



ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY

School of Civil Engineering and Architecture

Department of Civil engineering

A study on factors affecting Labor Productivity of Public Building
Construction Project in Addis Ababa

A thesis submitted in partial fulfillment of the requirements for the
Degree of Master of Science in Construction Management

By: Endeshaw Zeleke

Adama, Ethiopia

April, 2017



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Advisor: Dr. Girmay Kahssay

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DECLARATION

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

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Place: Adama Science and Technology University

Adama, Ethiopia

Date of submission: April, 2017



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Acronyms	Definition
AA	Addis Ababa
ECOTEMPA	Ethiopian Construction Technology and Management Professional Association
EEA	Ethiopian Economic Association
ETB	Ethiopian Birr
GC	Gregorian calendar
GDP	Gross Domestic Product
MoUDC	Ministry of Urban Development and Construction
MS	Micro Soft
No	Number
PMI	Project Management Institute
RII	Relative Importance Index
SPSS	Statistical Package for Social Science
WBG	World Bank Group
W	Weight

Abstract

Construction industry is a major player in economy of any countries by generating employment and wealth to the nations through its forward and backward linkages with other sectors. However many projects in developing countries experienced extremely high cost overrun, time slippage and low quality..

There are so many different factors that result in such a problems in building construction project but Productivity is one of the most important factors affecting the overall performance of any construction projects. Since construction productivity in developing country like Ethiopia is highly dependent on labor productivity the objective of this study is to identify factors affecting labor productivity, analyze and rank these factors affecting labor productivity and recommend ways to improve labor productivity of public building construction project in Addis Ababa.

To achieve this objectives data collection was carried out through the review of literatures and informal discussion with colleagues and professionals in the sector. Based on the literature review and informal discussion the study was identified 52 possible factors affecting labor productivity that was used for this study. After those factors was identified a questionnaire was designed by categorizing each factors under eight groups namely 11 factors under management related factors, 5 under Tools and equipment related factors, 5 under material related factors, 10 under manpower related factors, 7 under Motivational related factors, 6 under technical related factors, 5 under subcontracting related factors and 3 under external factors. Then the totals of 50 questionnaires were distributed to 30 public building construction project professionals in Addis Ababa. From a total of 50 questionnaires 44 of them were responded correctly. Among 44 respondents 29 of them were from contractor side and 15 of them were from consultant side.

After collecting the questionnaires data analyzing was carried out by using Microsoft excels and SPSS software and Relative importance index (RII) was used to rank the factors based on the rates of the respondents. Based on the rates to each factors given by respondent of this study most top ten critical factors negatively affecting labor productivity of public building construction projects in Addis Ababa was identified. Accordingly most top ten critical factors are: (1st) Low salaries and wages of labor, (1st) Construction Methods, (2) Late payment of salaries and wages to labor, (3rd) Poor planning and scheduling, (3rd) Inefficiency of equipments, (3rd) Late delivery of materials, (4th), Lack of clear and daily task assignments to workers, (5th) Shortage of tools and equipments, (6th) Lack of Coordination between crews, (7th) Lack of skills of labors, (7th) Rework as result of poor work performance, (8th) Shortage of experienced labors, (9th) Suitability and adequacy of equipments, (9th) Lack of training for labor, (10th) Lack of supervision of labors during work, (10th) Lack of maintenance of equipments, (10th) Shortage of materials and (10th) Project complexity/unfamiliarity of projects to workers. Some factors were get equal weights and they were given the same rank according to this research.

The result of this study was compared with previous study and the ranks given to each factor were different from researchers to researchers. Based on the results of this research finally conclusions and recommendation were made on the ways to improve labor productivity on public building construction projects in Addis Ababa for contractors who wants to have higher productivity from their workers.

Key words: Construction Industry, Construction Productivity, Labor Productivity,

1. Background of the study

1.1. General Introduction

The Construction Industry in Ethiopia can be categorized into three major sectors; namely, Transport and Communication (Road, Railway, Airway, and Telecommunication related physical works); Water Works and Energy; and Buildings and Other Physical Infrastructures. Accordingly, their capital budget requirements vary extensively depending on the focus the economic trend requires for the nation development.

Construction involves different stakeholders among which contractors, consultant and employer play a great role. And it also involves various resource, technologies, contracting methods, financing arrangements and regulatory mechanisms and has different phases such as initiation and planning; designing, execution and completion stage, and then they are used, maintained, repaired, renovated and eventually demolished or replaced in their life cycle.

A successful construction project is one that is completed on time, within budget, meets specified standards of quality, and strictly conforms to safety policies and precautions. All of this is feasible only if the premeditated levels of productivity can be achieved. According to Kuykendall (2007) due to the nature of construction projects, its importance to society and the existing economic resources, more emphasis should be given to improving productivity. Several researches were conducted related to construction productivity and most of them were concluded that labor productivity plays a great role for the productivity of construction projects. This is because of construction projects are mostly a labour intensive industry and labour costs comprises of around 30-50% of total project's costs in developing countries as it were reported in several studies such as Hanna et al (2005) , Yates and Guhathakurta (1993) and McTague and Jergeas (2002)

Linjesh and Srinivasa (2015) have also reported that labor productivity is one of the most important factors that affect overall performance of any small or medium or large construction industry. According to his finding poor productivity of construction workers is one of the main causes of cost and time overruns in construction projects.

Irene (2008) on his study of factors affecting labor productivity suggests that Construction is a labour intensive as well as craft-based activity and their behavior has an enormous influence upon the organisation and performance of construction firms. He also reported that for sustainable development of construction industry concentrating on labour management strategies is necessary in addition to sustainable building technologies and construction materials. Razak et al (2014) also concluded that to survive in the global market and stay competitive labor should keep their productivity high. According to Razak et al (2014) the effects of good productivity is not only affects a company performance as a whole, it also influences standard of living of society through increasing per capita income.

According to WBG (2015) In Addis Ababa, productivity performance is different among firms. Foreign owned, publicly owned, and older firms appear more efficient than domestic, private and young firms. According to the reports of WBG (2015) labor productivity in Addis Ababa compared well with firms in peer countries with same level of development like Kenya, Bangladesh, Egypt Nigeria, but in Addis Ababa there is higher capital intensity of labor rather than more efficient production. According to their report a more literate and trainable labor force would not only increase productivity in Ethiopia, but also make the country more attractive to international firms seeking to invest in Africa. There is also a report by (EEA, 2006/7) on labor productivity in Ethiopian construction industry that shows labor productivity is low in Ethiopia due to less wages and salaries.

Increasing 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. Achieving better productivity in building construction projects requires detailed studies on identifying factors affecting productivity. Therefore this study focus on identifying factors affecting labor productivity because of labor has significant effects on the productivity of construction projects and various labors have different variables affecting their productivity levels. Better labor productivity in construction can be achieved by identifying factors affecting labor productivity and working out on the critical factors.

1.2.Statement of the problem

Construction industry makes significant contributions to the socio-economic development process of a country. Its importance emanates largely from the direct and indirect impact it has on all economic activities. It contributes to the national output and stimulates the growth of other sectors through a complex system of linkages. Construction industry has also important contributions to the Ethiopian economy, as demonstrated by its share in the gross domestic product (GDP). For instance, according to (EEA, 2006/7) report the share of the construction sector in the total GDP averaged at about 5.2 percent in the period 2002/03-2006/07. Over this period, there has been increased investment on the development and expansion of various infrastructure projects like roads, airports and residential and non-residential housing units.

Previous researches shown that, from various project-costs components such as labors, materials and equipment's, labor components are considered the most risk. Calvert et.al (1995) as cited in the study of Chan (2002) reported that the productivity of construction industry depends on different factors and labor productivity is one of the most important factor that need to be carefully considered in successfully completing construction projects in time and within budget. Construction productivity influenced significantly by the availability of local construction financing, labor, materials, and equipment. These factors should be addressed and managed in a competent and professional manner to benefit from the industry. Dozzi and AbouRizk (1993) also suggested that factors affecting productivity in construction such as material timeliness, labour effectiveness, and management practices need to be examined.

Because labor is more variable and unpredictable than other project-cost components, it is necessary to understand the effects of different factors on labor productivity. Different researchers have identified that Labor productivity can be affected by variety of internal and external factors which determines the productivity of construction industry at large. Therefore identifying factors affecting labor productivity in building construction project helps to work out on the critical one out of the variable factors to improve the labor productivity that will improve the construction productivity at large. Therefore, the objective of this research is to identify and rank factors influencing labor productivity and recommend

ways to improve labor productivity that are applicable to the Ethiopian building construction project specifically in Addis Ababa.

1.3. Research Questions

This research will answer the following questions:

1. What are the factors affecting labor productivity in building construction project in Addis Ababa?
2. Which factors are critically affecting labor productivity in Addis Ababa building construction project?
3. What are the recommendations to improve labor productivity in Addis Ababa building construction project?

1.4. Objectives

1.4.1. General objective

The general objective of this research is to identify and rank factors affecting Labor Productivity in public Building Construction Project in Addis Ababa. Understanding these factors affecting labor productivity is helpful for the construction professionals in order to efficiently and effectively delivers the projects as per the time and cost planned. 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.

1.4.2. Specific objectives

The specific objectives of the study;

1. To identify factors affecting labor productivity in public building construction projects in Addis Ababa.
2. To analysis and rank the factors affecting labor productivity of public building construction projects in Addis Ababa.
3. To make recommendations on how to improve labor productivity in public building construction project in Addis Ababa.

1.5. Significance of the study

Any construction company wants to be more profitable from the works they involved in. Thomas and Yiakoumis (1987) was suggested that increased productivity in the construction industry benefits the two Contracting parties; the Client and the Contractor of the project. According to Thomas and Yiakoumis (1987) for Clients increased productivity lowers costs, shorten 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. Since construction industry involves large number of labors and their productivity affects overall productivity of the construction company.

The main significance of this research study is to provide essential information about factors affecting labor productivity to the project stakeholders especially for contactors who widely involve labors in all their activities to enable the project's successfully completed. The conclusion of this research helps the contacting parties to improve the productivity of the building construction project by giving emphasis on the critical factors identified by this research.

Additionally in order to enhance the construction industry in Ethiopia, improving of labour productivity has a significant role due to the fact that 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 get benefit from improvement of construction labour productivity.

1.6.Delimitation/Scope

The study area for this research was limited to public building construction project in Addis Ababa because of it is the capital city of Ethiopia which involves different public building construction projects actively. There were different types of public construction projects in Addis Ababa however; the research focus is only on building construction projects due to the fact that construction of buildings in Addis Ababa involves many labors with various positions.

All public building construction projects were controlled by Addis Ababa ministry of construction through two streams. The first stream is for projects with high contract amount and controlled under Addis Ababa city ministry of construction and the second division is projects with less contract amount that is controlled and supervised by sub cities construction office. This study was limited to building projects with high contract amount and controlled under Addis Ababa city ministry of construction by taking considering the fact that contactors involved in these projects are grade three and above who have good experience on the study area.

As it is studied by different researches most of construction projects productivity is largely dependent on labor productivity. Low labour productivity is one of the reasons for delay and cost over run for the construction projects. Thus, this research mainly focused on identifying the critical factors which affect labour productivity on building projects. There were only 30 public building construction project which were under construction while the study was conducted. Therefore the research was limited on these building projects as targeted projects of the study.

1.7. Organization of the study

This research was organized into five chapters as **chapter one**: background of the study which describes about previous related studies and general research information. **Chapter two**: is about reviewing literature regarding labor productivity and factors affecting labor productivity on building construction projects. **Chapter three** describes about the methodology used in conducting this research. **Chapter four**: is about analyzing and discussing the collected data using SPSS and MS excel and chapter five is about conclusions and recommendation. It is summarized as follow.

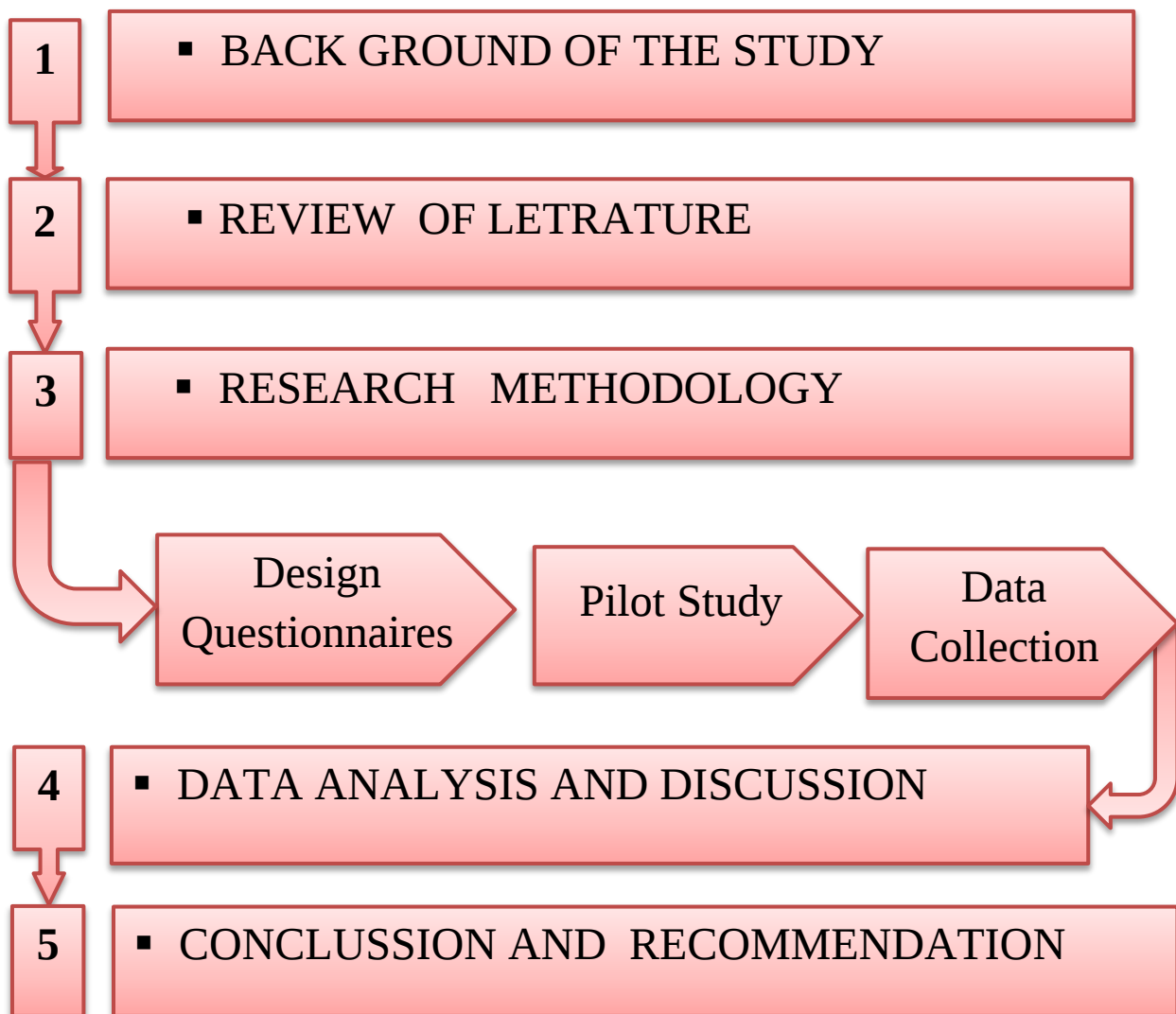


Figure 1 Organization of the Study

2. Review of the Literature

2.1. General Overview of Construction industry

2.1.1. Definition of construction industry

According to MoUDC (2012) Construction industry is a sector of the economy that transforms various resources into constructed physical economic and social infrastructure necessary for socio-economic development. It embraces the process by which the said physical infrastructure are planned, designed, procured, constructed or produced, altered, repaired, maintained, and demolished. MoUDC (2012) Classify construction industry as:

- Buildings such as residential buildings in urban and rural areas, Non-residential buildings, i.e. factory buildings, ware houses, office buildings, garages, hotels, schools, hospitals, clinics, etc.
- Transportation systems and facilities which are airports, harbors, highways, subways, bridges, railroads, transit systems, pipelines and transmission and power lines.
- Structures for fluid containment, control and distribution such as water treatment and distribution, sewage collection and treatment distribution systems, sedimentation lagoons, dams, and irrigation and canal systems. Underground structures, such as tunnels and mines.

