear instruction. As it is studied in different researches, there is a 30% loss of productivity when work changes are being performed [3]. The following are design related issues that lowers labour productivity;

- Design changes
- Incomplete drawing
- Inaccurate design

2.5.2. Work plan Related Factors

When there are early delays in a project, compressions of the overall time frame for a later activity are often the way to compensate interruptions and to complete the assigned task on schedule. From a professional scheduling perspective, schedule compression may be possible without accelerating individual work activities by utilizing float in the project's overall schedule. However, on many projects, schedules are not fully resource loaded. As a consequence, a

properly updated schedule reflecting the delays may show the project finishing on time without shortening individual activities. Schedule compression may result to force extra labors for the desired task by the contractor because of shortening the overall duration, allowing the contractor to complete the total remaining work. Schedule compression, when linked with overtime, often results in major productivity losses due to shortages of material tools or equipment to support the extra labor's, resulting in difficult for planning and coordinating the task, and unavailability of experienced labors (National Electrical Contractors Association, 1983).

Improper scheduling of work, shortage of critical construction equipment or labor, may result in loss of productivity. Improper planning of project-initiation procedures generally lead to lost labor productivity.

- Absence of working schedule
- Lack of updating Schedule

2.5.3. Material Related Factors

Poor material management is one of the most key factors that affect productivity in the construction industry. Productivity at the projects can be affected if required materials are not available at the correct location and time. The size of the construction site and the material storage location has a significant impact on productivity because laborers require extra time to move required materials from inappropriate storage locations, thus resulting in productivity loss [3]. Poor-quality material used for work is the other factor because poor materials generally lead to unsatisfactory work and can be rejected by supervisors, thus reducing the productivity.

2.5.4. Equipment and Technology Related Factors

Inappropriate type and size of construction equipment often affects the productivity of construction projects. In order to increase job-site productivity, it is beneficial to select equipment with the proper characteristics and a size most suitable for the work conditions at a construction site. Lack of equipment and frequent damage of equipments are investigated from previous researches as the main casual factors for low productivity because it takes a long time for the laborers to complete the specific work.

Technology advancement has also an effect on overall productivity on construction site. Tools and machinery have increased both in power and complexity. These advances in technology can significantly change skill requirements. Goodrum and Haas have shown that when the technology is becoming more advanced, the productivity of labors will be improved by 30 % to 45 %.

Literatures describe that technology can enhance productivity of individual tasks. Note that while technology can generally improve labor productivity, there is a cost associated with employing technology. Improvement in labor productivity is not an ultimate goal. For example, capital investment in technology can be increased to improve labor productivity, but this approach may not be the optimal solution when overall costs and benefits are considered [15].

Decrease in productivity is usually caused when there is insufficient quantity or quality of tools and equipment to meet the needs of the project, frequent damage of equipment and absence of technological advancements for machineries.

2.5.5. Labor Related Factors

Literatures show that to achieve good productivity, labor plays a significant role. The following are the major causes for low productivity on construction projects those are related to labor.

There should be sufficiently skilled and experienced laborers on projects in order to make the projects productive. If labors are unskilled and in lack of experience, they take longer time to complete specified task and there will be a possibility of rework, therefore incompetence of labors can be considered as one of the possible causes for the decrease in productivity.

Misunderstanding among laborers creates disagreements about responsibilities which leads to a lot of work mistakes resulting rework and consequently it decreases labor productivity.

Lack of compensation and increased laborer age negatively affect labor productivity because labor speed and strength decline over time and reduce productivity [18].

Overcrowded labor force on projects is found out to be one of the main reasons for low productivity. This is caused when work planners hire too many workers for the estimated work scope and duration. One of the causes for overstaffing is the false assumption that increased manpower will always result in increased work productivity.

Lack of labor experience, high absenteeism of labors, incompetence of labors, use of alcohol and drugs, overcrowded labor force, poor relationship between labors, indiscipline labors, and personal problems are the main factors which negatively affects labor productivity

2.5.6. Health and Safety Related Factors

At construction projects accidents are frequently happened which have high impact on labor productivity. Various accident types occur at the site, such as an accident causing death and resulting in a total work stoppage for a number of days. An accident that causes an injured person to be hospitalized results in a work decrease of the crew for which the injured employee worked. Small accidents resulting from nails and steel wires can stop work and, thus, decrease productivity [3]. Providing safety equipment and employing a safety officer helps labors to recognize the required safety regulations and to follow them, which can reduce the number of accidents, thus increasing productivity.

2.5.7. Supervision Related Factors

Work inspection by the supervisor is an essential process to proceed the work. For example, the contractor cannot cast concrete before an inspection of the formwork and steel work, thus affecting labor productivity (Zakeri et al., 1996). With non-completion of the required work according to the specifications and drawings, supervisors may ask for the rework of a specific task. Unclear instruction given by supervisors, change of supervisors, incompetence of supervisors and supervisors absenteeism are some of the major contributing factors for low labor productivity.

2.5.8. Project Characteristics Related Factors

Productivity on construction projects is highly dependent on the characteristics of the project such as uniqueness, complexity, size, site congestion, contract type and appropriate site layout for temporary facilities.

Construction projects are complex, unique and more often difficult. Projects in construction are never designed or built exactly in the same manner as previous projects. Environmental factors such as the landscape, weather and physical location force every project to be unique from its

predecessors. There are also aesthetic factors that create uniqueness from project to project. Such factors have a significant impact upon major project characteristics. While most construction personnel find this uniqueness to be an attractive element for a career in construction, it can have an adverse effect upon construction productivity [19].

Project uniqueness requires modifications in the construction processes. These modifications require workers to go through a learning curve at the beginning stages of each project activity. Therefore modifications due to uniqueness of projects decrease the productivity of workers at the beginning of each project activity.

To accomplish substantial productivity, every member of a crew requires adequate space to perform task without being affected with/by the other crew members. When more labors are allotted to perform particular task, in a fixed amount of space, it is probable that interference may occur, thus decreasing productivity. The types of activities and construction methods also influence labor productivity [3].

Additionally, poor site layout can contribute to a loss of productivity. Laborers have to walk or drive a long way to stores, lunch rooms, rest areas, washrooms, entrances, and exits, affecting overall productivity (Association for the Advancement of Cost Engineering (AACE) International Recommended Practice No. 25R-03, 2004).
Furthermore, absence of sanitary facilities, Power supply and insufficient lighting contributes to decrease in productivity.

When work is in a confined space with limitations on ventilation, this can result in nonproductive labor to provide. Time is also lost when getting to and from the work area.

2.5.9. Quality of Work Related

Quality of work related issues have an influence on the productivity of labour on the construction projects. Ambiguous Specification, correction/rectification of works and rework are some of the factors related to quality issues that affects labour productivity by increasing labour lost hours.

- Ambiguous Specification
- Correction/Rectification of works
- Rework

2.5.10. Leadership, coordination and Organization Related Factors

Management complicates progress in productivity within the construction industry. Past studies found that poor management was responsible for over half of the time wasted on a job site (Business Round Table, 1983). Good management is required for profitability and success.

As the previous researches show there is currently a lack of formal training in the construction industry. This lack of training is due to practical concerns such as employers completing the increased percentage of nonunion work. In general, the workforce of contractors is highly mobile. For this reason, contractors are often reserved to invest capital to train those who may soon be someone else's employees. The result may be a decrease in the construction workforce average capability level.

These also affect the productivity of the site as they are the providers of most resources to the construction project. Poor scheduling and communication between the project office and the head quarter contribute a lot besides cash flow problems in causing disruption of projects temporarily.

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

Motivation is one of the important factor affecting construction labor productivity. Motivation can best be accomplished when labors personal ambitions are similar to those of the company. Factors such as payment delays, a lack of a financial motivation system, non-provision of proper transportation, and a lack of training sessions are grouped in this topic [20].

2.5.11. Stakeholders Related Factors

Preconditions are factors which affect the productivity of a construction site by the action of external bodies. They are not controllable by the project management; however, the consultant project manager can control them to some extent by applying integration management.

Client: These are one of the most important bodies which influence the productivity of the project site by changing their requirement; the project scope. This action causes change and additional design to be produced causing temporary shortage of design information to the contractor unless prior design revision and engineering control is done in before the execution of works. Studies made in other countries shows that the increase in percentage of change orders is directly proportional to loss of productivity. At other time clients may limit the project completion time but providing design changes in such a case the contractor may be forced to use overtime works which has also similar effect in reducing productivity.

Consultant/Designer: These are among the most important parties affecting the overall productivity of the construction site. It is known that design information in the form of drawings and specifications are one of the most important inputs of the construction process. Unless the engineering information is appropriately scheduled and controlled like other resources it will cause loss of productive time of workers. The following are some of the factors lays under this category;

- Financial difficulties of the owner/Payment delay
- Misunderstanding between the Owner, Consultant and Contractor
- Lack of General support to the contractor

2.5.12. External Factors

Weather conditions are significant factor to consider for completion of any construction project. Adverse winter weather, such as winds and rains, reduces productivity, particularly for external

work such as formwork, T-shape work, concrete casting, external plastering, external painting, and external tiling. Adverse weather sometimes stops the work totally [3]. Law and order, stability of government, etc. are essential for high productivity in the construction industry. The government's taxation policies influence willingness to work and expansion of plants.

Extreme weather conditions (such as extreme heat or cold) will also increase absenteeism and turnover.

Various natural factors affecting labor productivity collected from previous study are weather conditions of the job-site and geographical conditions. Others factors such as fuel, water, and minerals also affect productivity to certain extent. Productivity is found to be highly affected if weather recorded are too be extreme (too cold, heavy rainfall, too hot.

If workers work on holidays, there is not only a cost factor for holiday pay, but there is usually a loss of productivity as well. It may be addressed as a morale factor since workers are away from families and working instead of enjoying the holidays, or it can also be factored separately. Either way, there is usually a productivity loss to consider. The following are some of the factors lays under this category;

- Bad weather (rain, hotness, etc.)
- Unstable political conditions
- Holidays

2.6. Improving Labour Productivity

Productivity is one of the key components of every company's success and competitiveness in the market. For projects located in the same construction area, labor, equipments and materials costs are basically the same. One of the few opportunities to increase the bottom line of profitability is to increase productivity. Increasing productivity benefits a contactor in several ways [18];

- Projects can be completed more quickly
- Project cost can be lowered
- The Contractor can submit more competitive bids
- The Project can be more profitable

According to Michael P.Rollage (2012), improving labour productivity at construction site is easy to pose as a strategy plan, but not so easy to achieve given the complexity of the construction process.