In Ethiopia construction industry comprises of organizations and persons who include companies, firms and individuals working as Client, consultants, main contractors and sub-contractors, material and component producers, plant and equipment suppliers. The government is involved in the industry as client, financier, regulator and operator.

According to MoUDC (2012) construction industry in recent year has undergone dynamic changes due to improved technologies, increased competition, customer expectations and demands and scarcer economic resources. Therefore to overcome problems coming from these dynamic changes the industry needs improved, competent and effective managerial skills.

2.1.2. The Role of the Construction Industry in the Ethiopian Economy

The construction industry has important contributions to the Ethiopian economy, as demonstrated by its share in the GDP. Ethiopian construction industry policy also suggests that construction industry of Ethiopia has contributed much in reduction of poverty, in increasing employment expansion through small and medium enterprise development and job creation through the construction of low cost houses in Addis Ababa which was subsequently replicated to other regions.

According to EEA (2006) the industry contributed to the nation development through four main categories.

1. Contribution to national income: according to EEA report the share of the construction sector in the total GDP averaged at about 5.2 percent in the period 2002/03- 2006/07. Over this period, there has been increased investment on the development and expansion of various infrastructure projects like roads, airports and residential and non-residential housing units.

2. Contribution to employment: according to the report the role of the construction industry in terms of creating employment opportunities especially in urban areas is becoming very high.

3. Contribution to government revenue: the construction industry also contributes to the generation of revenue for the government. The rental income tax is one of the major revenue sources within the construction industry to the government.

4. Multiplier effect: The construction industry generates one of the highest multiplier effects through its extensive backward and forward linkages with other sectors of the economy.

2.2. Construction Project Management

PMI (2013) Define projects as a temporary endeavor under taken to create a unique product, service, or result. The temporary nature of projects indicates a definite beginning and end. According to PMI (2013) the end of project is reached when the project's objectives have been achieved or when the project is terminated because its objectives will not or cannot be met, or when the need for the project no longer exists. Project management institute lists some examples of projects as follow:

- Developing a new product or service
- Effecting a change in the structure, staffing, or style of an organization
- Developing or acquiring a new or modified information system
- Constructing a building or infrastructure, or
- Implementing a new business process or procedure.

Project management according to PMI (2013) is defined as the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements through the uses of the process such as: Initiating, Planning, Executing, Monitoring and Controlling and Closing.

According to Dennis (2004) project management is successful when three primary objectives have been met. These three primary objectives according to him are: delivery or completion on or before the date agreed with the customer, completion within the budgeted cost and a project that meets the set standards of quality.

ECOTEMPA (2007) on their annual report define Construction Project management as Managing: Construction Planning, Design Services & Works Phases, Time & Progresses including productivities; Cost & Cash Flows; Quality & Specifications; and Stakeholders and Organizational Behaviors With Organization Resources By Planning; Organizing and Coordinating, Implementing; Monitoring, Controlling and Evaluating (1) Processes, (2) Resources & (3) Stakeholders Within Quality, Time, Cost and Environmental Constraints.

2.3. Productivity and productivity management in construction process

2.3.1. Concept of productivity

The concept of Productivity is complex. In different research works and books it has been stated that it could be interpreted in varied contexts depending on the objectives sought. The objectives in turn determine the parameters involved in its assessment in relation to the benchmark used for its comparison. (Durdyev and Mbachu, 2011)

Because of its central importance to competitiveness and world prosperity, the topic of productivity has been a matter of interest since the beginning of industrialization. (Pekuri et al, 2011). According to their suggestion Productivity is one of the most important and influential basic variables governing economic production activities. While high productivity can be a significant source of competitive advantage for companies, it also contributes to the general well-being of a society. Wen and Albert (2012) states that due to the size of the construction industry, productivity trends in this industry have notable effects on national productivity and on the economy as a whole. They suggested that increased pressure of global competition has forced companies and authorities to put even greater emphasis on productivity improvements. Widespread discussions have resulted in multiple interpretations of the concept of productivity; despite the fact that the term is commonly used by both academics and practitioners, it is often confused or used interchangeably with similar terms such as profitability and performance.

Pekuri et al. (2011) states the difference between productivity, profitability and performance as follows: **profitability** takes into account monetary effects. 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. **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. 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).

2.4. Definition of Productivity

Concise oxford dictionary (2001) defines productivity as” the state or quality of producing something, the effectiveness of productive effort”. The American association of cost engineers, moreover, defines the productivity as a “relative measure of labour efficiency, either good or bad. Soham (2013) Expressed productivity as “how much is produced per unit input. Similarity Shashank et al. (2014) defined Productivity as the ratio of outputs to inputs.

Sumanth (1984) Defined productivity as the effective utilization of resources (inputs) in producing goods and/or services (output). And also he proposed three different meanings of productivity as partial productivity, total factor productivity and total productivity. According to him **Partial productivity** is the ratio of output to one type of input. For example, labour productivity (the ratio of output to labour input) is a partial productivity measure. Similarly, capital productivity (the ratio of output to capital input). And material productivity (the ratio of output to materials input) is other examples of partial productivity. **Total-factor productivity** is the ratio of net output to the sum of associated labour and capital (factors) inputs. Net output is the total output minus the intermediate goods and services purchased. In this case, the denominator of this ratio is made up of labour and capital inputs factors. **Total productivity** is the ratio of total output to the sum of all inputs factors. Thus, a total productivity measure reflects the joint impacts of all inputs in producing the output.

Gundecha (2012) Was also defined productivity as an average direct labor hours that required installing per units of material.

According to Bernolak (1997) 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. According to him resources means 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.

As we have seen from the above definition there is no unique definition given to productivity. But the definition of productivity used for this study is the ratio of outputs to inputs. 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.**

2.5. Construction productivity

According to Eddy (2008) in construction industry because of tradition and practical reasons construction productivity is usually expressed as the amount of time required to produce a unit of output, where the unit output varies according to the circumstance. Eddy suggests that construction productivity is expressed as for example like quantity of m^3/hr , m^2/hr and so forth. Construction productivity can be viewed with respect to the level of hierarchy of construction projects structure.

Construction productivity and labor productivity are two important words that determine the profit and loss of construction business. Labor productivity is a sub domain of the overall construction productivity at the same time construction productivity is highly dependent on labor productivity as construction is a labor intensive industry. In most countries literature showed that the labor cost alone will account for 30-40% of the total cost of the project. Since labor productivity determines the economy of a project, having a control over labor productivity and the related factors will increase the overall productivity. In construction industry numerous activities are involved which relies only on human resource, so an effective use and proper management of labor for each activity is very important. (Prakash et al, 2015).

Similarly the conclusion given by Shashank et al. (2014) and Hendrickson (2000) define Productivity in construction as output per labor hour and they supports that labor productivity plays a great role on construction productivity and he his conclusion was to consider construction productivity as a measure of technical or engineering efficiency of labor. According to their finding 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.

According to Dozzi and AbouRizk (1993) Construction is a unique industry where field experience plays an important role in maintaining high levels of productivity. The qualities of the field-management team will eventually determine the levels of productivity achieved on a given project. An experienced person can tell about the level of activity on a project in a variety of ways. For example, a unique and inexpensive technique for measuring productivity is observing the sound level on a project.

According to Allison L. Huang et al. (2005) and Eddy (2008) the nature of the construction process needs measures of construction productivity at three major levels: such as company level, project level and task level as described below.

1. **Company level productivity:** this is at top of the construction hierarchy which can be defined as an organization whose primary emphasis is to build a facility or some system in the facility in order to satisfy customer's expectation by providing quality at a reasonable cost while complying with industry and government standards regarding safety and environmental issues. At company level main focus is on strategic business decisions such as market selection, definition of products and services, definition of growth and profitability targets, selection of personnel, and establishment of a succession plan among others. The intent of measuring construction productivity at company level is to determine the overall performance of contracting organization.
2. **Project level:** at the project level the main focus is on scope definition, identification of project requirements and construction activities development of contractual arrangements and planning and control of cost, time and resources. The intent of measuring labor productivity at project level is to determine the level of performance of contracting organization by project. 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 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.

3. **Task level:** a task level is an elemental work assignment. The main focus at the task level is on basic knowledge and skills of crew members. Tasks in construction refer to specific construction activities such as concrete placement or structural steel erection. 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.

2.6. Measurement of construction productivity

Productivity measurement is the quantification of both the output and input resources of a production system. The goal of productivity measurement is productivity improvement, which involves a combination of increased effectiveness and a better use of available resources. while productivity can be given the sort of shorthand definition as the ratio between output and input, what productivity really is as well as how it can be measured has always provoked a great deal of controversy among experts. In essence, it can be said that the measurement of productivity is only simple conceptually. In practice, however, both measurement of outputs and inputs involves aggregation problem, and this problem alone has situated productivity measurement in the sphere of complexity.

Productivity measurement models can be classified in many ways. According to Dozzi and AbouRizk (1993) the two most important measures of labour productivity are: The effectiveness with which labour is used in the construction process and the relative efficiency of labour doing what it is required to do at a given time and place. In the first case, technological innovations or design improvements have the most significant impact because it is the effectiveness with which labour is used in the building process that is being measured. Contractors and organized labour are, however, more interested in the second measure, the relative efficiency of labour. Labour efficiency is the basis of most tender estimates, as well as the benchmark by which performance is measured and monitored.

Jarkas and Bitar (2012) and Sink et al. (2007) cited in Anu (2014) suggests two measures of productivity are most commonly used in the construction industry. The first measure of productivity is the Single/partial factor productivity and the second measure of productivity is Total factor productivity.

Jarkas and Bitar (2012) and Sink et al. (2007) have explained Single/partial factor productivity and Total factor productivity as follows:

1. **Single/partial factor productivity**, often referred to as single factor productivity, where outputs and single or selected inputs are considered. According to their suggestion the most commonly used single factor measure of productivity is the labor productivity, the ratio of output to either employment or labor hours.

$$\text{Single factor productivity} = \frac{\text{output}}{\text{single input}} \dots\dots\dots \{1\}$$

2. **Total factor productivity**, where outputs and all inputs are considered total factor measures do not seem to be widely used in construction. Total Productivity measures are designed to address this shortcoming of labor productivity measures. An increase in total factor productivity implies more output can be produced for a given level of inputs. Total factor productivity 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. The analyses can be done on both inputs and outputs in more flexible forms.

$$\text{Total factor productivity} = \frac{\text{Total output}}{\text{total input}} = \frac{\text{Total output}}{\text{material} + \text{labor} + \text{machinery}} \dots\dots \{2\}$$

2.7.Review of Labor productivity on construction projects

Hendrickson (2000) suggests that labor constitutes a large part of the construction cost and the quantity of labor hours in performing a task in construction is more vulnerable to the influence of management than are materials or capital, according to Hendrickson (2000) construction productivity measure is often referred as labor productivity. Hendrickson (2000) Also states 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.

Construction labour productivity has been extensively studied by researchers to identify opportunities for productivity improvement. Construction labour productivity is usually defined as the gross product output per person employed or man-hour worked. (Mbor, 1996).

Hourly outputs are widely used to measure labor productivity in construction research. Thomas and Yiakoumis (1987) and Sonmez and Rowings (1998) defined labor productivity as using a labor hour as the input unit and the physical quantity of the completed work as output. For example, concrete placement uses a labor hour as input and the cubic meter of concrete placed as output. Therefore according to them labor productivity for concrete placement can be expressed as hours per cubic meter or cubic meters per hour.

Construction Labor productivity is measured in actual work hours per installed quantity; specifically, this pertains to the number of actual work hours required to perform the appropriate units of work. When defined in this manner, lower productivity values indicate better productivity performance. (Eastman and Sacks, 2008). Compared with cost-based output measures measurement by hourly output helps to avoid many external factors that cause cost variance. Thus, hourly output is commonly recognized as a more reliable measurement of productivity for construction operational activities.

Horner & Talhouni (1998) cited in Nirajan (2015) suggests that labor productivity is measured in three different approaches. The first approach deals with total time, also called total paid time (input). The second approach deals with available time, estimated as total time minus unavoidable delays, meal breaks, and weather. The third approach deals with the productive time, which is obtained by subtracting avoidable delays from available time.

$$\text{labor productivity} = \frac{\text{out put}}{\text{total time}} \dots\dots\dots\{3\}$$

$$\text{labor productivity} = \frac{\text{out put}}{\text{available time}} \dots\dots\dots\{4\}$$

$$\text{labor productivity} = \frac{\text{out put}}{\text{productivity time}} \dots\dots\dots\{5\}$$

2.8. Review of Factors affecting labor productivity on construction productivity

There have been so many studies conducted previously to determine the factors affecting labor productivity in construction projects in the developed and developing countries. Past studies and research show the number of factors affecting productivity, there are still anonymous factors need to be further studied even in developed countries. (Makulsawatudom and Emsley, 2002). 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. Different factors affecting labor productivity reviewed from past studies are summerized and Discussed as below:-

Mistry (2013) in his study on Critical factors affecting labour productivity in construction projects: case study of south Gujarat region of India identified about 27 factors and categorized them into four main groups as:

1. Technological group: Clarity of technical specification, The extent of variation/change order, During execution, Coordination level among design disciplines, Design complexity level, Rework, Site lay out, Inspection delay/stringent by the engineer and Site restricted access
2. Human/labor group: Motivation of labour, Skill of labour, Physical fatigue, A shortage of experienced labour
3. Management group: Construction managers lack of leadership, Lack of labour supervision, Working overtime, Crew size and composition, Unsuitability of storage location, Accidents as a result of poor site safety programme, Proportion of work subcontracted, Unrealistic scheduling and expectation of labour performance, Shortage of materials, Construction method and Payment delay
4. External group:-High/low temperature, High humidity, High wind and Rain

According to the finding of Mistry (2013) from all 27 factors identified based on RII value of each factors the top five critical factors affecting labor productivity were: - delay in payments, Skill of Labour, Clarity of Technical Specification, Shortage of Materials, and Motivation of Labour in descending order.

Gundecha (2012) in his study of factors affecting labor productivity at a building construction project in USA was identified about 40 factors affecting labor productivity and categorized them into five groups as follow:

1. Manpower factors:-Lack of experience, Absenteeism, Alcoholism, Misunderstanding among laborers, Age, Lack of competition among the laborers, Disloyalty, Personal problems.
2. External factors: Supervision delays, Variations in the drawings, Incomplete drawings, Rework, Design changes, Inspection delays from the authorities, Payment delays, Complex designs in the provided drawings, Implementation of government laws.
3. Communication factors: Change orders from the designers, Change orders from the owners, Misunderstanding among owner, Contractors, and the designer, Disputes with the, Disputes with the owner.
4. Resources factors:- Lack of required construction material, Lack of required construction tools/equipment, Insufficient lighting, Poor site condition, Differing site condition from plan, Material storage location, Poor access within construction site, Violation of safety laws, Quality of required work, Inadequate transportation facilities for workers, Inadequate construction material, Increase in the price of material.
5. Miscellaneous factors: - Shortage of water and/or power supply, Accidents during construction, Weather conditions, working overtime, and Project objective not well defined.

According to Gundecha (2012) finding using RII method the most top ten critical factors were: Lack of required construction material, Shortage of power and/or water supply, Accidents during construction, Lack of required construction tools/equipment, Poor site condition, Insufficient lighting, Weather condition, Differing site conditions from plan, Material storage location, Working overtime.

Sherif, et al (2014) on their study on Critical factors affecting construction labor productivity in Egypt have perceived overall 27 factors in to four major categories as follows:

1. Technological group: Clarity of technical specification, Inspection delay/stringent by the engineer, Rework, Coordination level among design disciplines, Design complexity level, the extent of variation/change order during execution, Site layout, Site restricted access
2. Human group: Skill of labor, a shortage of experienced labor, Motivation of labor, Physical fatigue
3. Management group: Payment delay, Lack of labor supervision, working overtime, Construction managers lack of leadership, Proportion of work subcontracted, Construction method, Crew size and composition, Unsuitability of storage location, Shortage of materials, Accidents as a result of poor site safety program, "Unrealistic scheduling and expectation of labor performance
4. External group: High humidity, High/low temperature, High wind, Rain

Sherif, et al (2014) concluded that from these identified factors the top ten critical factors affecting construction labor productivity were:-Payment delay, Skill of labor, A shortage of experienced labor, Lack of labor supervision, Motivation of labor, Working overtime, Construction managers lack of leadership, High humidity, Clarity of technical specification, High/low temperature in descending order.

Shashank et al (2014) on his study of Analysis of Key Factors Affecting the Variation of Labour Productivity in Construction Projects in Bangalore, India identified 36 factors and categorized them in to eight groups according to their characteristics as follows:

1. Manpower group: Lack of labour skills, Increase of laborer age, Labour absenteeism, Lack of training, Labour personal problem.
2. Managerial group: Poor site management, Poor communication, Misunderstanding between labour and supervisor, Lack of periodic meeting with labors.
3. Environmental group: Weather changes, Project location, working with confined place, large project size.

4. Safety group: Payment delay, Non provision of transport means, Lack of financial motivation system, Lack of places for eating and relaxation
5. Material/Equipment group: Material shortage, Unsuitable material storage location, Old and inefficient equipment, Tools and equipment shortages
6. Schedule group: Working 7 days per week without taking holiday, Poor work planning, Overcrowding, Misuse of time schedule
7. Motivation group: Ignore safety precautions, Accident, No safety engineer in site, Insufficient lighting, Working at high places
8. Quality group: Low quality raw materials, High quality of required works, Rework, Quality inspection delay.

The conclusion of Shashank et al (2014) was based on the group ranking and his analysis suggests six main groups have significant impact on the labour productivity in the construction projects. These are Manpower group, Managerial group, Motivation group, Material/Equipment group, Safety group and Quality group in descending order.

Wagaye (2014) conducted a study on Building Construction Productivity of Labour Improvement Model Designing for Defense Construction Enterprise in Ethiopia and Identified about 30 factors affecting labor productivity and categorized them in to two major groups as internal factors and external factors as follow:-

1. Internal constraints:

- 1.1.Characteristics of the project: Site conditions: access, subsoil; topography, Project complexity, Build ability issues,
- 1.2.Work force related constrains: Level of skill and experience of work force, Level of labour involvement, Rework problem due to construction error, Relationship among labors for coordination, Workforce absenteeism, Level of staffs turnover, Health of the workforce, Level of familiarity, with current job and conditions, Level of work force moral
- 1.3.Technology related constraints: Use of machineries and equipment on construction project, Employed machinery and equipments condition, Inadequate IT infrastructure and application in enterprise.

1.4. Management related constraints: Level of management commitment, Material shortage at project site/delay, Project budget shortage/delay, Project leadership style, Work stop due to late payment of labour force, Incentive mechanism employed, Adequacy of planning and risk management process, Proper coordination and execution follow up and control, Management relationship, Excess/insufficient manpower, Project team competency problem, Underestimating project cost.

2. External constraints:

2.1. Unforeseen constraints: Stop work order because of site accident, Inflation/Fluctuations in labour, materials, etc., Poor weather condition:- high rain; high wind, heat, humidity, cold.

2.2. Consultant's related constraints: Lack of consultant's site staffs experience causing unreasonable insistence on compliance to specification without due regard for practicality or site condition, Incomplete Design/delay, Slow response of consultant's site staffs attending to inspection work, Consultant's slow payment Certificate verification.

2.3. Other external constraints: Local legal issues, Contractual problem, Right of way.

According to Wagaye (2014) finding the most critical factors affecting building projects labor productivity were Levels of skills and experience of workforce, Levels of staff turnover, Rework problems, Levels of management commitment for change, Project budget shortage or delay, Poor incentive mechanism, Employed machinery and equipments poor condition, Right-of-way problem and Poor weather condition in descending order.

Benviolent (2014) Have identified about 38 factors Affecting Labor Productivity on Building Projects in Zimbabwe and drawn them it in to seven group categories as follows:-

1. Materials related factors: such as unavailability of materials, late delivery of materials.
2. Manpower related factors: lack of man-power skills, labour inexperience, Absenteeism, Working for long periods without holiday, Inappropriate use of skills
3. Motivation related factors: late payment of salaries and wages, low remuneration, Lack of incentive schemes, Availability of site facilities, Worker retention schemes, Lack of

worker respect or recognition, Health and safety provisions, Health and safety provisions.

4. Plant and equipment related factors: suitability/adequacy of plant and equipment, plant break-down, shortage of tools and equipment, Inefficiency of equipment.
5. Management related factors: supervisory incompetence, Instruction delays, Inspection delays, Lack of coordination, Poor communication, Poor management practice, Poor relations between management and workers, increasing laborers in order to accelerate works, Compliance to statutory regulations.
6. Technical related factors: Alterations of design during project execution, Poor site layout and organization, Incomplete drawings, Poor site conditions, project complexity, Construction methods, Crew size inefficiency, Alterations of schedule, Reworks
7. Other factors: Inclement weather, On-site accidents

Benviolent (2014) concluded that unavailability of materials, late payment of salaries and wages, suitability/adequacy of plant and equipment, supervisory incompetence, and lack of manpower skills, are the top five most important factors affecting on labor productivity.

Ghanim (2016) on his study of Significant Factors Affecting Labor Productivity at Construction Sites in Jordan identified about 37 factors negatively affecting labor productivity in construction and classify them into five groups as:

1. Labor group: Lack of skilled labor, Lack of labor in the market, Work overtime, Tool shortage, Labor absenteeism, labor personal problem, poor safety and health management, incentives, bad labor relation.
2. Technical group: Poor planning and scheduling, poor site management, Rework due to construction error, Lack of supervisor's experience, slow response of consultant's, variation/change order, design complexity, communication problems between parties, late issues of drawing and clarity of technical specification.
3. Project group: Disruption of power/ water supplies, Project location far from suppliers, Poor weather conditions, Poor site drilling ability, site congestion, poor site conditions, project size.
4. Financial group: Payment delay to the suppliers, Lack of financial motivation, financial conditions of contractors, low wages, payment delay by client.

5. Material and equipment group: Material shortage on project site, Equipment shortage, Old and inefficient equipment, low qualities of materials, poor material storage location, construction methods.

According to Ghanim (2016) finding Poor planning and scheduling, material shortage at project site, equipment and tools shortage, lack of skilled labor, poor site management, rework due to construction errors, old and inefficient equipment, lack of supervisor's experience, payment delay to suppliers and slow response of consulting staff inspecting the work were the most critical factors affecting labor productivity.

Attar et al (2014), identified factors affecting construction labour and grouped them into 15 categories according to their characteristics, namely:- Design factors, Execution plan factors , Material factors, Equipment factors, Labour factors, Health and safety factors, Supervision factors, Working time factors, Project factors, Quality factors, Financial factors, Leadership and coordination factors, Organization factors, Owner/consultant factors and External factors. The groups of factors which have high impact on labor productivity according to (Attar et al, 2014) finding were supervision factors, material factors , execution plan factors, design factors , equipment factors, owner/consultant factors, health and safety factors in descending order.

Kuykendall (2007) Based on his study of key factors affecting labor productivity in the construction industry in Florida identified factors affecting labor productivity such as Tool Management, Equipment Management, Access Planning, Management Skills, Safety, Quality Control, Scheduling, Employee Training/ Skills, Employee Age, Temperature/ Humidity, Employee Motivation and Degree of Bilateral Communication. According to Kuykendall (2007) finding the most critical factors were Management Skills, Scheduling, Safety, Employee Motivation, and Equipment Management in descending order.

According to Horner and Talhouni (1995) the most factors affecting labor productivity are fatigue, increased absenteeism, decreased morale, reduced supervision effectiveness, poor workmanship, resulting in higher rework and increased accidents.

2.9.New factors affecting labor productivity of public building construction projects identified by this study

In Ethiopia most of public projects were constructed by both main contractors and subcontractors. As a result this study identified subcontractor related factors affecting labor productivity in Addis Ababa public building construction projects. Based on the experience of the researcher and discussion with professionals in the field the three subcontractors related factors, one management related factor, one manpower related factor and one external factor were identified and discussed as follows:

1. Coordination problems of main contractor and sub-contractors: in several building projects there are activities carried out by subcontractors and some by main contractors. Since the completion of these activities are interdependent if there is no proper coordination among them one waits the other for completion by stop working which have direct negative impact on productivity.
2. Communication problems between sub-contractors: when there is more than one subcontractor on a single project there are communication problems. For example subcontractor working HCB wall and subcontractors for electrical works if there is no proper communication between them there are a number of reworks which result on poor productivity.
3. Relationship between workers of subcontractor and workers of main contractor: most of the time there is complexity among workers of subcontractor and main contractor which lead them have bad relationship on works.
4. Reassignment of Manpower from one task to another: this happens when a worker is forced to be assigned from one task to other for example when labors working carpentry work is assigned to concrete work.
5. Labor operating system (daily wage or lump sum): labors in construction industry are employed either on daily base payment system or on lump sum basis. Lump sum is when labors are given works to be executed in lump sum ways whereas daily basis is most common practice which involves paying labor per day of work irrespective of what they produce.
6. Cultural and social related problems: this is bad work habit inherited from culture and from the society such as not working on holidays, underestimating works and workers.

2.10. Identification of Possible Factors Affecting labor Productivity in Building Construction

Based upon the Literature Review, this study extracts various factors affecting labor productivity in building construction projects from the above researches. In this research some similar factors from the above researchers were merged together, and some new factors were added. Therefore this study puts about 52 factors under eight main category including management related factors, resource related factors, technical related factors and external factors based on their characteristics and summarized in table-1 as follow with their sources. Factors do not take into consideration any values. They are arranged randomly under each category and 'x' is used to indicate the factor is not included by researcher where as '✓' is used to indicate the factors were included by researcher on their study.

Table 1 Summary of possible factors affecting labor productivity of building construction projects extracted from previous research and identified for this study.

No	Factors affecting labor productivity of building construction projects	Mistry (2013)	Gundecha (2012)	Sherif, et al (2014)	Shashank et al.(2014)	Benviolent (2014)	Ghanim (2016)	Wagaye (2014)
a. Management related factors								
1.	Lack of clear and daily task assignments to workers/unclear instruction	x	x	x	x	✓	x	x
2.	Lack of leadership skill of construction managers	✓	x	✓	x	✓	x	✓
3.	Lack of supervision of labor during work	✓	x	✓	x	✓	✓	✓
4.	Lack of periodic meeting with labor	x	x	✓	✓	x	x	x
5.	Lack of Coordination between crews	x	✓	✓	x	✓	✓	✓
6.	Crew size inconsistency by adding or deleting crew members.	✓	x	✓	x	x	x	x
7.	Delay in inspection and supervision by engineer	✓	✓	✓	x	✓	✓	✓
8.	Reassignment of Manpower from one task to another	x	x	x	x	x	x	x

9.	Over employment of labor to accelerate works	✗	✗	✗	✓	✓	✗	✓
10.	Poor safety program which causes accident during construction	✓	✓	✓	✓	✓	✓	✓
11.	Poor planning and scheduling of manpower	✓	✗	✓	✓	✓	✓	✓
b. Plant and equipment related								
12.	Inefficiency of equipments	✗	✓	✗	✓	✓	✓	✓
13.	Lack of maintenance of equipments	✗	✗	✗	✓	✓	✗	✗
14.	Shortage of tools and equipments	✗	✓	✓	✓	✓	✓	✗
15.	Suitability and adequacy of equipments	✗	✗	✗	✓	✓	✓	✗
16.	Improper Usage of equipments	✗	✗	✗	✗	✗	✗	✗
c. Material related								
17.	Insufficient or poor material handling	✗	✗	✓	✗	✗	✓	✓
18.	Lack of adequate space for storage of materials	✗	✓	✓	✗	✗	✓	✗
19.	Late delivery of materials	✗	✗	✗	✓	✓	✓	✗
20.	Poor quality of materials	✗	✗	✗	✓	✗	✓	✓
21.	Shortage of materials	✓	✓	✓	✓	✓	✓	✗
d. Manpower related								
22.	Absenteeism of labor	✗	✓	✗	✓	✓	✓	✓
23.	Lack of Moral and attitude of labor toward works	✗	✓	✓	✗	✗	✓	✓
24.	Different addiction of labor such as alcoholism, chewing khat	✗	✓	✗	✗	✓	✗	✗
25.	Fatigue and working overtime	✓	✓	✓	✗	✓	✓	✓
26.	Labor turnover	✓	✓	✗	✗	✗	✓	✓
27.	Improper use of skills of labors	✗	✗	✓	✗	✓	✗	✓
28.	Lack of skills of labors	✓	✗	✓	✓	✓	✓	✓
29.	Shortage of experienced labors	✓	✓	✓	✗	✓	✓	✓
30.	Labor operating system (daily wage or lump sum)	✗	✗	✗	✗	✗	✗	✗
31.	Coordination problem among labor	✗	✓	✓	✓	✓	✓	✓

e. Motivational related								
32.	Lack of incentives to labor	✗	✗	✓	✓	✓	✓	✓
33.	Lack of respect for labor from managers	✗	✗	✗	✗	✓	✓	✗
34.	Lack of training for labor	✗	✗	✗	✓	✓	✗	✗
35.	Late payment of salaries and wages to labor	✗	✗	✓	✓	✓	✓	✓
36.	Low salaries and wages of labor	✗	✗	✓	✓	✓	✓	✗
37.	unavailability of site facility	✗	✓	✗	✓	✓	✗	✓
38.	Lack of Labors retention scheme/plan	✗	✗	✗	✗	✓	✓	✗
f. Technical related factors								
39.	Clarity of specification	✓	✓	✓	✗	✓	✓	✓
40.	Construction Methods	✓	✗	✓	✗	✓	✓	✗
41.	Drawing clarity	✓	✓	✓	✗	✓	✓	✓
42.	Project complexity/unfamiliarity of projects	✓	✓	✓	✓	✗	✓	✓
43.	Rework as result of poor work performance	✓	✓	✓	✓	✓	✓	✗
44.	Site organization problem	✗	✓	✓	✓	✗	✓	✗
g. Subcontracting related								
45.	Coordination problems of main contractor and sub-contractors	✗	✗	✗	✗	✗	✗	✗
46.	Communication problems between sub-contractors	✗	✗	✗	✗	✗	✗	✗
47.	Insufficient supervision of subcontractors	✗	✓	✗	✗	✓	✓	✗
48.	Relationship between workers of subcontractor and workers of main contractor	✗	✗	✗	✗	✗	✗	✗
49.	Lack of experience of subcontractors	✓	✗	✓	✗	✓	✗	✗
h. External factors								
50.	Poor weather conditions	✓	✓	✓	✓	✓	✓	✓
51.	Local legal issues	✗	✓	✗	✗	✓	✓	✓
52.	Cultural and social related problems	✗	✗	✗	✗	✗	✗	✗

3. Methods and Procedures

3.1. General

The methodology used for carrying out this research work was focused on the review of literature and discussion with friends and professionals in the sector. Based on the literature review the study identified the possible factors affecting labor productivity that was used for this study. After those factors were identified a questionnaire was designed following contextual and conceptual review of literature, and was distributed to professionals involved in public building construction projects in AA. There were professionals from contractor and consultant that were actively participating in building construction projects in AA. Analysis was done based on the questionnaires collected from the respondents of the study. And finally, conclusions were made and recommendations were forwarded according to the findings of the analysis and discussions.