To improve labour productivity at construction sites the construction company should be committed to improving productivity and reinforce that with implementing best practices for planning and implementing projects then it is possible to achieve improvement. As it is mentioned in previous studies, the different working cultures which results in improved labor productivity would include:

- Implementing best practices for quality engineering
- Effective planning of all phases
- Lessons learned and continuous improvement across projects
- Supply Chain management and materials management
- Right tools and equipment
- Effective collaborative team building and communications

2.7. Ethiopian Construction Industry

2.7.1. Overview of Ethiopian Construction Industry

As it is studied in various researches, the construction industry is growing at a fast pace all over the world. In line with the growth of the construction industry, subsequent growth of construction companies are internationally observed.

In our country Ethiopia, the growth and increasing demand for the construction industry has followed a similar pattern as observed in the trend of the world. Currently, construction is one of the sectors leading the way towards modernization and industrialization in Ethiopia. Different researches indicate that, the construction sector in Ethiopia, generally in the world, contributes to about fifty percent of the total capital. It is also said that the construction industry is being the second largest employer in the country and it's also an engine for technology, innovation and overall development (Ethiopian Roads Authority in 2000, a study on Domestic Construction Industry).

As many researchers witnessed that, the construction industry in Ethiopia is a sector that opens the door for the growth of many additional industries. Specially, Building works require high input of other industries. For instance, they require different metal products, clay works, and cement and cement products, etc. as such, the growth of these industries will surely follow the growth of the construction industry. Similarly, when the construction and renovation of housing increase, the demand for household furniture increased; thereby, indirectly, opening the door for the growth of the furniture industry. All in all, the construction industry is a sector that can entertain big micro companies, that is widely labor based.

Industry Policy of the Federal Democratic Republic of Ethiopia says that the construction industry is being given special focus in the policies of the country. The construction industry is one of the three sectors of the economy identified by the Ethiopia Government for special consideration to foster the country's economic development. However, the general state of the domestic construction industry in Ethiopia is still characterized by inadequate capital base, old and limited numbers of equipment, low levels of equipment availability and utilization, deficiencies in technical, managerial, financial and entrepreneurial skills, limited experience and participation of the private sectors in construction and consultation works, and insufficient and ineffective use of labor-based road construction and maintenance technology.

According to the Ethiopian Economic Association (fifth annual report on the Ethiopian Economy published in March 2007), the construction industry has important contributions to the Ethiopian economy, as demonstrated by its share in the GDP. The report has described that, there has been increased investment on the development and expansion of various infrastructure projects like roads, airports and residential and non-residential housing units in Ethiopia.
The role of the construction industry in terms of creating employment opportunities especially in urban areas is becoming visible as it is reported by Ethiopian Economic Association.

2.7.2. Productivity in Ethiopian Construction Industry

Different researches show that the construction projects management in Ethiopia is not scientific. In line with this as it was confirmed during past studies the performance of most construction projects were not good. The performance of projects were usually measured with the tendency

of projects to be completed with in the specified time, budgeted cost and quality standards stated in the specification and contract documents.

The impact of low labour productivity on the performance of construction projects is a significant factor that lowers the overall performance of the project.

A study has conducted by Chia F. et al, for estimating the construction labour productivity of 79 selected countries, among these Ethiopia was the one. The real (purchasing power parities converted) and nominal construction expenditure from the Report of 2005 International Comparison Programme published by the World Bank and construction employment from the database of labour statistics (LABORSTA) operated by the Bureau of Statistics of International Labour Organization were used by the researcher in the estimation.

According to the study conducted by Chia F. et al, the following comparative analysis (Table 2.2) is conducted with construction expenditure and construction employment data obtained from the World Bank's International Comparison Program 2005 and the database maintained by LABORSTA, an International Labour Office database on labour statistics operated by the ILO Department of Statistics.

Real construction expenditure of 79 countries from the 2005 ICP report and total employment in construction obtained from LABORSTA are used as 'output' and 'input' respectively for the labour productivity estimation.

Table 2-2 Summary of construction labour productivity in real (PPP-converted) international dollars and nominal US dollars [21]

Country Name	Real (PPP-converted) construction labour productivity		Nominal construction labour productivity	
	International $/ Employee	Ranking	US $/ Employee	Ranking
Iceland	188,440.26	3	229,185	1
Norway	123,139.59	14	175,657	2
Ireland	114,328.69	17	164,954	3
France	132,262.89	12	159,337	4
Luxembourg	140,468.49	8	152,920	5
Canada	155,497.51	7	151,113	6

Finland	126,774.61	13	145,653	7
Netherlands	103,708.41	20	144,123	8
Switzerland	85,469.51	27	140,957	9
Belgium	118,825.99	16	129,192	10
Denmark	83,528.75	30	127,742	11
United States	119,808.88	15	119,809	12
Australia	110,703.43	19	117,781	13
Austria	88,891.75	22	110,663	14
Sweden	60,400.53	39	106,246	15
Germany	88,722.03	23	105,392	16
Macao, China	188,934.34	2	101,283	17
Japan	87,551.91	25	94,540	18
Italy	98,789.40	21	89,922	19
New Zealand	69,210.93	36	87,510	20
United Kingdom	62,561.58	37	87,168	21
Greece	110,842.93	18	86,868	22
Slovenia	139,302.76	10	84,249	23
Israel	132,448.83	11	83,512	24
Spain	81,336.14	32	82,209	25
Korea, Rep.	140,014.44	9	78,785	26
China	283,160.01	1	66,794	27
Kuwait	179,348.12	4	60,161	28
Cyprus	76,766.07	33	56,729	29
Estonia	74,660.20	34	54,013	30
Peru	176,037.06	5	53,555	31
Malta	83,856.28	29	53,449	32
Croatia	82,480.21	31	52,130	33
Madagascar	164,344.34	6	45,204	34
Hungary	58,167.90	41	43,340	35
Montenegro	87,907.33	24	40,192	36
Portugal	57,878.77	43	38,282	37
Taiwan, China	83,987.16	28	37,283	38
Armenia	86,553.76	26	36,432	39
Czech Republic	57,906.17	42	35,256	40

Poland	61,719.63	38	33,032	41
Albania	58,190.52	40	32,830	42
Turkey	46,485.87	49	28,231	43
Lithuania	39,252.91	56	28,043	44
Argentina	72,397.35	35	27,305	45
Slovak Republic	44,232.60	53	26,538	46
Mexico	36,790.95	59	26,045	47
Latvia	40,414.76	55	25,760	48
Georgia	54,403.69	45	22,564	49
Romania	45,823.61	51	21,583	50
Kazakhstan	47,628.87	48	21,479	51
South Africa	28,498.32	66	18,286	52
Colombia	50,304.08	46	16,634	53
Macedonia, FYR	50,232.09	47	16,443	54
Russian Federation	32,001.74	64	16,147	55
Mauritius	34,603.74	63	15,584	56
Bulgaria	41,624.39	54	15,075	57
Hong Kong, China	27,724.31	68	14,794	58
Uruguay	34,942.23	62	14,399	59
Chile	29,636.64	65	13,294	60
Serbia	36,319.90	60	12,755	61
Indonesia	44,524.47	52	11,706	62
Malaysia	46,365.44	50	11,140	63
Brazil	25,614.13	72	11,058	64
Moldova	26,795.96	70	11,057	65
Bhutan	57,009.94	44	10,500	66
Ukraine	28,206.74	67	9,811	67
Thailand	39,088.05	57	8,465	68
Iran, Islamic Rep.	36,215.22	61	7,956	69
Bangladesh	37,905.62	58	7,398	70
Azerbaijan	19,209.88	74	7,340	71
Venezuela, RB	9,340.78	78	5,784	72
Egypt, Arab Rep.	25,754.70	71	5,147	73
Pakistan	20,132.84	73	4,449	74

Mongolia	26,982.98	69	4,196	75
Philippines	17,217.15	75	3,889	76
Ethiopia	14,827.21	76	3,460	77
Bolivia	9,974.70	77	2,154	78
Kyrgyz Republic	4,581.21	79	1,603	79

The above Table 2-2 shows that among the 79 selected countries on real measurement basis, the top five ranked countries are 1)China, 2)Macao, China, 3)Iceland, 4)Kuwait and 5)Peru.

To see the positions of African countries among the 79 selected countries on real measurement, the above table indicates that, Madagascar is ranked in the 6th position, Mauritius is ranked in the 63th position, South Africa is ranked in the 66th position, Egypt, Arab Rep. is ranked in the 71th position and Ethiopia is ranked in the 76th position.

Among selected African countries, Madagascar is the 1st, Mauritius is the 2nd, South Africa is the 3rd, Egypt. Arab Rep. is the 4th and Ethiopia is 5th (last) in attaining higher construction labour productivity.

2.7.3. Gap Analysis

As it is studied in different countries construction projects worldwide have been experiencing significant cost and time overruns, with low labour productivity identified as a major reason for project delays and cost overruns.

The comparative analysis above indicates that labour productivity is different from country to country. Ethiopia is ranked on 76th among the 79 selected countries on real measurement basis. The position of Ethiopia has a critical implication about the productivity of labour in the Ethiopian construction industry. This might be a possible reason for projects being delayed and completed over the budgeted cost.

In order to enhance the construction industry in Ethiopia, improving of labour productivity has a significant role due to the fact that the construction industry involves an employment of huge number of employees to carry out the work. In line with this all the related stakeholders of the construction industry including the government should take their parts in the improvement of construction labour productivity.

It is known that most of the contract types of the construction projects in Ethiopia are fixed rate types; hence Contractors specially face serious problems due to lower labour productivity in their projects. The contractors should study and identify internal and external factors influencing the productivity of labours to minimize the impact on the performance of their projects. Furthermore it is very vital to identify opportunities that enable the construction productivity to be improved.

As it is assured by various studies most of the labour productivity influencing factors are related to contractors' inability to supply of materials, deployment of machineries, assignment of competent personnel, financial stability and overall project managment.

Different previous studies indicate that issues related to the responsibilities of Consultants and Clients are among the major factors affecting labour productivity. Factors related to incompleteness of design, lack of appropriate supervision, technical competency of Engineers and unclear specification are the major gaps forwarded by many studies as a major gaps of consultants attributes for lower labour productivity in the construction projects.

On the other hand employers interference, variation orders and delayed issuance of payments are the major factors related to Clients that influences the productivity of labour in the construction projects.
Effect of bad weather, rain, wind, high/low temperature and unforeseen conditions (Eg. ground condition) are among the critical reasons for lower labour productivity.

Like other countries, the construction industry in Ethiopia has a significant role in the development of other industries. Accordingly the improvement of the growth of the construction industry contributes for the growth of many other sectors. Improvement of construction labour productivity is therefore critical.