3.2. Sampling

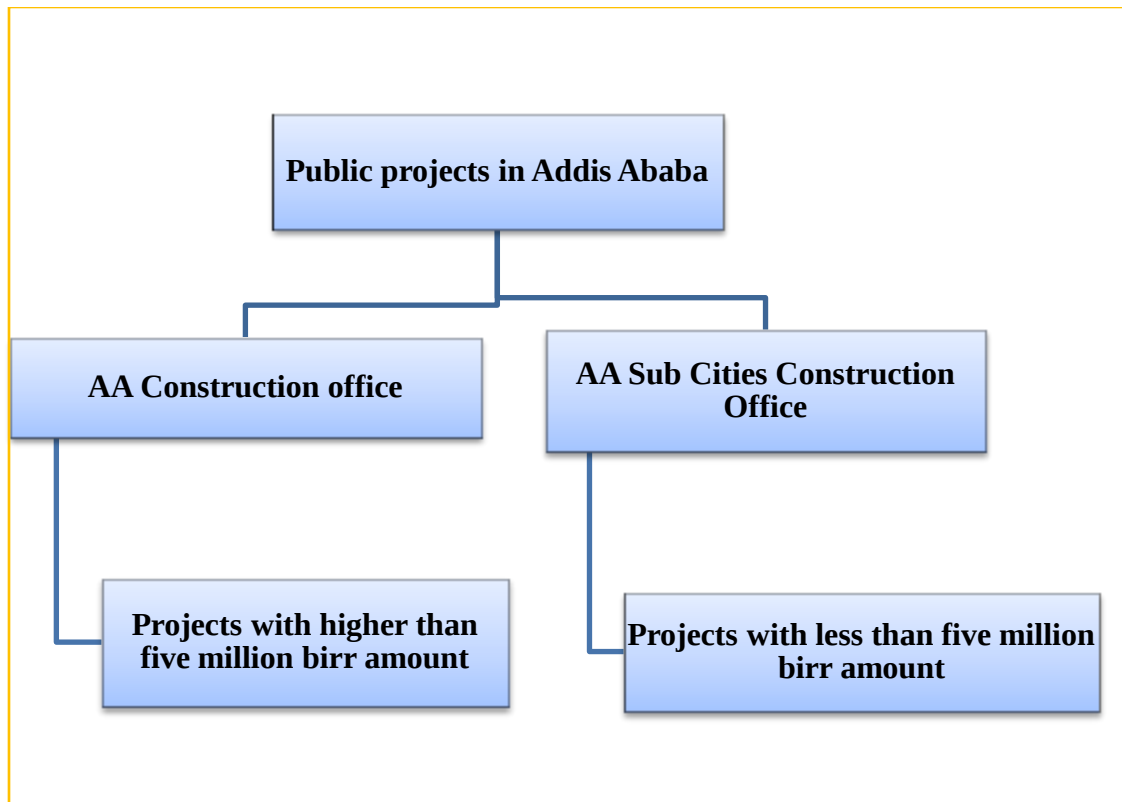


Figure 2 public projects execution category in AA (source AA city construction office)

As we have seen from the above figure some projects whose contract amount is relatively less than five million ETB is forwarded to sub cities construction office for its execution. For projects with greater contract amount and which needs contractors of grade three and above is executed under the control of Addis Ababa city construction office. To get all the information need for the research this study was considered all building construction projects under the control of Addis Ababa city construction office and which are under construction. Among several construction projects there were only 30 building projects which are under construction in different ten sub cities of AA and controlled by AA city construction office were used as sample of this research.

3.3.Data collection

The sources of data for this study was the review of available literature on the topic of factors affecting labor productivity, Design questionnaires and distribute to the randomly selected samples for this study. For this study, data was collected using both primary and secondary sources. The primary data was obtained through questionnaire directed to contractors and consultants that are involved in Addis Ababa public building construction 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 three sections i.e. general information about respondent, section two is about rating the factors affecting labor productivity based on their experience and section three is about listing the most important factors affecting labor productivity based on their experience .

3.4.Data analysis

A descriptive statistical method was used for the analysis of the data which provided a general overview of the results in order that some kind of interpretations and discussions. Moreover, reviewed literature was used as one of the main backbone for the analysis of the findings. For summarizing of the collected data and to determine the number of responses belonging to each category, frequency tables and charts was used with the help of SPSS and Microsoft excel soft wares.

For primary data analyzing Relative Importance Index (RII) analysis was used. For all factors the important index was calculated and the index vales were ranked. And also the group index was calculated by taking the average RII values in each group. Then Spearman's rank correlation coefficient was used to measure and compare the association between the rankings of two parties for a single factor. For this study Spearman rank correlation was calculated using SPSS software for both contractor and consultant. The respondents of this research were only contractor and consultant and therefore correlation is required for both only.

4. ANALYSIS AND DISCUSSION

4.1. Data collection

In successfully completing this research the major part was collecting the accurate data from the stakeholders/professionals of public building construction projects. It was so difficult to collect the data from these stakeholders because of the public building construction project in Addis Ababa were very scattered under each of ten sub cities. All public construction projects in Addis Ababa are under the controlled of Addis Ababa city ministry of construction. Among these public construction projects there were only 30 under construction building projects were selected.

For this study seventy questionnaires were distributed to professionals involved in 30 public building constructions projects in Addis Ababa. Among seventy distributed questionnaires fifty questionnaires were collected and six of them are incomplete because of missing answers for some parts of the questions. Therefore only forty four questionnaires were obtained as accurate data used for this study.

Table 2 summery of collected data

Number of distributed questionnaires	70
Total number of collected questionnaires	50
Incomplete responses	6
Accurate data collected for the study	44

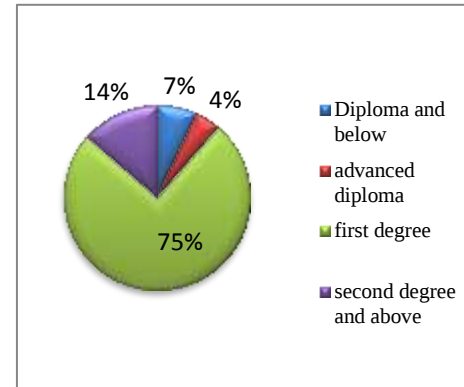
4.2. Respondent profiles

4.2.1. Educational background

Table 3 Educational background

Level	No Of Respondents	Percentage (%)
Diploma And Below	3	7
Advanced Diploma	2	5
First Degree	33	75
Second Degree And Above	6	14

Figure 3 Educational background



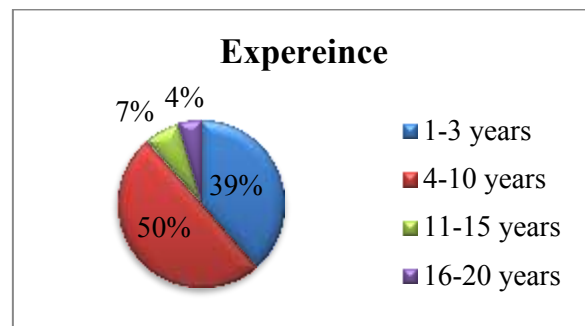
As it has been described on the above table most of the respondents to this study were first degree holders which are about 75%, about 14% were the holder of Second Degree and above and about 12% were advanced diploma and below. This indicates that the major respondents educational back ground were first degree and above.

4.2.2. Experience of the respondents

Table 4 Experience of the respondents

Year of Experience	No of Respondents	Percentage (%)
1-3 Years	17	39
4-10 Years	22	50
11-15 Years	3	7
16-20 Years	2	4

Figure 4 Experience of the respondents



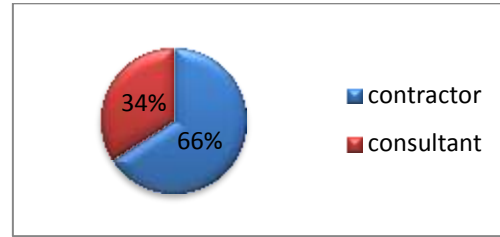
The work experiences of the respondents have a great role in getting accurate data for the research. Most of the respondents to this study have 4-10 year of experiences which is about 50% of total respondents. There were also about 39% professionals who have 1-3 years of experience especially from the consultant side as it has been observed from the lists of the respondents.

4.2.3. Types of Organization

Table 5 Organization

No	Types of Organization	No of Respondents	Percentage (%)
1	Contractor	29	66
2	Consultant	15	34

Figure 5 Organization



The Addis Ababa city ministry of construction was acting as a consultant for major parts of the public building construction projects and some the projects were under the private consultant. Most of the contractors who were allowed to participate on these public building projects have a license of grade 3 and above. Therefore the questionnaires were collected from the professionals of these two parties. About 66% of the respondents were from contractor side where as 34% were from consultants.

4.2.4. Position of respondents

Table 6 positions of respondents

No	Position	Number of Respondents	Percentage (%)
1	Project Manager	6	14
2	Office Engineer	10	23
3	Site Engineer	12	27
4	Contract Administrator	1	2
5	Resident Engineer	13	30
6	Surveyor	1	2
7	Forman	1	2
8	Other	0	0

As we have seen above most of the respondents' position were site and office engineer from contractors and resident engineer from consultants. Both professionals have a direct relation with labor they can easily figure out the factors affecting labor productivity. There were also about 14% project managers who have many years of experience. Less number of respondents was contract administrator, survey and Forman.

4.2.5. Project Contract Amount

Table 7 projects amount

No	Amount Ranges in ETB	Number of Respondents	Percentage (%)
1	1-50 Million	14	32
2	51-150 Million	13	31
5	150 million and Above	10	37

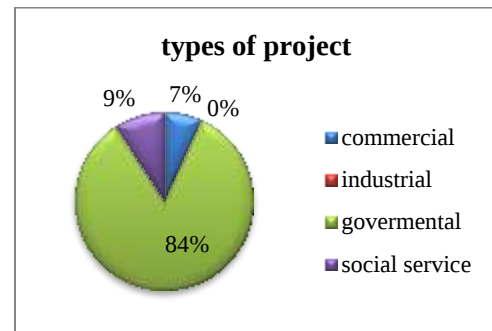
The execution of public projects in Addis Ababa city are categorized in to two as the execution of the projects by construction office of each sub city and the execution of the projects under the control of Addis Ababa city the ministry of construction. These projects with an amount of less than ten million are controlled by construction office of each sub city. Whereas the projects with greater than ten million ETB falls under the control of Addis Ababa city the ministry of construction. Therefore about 37% of the public building construction projects in Addis Ababa have a contract amount of 150 million and above. About 62% were between 1-150 million ETB.

4.2.6. Types of Project

Table 8 types of projects

Types Of Project	Number Of Respondents	Percentage (%)
Commercial	3	7
Industrial	0	0
Governmental	37	84
Social Service	4	9

Figure 6 types of project



The major types of projects which account for 84% of total projects used for this research were governmental buildings that will serve for office purpose. The other about 9% were social service projects like sport and entertainment centers and about 7% of the projects were commercial buildings.

4.3. Measurements of data

The degrees of impacts of factors affecting labor productivity of building construction project vary from project to project. In order to overcome with these different degrees of impact, it was decided to consider five levels of impacts: very high impact, high impact, medium impact, low impact and very low impact. In order to select the suitable technique of study, the level of measurement is to be studied. In this research, five ordinal scales were used. An ordinal scale, as shown in Table below is a ranking or a rating of data that normally uses integers in descending order. The numbers assigned were (5, 4, 3, 2, and 1).

Table 9 Ordinal Scale Used For Data Measurement

Level of impact	Very high impact	High impact	Medium impact	Low impact	Very low impact
Measurement	5	4	3	2	1

4.4. Reliability analysis

Cronbach's alpha is generally used as a measure of the reliability of a set of questions in a survey. This is because it combines the split-half method and item-total correlation and thus calculates the mean value of the reliability which can be obtained by the split-half method for all the data of the concept. According to (Linjesh et.al, 2015) the value of Cronbach's alpha for acceptable reliability is 0.7. For this study all 52 variables with the rates given by 44 respondents were feed into SPSS software then reliability analysis was carried out using Cronbach's alpha model.

Table 10 Case Processing Summary and Reliability Statistics

		No of response	%	Cronbach's Alpha	No of Items
Cases	Valid	44	100.0	0.966	52
	Excluded	0	0		
	Total	44	100.0		

Cronbach's alpha was calculated using SPSS software and cronbach's alpha value obtained is 0.966 which is greater than minimum required value of 0.7. This values shows that all the factors are reliable and no need to exclude any of them.

4.5. Correlation

Correlation is a measure of linear relationship between two variables. It expresses the extent to which two variables vary together. The respondent of this research was contractor and consultant as a result it is required to know the correlation factor between the two parties on each of 52 factors. As shown on the following table both contractor and consultant have positive correlation on each factors which is equal to 0.477 as calculated by SPSS 2000 using the RII values of each factors under both parties.

Table 11 correlation factors for contractors and consultant

Correlations				
			contractor	consultant
Spearman's rho	contractor	Correlation Coefficient	1.000	0.477
		N	52	52
	consultant	Correlation Coefficient	0.477	1.000
		N	52	52

4.6. Factors affecting labor productivity of building construction projects

There were about 52 identified as factors affecting labor productivity of building construction project from literature review by considering the weights the get from previous studies. These 52 factors were categorized under eight major groups as management related factors, tools and equipment related factors, material related factors, manpower related factors, motivation related factors, technical related factors, subcontracting related factors and external factors. The respondents were requested to rate for each of 52 factors under each category based on their experience on construction projects.

The results of the respondents then analyzed using Relative Importance Index (RII) for all factors together and on group factors. After calculating RII for each top ten factors were identified and ranked and followed by discussion as follow. In addition to ranking all factors individually, based on the mean RII values of each group ranking and discussion was conducted.

RII was calculated using the following equation. (Dennis, 2004), (Gundecha, 2012), (Ghanim, 2016) and etc

$$RII = \frac{W}{5N} \dots \dots \dots \{7\}$$

Where, RII= relative importance index

$$\text{Weight (W)} = 5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1$$

$$n_5 + n_4 + n_3 + n_2 + n_1 = \text{number of respondents under each level}$$

$$N = \text{Total number of respondents}$$

4.6.1. Management related factors

Table 12 Rank of Management Related Factors

<i>Management related factors</i>	Weight	RII	RANK
Poor planning and scheduling	180	0.818	1
Lack of clear and daily task assignments to workers	179	0.814	2
Lack of Coordination between crews	177	0.805	3
Lack of supervision of labors during work	172	0.782	4
Delay in inspection and supervision by engineer	171	0.777	5
Lack of leadership skill of construction managers	170	0.773	6
Poor safety and health program	159	0.723	7
Crew size inconsistency by adding or deleting crew members.	158	0.718	8
Reassignment of Manpower from one task to another	155	0.705	9
Lack of periodic meeting with labors	141	0.641	10
Over employment to accelerate works	132	0.600	11

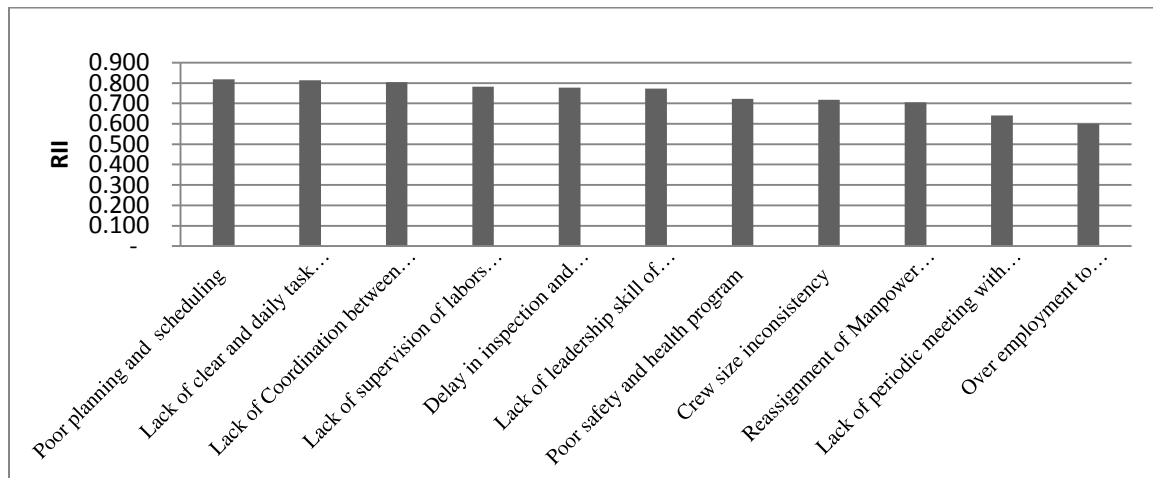


Figure 7 Rank of Management Related Factors

Table 10 & figure 1 above shows the rank of management related factors based on their RII values. There are about 11 factors categorized under management related factors. Among eleven management related factors poor planning and scheduling was ranked first and it was ranked 4th among all factors with RII value of 0.818. Poor planning and scheduling was ranked first in Ghanim (2016) study. This shows that Poor planning and scheduling have high impact on labor productivity of building construction project. The productivity of the workers can be increased if there would be a proper plan and schedule for the works to be accomplished ahead of time. Lack of clear and daily task assignments was ranked second on

management group and ranked 7th among all factors with RII value of 0.814. To increase labor productivity assigning them with clear task daily plays a great role because if labors don't know what to do at what time then their productivity will be less. Lack of coordination between crews ranked 3rd on management group and ranked 9th among all factors with RII value of 0.805. The remaining factors were ranked below 10 among all factors affecting labor productivity according to the respondents.