A critical attention should be given by the construction professionals in Ethiopia to improve the productivity of labour in the construction projects. In order to improve the construction productivity identifying the influencing factors is very vital. After productivity factors are identified, all the related stakeholders can take respective actions to mitigate these issues.

Hence, this study aims to identify the critical factors influencing labour productivity in building construction projects.

3. Research Methodology

3.1. Research Approach

The study aims to assess the practice of labour productivity measurement on building construction projects mainly focuses to investigate critical factors affecting labor productivity in building construction projects and rank the factors according to their frequency of occurrence, level of impact and the combination of the two. Different literatures related to this research are reviewed, and in order to see the Ethiopian building construction practices the following research methodology is implemented. Therefore the actual data is collected and analyzed to find the actual practices in relation to labour productivity and the critical factors affecting labour productivity in building construction projects.

For this study, data was collected using both primary and secondary sources. The primary data was obtained through questionnaire directed to contractors that are involved in Ethiopian building projects. The secondary data was obtained from previously done different researches, internet, journals, books and different articles in published documents. The secondary data was used as a source for problem identification and was used as criteria for developing and analyzing the primary data. Questionnaire is chosen as a research instrument to gather data; the questionnaire contains an introduction part which defines the different terms that were used in the research.

The nature of the research is both qualitative and quantitative because of some of the data collected is in descriptive form while the others of the data are in numeric form.

3.2. Survey Questionnaires

The research instrument used in this research is questionnaire which was designed in such a way that it ensures to address the objectives of the study categorized by different parts. The first part of the questionnaire is targeted to gather information about the respondents and firms profile; questions in this part were created to collect information such as job position, work experience and projects' contact information. The second part of the questionnaire aims to have data about the awareness and understanding of contractors on productivity in the construction projects. The third part contains the various aspects of productivity affecting factors to be rated by the

respondents with respect to their frequency of occurrence and level of impact as well as the general experiences implemented to improve productivity and proposed suggestion to improve productivity on construction projects. The factors which were identified from previous research will be used as a basis for preparing a questionnaire to investigate its influence on the productivity of Ethiopian construction industry.

The questionnaire was design based on the fact that they had to be simple, clear and understandable for the respondents and at the same time they should be able to be interpreted well by the researcher. The questionnaire contains both close and open ended questions. The close ended questions had a number of choices of possible answers and the respondents selected whatever they feel was most appropriate. The closed ended questions were selected because they are easier to answer and assess. Open ended questions were used only in few places where the response options were relatively wide.

Two different types of questionnaires are designed to be responded by Construction contractors Company's Head office and project sites. The main intention of the questionnaires prepared addressed to head offices is to study the productivity related issues that can only be answered by head office and in addition to have an overall look on the productivity of their projects since there are many projects administrated in a single company. A total of 25 questionnaires were distributed for construction contractors at their head offices and 15 are successfully collected. Most of these questionnaires were filled by Contract Administration Engineers, Technical managers, deputy managers, Project Coordinators and office engineers in different companies. On the other hand project sites are the direct sources of data relevant with the objectives of this study. Hence, a total of 37 questionnaires were distributed for 37 building construction projects undertaking by grade three and above contractors and 23 are successfully collected. Most of these questionnaires were filled by Project Managers, Project Engineers, Site Engineers and office engineers at different projects.

Table 3-1 Targeted Respondents

Targeted Respondents	**No of Distribution**	**No of Respondents**
Building Construction Projects	37	23
Contractors Head Offices	25	15
Total	**62**	**38**

3.3. Research Population and Sampling

Low labour productivity affects all contractors of different class and category. However, the research focus is only on building construction companies and projects due to the fact that construction of buildings uses many labours with various positions. On the other hand grade three and above contractors are selected by taking in to consideration these contractors have more experience related to the study area.

Therefore, the study populations included for this research work are domestic contractors of grade three and above and building projects under taking by grade three and above contractors in Addis Ababa.

3.4. Data Analysis Method

The analyses of the data obtained from questionnaires have processed which involves simple statistical approach, examining, tabulating and categorizing based on the chosen measurement scale. Most of the findings were presented in the form of tables, pie charts and bar graphs to clearly illustrate the result and to help to easily understand.

In this research, ordinal scales were used. An ordinal scale, as shown in the Tables 3-2, is a ranking or a rating of data that normally uses integers in ascending or descending order. The numbers assigned (1, 2, 3, 4,5) are simply numerical labels.

Table 3-2 Ordinal Scale Used for Measuring of the level of Effect

Item	Critical Effect	High Effect	Medium Effect	Low Effect	No Effect
Scale	5	4	3	1	2

In this study, an ordinal measurement scale 1 to 5 was used to determine the effect level. Respondents were asked to rank factors affecting labour productivity according to the degree of importance (5 = affects with very large degree; 4 = affects with large degree; 3 = affects with average degree; 2 = affects with little degree; and 1 = Not affects);

For analyzing data by ordinal scale, a relative importance index (RII) was used for each factor by the following equation 3.1 [22]:

$$\text{Importance Index} = \frac{5n_1+3n_2+4n_3+2n_4+n_5}{5(n_1+n_2+n_3+n_4+n_5)} \quad \text{----------Eq.3.1}$$

where *n1* represents the number of respondents who answered "Critical effect", *n2* represents the number of respondents who answered " High effect", *n3* represents the number of respondents who answered "medium effect", *n4* represents the number of respondents who answered "low effect" and *n5* represents the number of respondents who answered "no effect".

In order to study the frequency of occurrence, an ordinal measurement scale 1 to 4 was used to determine the level of the Effect. Respondents were asked to rank factors affecting labour productivity according to the degree of importance (4 = Frequency of very large degree; 3 = Frequency of large degree; 2 = Frequency of little degree; and 1 = Frequency of no occurrence);

Table 3-3 Ordinal Scale Used for Measuring of the Frequency of Occurrence

Item	Very Often	Often	Some Times	None
Scale	4	3	2	1

For analyzing data by ordinal scale, a relative importance index (RII) was used for each factor by the following equation 3.2 [2]):

$$\text{Frequency Index} = \frac{4n_1+3n_2+2n_3+n_4}{4(n_1+n_2+n_3+n_4)} \quad \text{----------Eq.3.2}$$

where *n1* represents the number of respondents who answered "Very Often", *n2* represents the number of respondents who answered "Often", *n3* represents the number of respondents who answered "Some Times" and *n4* represents the number of respondents who answered “None”.

In order to rank the overall impact of labour productivity affecting factors on construction projects, the Severity Index (SI) which is the multiplication of the importance and frequency indices was used for each factor [22];

Severity Index = Importance Index X Frequency Index ----------Eq.3.3

As it is discussed above, the SI was used to rank the different factors affecting labor productivity. These rankings are used to compare both the level of effect and the frequency of occurrence of the factors as perceived by respondents.

4. Analysis and Discussion

4.1. Overview of Labour Productivity Practices of Contractors in Ethiopia

In order to see the contractors overall practice in relation to labour productivity at their construction projects, questionnaires were designed and distributed to contractors head office and projects. Construction companies their grade $\geq$ 3 were randomly selected to respond to the questionnaires. The survey of selected building projects in Addis Ababa, Ethiopia is done for investigating major factors that influence labour productivity on the projects. Moreover, the study is intended to assess the productivity improvement practices, and indicate the direction of how the labour productivity on projects will be improved.

The reliability of the returned questionnaires were checked before starting the analysis, two questionnaires from were rejected due to incompleteness and two questionnaires from contractors head office were rejected due to their grade is below grade three; hence, out of the returned 38 questionnaires 34 were found to be suitable for data analysis.

As it is described in the Table 4-1 below; a total of 62 questionnaires were targeted to be collected and out of these 38 which is 61% are successfully responded, and it is believed to be adequate for this study.

Table 4-1 Summary of questionnaire distribution and response rate

Total Number of Questionnaires Distributed	Successfully Responded	Response Percentage (Rate)
62	38	61%

4.1.1. Respondents' Profile

4.1.1.1. Respondents' Working Position/Job Title

As it is illustrated in the figure below, the respondents for the questionnaire are mainly Contract Engineers (26%), Project Managers (24), Office Engineers (15%), Technical Managers (12%) and Project Coordinators (12%) of the selected construction firms. Therefore, the following

analysis and discussion of the study are performed based on the responses received on the questionnaire from these professionals.

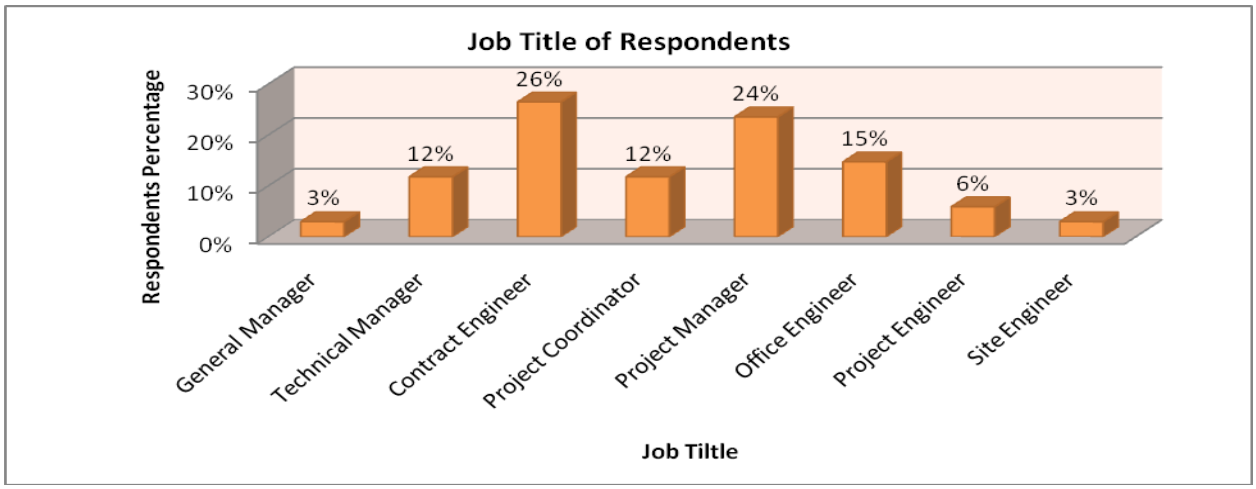

Figure 4-1 Respondents Working Position/Job Title

4.1.1.2. Experience of Respondent's in the Construction Industry

The work experience of the respondents in the construction firms are assessed and found to be 50% above ten years, 26% from five to ten years and 15% from two to five years.

The overall profile implies that most of the respondents have adequate experience in the construction firms. This indicates that, the respondents could provide the required information for all items included in the questionnaire.

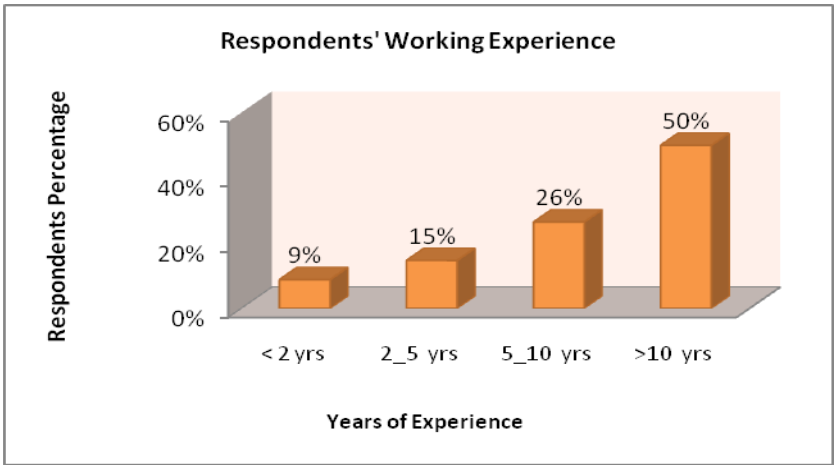

Figure 4-2 Respondents Working Experience

4.1.2. Companies' Profile

4.1.2.1. Grade of Construction Firms

41% of the selected contractors are grade one building contractors, 35% of the selected contractors are grade one general contractors and 21% of the selected contractors are grade three building contractors. This implies that majority of the data are collected from grade one contractors.

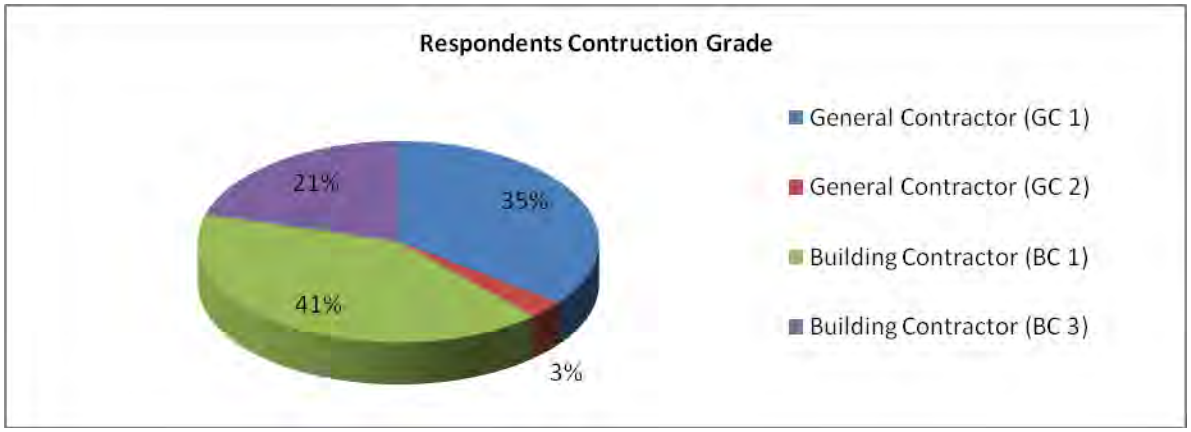

Figure 4-3 Grade of Respondent Firms

4.1.2.2. Number of Active Projects in the Firms

The total number of active projects at hand indicates the size of the firms. As it is described in the figure below the number of active projects at the hands of the respondent's firms are; 46% of the firms have from 5-10, 38% have from 10-20, 8% have below 5 and 8% have above 20 active projects. Hence the data surveyed from most of the firms are the indication of various projects.

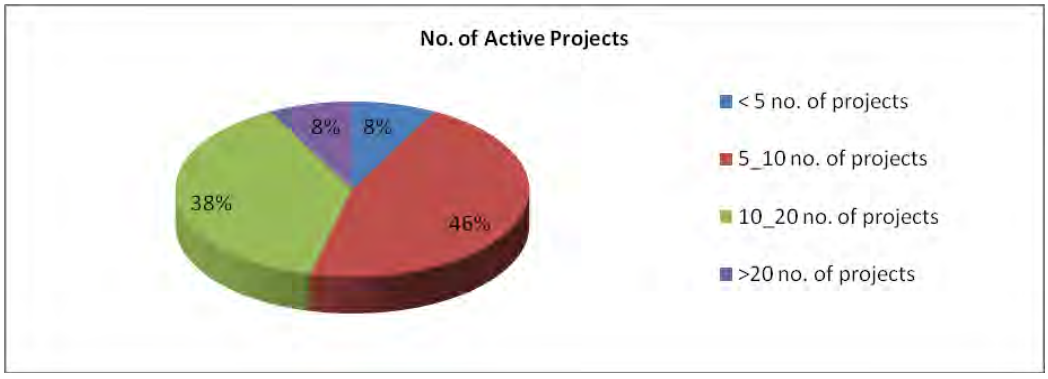

Figure 4-4 Number of active Projects in the Firms

4.1.2.3. Projects' Contract Amount

The figure below shows that 69% of the respondents were in handling projects with a contract amount of Birr above 50 Million, 23% of the respondents were in handling projects with a contract amount of Birr between 30-50 Million and 8% of the respondents were in handling projects with a contract amount of Birr between 10-30 Million.

Most of the respondents have projects with amount of Birr above 50Million; this indicates that most respondents administer huge projects having different type of works. In these types of projects the involvement of labour to execute the works is high.

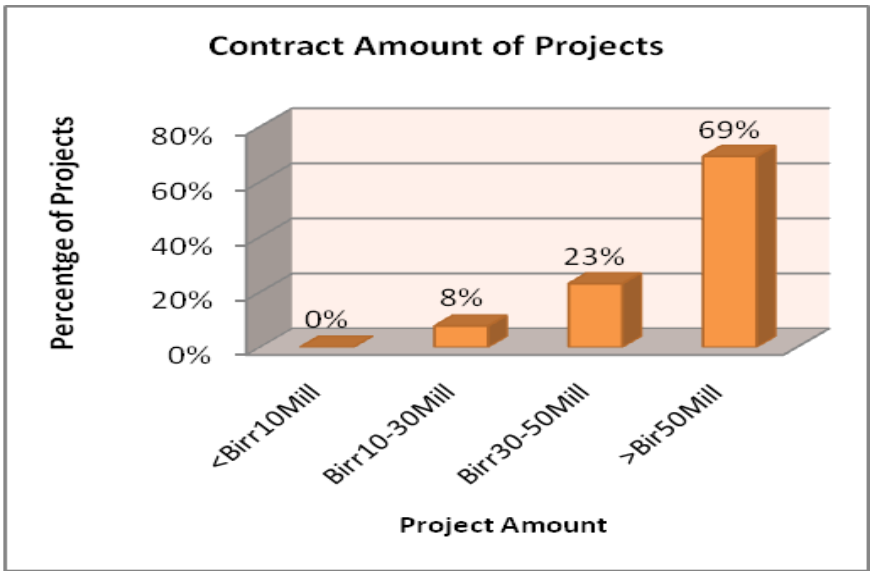

Figure 4-5 Contract amount of projects

4.1.3. The impact of poor labor productivity on the performance of projects

The performance of projects to be completed within the planned time and budgeted cost is assessed and found to be 3% Very Good, 41% Good, 53% Bad and 3% Very Bad. This shows that the performances of above half of the projects of the respondents are bad with respect to time and cost of the project.

The impact of poor labor productivity on the performance of the projects are also assessed and 47%, 32%, 18% and 3% of the respondents rate the impact of low labour productivity on the performance of building projects as high, very high, low and very low respectively.

From this result it can be said that most construction professionals practiced that the tendency of projects performance to be affected by poor labour productivity is high.

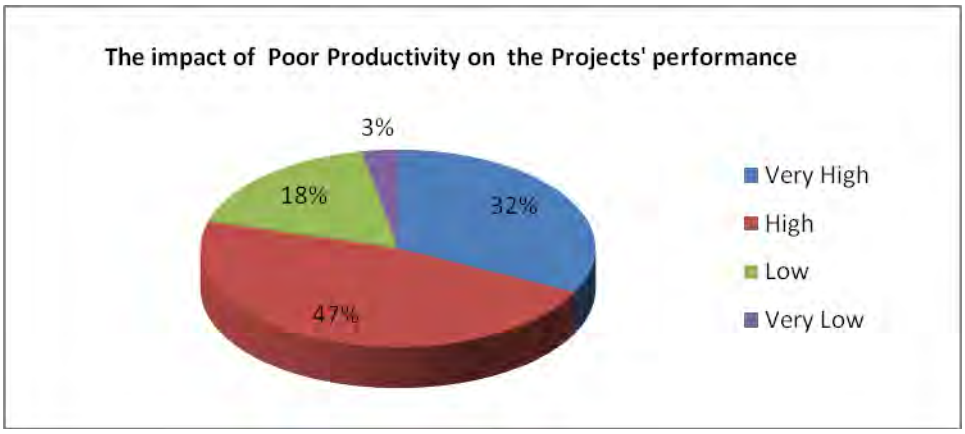

Figure 4-6 The impact of poor labor productivity on the Performance of Projects

4.1.4. Labour Productivity Measuring Practices of Building Contractors

4.1.4.1. Do Contractors have an experience of measuring labor productivity in the projects?

This question answers whether contractors measure productivity on their projects or not. The assessment indicates that 12% of the respondents' measure productivity and the rest 88% do not.

The reason of why Contractors do not Measure Productivity is studied. The reasons given by 36% of the respondents are "negligence", 27% of the respondents believe that it is due to "lack of awareness" and 18% of the respondents consider that measuring productivity is "difficult to implement".

The result of this assessment indicates that most of the contractors do not measure labour productivity as it is responded by 27% of the contractors do not measure productivity due to lack of awareness, 36% of them are due to negligence and 18% of the contractors believes that measuring of labour productivity is difficult to implement.