4.6.2. Tools and equipment related factors

Table 13 Rank and RII values of Tools and Equipment Related Factors

No	<i>Tools and Equipment related factors</i>	Weight	RII	rank
12	Inefficiency of equipments	180	0.818	1
14	Shortage of tools and equipments	178	0.809	2
15	Suitability and adequacy of equipments	173	0.786	3
13	Lack of maintenance of equipments	172	0.782	4
16	Improper Usage of equipments	171	0.777	5

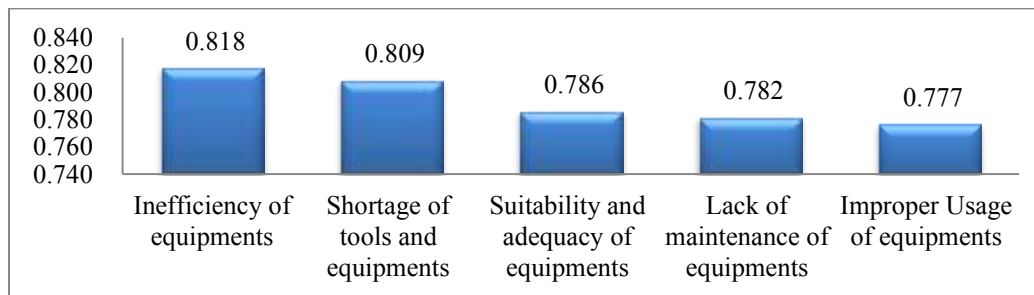


Figure 8 Rank and RII values of Tools and Equipment Related Factors

There were about five factors under tools and equipment related groups. Among five of them inefficiency of equipment and shortage of tools and equipment were ranked 1st and 2nd and among all factors they were ranked 5th and 8th respectively according to the respondents. This shows that Inefficiency of equipment and shortage of tools and equipment have high impact on labor productivity of building construction projects.

4.6.3. Material related factors

Table 14 Material related factors

No	Material related factors	Weight	RII	rank
19	Late delivery of materials	180	0.818	1
21	Shortage of materials	172	0.782	2
17	Insufficient or poor material handling	166	0.755	3
18	Lack of adequate space for storage of materials	157	0.714	4
20	Poor quality of materials	153	0.695	5

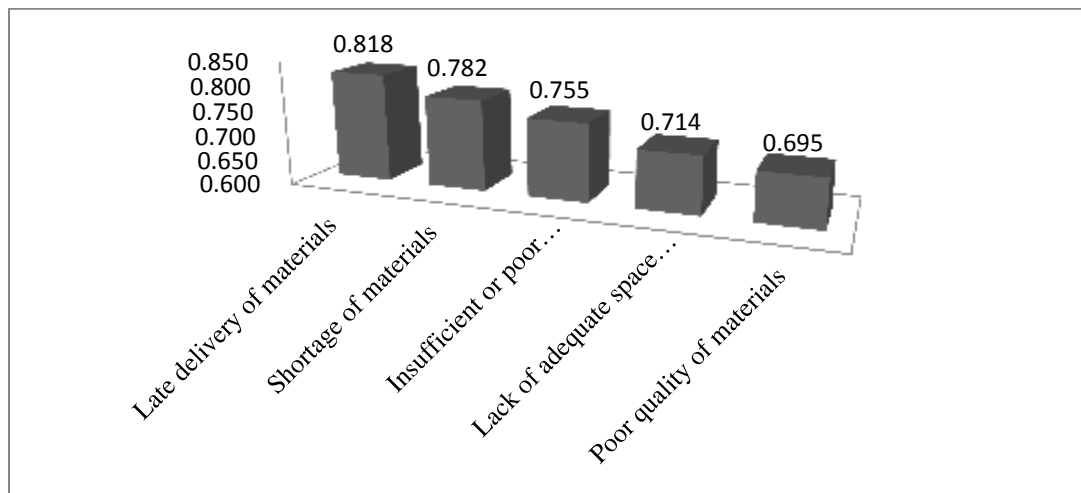


Figure 9 Material related factors

Among five factors under material related group late delivery of materials to the site was ranked first with RII value of 0.818. From all 52 factors it was ranked 6th place but the RII value of 4th, 5th and 6th factors were equal which are poor planning and scheduling from management group, Inefficiency of equipments from tools and equipment group and late delivery of materials from material related factors group respectively. Therefore late deliveries of construction material to site have high impact on labor productivity since without the availability of material it is impossible for labors to work which directly reduces their productivity. Shortage of materials was ranked 2nd from material related group and ranked 17th among all factors. Insufficient or poor material handling, Lack of adequate space for storage of materials and Poor quality of materials ranked 3rd, 4th and 5th and from all factors it were ranked 26th, 39th and 44th respectively.

4.6.4. Motivation related factors

Table 15 motivation related factors

No	Motivational related factors	Weight	RII	rank
36	Low salaries and wages of labor	184	0.836	1
35	Late payment of salaries and wages to labor	182	0.827	2
34	Lack of training for labor	173	0.786	3
32	Lack of incentives to labor	159	0.723	4
33	Lack of respect or recognition for labor from managers	159	0.723	5
37	unavailability of site facilities such as places for eating and relaxation , transport means and etc	154	0.700	6
38	Lack of Labors retention scheme/plan	141	0.641	7

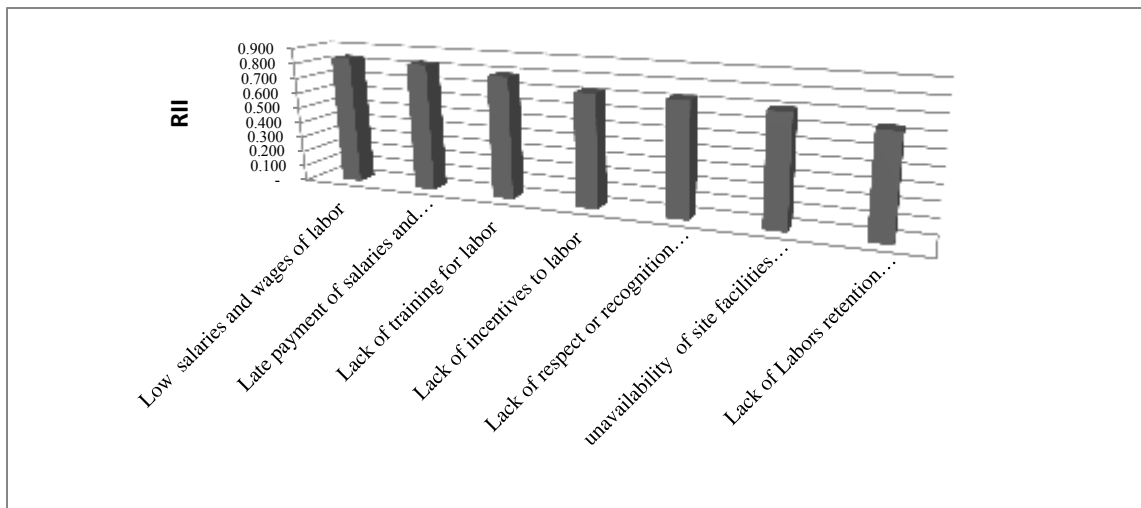


Figure 10 motivation related factors

Among seven factors of motivation related groups low salaries and wages and late payment of salaries and wages to labors were ranked 1st and 2nd with RII value of 0.836 and 0.827 respectively. Low salaries and wages and late payment of salaries and wages to labors was also ranked 1st and 3rd respectively from all 52 factors affecting labor productivity on building construction projects. According to this study Low salaries and wages and late payment of salaries and wages to labors are among the critical factors that need to be improved to increase the productivity of labors involved in building construction projects. Lack of training for labor for labors was ranked 3rd among motivation related groups and ranked 14th from all factors which shows that it has high impact on labor productivity.

As shown in the above table Lack of incentives to labor, Lack of respect or recognition for labor from managers and unavailability of site facilities such as places for eating and relaxation, transport means and etc have RII values of 0.73, 0.73 and 0.7 respectively. This shows that relative to the other factors these factors have medium impacts on labor productivity. According to the response Lack of Labors retention scheme/plan has RII value of 0.641 which shows that Lack of Labors retention scheme/plan was among the factors which have very low impact on labor productivity.

4.6.5. Manpower related factors

Table 16 Manpower related factors

No	<i>Manpower related factors</i>	Weight	RII	rank
28	Lack of skills of labors	175	0.795	1
29	Shortage of experienced labors	174	0.791	2
27	Improper use of skills of labors	168	0.764	3
31	Coordination problem among labor	161	0.732	4
30	Labor operating system (daily wage or lump sum)	159	0.723	5
26	Labor turnover	158	0.718	6
22	Absenteeism of labor	156	0.709	7
23	Lack of Moral and attitude of labor toward works	155	0.705	8
25	Fatigue and working overtime	148	0.673	9
24	Different addiction of labor	142	0.645	10

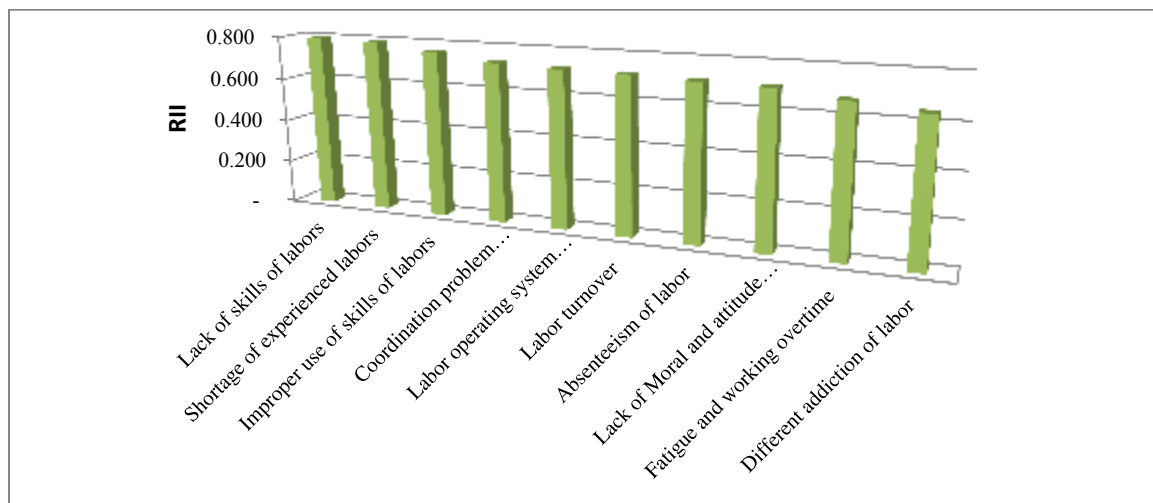


Figure 11 Manpower related factors

As show above there are about ten factors under manpower related factor groups. Among these ten factors lack of skill of labors was ranked 1st and ranked 10th among all 52 factors with RII value of 0.795. Shortage of experienced labors was also ranked 2nd among manpower related factors and ranked 12th from all 52 factors with RII value of 0.791. Skills and experience of labors have high impact on their productivity since any construction activity requires specific skills and experience to be accomplished with high productivity. Improper use of skills of labors was ranked 3rd under this category and ranked 20th from all factors with RII value of 0.764. The other factors under manpower group fall below 20th rank from all 52 factors used for this study.

4.6.6. Technical related factors

Table 17 Technical related factors

No	Technical related factors	Weight	RII	rank
40	Construction Methods	184	0.836	1
43	Rework as result of poor work performance	175	0.795	2
42	Project complexity/unfamiliarity	172	0.782	3
44	Site organization problem	168	0.764	4
39	Clarity of specification	165	0.750	5
41	Drawing clarity	164	0.745	6

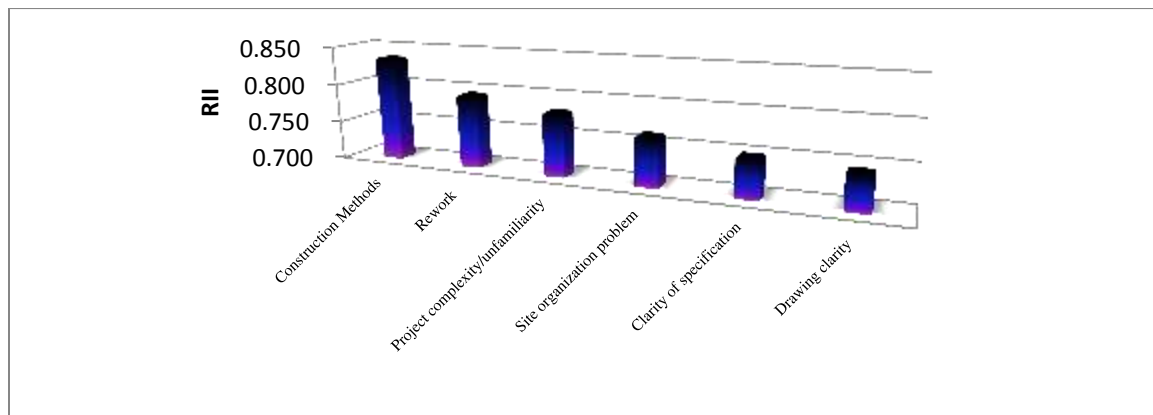


Figure 12 Technical related factors

Under technical related group there were six factors provided for the respondents. According to the respondents among these six factors Construction Methods was ranked 1st and it is ranked 2nd among all 52 factors used for this study with RII value of 0.836 which is equal to

the RII value of 1st ranked factors (Low salaries and wages of labor). This leads to the conclusion of construction methods are among the critical factors affecting labor productivity on building construction projects. Rework as result of poor work performance also ranked 2nd among technical related group and ranked 11th among all 52 factors and it is also among the critical factors.

Project complexity/unfamiliarity was ranked 3rd among technical group with RII value of 0.782 and ranked 18th among all factors. Site organization problem, Clarity of specification and Drawing clarity have RII values of 0.764, 0.750 and 0.745 respectively which shows that they have medium impacts on labor productivity.