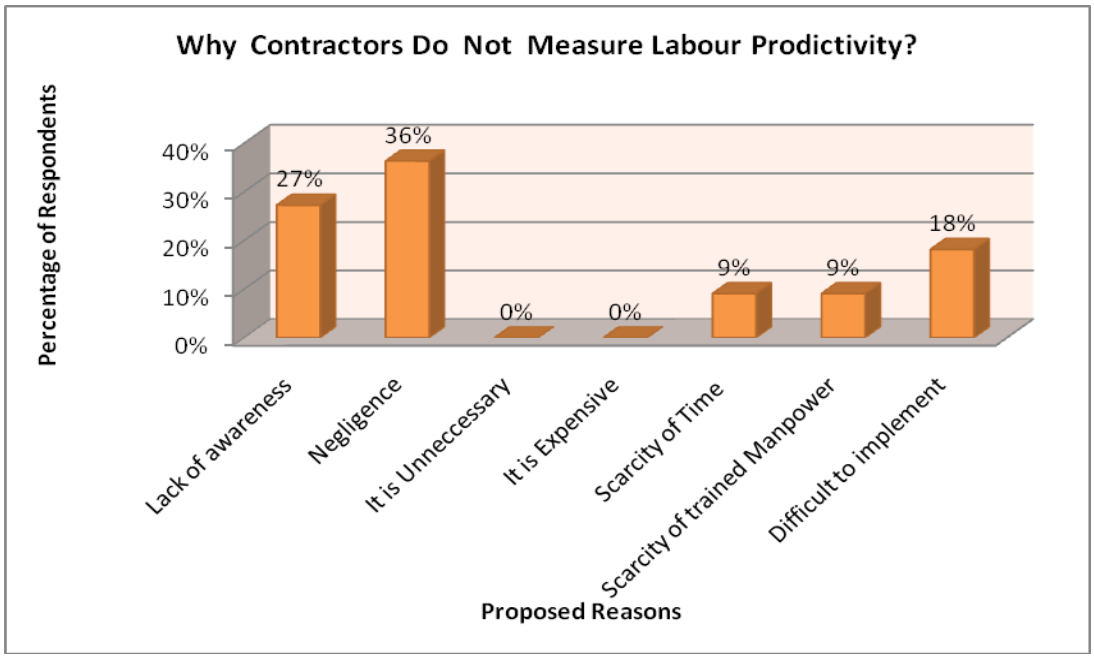

Figure 4-7 Reasons for not Measuring Productivity

4.1.4.2. Labor Productivity Measurement Approaches Implemented

As it is mentioned above 12% of the respondents have a practice of measuring labour productivity. Hence, it is found out that "Jobs completed per jobs scheduled" and "Output per worker hours" are implemented by 54% and 38% of the respondents respectively as approaches to measure labour productivity.

It might be correct to measure labour productivity based on "Jobs completed per jobs scheduled", if the work schedule is prepared based on the reliable data.

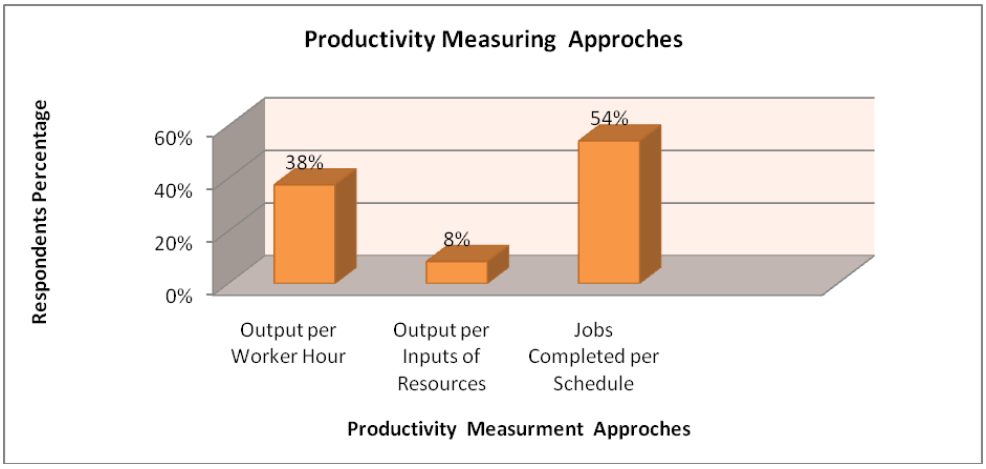

Figure 4-8 Productivity Measurement Approaches Implemented

4.1.5. Labour Productivity Data Basis used for Setting of Unit Rates

Setting of competitive prices for contractors is crucial, the prices set by contractors should be reasonable to minimize the probability of being non profitable and should not be higher to increase the chance of being successful in bid competition. Labour cost is one of the major components to compute unit prices of each work items of the building works, hence the labour productivity (output per hour) is the main input to determine labour costs.

Therefore, Contractors experience is assessed inorder to see their cost computation experience in relation to the considering the existing real situation of their labour productivity. In line with this, 17% of respondents partially consider the real labour productivity data recorded by their companies to set labour prices, while the rest 83% of the respondents do not consider it at all rather they use data sources available in their company. Respondents who partially consider the labour productivity of the existing real data to set labour cost is only for some types of trades of works.

It is also tried to assess the respondents' labour productivity data basis which is used by most of the respondents and it is found that it is a document published by Ministry of Works and Urban Development (1998), which they call it "standard" in their response.

From this survey it can be generalized for most of the contractors that the basis of computing labour cost was based on the labour productivity data published by Ministry of Works and Urban Development (1998).

4.1.6. Labour Productivity Data Basis used for the preparation of Working Schedules

Preparation of working schedule (time plan) is one of the major works performed by the contractors in order to plan the completion period of the works of project. Labor Productivity (output per hour) is the main input to determine the duration required to execute an activity.

Working schedule preparation experienced by contractors is assessed and 18% of the respondents partially use the real labour productivity data recorded by their companies to

determine the required time that will be taken to perform a specific activity, while the rest 82% of the respondents do not consider it at all.

The respondents were also asked how they determine the completion time required for the execution of the activities and most of them reply that they simply distribute the total works of the project to be completed in the given time specified in the contract agreement.

Respondents who partially consider the labour productivity of the existing real data for determining the required completion time is only for some types of trades of works.

4.2. Survey of Factors Affecting Labour Productivity in Building Construction Project site

4.2.1. Introduction

The survey of Contractors involved in the construction of building projects and building projects in Addis Ababa, Ethiopia is done for investigating major factors that influence labour productivity on the projects.

The factors that affect labour productivity are taken from previous different studies and fifty three factors are selected by taking in to consideration their weights given by the previous researchers. The fifty three factors are summarized and categorized in to twelve groups according to their characteristic in order to help the respondents to easily understand. The respondents were requested to rate all the 53 factors with respect to their level of effect and frequency of occurrence.

The top ten factors rated by respondents with respect to their level of effect and frequency of occurrence are ranked by calculating using relative importance index (RII) and the impact of the two is also studies and discussed below.

4.2.2. Major Factors Affecting Labour Productivity with respect to level of Effect

The study was performed by considering the rate given by the respondents for the 53 factors affecting labor productivity for building construction, and their RII was calculated.

The top ten factors affecting labor productivity with their level of effect as rated by considering all responses are 1) Shortage of material with a value of RII=0.833, 2) Lack of follow up the work progress and Financial difficulties of the owner/Payment delay with a value of RII=0.820, 3) Lack of Motivation with a value of RII=0.800, 4) Incomplete facilities (water, power supply & sanitary) and Delays in decisions making with a value of RII=0.787, 5) Inspection and Instruction delay with a value of RII=0.780, 6) Incomplete and Inaccurate drawings with a value of RII=0.773, 7) Mistakes during construction(Rework)with a value of RII=0.767, 8) Cash flow and financial difficulties with a value of RII=0.760, 9) Poor resources management and Incompetence of labors with a value of RII=0.753 and 10) Lack of equipment and tools and Poor quality of material with a value of RII=0.747.

On the other hand, among the top ranked factors 10 (71%) of the critical factors lays under the responsibility of contractors, 3 (21%) of them lays under the responsibility of consultants and 1 (8%) lays under the responsibility of the Client.

The top ten ranked factors with their RII are as described in the table below;

Table 4-2 Top Ten Factors affecting Labour Productivity with Respect to Level of Effect

Rank	Top Ten Factors with Respect to Level of Effect	Responsible Stakeholder	RII
1	Shortage of material	Contractor	0.833
2	Lack of follow up the work progress	Contractor	0.820
2	Financial difficulties of the owner/Payment delay	Client	0.820
3	Lack of Motivation	Contractor	0.800
4	Incomplete facilities (water, power supply & sanitary)	Contractor	0.787
4	Delays in decisions making	Consultant	0.787
5	Inspection and Instruction delay	Consultant	0.780
6	Incomplete and Inaccurate drawings	Consultant	0.773
7	Mistakes during construction(Rework)	Contractor	0.767
8	Cash flow and financial difficulties	Contractor	0.760
9	Poor resources management	Contractor	0.753

9	Incompetence of labors	Contractor	0.753
10	Lack of equipment and tools	Contractor	0.747
10	Poor quality of material	Contractor	0.747

4.2.3. Major Factors Affecting Labour Productivity with Respect to their Frequency of occurrence

As it is stated above, the study was performed by considering the rate given by the respondents for the 53 factors affecting labor productivity on building construction, and their frequency index FI was calculated.

The top ten factors affecting labor productivity with their frequency of occurrence as rated by all respondents are The top ten factors with the highest level of effect on labor productivity by considering all responses are 1) Delays in decisions making with a value of FI=0.758, 2) Incomplete and Inaccurate drawings with a value of FI=0.742, 3) Shortage of material with a value of FI=0.734, 4) Frequent damage of equipments with a value of FI=0.724, 5) Change of work order/Variation with a value of FI=0.700 , 6) Change of workers with a value of FI=0.696, 7) Inspection and Instruction delay and Incomplete facilities (water & power supply, and sanitary) with a value of FI=0.692, 8) Lack of follow up the work progress with a value of FI=0.683, 9) Financial difficulties of the owner/Payment delay with a value of FI=0.667 and 10) Lack of Motivation with a value of FI=0.664 .

On the other hand, among the top ranked factors six (54%) of the critical factors lays under the responsibility of contractors, four (36%) of them lays under the responsibility of consultants and 1 (10%) lays under the responsibility of the Client.

The top ten ranked factors with their FI are as described in the table below;

Table 4-3 Top Ten Factors affecting Labour Productivity with Respect Frequency Occurrence

Rank	Top Ten Factors with Respect to Frequency Occurrence	Responsible Stakeholder	FI
1	Delays in decisions making	Consultant	0.758
2	Incomplete and Inaccurate drawings	Consultant	0.742

3	Shortage of material	Contractor	0.734
4	Frequent damage of equipments	Contractor	0.724
5	Change of work order/Variation	Consultant	0.700
6	Change of workers	Contractor	0.696
7	Inspection and Instruction delay	Consultant	0.692
7	Incomplete facilities (water & power supply, and sanitary)	Contractor	0.692
8	Lack of follow up the work progress	Contractor	0.683
9	Financial difficulties of the owner/Payment delay	Client	0.667
10	Lack of Motivation	Contractor	0.664

4.2.4. Factors having Critical Impact on Labour Productivity

The top ten factors rated by respondents with respect to their level of effect and frequency of occurrence are ranked as described above and the factors those have high effect and frequently occurred on the projects are rated by multiplying the rates of the two.