4.6.7. Sub contracting related factors

Table 18 Sub contracting related factors

No	<i>Subcontracting related factors</i>	W	RII	rank
49	Lack of experience of subcontractors	169	0.768	1
45	Coordination problems of main and sub-contractors	164	0.745	2
46	Communication problems between sub-contractors	161	0.732	3
47	Insufficient supervision of subcontractors	160	0.727	4
48	Relationship between workers of sub and main contractor	159	0.723	5

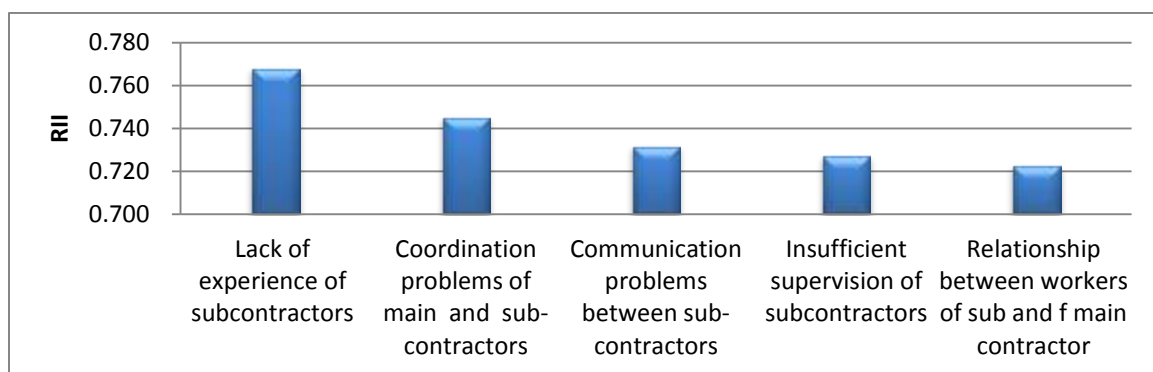


Figure 13 Sub contracting related factors

Among five subcontracting factors Lack of experience of subcontractors was ranked 1st and ranked 22nd among all 52 factors with RII value of 0.768. Coordination problems of main and

sub-contractors, Communication problems between sub-contractors, insufficient supervision of subcontractors and Relationship between workers of sub and main contractor were ranked 2nd, 3rd, 4th, and 5th with RII values of 0.745, 0.732, 0.727 and 0.723 respectively. This indicates that subcontracting related factors has medium impacts on labor productivity.

4.6.8. External factors

Table 19 External factors

No	<i>External factors</i>	Weight	RII	rank
50	Poor weather conditions	152	0.691	1
51	Local legal issues	140	0.636	2
52	Cultural and social related problems	124	0.564	3

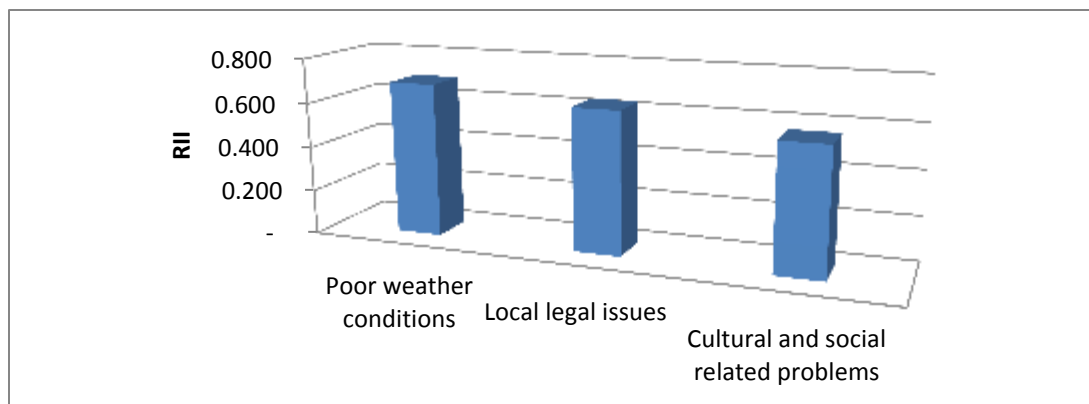


Figure 14 External factors

According to the response of this study external factor has less impact on building construction projects labor productivity. Poor weather conditions, local legal issues and Cultural and social related problems were the factors under external category with rank of 1st, 2nd and 3rd and RII values of 0.691, 0.636 and 0.564 respectively. This shows the fact that the impacts of these external factors on labor productivity are very less.

4.7. Group ranking based on mean values of RII

Table 20 Group ranking based on mean values of RII

no	<i>Group factors</i>	mean RII	rank
a	Tools and Equipment related factors	0.795	1
b	Technical related factors	0.779	2
c	Material related factors	0.753	3
d	Motivation related factors	0.748	4
e	Management related factors	0.741	5
f	Sub-contracting related factors	0.739	6
g	Manpower related factors	0.725	7
h	External factors	0.630	8

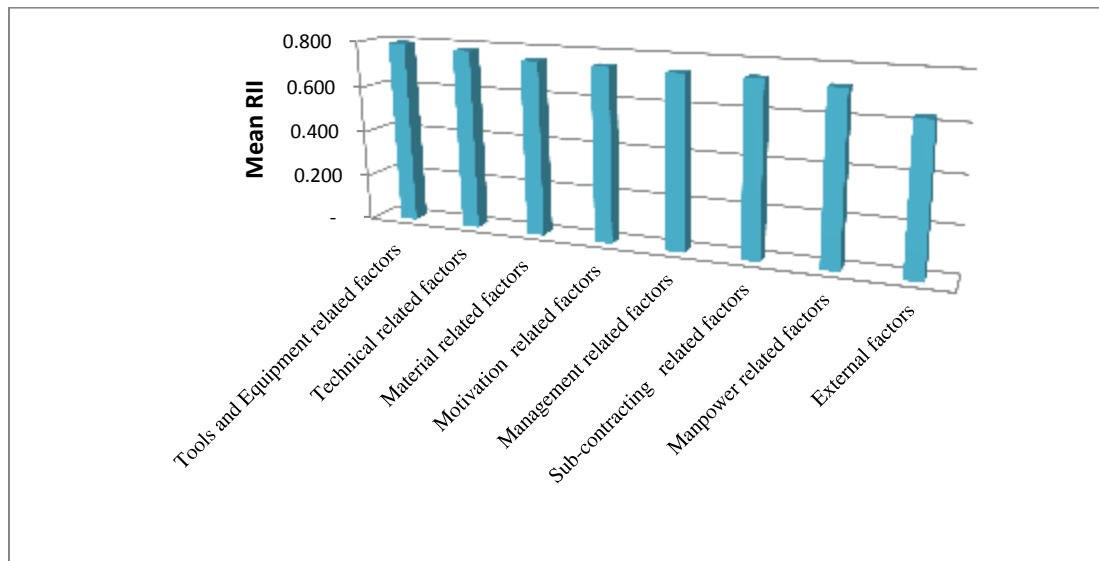


Figure 15 Group ranking based on mean values of RII

All 52 factors used for this study were grouped under eight categories. Among these 8 groups Tools and Equipment related factors was ranked 1st by mean RII value of 0.795. According to Kuykendall (2007) Tools and Equipment related factors was also ranked 1st. This implies that proper management of Tools and Equipments on building construction projects have high effect on productivity of labors. This reveals that the study was reliable as it is known

building construction projects involve large number of activities that require Tools and Equipment as an input for labor to have productivity properly.

The 2nd ranked group factor was Technical related factors with mean RII value of 0.779. Ghanim (2016) In his study of Study of Significant Factors Affecting Labor Productivity at Construction Sites in Jordan Technical related factors were ranked 1st group factors affecting labor productivity. Among the technical related factors construction method and rework as a result of poor performance of labor have a critical effects on labor productivity that let Technical related factors to be ranked 2nd from the group.

Material related factors and motivation related factors were ranked 3rd and 4th among the groups with Mean RII values of 0.753 and 0.748 respectively. From material related factors late delivery of material and shortage of material were the critical factors that lead material related factors to be ranked 3rd. Factors such as low salaries and wage and late payment were categorized under motivation related factors which have critical impact on labor productivity.

Management related factors was ranked 5th among the groups with RII value of 0.741. Among management related factors poor planning and scheduling, Lack of clear and daily task assignments to workers and Lack of Coordination between crews were critical factors that negatively affects labor productivity.

Subcontracting related and manpower related factors were ranked 6th and 7th with RII values of 0.739 and 0.725 respectively. According to this study External factors were ranked last because the impact of factors under this group is very less on productivity of labors on building construction projects.

4.8. Overall factors affecting labor productivity of Public building construction projects in Addis Ababa

There were 52 total factors used for this study based on the literature review and observation from the experience of the researcher. These 52 factors were grouped under eight category based on their similarities of their application. Based on the respondents rating frequency the relative importance indexes were calculated for each factors and the following rank were obtained. Among all 52 factors the study considers top ten of them as a critical factors affecting labor productivity of public building construction projects.

Table 21 Rank of over all factors affecting labor productivity

No	Overall Factors Affecting Labor Productivity	Weight	RII	Rank
36	Low salaries and wages of labor	184	0.836	1st
40	Construction Methods	184	0.836	2nd
35	Late payment of salaries and wages to labor	182	0.827	3rd
11	Poor planning and scheduling	180	0.818	4th
12	Inefficiency of equipments	180	0.818	5th
19	Late delivery of materials	180	0.818	6th
1	Lack of clear and daily task assignments to workers	179	0.814	7th
14	Shortage of tools and equipments	178	0.809	8th
5	Lack of Coordination between crews	177	0.805	9th
28	Lack of skills of labors	175	0.795	10th
43	Rework as result of poor work performance	175	0.795	11th
29	Shortage of experienced labors	174	0.791	12th
15	Suitability and adequacy of equipments	173	0.786	13th
34	Lack of training for labor	173	0.786	14th
3	Lack of supervision of labors during work	172	0.782	15th
13	Lack of maintenance of equipments	172	0.782	16th
21	Shortage of materials	172	0.782	17th
42	Project complexity/unfamiliarity of projects to workers	172	0.782	18th
7	Delay in inspection and supervision by engineer	171	0.777	19th
16	Improper Usage of equipments	171	0.777	20th
2	Lack of leadership skill of construction managers	170	0.773	21st
49	Lack of experience of subcontractors	169	0.768	22nd
27	Improper use of skills of labors	168	0.764	23rd
44	Site organization problem	168	0.764	24th

17	Insufficient or poor material handling	166	0.755	25th
39	Clarity of specification	165	0.750	26th
41	Drawing clarity	164	0.745	27th
45	Coordination problems of main contractor and sub-contractors	164	0.745	28th
31	Coordination problem among labor	161	0.732	29th
46	Communication problems between sub-contractors	161	0.732	30th
47	Insufficient supervision of subcontractors	160	0.727	31st
10	Poor safety and health program	159	0.723	32nd
30	Labor operating system (daily wage or lump sum)	159	0.723	33rd
32	Lack of incentives to labor	159	0.723	34th
33	Lack of respect or recognition for labor from managers	159	0.723	35th
48	Relationship between workers	159	0.723	36th
6	Crew size inconsistency by adding or deleting crew members.	158	0.718	37th
26	Labor turnover	158	0.718	38th
18	Lack of adequate space for storage of materials	157	0.714	39th
22	Absenteeism of labor	156	0.709	40th
8	Reassignment of Manpower from one task to another	155	0.705	41st
23	Lack of Moral and attitude of labor toward works	155	0.705	42nd
37	unavailability of site facilities	154	0.700	43rd
20	Poor quality of materials	153	0.695	44th
50	Poor weather conditions	152	0.691	45th
25	Fatigue and working overtime	148	0.673	46th
24	Different addiction of labor such as alcoholism, chewing khat	142	0.645	47th
4	Lack of periodic meeting with labors	141	0.641	48th
38	Lack of Labors retention scheme/plan	141	0.641	49th
51	Local legal issues	140	0.636	50th
9	Over employment to accelerate works	132	0.600	51st
52	Cultural and social related problems	124	0.564	52nd

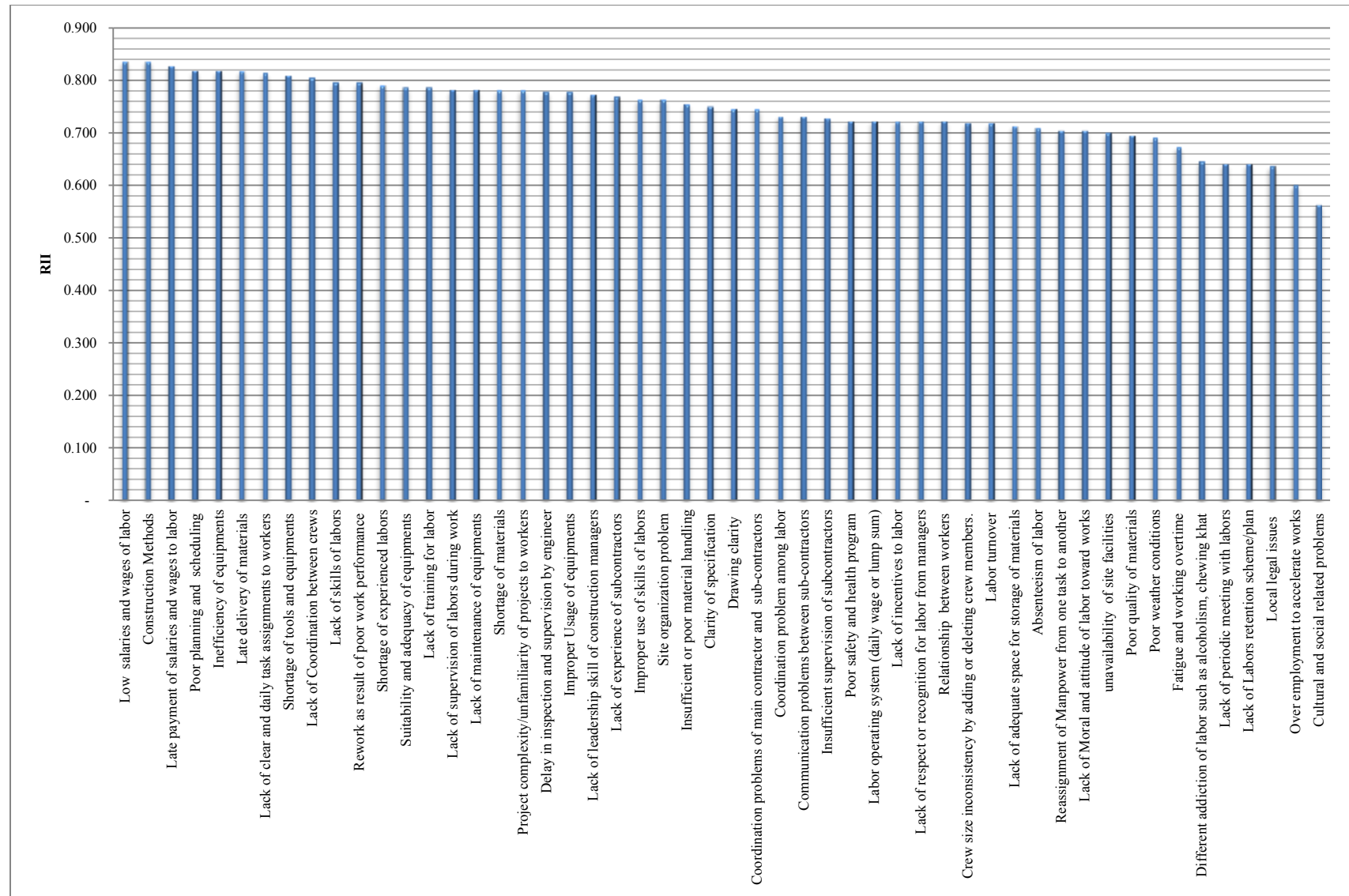


Figure 16 Rank of overall factors affecting labor productivity used for this study

4.9. Top ten critical factors affecting labor productivity of public building construction project

According to this research among all 52 factors the Top ten critical factors was used as most important factors that need to be improved and analyzed as follow and recommendation was given on these factors.

Table 22 Top ten critical factors affecting labor productivity

No	Top Ten critical factors affecting labor productivity	Group	Weight	RII	Rank
36	Low salaries and wages of labor	Motivational	184	0.836	1 st
40	Construction Methods	Technical	184	0.836	
35	Late payment of salaries and wages to labor	Motivational	182	0.827	2 nd
11	Poor planning and scheduling	Management	180	0.818	3 rd
12	Inefficiency of equipments	Tools& equip	180	0.818	
19	Late delivery of materials	Material	180	0.818	
1	Lack of clear and daily task assignments to workers	Management	179	0.814	4 th
14	Shortage of tools and equipments	Tools& equip	178	0.809	5 th
5	Lack of Coordination between crews	Management	177	0.805	6 th
28	Lack of skills of labors	Manpower	175	0.795	7 th
43	Rework as result of poor work performance	Technical	175	0.795	
29	Shortage of experienced labors	Manpower	174	0.791	8 th
15	Suitability and adequacy of equipments	Tools& equip	173	0.786	9 th
34	Lack of training for labor	Motivational	173	0.786	
3	Lack of supervision of labors during work	Management	172	0.782	10 th
13	Lack of maintenance of equipments	Tools& equip	172	0.782	
21	Shortage of materials	Material	172	0.782	
42	Project complexity/unfamiliarity of projects to workers	Technical	172	0.782	

Based on their relative importance index value calculated from the rate given by the respondents of the study among all factors top ten of them were considered as critical factors affecting productivity of labors on public building construction projects in Addis Ababa. As we have seen from the above table some factors have equal RII value which shows they have the same level of impact on labor productivity. Low salaries and wages of labor and construction method were ranked 1st and 2nd respectively but both have the same RII values which equals to 0.836.

Therefore this research considers both factors as 1st ranked factors from all factors listed under top ten factors. Late payment of salaries and wages to labor ranked 3rd with RII value of 0.827 which indicates that it is the second most important factor negatively affecting labor productivity. Poor planning and scheduling, Inefficiency of equipments and late delivery of materials were among the most critical factors affecting labor productivity ranked 4th, 5th, and 6th respectively with equal RII values of 0.818 in the list of all factors. Since they have the same RII values this study considered three of them as 3rd ranked factors.

Lacks of clear and daily task assignments to workers, Shortage of tools and equipments and Lack of Coordination between crews were also among top ten critical factors as shown in the above table with RII values of 0.814, 0.809 and 0.805 and rank of 4th, 5th and 6th respectively.

Lack of skills of labors and Rework as result of poor work performance have the same RII values which equals to 0.795 and were ranked 7th among top ten factors. Shortage of experienced labors is also among top ten critical factors with RII value of 0.791 and ranked 8th. Suitability and adequacy of equipments and Lack of training for labor were ranked 9th with RII values of 0.786. Lack of supervision of labors during work, Lack of maintenance of equipments, Shortage of materials and Project complexity/unfamiliarity of projects to workers are also among top ten factors ranked 10th with equal RII values which is 0.782.

The top most important factors that negatively affect labor productivity on building construction projects are summarized on the figure below.

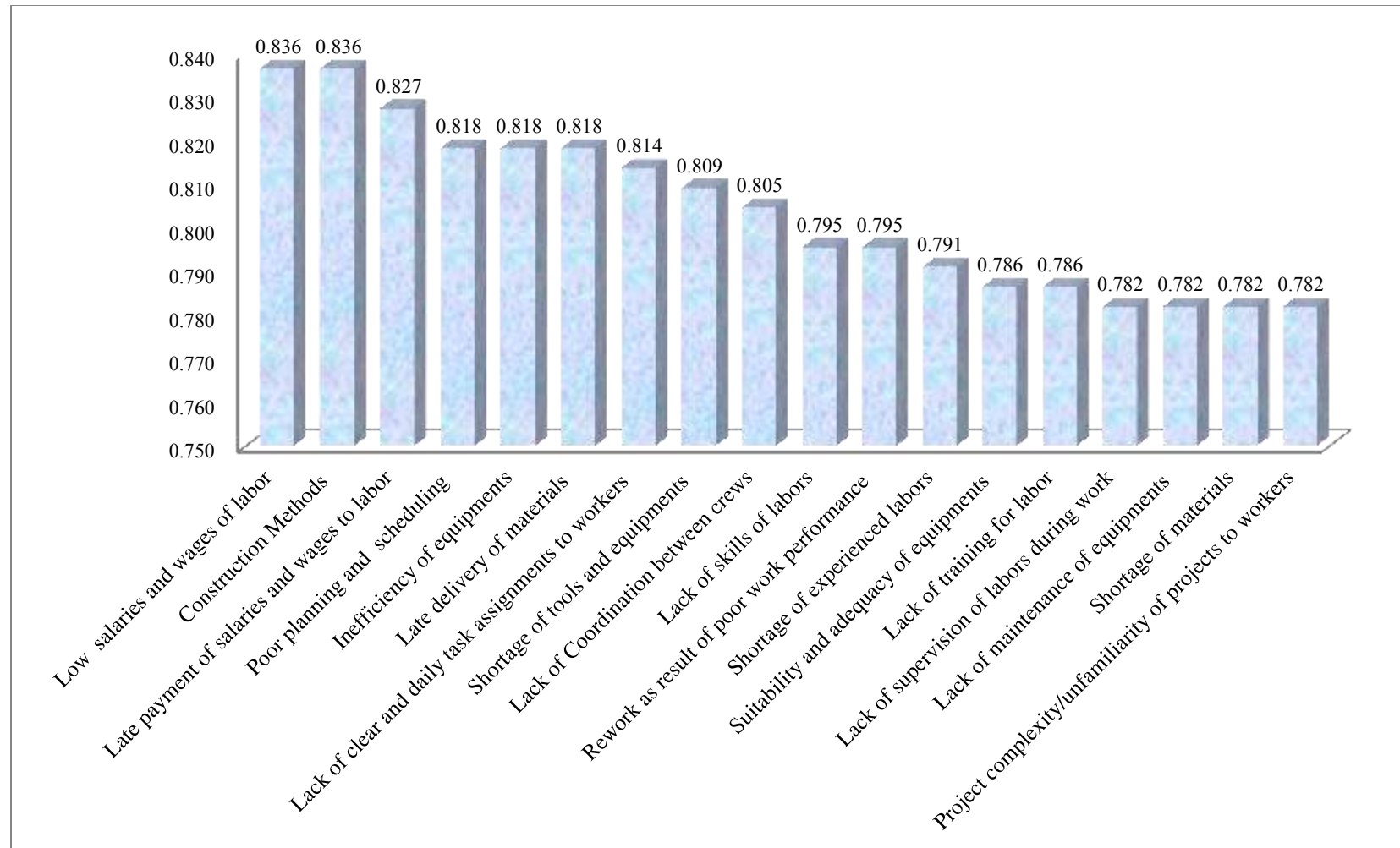


Figure 17 Top Ten Critical Factors Affecting Labor Productivity on Building Construction Projects In Addis Ababa

Based on the above discussion and finding of this study each of the top ten critical factors are explained as follow:-

1. **Construction Methods (RII=0.836):** According to the rates given by respondents of this study Construction methods was ranked 1st with equal RII values of Low salaries and wages of labors. It is known that there are a number of different methods used for execution of each activity on building construction projects which have significant effects of the productivity. Therefore employing the right construction method helps the labor to have high productivity. This result agrees with the result of Mistry et al. (2013) as he ranked Construction methods among top ten critical factors affecting labor productivity.
2. **Low salaries and wages of labors (RII=0.836):** According to this study salary and wages was also ranked 1st among 52 factors affecting labor productivity on building construction projects which shows that it have very high impacts on labor productivity. Other researchers such as Anu (2014) and Benviolent (2014) also ranked low salaries and wages among the most critical factors affecting labor productivity. This reveals the fact that low salaries and wages of labor have very high negative impacts on productivity of labors on construction projects. Most of the labors in Addis Ababa comes from local areas of the county and they life totally depends on the salaries and wages they get. Since Addis Ababa is the capital city of Ethiopia it is difficult for labors to live in the city with low wages and salaries because of accommodation problems and food problems which have direct impact on their productivity.
3. **Late payment of salaries and wages to labor (RII=0.827):** Late payment of salaries and wages is one of the factors under motivational group with was ranked 2nd among all 52 factors affecting labor productivity based on the rate of the respondents to this study. In Addis Ababa most of the contractors pays wages on weekly basis for daily labors and salaries on monthly basis for permanent staffs. Thus if payment is delayed from normal schedule of payment the moral of labors towards work will reduce which by far affects their productivity. This result agrees with the studies of Mistry et al (2013), Benviolent (2014), Sherif (2014) because in their study of factors affecting labor productivity they were ranked Late payment of salaries and wages to labor among top ten critical factors affecting labor productivity.

- 4. Poor planning and scheduling (RII=0.818):** According to the rates of the respondent poor planning and scheduling was ranked 3rd among top ten critical factors affecting labor productivity. There were also similar results by other researchers such as Ghanim (2016) and Anu (2014), which indicates poor planning and scheduling have high negative impact on productivity of labors on construction projects. Planning and scheduling in the construction industry, in recent years, have been well developed due to the availability of many computer software programs such as Microsoft projects and Microsoft excel that have reduced the time and cost of preparing such schedule.
- 5. Inefficiency of equipments (RII=0.818):** This is also ranked 3rd with equal RII of poor planning and scheduling. Inefficiency of equipments is when the productivity of construction equipment is lower than the expected output because of its age. The old equipment usually cause frequent breakdown due to poor maintenance and lack of regular service. In building construction projects there are a number of equipments required to execute different activities and there are activities carried out by labor side by side. Therefore when construction equipments are inefficient then they become obstructions for productivity of labors. This result also supported by the result of Ghanim (2016) on his Study of Significant Factors Affecting Labor Productivity at Construction Sites in Jordan.
- 6. Late delivery of materials (RII=0.818):** Late delivery of material was also ranked 3rd among top ten critical factors. On building construction projects there are frequent late delivery of construction materials to site which causes stopping of work until it delivered to the site. This is justified by the result of other researchers such as (Benviolent, 2014), (Gundecha, 2012), (Attar, 2014).
- 7. Lack of clear and daily task assignments to workers (RII=0.814):** According to the rates of the respondents lack of clear and daily task assignments to workers was ranked 4th with RII value of 0.814. If the daily activities are not clearly known and properly given to labors then they don't know what to do and when to do these activities which highly reduce their productivity on projects. For labors to be productive they have to know what to do clearly. Lack of clear and daily task assignments to workers was also ranked among top ten critical factors affecting labor productivity by other researchers such as (Attar, 2014) .

- 8. Shortage of tools and equipments (RII=0.809):** This also another most important factors affecting labor productivity which was ranked 5th with RII value of 0.809. Equipment shortage refers to unavailability of tools and equipments on construction site. The shortage of these item cause major idle time since employed labor are unable to progress their work as they need a minimum number of equipment to work effectively. This problem causes major idle time since employed workers are unable to progress their work due to material transportation problems and other related problems. If there are no enough tools and equipments on construction site then labors stop working which has direct impact on their productivity. This factor was found to be among most critical factors on other studies such as (Abdul et al, 2005),
- 9. Lack of Coordination between crews (RII=0.805):** Lack of Coordination between crews was ranked 6th and it was among top ten critical factors. There are a number of crews on building construction projects that are working together and if there is lack of coordination among each crew then their productivity reduced because of the productivity of each crew depends on each other. Lack of Coordination between crews was also ranked among the critical factor on the study of other researchers such as (Shashank et al, 2014).
- 10. Lack of skills of labors (RII=0.795):** Lack of skills of labors was ranked 7th and it is also among top ten factors. Many researchers such as Mistry et al. (2013), Ghanim (2016) and Sherif (2014), proved that Lack of skills of labors have very high impact on their productivity. In Addis Ababa labors start work as unskilled workers but over time they becomes skilled or semiskilled labors following only a little on-the-job training and gaining experience by becoming assistant to the skilled labors for a time.
- 11. Rework as result of poor work performance (RII=0.795):** Rework was also ranked 7th with equal rates of Lack of skills of labors. When there is poor performance on each activities of building construction project then there are defects observed on each activities that lead us to rework and reduces the productivity directly. The above shown result is consistent with some earlier findings Ghanim (2016) and Sherif (2014).
- 12. Shortage of experienced labors (RII=0.791):** Shortage of experienced labors was ranked 8th according to this study. Experience plays a great role to become more productive in all aspects of construction project. Since the technology in building

construction projects is dynamic with time it becomes difficult to get experienced labors for some activities especially for new technologies. This resulted is also supported by previous studies of Sherif (2014) and Benviolent (2014)

- 13. Suitability and adequacy of equipments (RII=0.786):** According to this study Suitability and adequacy of equipments was ranked 9th. For labors to be more productive the equipments they use must be suitable and adequate. This factor was also ranked among top critical factor on similar studies of other researchers like Jarkas and Bitar (2012) and Benviolent (2014)
- 14. Lack of training for labor (RII=0.786):** This is also ranked 9th with equal rates with Suitability and adequacy of equipments. Giving training for labors on building construction projects help them improve their experience and let them have high productivity.
- 15. Lack of supervision of labors during work (RII=0.782):** Lack of supervision of labors during work was ranked 10th with other three factors i.e. Lack of maintenance of equipments, Shortage of materials and Project complexity/unfamiliarity of projects to workers because they all were rated equally by the respondents of this research. Supervision of labors during work is a means of controlling labors on work to be efficient on their productivity. Therefore if there is no supervision of labors during work labors become less productive.
- 16. Lack of maintenance of equipments (RII=0.782):** It is also ranked 10th and is among the critical factors. Lack of maintenance of equipments refers frequent breakdown of major equipment, shortage of spare parts, improper service and maintenance, slack use of machinery or deliberate sabotage by operators. Construction equipments need maintenance and service while they are working on projects. If maintenance is not made on time then the equipment stop working which affects the productivity of labors which causes major idle time since employed workers un able to work without these equipments. This factor was also ranked among the most important factors on similar studies like Benviolent (2014) and Kuykendall (2007).
- 17. Shortage of materials (RII=0.782):** This factor was also ranked 10th and is among the critical factors. Shortage of materials refers to problems encountered due to inaccessibility of items or excessive time expended to acquire them. As a result of this,

workers are often idle waiting for materials and usually, the labor waste their time in unproductive work due to unavailability or shortage of material. As the construction activities are interdependent, the shortage of critical materials obstructs the work sequence and progress. Shortage of materials was also ranked among critical factors affecting labor productivity by other researchers such as Abdul et al (2005) and Ghanim (2016).

18. Project complexity/unfamiliarity of projects to workers (RII=0.782): according to the rates of the respondents of this research project complexity/unfamiliarity of projects to workers was also ranked 10th and it is among the top ten most important factors affecting labor productivity. Project complexity refers to the unfamiliarity of projects or activities of the building construction projects to workers. When the activities in a given project is new then labors start to know how to do the activities from scratch if they don't have experience related to such projects/activities which by far reduces their productivity.

4.10. From the opinion of the respondents the most important factors affecting labor productivity of building construction projects.

It was asked to list most important factors affecting labor productivity based on their own opinion. The result obtained was similar with the result of rating the given factors. As a result most of the factors identified were less payment to labors, poor planning and scheduling, Lack of coordination of labor, Lack of coordination of labor, Late payment of salary to labors, lack of incentives to labors, construction methods and material related problem were the most frequently listed factors and it was also identified as top ten critical factors from the rating of all 52 factors. Therefore this shows that both results were similar.