The study was performed by considering the rate given by the respondents for the 53 factors affecting labor productivity for building construction, and their Severity Index (SI) was calculated.

The top ten factors with the highest level of effect on labor productivity by considering all responses are 1) Shortage of material with a value of SI=0.613, 2) Delays in decisions making with a value of SI=0.597, 3) Incomplete and Inaccurate drawings with a value of SI=0.574, 4) Lack of follow up the work progress with a value of SI=0.560, 5) Financial difficulties of the owner/Payment delay with a value of SI=0.547 , 6) Incomplete facilities (water & power supply, and sanitary) with a value of SI=0.544, 7) Inspection and Instruction delay with a value of SI=0.540, 8) Lack of Motivation with a value of SI=0.531, 9) Frequent damage of equipments with a value of SI=0.523 and 10) Change of work order/Variation with a value of SI=0.513 .

On the other hand, among the top ten factors five (50%) of the critical factors lays under the responsibility of contractors, four (40%) of them lays under the responsibility of consultants and 1 (10%) lays under the responsibility of the Client.

The top ten ranked factors with their SI are as described in the table below;

Table 4-4 Top Ten Factors having Critical Impact on Labour Productivity

Rank	Top Ten Factors having Critical Impact	Responsible Stakeholder	SI
1	Shortage of material	Contractor	0.612
2	Delays in decisions making	Consultant	0.597
3	Incomplete and Inaccurate drawings	Consultant	0.574
4	Lack of follow up the work progress	Contractor	0.560
5	Financial difficulties of the owner/Payment delay	Client	0.547
6	Incomplete facilities (water & power supply, and sanitary)	Contractor	0.544
7	Inspection and Instruction delay	Consultant	0.540
8	Lack of Motivation	Contractor	0.531
9	Frequent damage of equipments	Contractor	0.523
10	Change of work order/Variation	Consultant	0.513

The following graph shows the top ten critical factors with their values of relative importance index, frequency index and severity index.

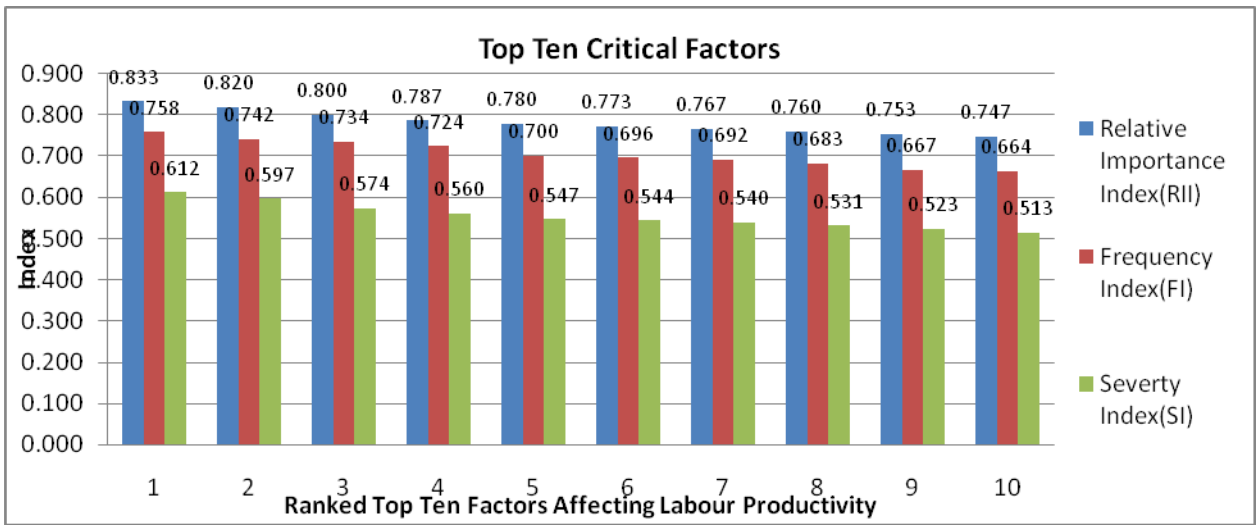

Figure 4-9 Top Ten Factors having Critical Impact on Labour Productivity

The highest ranked top ten factors are discussed below;

1. **Shortage of material (SI=0.612);** according to the respondents rate; lack of material was ranked as the most critical factor causing low labour productivity with a SI=0.61. Lack of material refers to problems encountered due to unavailability of materials on the project. As a result the labours become idle for waiting of materials.
   The contractor should plan ahead to ensure that the critical materials are available at site in adequate quantity all the time.

2. **Delays in Decisions Making (SI=0.297);** The result shows that delay of consultants in making decisions was believed having critical impact on the productivity of labor on projects with a SI=0.60. This has an indication that consultants are frequently delayed in decision making and the late decision had a high level of effect on the productivity of labour.

3. **Incomplete and Inaccurate drawings (SI=0.574);** incomplete and inaccurate drawings issued by consultants frequently affects the productivity of labor with a high level of effect as it is rated by respondents. This has a critical consequence of having more idle time of workers.
   It can be said that incomplete and inaccurate drawings are one of the critical factors that should get attention by consultants and contractors.

4. **Lack of follow up the work progress (SI=0.560);** lack of follow up of the progress of the work is rated as one of the factors that highly affect the productivity of labour. This indicates that the contractors did not perform a proper follow up of the progress of the works of the projects and the result of this highly affects the productivity of labour frequently.

5. **Financial difficulties of the owner/Payment delay (SI=0.547);** delay issuance of payment by client to contractor is believed by the respondents severely hinder the work progress. This delay factor was ranked fifth among the other factors. Delay in payment affects cash flow of contractors which in turn affects the payment to workers. This causes significant effects on workers' motivation.

6. **Incomplete facilities (water & power supply and sanitary facilities) (SI=0.544);** Incomplete facilities provided by the contractor was ranked sixth among the most critical factors with an severity index of 0.544. This severely causes workers idling as result of interruption of works due to unavailability of water and power. In addition lack of appropriate sanitary facility for the labour critically affects the productivity of workers.

7. **Inspection and Instruction Delays (SI=0.540);** Delayed inspection and instruction by the consultant was ranked as seventh with a severity value of SI=0.54 having a critical impact on the productivity of labor. The delay in inspection and instruction by the consultant causes workers idling resulting from waiting for their decision.

8. **Lack of Motivation (SI=0.531);** results show that lack of motivation for workers has a critical impact in lowering the productivity of labours with a severity index of 0.531. Lack of motivation is ranked eighth its impact in lowering the productivity of labour. Lower salary, lack of recognition and lack of promotion are some of the grounds that might affect the workers' motivation.

9. **Frequent Damage/breakdown of Equipments (SI=0.523);** frequent breakdown of equipments causes major idle time since employed workers are unable to progress their work. The frequent break down of equipments was ranked ninth in its impact in lowering the productivity of labour with a severity index of 0.523.

10. **Change of Work Order /Variation (SI=0.513);** Change work order by consultants was ranked the tenth factor causing low labour productivity (SI=0.513). Change order might occur due to design errors, modification works, additional works and/or due to other related reasons that results change of work orders. The change of work order disturbs the sequence of works planned by the contractor. In addition the change of work order needs the consultants approved work order and other required documents

4.2.5. Least Ten Factors with Low Impact on Labour Productivity

The least ten factors with the lowest impact on labor productivity by considering all responses are 1) Contract type of the project with a value of SI=0.221, 2) Increased labor Agewith a value of SI=0.243, 3) Overcrowded labor force with a value of SI=0.267, 4) Indiscipline labor with a value of SI=0.312, 5) Congestion of Site with a value of SI=0.339, 6 Change of supervisor with a value of SI=0.345, 7) Design changes with a value of SI=0.350, 8) Bad health of labors with a value of SI=0.352, 9) Unforeseen Conditions (Ex. Ground Condition) with a value of SI=0.357 and 10) Lack of Safety tools with a value of SI=0.380.

The least ten ranked factors with their SI are as listed in the table below;

Table 4-5 Least Ten Factors having Low impact on Labour Productivity

Rank	The Least Ten Factors having Low Impact	SI
1	Contract type of the project	0.221
2	Increased labor Age	0.243
3	Overcrowded labor force	0.267
4	Indiscipline labor	0.312
5	Congestion of Site	0.339
6	Change of supervisor	0.345
7	Design changes	0.350
8	Bad health of labors	0.352
9	Unforeseen Conditions (Eg. Ground Condition)	0.357
10	Lack of Safety tools	0.380

4.2.6. Suggestions for Improvement of Labour Productivity

The practice of contractors with regarding to improving productivity of their labours is studied and 65% of the surveyed construction companies have used different approaches to improve labour productivity on their projects while the others 35% do not.

Contractors' ideas based on their experience were collected, tabulated, grouped and prioritized in accordance to the number of times quoted by respondents. Respondents made different

suggestions for construction labour productivity improvement. The following are lists of top five areas recommended by respondents for improvement of labour productivity on construction projects.

1. Timely supply of Material and Equipments
2. Using work plan(schedule) and monitoring of the progress of the project
3. Acquiring complete drawing and specification
4. Motivations, incentives, recognition and related approaches
5. Subcontracting works

It is found that; timely supply of Material & Equipments, using work Plan (schedules) and Continuous monitoring of the progress of the project, Acquiring complete drawing & specification, Motivating labours, and Subcontracting works are labour improvement approaches suggested by the respondents in the rank of their effectiveness.

4.3. Comparison of Critical Factors Affecting Construction Productivity in Ethiopia with other countries practice abroad

This study compares the survey results of the critical factors affecting labour productivity identified in this study with other countries.

The Table 4.6 lists the top five critical factors affecting labor productivity in construction projects of different countries studied in the past five years (Indonesia, New Zealand, Kuwait, India , Egypt and this study (Ethiopia) ;

Table 4-6 Top five factors in different countries

Rank	Indonesia Soekiman et al. (2011)	New Zealand Tran and Tookey (2011)	Kuwait Jarkas and Bitar (2012)	India Mistry and Bhatt (2011)	Egypt El-Gohary and Aziz (2014)	Ethiopia This Study (2016)
1	Lack of Materials	Reworks	Clarity of technical specifications	Payment delay	Labor experience and skill	Shortage of material
2	Labors strikes	Level of skill and experience of the workforce.	The extent of variation/change orders during execution	Skill of labor	Incentive programs	Delays in decisions making of the Consultant
3	Delay in arrival of materials	Adequacy of method of construction	Coordination level among various design disciplines	Clarity of technical specification	Availability of the materials and their ease of handling	Incomplete and Inaccurate drawings
4	Financial difficulty of owner	Build-ability issues	Lack of labor supervision	Material shortage	Leadership and competency of construction management	Lack of follow up the work progress
5	Unclear instruction to laborer	Inadequate supervision and coordination	Proportion of work subcontracted	Motivation	Competency of labor supervision	Financial difficulties of the owner/Payment delay

Results of the comparative analysis show that the findings of each study are different from the others. These dissimilarities indicate that the factors affecting construction productivity are different from country to country, place to place and project to project based upon different circumstances.

The study concludes that these dissimilarities are due to differences in the situations such us climatic conditions, Political conditions, availability of innovative technology and other circumstances from country to country.

However, there are some common factors observed among the studies in different countries, including a delay in providing drawings, a delay for payments from the owner to contractors, equipment-related delays, Supervision and instruction by consultants, labor skills related, motivation of labors, material related delays, clarity of specifications and drawings, and slowness of consultant for decision.

The common factors identified in most of the countries as a critical factor are 1.Material supply and availability related 2.Payment Delay, 3.Improper Supervision by the consultant, 4.Unclarity of drawings and specification, and 5.Incompetency of labours. The four factors identified in this study in our country are among the five most common factors investigated in most of the selected countries.

As a major objective of this study, it is to identify and rank factors influencing labour productivity in the building construction projects of the Ethiopian construction industry. As it is described in the previous chapter; the top ten critical factors that frequently occurred with high level of influence in lowering labour productivity is identified and ranked with their level of severity are 1)Shortage of material, 2)Delays in decisions making, 3)Incomplete and Inaccurate drawings, 4) Lack of follow up the work progress, 5) Financial difficulties of the owner/Payment delay , 6)Incomplete facilities (water & power supply, and sanitary facilities), 7)Inspection and Instruction delay, 8)Lack of Motivation, 9)Frequent damage of equipments and 10)Change of work order/Variation

Good productivity in construction projects has a significant impact in the successful completion of a project, and it also influences the growth of a company as a whole.

The findings of this study can be used as focus areas to improve labour productivity in building projects. The Contractors, Consultants and Clients can use the identified factors as a checklist to take their responsibilities for the improvement of labour productivity .

5. Conclusions and Recommendations

The results of the questionnaire survey and discussion of the findings in line with the literature review were presented in the previous section. Conclusions derived from the research findings are made and the relevant recommendations & future research areas are forwarded.

5.1. Conclusions

1. The survey result indicates that most construction professionals practiced that projects performance is highly affected by poor labour productivity
2. Most of the contractors do not have experience of measuring labour productivity on their projects due to negligence, lack of awareness and believing that measuring productivity is difficult to implement.
3. The data basis for the computation of labour costs to set unit rates is based on the national standard for most of the contractors. They are advised to consider the actual recorded company level labour productivity data.
4. The top ten labour productivity influencing factors rated by their level of effect and frequency of occurrence are; 1)Shortage of material, 2)Delays in decisions making, 3)Incomplete and Inaccurate drawings, 4) Lack of follow up the work progress, 5) Financial difficulties of the owner/Payment delay , 6)Incomplete facilities (water & power supply, and sanitary facilities), 7)Inspection and Instruction delay, 8)Lack of Motivation, 9)Frequent damage of equipments and 10)Change of work order/Variation
5. Among the top ten critical factors five (50%), four (40%) and 1 (10%) of them lays under the responsibility of Contractors, Consultants and Clients respectively
6. The study result shows that 1) Contract type of the project, 2) Increased labor Age, 3) Overcrowded labor force, 4) Indiscipline labor, 5) Congestion of Site, 6) Change of supervisor, 7) Design changes, 8) Bad health of labors, 9) Unforeseen Conditions (Ex.

Ground Condition) and 10) Lack of Safety tools factors were ranked in the lowest position with their lowest impact on productivity of labour.

7. The result of the comparative analysis made on the investigated critical factors affecting labour productivity studied in different countries differs to each other due to differences in situations of one country to the other.

5.2. Recommendations

1. Contractors are advised to give serious attention in measuring labour productivity and they are also recommended to participate in trainings and workshops to increase their knowledge, since negligence and lack of awareness were identified as a major causes for not measuring productivity in building construction projects.

2. Special attention should be given by the contractors on the issues related to Shortage of material, Lack of follow up the work progress, Incomplete facilities (water & power supply, and sanitary), Lack of Motivation and Frequent damage of equipments in order to minimize their impacts on affecting labour productivity
3. Special attention should be given by the consultants on the issues related to Delay in Decision making, Incomplete and Inaccurate drawings, Inspection and Instruction delay, and Change of work order/Variation in order to minimize their impacts on affecting labour productivity
4. Special attention should be given by the clients on the issues related to Financial difficulties of the owner/Payment delay in order to minimize the impact on affecting labour productivity
5. The contractor should plan ahead to handle the effect of the critical factors by taking in to consideration the ranks as listed in this study
6. It is found that; timely supply of Material & Equipments, using work Plan (schedules) and Continuous monitoring of the progress of the project, Acquiring complete drawing & specification, Motivating labours, and Subcontracting works are labour improvement approaches suggested by the respondents in the rank of their effectiveness.
7. The following are suggested for future studies;
    - A study on assessing effective ways to measure labour productivity

- Identifying the factors affecting labour productivity in the Ethiopian construction industry

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Appendices

Questionnaire to Construction Contractors at Project

Questionnaire to Construction Contractors at Project

ADDIS ABABA UNIVERSITY
ADDIS ABABA INSTITUTE OF TECHNOLOGY
GRADUATE STUDY PROGRAM

Research Topic "LABOR PRODUCTIVITY MEASURMENT ON BUILDING CONSTRUCTION PROJECTS"

This research survey is designed to fulfill an academic requirement for an M.Sc program in Construction Technology and Management at the Addis Ababa University. I can assure you that the research data will only be used solely for the academic purpose and will be treated with strict confidentiality. Particular mentioning of names will not be required anywhere.

Your open and prompt response is highly appreciated.

Definition

Productivity is a multidimensional term, the meaning of which can vary, depending on the context within which it is used. The basic concept of measuring productivity in construction is the ratio of input to output. According to a research conducted by the Federal Government of United States, there are two basic approaches to measuring productivity, **single factor or partial** and **multifactor or total** productivity measures. Choosing between them usually depends on the purpose of the productivity measurement and the availability of data.

Single/Partial factor measures use only one input in the denominator. Most commonly used single factor measure of productivity is the **labor productivity**, the ratio of output to either employment or labor hours.

Labor Productivity=Output/Labour Input

Multi/Total factor productivity measures use a weighted average of all inputs in the denominator. The weights usually correspond to each input's share of total expenditures. Multifactor measures reflect the joint impact of all inputs on productivity more accurately than single factor measures because the quantities of all inputs are in effect held constant, whereas only one input is held constant in the single factor approach. Multifactor measures do not seem to be widely used in construction.

Total Factor Productivity=Construction Output/Resources Used

Thus, a total productivity measure reflects the joint impact of all the inputs in producing the output. However, it is important to note that labor productivity is a measure of the overall effectiveness of an operating system in utilizing labor, equipment and capital to convert labor efforts into useful output, and is not a measure of the capabilities of labor alone.

Productivity in this research is defined as the ratio of outputs over inputs (single factor labor productivity), example the ratio of the Volume of concrete casted per hour.

OBJECTIVES OF THE SURVEY

The objective of the survey is to gather reliable information so as to achieve the following research objectives;

5. To assess the productivity measurement practices in the Ethiopian construction industry
6. To identify factors affecting construction productivity on building projects.
7. To assess productivity improvement measures taken on building construction projects.
8. To compare the major factors affecting construction labor productivity on building projects in Ethiopia with other country projects abroad.

Thank you in advance for your time!

RESEARCHER'S INFORMATION

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Phone; **+251-0910043207**
E-mail; **mekidesruth@gmail.com**

Field of study; **MSc. in Civil Engineering (Construction Technology and Management Stream)**
Advisor; **Abebe Dinku (Prof. Dr.-Ing.)**

I. Personal and Company Information

1. What is your position in the firm?

_____

2. Total years of your experience in the construction industry:

Below 2 years ☐ 2-5 years ☐
5-10 years ☐ above 10 years ☐

3. What is the grade of your company?

GC 1 ☐ GC 2 ☐ GC 3 ☐ below GC 4 ☐

BC 1 ☐ BC 2 ☐ BC 3 ☐ below BC 4 ☐

4. What is the contract amount(in Birr) of the project?

< 10 Million ☐ 10-30 Million ☐

30-50 Million ☐ > 50 Million ☐

5. What is the contract duration (in Months) of the project?

< 6 months ☐ 6-12 Months ☐

12-18 months ☐ > 18 Months ☐

6. What is the progress/status of the project (ahead/lag) as per the schedule)?

Ahead from the schedule ☐ As per the schedule ☐
Lags from the schedule ☐ Not known ☐

II. General Questions Related to Productivity

1. In general, how do you describe the performance of your project (the tendency of project to be completed with in the planned time?

Very Good ☐ Good ☐ Bad ☐ Very Bad ☐

2. If your answer is bad/very bad, how do you rate the impact of poor labor productivity on the performace of your project?

   Very High ☐ High ☐ Low ☐ Very Low ☐

3. Do you measure productivity in your construction project?

   Yes ☐ No ☐

4. If you say yes for question no.3, what is your approach/method of productivity measurment?

   Output per worker hours ☐

   Output per inputs of material, labor & machineries ☐

   Jobs completed per jobs scheduled ☐

   Other, (please specify)……

5. If you say No for question no.3, what could be your reason?

   Lack of awareness ☐

   Negligence ☐

   It is Unneccessary ☐

   It is expensive ☐

   Scarcity of Time ☐

   Scarcity of trained manpower ☐

   Measuring productivity is difficult to implement ☐

   Other, (please specify)……

III. Factors Affecting Productivity

1. Rating of the ***effect*** and ***frequency*** of factors on Productivity

1.1. From your experience, how do you rate the level of **effect** of the following factors on the Productivity of your project?

Please mark from 1-5, in the table below: 5 to be the factor which has critical effect and 1 to be the factor which has no effect.

Legend; CE=Critical Effect=5 HE=High Effect=4 ME=Medium Effect=3 LE=Low Effect=2 NE=No Effect=1

1.2. From your experience, how do you rate the occurrence **frequency** of the following factors on your project?

Please mark from 1-4, in the table below: 4 to be the factor which is very frequently occurred and 1 to be the factor which is not occurred.

Legend; VO=Very Often=4, O=Often=3, ST=Some Times=2, No=None=1

No	Factors	1.1. Rate of level of Effects						1.2. Frequency of occurrence			
		CE =5	HE =4	ME =3	LE =2	NE =1		VO =4	O =3	ST =2	No =1
I.	**Design and Specification Related Factors**										
1	Design changes										
2	Incomplete and Inaccurate drawings										
3	Delay Preparation and delivery of drawings										
4	Ambiguous and incomplete Specification										
II.	**Supervision Related Factors**										
5	Unclear instruction given by the supervisor										
6	Delays in decisions making										
7	Change of work order/Variation										
8	Change of supervisor										
9	Incompetence of supervisors										
10	Supervisors absenteeism										
11	Inspection and Instruction delay										
III.	**Material Related Factors**										
12	Shortage of material										
13	Poor quality of material										

14	Material storage location										
IV.	**Equipment and Technology Related Factors**										
15	Lack of equipment and tools										
16	Frequent damage of equipments										
17	Absence of technological advancements for machineries										
V.	**Labor related Factors**										
18	High absenteeism of labors										
19	Incompetence of labors										
20	Overcrowded labor force										
21	Misunderstanding/poor relationship between labors										
22	Increased labor Age										
23	Indiscipline labor										
24	Use of alcohol and drugs										
25	Personal Problems										
VI.	**Health and safety Related Factors**										
26	Accidents during construction										
27	Lack of Safety tools										
28	Bad health of labors										
VII.	**Project Related Factors**										
29	Inappropriate site lay out (Temporary facilities and Offices)										
30	Incomplete facilities (water & power supply, and sanitary)										
31	Congestion of Site										
32	Complexity of the project										
33	Size of the project										
34	Contract type of the project										
VIII.	**Organization(Contractor) and Management Related Factors**										
35	Poor resources management										
36	Absence of working plan										

37	Lack of using working plans										
38	Lack of follow up the work progress										
39	Change of workers										
40	Lack of Training for workers										
41	Bad working condition										
42	Too much work load										
43	Poor communication in the site										
44	Lack of Motivation										
45	Mistakes during construction(Rework)										
46	Cash flow and financial difficulties										
IX.	**Stake Holders Related Factors**										
47	Financial difficulties of the owner/Payment delay										
48	Owner Interference										
49	Lack of communication between parties (Owner, Consultant and Contractor)										
50	Lack of General support to the contractor										
X.	**External Factors**										
51	Effect of Bad weather (rain, wind, high/low temperature, etc.)										
52	Unforeseen Conditions (Eg. Ground Condition)										
53	Holidays										
	Others(please specify)										
1											
2											
3											
4											
5											

2. Have you taken corrective actions to improve labor productivity when it becomes lowered?

Yes ☐ No ☐

If you say “Yes”, what productivity improvement methods have you applied?

Please list at least five methods in descending order of effectiveness with most effective first.

I. _____

II. _____

III. _____

IV. _____

V. _____

3. What do you feel could be done to enhance/improve productivity on construction site?

Please list at least five suggestions in descending order of importance with most important first.

I. _____

II. _____

III. _____

IV. _____

V. _____

Thank You!

Questionnaire to Contractors at Head Office

Questionnaire to Contractors at Head Office

ADDIS ABABA UNIVERSITY
ADDIS ABABA INSTITUTE OF TECHNOLOGY
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Labor Productivity=Output/Labour Input

Multi/Total factor productivity measures use a weighted average of all inputs in the denominator. The weights usually correspond to each input's share of total expenditures. Multifactor measures reflect the joint impact of all inputs on productivity more accurately than single factor measures because the quantities of all inputs are in effect held constant, whereas only one input is held constant in the single factor approach. Multifactor measures do not seem to be widely used in construction.

Total Factor Productivity=Construction Output/Resources Used

Thus, a total productivity measure reflects the joint impact of all the inputs in producing the output. However, it is important to note that labor productivity is a measure of the overall effectiveness of an operating system in utilizing labor, equipment and capital to convert labor efforts into useful output, and is not a measure of the capabilities of labor alone.

Productivity in this research is defined as the ratio of outputs over inputs (single factor labor productivity), example the ratio of the Volume of concrete casted per hour.

OBJECTIVES OF THE SURVEY

The objective of the survey is to gather reliable information so as to achieve the following research objectives;

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Thank you in advance for your time!

RESEARCHER'S INFORMATION

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Field of study; **MSc. in Civil Engineering (Construction Technology and Management Stream)**
Advisor; **Abebe Dinku (Prof. Dr.-Ing.)**

I. Personal and Company Information

7. What is the name of the firm?(Optional)

_____

8. What is your position in the firm?

_____

9. Your years of experience in the construction industry:

Below 2 years ☐ 2-5 years ☐
5-10 years ☐ above 10 years ☐

10. Which of the following grades qualifies your company?

GC 1 ☐ GC 2 ☐ GC 3 ☐ below GC 4 ☐

BC 1 ☐ BC 2 ☐ BC 3 ☐ below BC 4 ☐

11. How many active building projects do you have at hand?

< 5 projects ☐ 5-10 Projects ☐

10-20 Projects ☐ > 20 Projects ☐

II. General Questions Related to Productivity

6. In general, how do you describe the performance of your projects (the tendency of project to be completed with in the planned time and Budgeted cost?

Very Good ☐ Good ☐ Bad ☐ Very Bad ☐

7. If your answer is bad/very bad, how do you rate the impact of poor labor productivity on the performace of your projects?

   Very High ☐ High ☐ Low ☐ Very Low ☐

8. Do you measure productivity in your construction projects?

   Yes ☐ No ☐

9. If you say Yes for question no.3, what is your approach/method of productivity measurment?

   Output per worker hours ☐

   Output per inputs of material, labor & machineries ☐

   Jobs completed per jobs scheduled ☐

   Other, (please specify)……

10. If you say No for question no.6, what could be your reason?

    Lack of awareness ☐

    Negligence ☐

    It is Unneccessary ☐

    It is expensive ☐

    Scarcity of Time ☐

    Scarcity of trained manpower ☐

    Measuring productivity is difficult to implement ☐

    Other, (please specify)……

11. In your company when you price bid(in the analysis of cost breakdown to determine unit price), did you consider the actual labor productivity practiced in your projects?

    Yes ☐ No ☐

If your answer for quastion number 6 is No, How do you compute labour productivity for the estimation of labour cost?

……..……..……

……...……

……..

12. In your company when you prepare working schedule (time plan), did you consider the actual labor productivity practiced in your projects?

Yes ☐ No ☐

If your answer for quastion number 7 is No, How do you compute the completion time required for the work items?

……..……..……

……...……

……

III. Factors Affecting Productivity

4. Rating of the *effect* and *frequency* of factors on Productivity

4.1. From your experience, how do you rate the level of **effect** of the following factors on the Productivity of your project?

Please mark from 1-5, in the table below: 5 to be the factor which has critical effect and 1 to be the factor which has no effect.

Legend; CE=Critical Effect=5 HE=High Effect=4 ME=Medium Effect=3 LE=Low Effect=2 NE=No Effect=1

4.2. From your experience, how do you rate the occurrence **frequency** of the following factors on your project?

Please mark from 1-4, in the table below: 4 to be the factor which is very frequently occurred and 1 to be the factor which is not occurred.

Legend; VO=Very Often=4, O=Often=3, ST=Some Times=2, No=None=1

No	Factors	1.2. Rate of level of Effects						1.2. Frequency of occurrence			
		CE =5	HE =4	ME =3	LE =2	NE =1		VO =4	O =3	ST =2	No =1
I.	**Design and Specification Related Factors**										
1	Design changes										

2	Incomplete and Inaccurate drawings										
3	Delay Preparation and delivery of drawings										
4	Ambiguous and incomplete Specification										
II.	**Supervision Related Factors**										
5	Unclear instruction given by the supervisor										
6	Delays in decisions making										
7	Change of work order/Variation										
8	Change of supervisor										
9	Incompetence of supervisors										
10	Supervisors absenteeism										
11	Inspection and Instruction delay										
III.	**Material Related Factors**										
12	Shortage of material										
13	Poor quality of material										
14	Material storage location										
IV.	**Equipment and Technology Related Factors**										
15	Lack of equipment and tools										
16	Frequent damage of equipments										
17	Absence of technological advancements for machineries										
V.	**Labor related Factors**										
18	High absenteeism of labors										
19	Incompetence of labors										
20	Overcrowded labor force										
21	Misunderstanding/poor relationship between labors										
22	Increased labor Age										
23	Indiscipline labor										
24	Use of alcohol and drugs										
25	Personal Problems										
VI.	**Health and safety Related Factors**										

26	Accidents during construction										
27	Lack of Safety tools										
28	Bad health of labors										
VII.	**Project Related Factors**										
29	Inappropriate site lay out (Temporary facilities and Offices)										
30	Incomplete facilities (water & power supply, and sanitary)										
31	Congestion of Site										
32	Complexity of the project										
33	Size of the project										
34	Contract type of the project										
VIII.	**Organization(Contractor) and Management Related Factors**										
35	Poor resources management										
36	Absence of working plan										
37	Lack of using working plans										
38	Lack of follow up the work progress										
39	Change of workers										
40	Lack of Training for workers										
41	Bad working condition										
42	Too much work load										
43	Poor communication in the site										
44	Lack of Motivation										
45	Mistakes during construction(Rework)										
46	Cash flow and financial difficulties										
IX.	**Stake Holders Related Factors**										
47	Financial difficulties of the owner/Payment delay										
48	Owner Interference										
49	Lack of communication between parties (Owner, Consultant and Contractor)										
50	Lack of General support to the contractor										

X.	External Factors										
51	Effect of Bad weather (rain, wind, high/low temperature, etc.)										
52	Unforeseen Conditions (Eg. Ground Condition)										
53	Holidays										
	Others(please specify)										
1											
2											
3											
4											
5											

2.Have you taken corrective actions to improve labor productivity when it becomes lowered?

Yes ☐ No ☐

If you say "Yes", what productivity improvement methods have you applied?

Please list at least five methods in descending order of effectiveness with most effective first.

VI. _____

VII. _____

VIII. _____

IX. _____

X. _____

3. What do you feel could be done to enhance/improve labour productivity on construction projects?

Please list at least five suggestions in descending order of importance with most important first.

VI. _____

VII. _____

VIII. _____

IX. _____

X. _____

Thank You!