4.11. Comparison of the results this study with other countries research results

Table 23 Comparison of the results of this study with other countries research results

Rank	Jordan (Ghanim, 2016)	USA (Gundecha, 2012)	India (Mistry et al, 2013)	Malaysia,(Abdul et al,2005)	Zimbabwe (Benviolent, 2014)	Egypt (Sherif, 2014)	Ethiopia (This study,2017)
1	Poor planning and scheduling	Lack of required construction material	Payment delay	Material shortage at project site	Unavailability of material	Payment delay	- Low salaries and wages of labor - Construction Methods
2	Material shortage	Shortage of power and/or water	Skill of labour	Non-payment to suppliers	Suitability of Plant and equipment	Skill of labor	Late payment of salaries and wages to labor
3	Equipment shortage	Accidents during construction	Clarity of technical specification	Change order by consultants causing project delay	Late payment of salaries and wages	A shortage of experienced labor	- Poor planning and scheduling - Inefficiency of equipments - Late delivery of materials
4	Lack of skilled labor	Lack of required construction tools/equipment	Shortage of materials	Late issuance of drawing by consultants	Supervisory incompetence	Lack of labor supervision	Lack of clear and daily task assignments to workers
5	Poor site management	Poor site condition	Motivation of labour	Incapability of contractor's site management	Lack of manpower skills	Motivation of labor	Shortage of tools and equipments
6	Rework due to construction error	Insufficient lighting	Construction method	Late issuance of progress payment by client to contractor	Lack of labour experience	Working over time	Lack of Coordination between crews
7	Old and inefficient equipment	Weather condition	Physical fatigue	Late supply of materials in the market	Plant breakdown	Construction managers lack of leadership	- Lack of skills of labors - Rework as result of poor work performance

8	Lack of supervisors experience	Differing site conditions from plan	Inspection delay/stringent by the engineer	Lack of foreign and local workers in the market	Late deliveries of material	High humidity	Shortage of experienced labors
9	Payment delay to the suppliers	Material storage location	A shortage of experienced labour	Coordination problem with subcontractor	Shortage of tools and equipment	Clarity of technical specification	▪ Suitability and adequacy of equipments ▪ Lack of training for labor
10	Slow response of consultant's staff	Working overtime	Construction managers lack of leadership skill	Equipment shortage	Low remuneration	High/low temperature	▪ Lack of supervision of labors during work ▪ Lack of maintenance of equipments ▪ Shortage of materials ▪ Project complexity

This study compares the results of the critical factors affecting labour productivity identified in this study with other countries. As it can be seen from the above table 24 the ranking of factors affecting labor productivity is different in different country such as Jordan, India, USA, Malaysia, Zimbabwe and Egypt. Even though the comparison table shows that the rank given to each factors by different

countries researchers were different there are some common factors observed among the studies including, Late payment of salaries and wages, material shortage, shortage of equipments, experience and skills of labors, rework and Lack of supervision of labors during work.

5. Conclusion and recommendation

5.6. Conclusion

The general objective of this study were to identify and rank factors affecting Labor Productivity in public Building Construction Project in Addis Ababa and provide essential information about factors affecting labour productivity to construction professionals to enable the project's to be successful.

As part of its aim, this study identifies and ranks the factors affecting labor productivity public Building Construction Project in Addis Ababa. Based on the result the following eighteen factors were identified as the top ten most critical factors that negatively affecting labor productivity in descending order.

- Low salaries and wages of labor
- Construction Methods used on building projects
- Late payment of salaries and wages to labor
- Poor planning and scheduling
- Inefficiency of equipments
- Late delivery of materials
- Lack of clear and daily task assignments to workers
- Shortage of tools and equipments
- Lack of Coordination between crews
- Lack of skills of labors
- Rework as result of poor work performance
- Shortage of experienced labors
- Suitability and adequacy of equipments
- Lack of training for labor
- Lack of supervision of labors during work
- Lack of maintenance of equipments
- Shortage of materials
- Project complexity/unfamiliarity of projects to workers

Analysis was also made on factors identified by respondents from their own experience. less payment to labors, poor planning and scheduling, Lack of coordination of labor, Lack of coordination of labor, Late payment of salary to labors, lack of incentives to labors, construction methods and material related problem were identified as most important factors and it is consentient with the ranks given to the top ten most critical factors that negatively affecting productivity of labors on public building construction projects in Addis Ababa.

There was also a comparative analysis conducted on factors identified by this study and factors identified by researchers of other countries which shows that the rank given to factors affecting labor productivity are varying from country to country. But there are some common factors identified as most important factors affecting labor productivity including late payment of salaries and wages, material shortage, shortage of construction equipments, experience and skills of labors, rework and Lack of supervision of labors during work.

In conclusion, it is believed that the outcomes of this paper can assist in achieving high labor productivity by focusing and acting upon the above top ten most important factors affecting labor productivity. Furthermore, by focusing on the significance of the evaluated factors affecting labor productivity, Ethiopian construction companies who are working in Addis Ababa could be well guided in their efforts to addressing the factors in a time, cost and quality effective manner that was related with labor productivity.

5.7. Recommendation

Based on the result of this study the following recommendation was given to improve productivity of labor on public building construction projects in Addis Ababa.

1. Any construction company who involved in building construction projects in Addis Ababa should motivate their labors by improving salaries and wages so that their productivity will be improved. And also they should pay salaries and wages on time because one of the most problems that labors usually raise is late payments of salary and wages by contractors. Since most of the labors in Addis Ababa have low income if they are not paid timely then they will phases challenges for running their own life that have negative impacts on their productivity. Basic needs of labor must be fulfilled initially to expect good output from them. Even though human relation theories disagree with increasing payment for employees for higher productivity, practitioners such as Robert Own (1771-1858) on human resource management theories also agree with increasing productivities of employees by increasing remuneration for employees.
2. Since building projects involve different methods for single activity careful attention should be given to construction method used on projects to improve labor productivity and study should be conducted to have best methods employed for each activity of building construction projects. In addition to construction method activities and tasks should be a clearly assigned to labors daily so that they know what to do at what time which let them more productive.
3. For construction company to improve their labor productivity there should be proper planning and scheduling of works and labors. Since a well prepared plan and schedule is instrumental in formulating directions, setting in sequential order various operations, coordinating functions, setting targets, forecasting resources, budgeting costs, controlling performance and motivating people which have direct impact on productivity.
4. Shortage, inadequacy and inefficiency of tools and equipments are also other critical factors that should be solved by construction companies. As it was frequently mentioned by many researchers labor productivity is dependent on tools and equipments therefore if there is shortage and inefficiency of tools and equipments on construction site labor

become idle and stop working. Therefore tools and equipments should be properly scheduled and should be properly maintained.

5. The other issue that needs careful concern is construction material shortage and late delivery of construction material to project site. These two issues are frequently mentioned by many researchers as critical issues which significantly influence the construction labour productivity. Material quantity should be properly scheduled and it should be timely delivered.
6. Construction Company should give special training to their workers on building construction activities to improve their skills of work and to enhance their experience which help labors to be more productive on building construction projects. Additionally Construction Company has to work to avoid reworks on each activity by carefully supervising labor during work.
7. On construction project there are a number of crews involved and the output of one crew depends on the output of others therefore crews should have good coordination to avoid problems coming from lack of Coordination between crews.
8. When any construction company contracts new complex Project /unfamiliar projects they should have to train their workers regarding the projects nature , how it will be executed and the technologies required for it execution.

5.8. Future work

- This study was limited to public building construction projects in Addis Ababa and further study should be done on factors affecting labor productivity in Ethiopian construction industry in general.
- Similar study on developing models to improve labor productivity in construction industry also necessary for construction companies in Ethiopia.

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Appendex-1 RESEARCH QUESTIONNAIRES



ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY

SCHOOL OF ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING

DEGREE OF MASTER'S IN CONSTRUCTION MANAGEMENT

Dear respondent,

Thank you very much for your willingness to take time to respond to this research questionnaire. The study is being conducted by a postgraduate student at Adama Science and Technology University, school of Engineering, Department of civil engineering, Degree of Master's in Construction Management. It is all about questions pertaining to factors affecting labor productivity of public building construction projects.

The participation is fully on voluntary basis, and your accurate and frank responses are imperative for the successful accomplishment of the study.

Please be assured that your responses will be treated in a strictly confidential manner, and the results will be used only for the purpose of this research, presented only at aggregate level without focusing on individual company.

Kindly, therefore, please return the questionnaire upon completing each item appropriately.

Thank you in advance.

Respectfully;

Endeshaw Zeleke

SECTION-1 Please mark (✓) in the box provided

1.1.Respondent profile					
Educational status	Diploma and below ☐	Advanced Diploma ☐	First Degree ☐	Second degree and above ☐	
Total Work experience	_____years				
Your organization	Contractor ☐	Consultant ☐	Employer ☐	Other _____(specify)	
Current Position	Project manager ☐	Office engineer ☐	Site engineer ☐	Contract administrator ☐	
	Resident engineer ☐	Surveyor ☐	Forman ☐	Other(specify) _____	
1.2.Project information					
Type of public building project	Commercial ☐	Industrial ☐	Governmental ☐	Social service ☐	Other(specify) _____
Project contract amount (ETB)	_____(specify)				

SECTION-2 Please try to fill the questionnaires provided below based on the level of impact they have on productivity of labor in your company by marking (✓) in the box provided.

➤ Hint

Number	Meaning
5	Very High impacts
4	High impacts
3	Medium impacts
2	Low impacts
1	Very Low impacts

n o	Factors affecting labor productivity of building construction projects	Level of impacts				
		5	4	3	2	1
a. Management related factors						
1	Lack of clear and daily task assignments to workers/unclear instruction	☐	☐	☐	☐	☐
2	Lack of leadership skill of construction managers	☐	☐	☐	☐	☐
3	Lack of supervision of labor during work	☐	☐	☐	☐	☐
4	Lack of periodic meeting with labor	☐	☐	☐	☐	☐
5	Lack of Coordination between crews	☐	☐	☐	☐	☐
6	Crew size inconsistency by adding or deleting crew members.	☐	☐	☐	☐	☐
7	Delay in inspection and supervision by engineer	☐	☐	☐	☐	☐
8	Reassignment of Manpower from one task to another	☐	☐	☐	☐	☐
9	Over employment of labor to accelerate works	☐	☐	☐	☐	☐
10	Poor safety program which causes accident during construction	☐	☐	☐	☐	☐
11	Poor planning and scheduling of manpower	☐	☐	☐	☐	☐

b. Tools and Equipment related factors		Level of impact				
		5	4	3	2	1
12	Inefficiency of equipments	☐	☐	☐	☐	☐
13	Lack of maintenance of equipments	☐	☐	☐	☐	☐
14	Shortage of tools and equipments	☐	☐	☐	☐	☐
15	Suitability and adequacy of equipments for labor	☐	☐	☐	☐	☐
16	Improper Usage of equipments (lack of using the right equipment for the right activity)	☐	☐	☐	☐	☐
c. Material related factors		5	4	3	2	1
17	Insufficient or poor material handling	☐	☐	☐	☐	☐
18	Lack of adequate space for storage of materials on site	☐	☐	☐	☐	☐
19	Late delivery of materials on site	☐	☐	☐	☐	☐
20	Poor quality of materials	☐	☐	☐	☐	☐
21	Shortage of materials on site	☐	☐	☐	☐	☐
d. Manpower related factors		5	4	3	2	1
22	Absenteeism of labor	☐	☐	☐	☐	☐
23	Lack of Moral and attitude of labor toward works	☐	☐	☐	☐	☐
24	Different addiction of labor such as alcoholism, chewing khat	☐	☐	☐	☐	☐
25	Fatigue and working overtime	☐	☐	☐	☐	☐
26	Labor turnover	☐	☐	☐	☐	☐
27	Improper use of skills of labors	☐	☐	☐	☐	☐
28	Lack of skills of labors	☐	☐	☐	☐	☐
29	Shortage of experienced labors	☐	☐	☐	☐	☐
30	Labor operating system (daily wage or lump sum)	☐	☐	☐	☐	☐
31	Coordination problem among labor	☐	☐	☐	☐	☐

e. Motivation related factors		Level of impact				
		5	4	3	2	1
32	Lack of incentives to labor	☐	☐	☐	☐	☐
33	Lack of respect or recognition for labor from managers	☐	☐	☐	☐	☐
34	Lack of training for labor	☐	☐	☐	☐	☐
35	Late payment of salaries and wages to labor	☐	☐	☐	☐	☐
36	Low salaries and wages of labor	☐	☐	☐	☐	☐
37	unavailability of site facilities such as places for eating and relaxation , transport means and etc	☐	☐	☐	☐	☐
38	Lack of Labors retention scheme/plan	☐	☐	☐	☐	☐
f. Technical related factors		5	4	3	2	1
39	Clarity of specification	☐	☐	☐	☐	☐
40	Construction Methods	☐	☐	☐	☐	☐
41	Drawing clarity	☐	☐	☐	☐	☐
42	Project complexity/unfamiliarity of projects to workers	☐	☐	☐	☐	☐
43	Rework as result of poor work performance	☐	☐	☐	☐	☐
44	Site organization problem	☐	☐	☐	☐	☐
g. Sub-contracting related factors		5	4	3	2	1
45	Coordination problems of main contractor and sub-contractors	☐	☐	☐	☐	☐
46	Communication problems between sub-contractors	☐	☐	☐	☐	☐
47	Insufficient supervision of subcontractors	☐	☐	☐	☐	☐
48	Relationship between workers of subcontractor and workers of main contractor	☐	☐	☐	☐	☐
49	Lack of experience of subcontractors	☐	☐	☐	☐	☐

h. External factors		5	4	3	2	1
50	Poor weather conditions	☐	☐	☐	☐	☐
51	Local legal issues	☐	☐	☐	☐	☐
52	Cultural and social related problems	☐	☐	☐	☐	☐

SECTION -3

1. From your experience what are the most important factors affecting labor productivity of building construction projects?

Appendix 2. Rate of respondents for each factors and values of weight and RII to each factors affecting labor productivity

no	<i>factors</i>	Response Frequency					Weight	RII
		5	4	3	2	1		
	Management related factors							
1	Lack of clear and daily task assignments to workers/unclear instruction	23	7	9	4	1	179	0.814
2	Lack of leadership skill of construction managers	20	10	6	4	4	170	0.773
3	Lack of supervision of labors during work	17	15	7	1	4	172	0.782
4	Lack of periodic meeting with labors	5	12	17	7	3	141	0.641
5	Lack of Coordination between crews	19	13	7	4	1	177	0.805
6	Crew size inconsistency by adding or deleting crew members.	9	15	14	5	1	158	0.718
7	Delay in inspection and supervision by engineer	17	12	10	3	2	171	0.777
8	Reassignment of Manpower from one task to another	10	11	15	8	0	155	0.705
9	Over employment to accelerate works	7	10	9	12	6	132	0.600
10	Poor safety and health program which causes accident during construction	17	7	10	6	4	159	0.723
11	Poor planning and scheduling	22	12	4	4	2	180	0.818
							mean	0.741
	a. Tools and Equipment related factors						Weight	RII
12	Inefficiency of equipments	22	11	6	3	2	180	0.818
13	Lack of maintenance of equipments	18	12	7	6	1	172	0.782

14	Shortage of tools and equipments	18	18	3	2	3	178	0.809
15	Suitability and adequacy of equipments	13	19	8	4	0	173	0.786
16	Improper Usage of equipments	20	11	5	4	4	171	0.777
mean								0.795
	b. Material related factors						Weight	RII
17	Insufficient or poor material handling	16	11	11	3	3	166	0.755
18	Lack of adequate space for storage of materials	13	10	13	5	3	157	0.714
19	Late delivery of materials	20	14	5	4	1	180	0.818
20	Poor quality of materials	14	10	8	7	5	153	0.695
21	Shortage of materials	16	17	4	5	2	172	0.782
mean								0.753
	c. Manpower related factors						Weight	RII
22	Absenteeism of labor	9	17	10	5	3	156	0.709
23	Lack of Moral and attitude of labor toward works	16	5	13	6	4	155	0.705
24	Different addiction of labor such as alcoholism, chewing khat	11	10	9	6	8	142	0.645
25	Fatigue and working overtime	6	16	12	8	2	148	0.673
26	Labor turnover	11	12	15	4	2	158	0.718
27	Improper use of skills of labors	17	11	9	5	2	168	0.764
28	Lack of skills of labors	21	11	5	4	3	175	0.795
29	Shortage of experienced labors	18	14	7	2	3	174	0.791
30	Labor operating system (daily wage or lump sum)	11	15	11	4	3	159	0.723
31	Coordination problem among labor	12	12	14	5	1	161	0.732

							mean	0.725
	d. Motivation related factors						Weight	RII
32	Lack of incentives to labor	13	12	11	5	3	159	0.723
33	Lack of respect or recognition for labor from managers	13	10	13	7	1	159	0.723
34	Lack of training for labor	14	17	9	4	0	173	0.786
35	Late payment of salaries and wages to labor	21	11	9	3	0	182	0.827
36	Low salaries and wages of labor	19	15	9	1	0	184	0.836
37	unavailability of site facilities such as places for eating and relaxation , transport means and etc	13	6	17	6	2	154	0.700
38	Lack of Labors retention scheme/plan	3	12	21	7	1	141	0.641
							mean	0.748
	e. Technical related factors						Weight	RII
39	Clarity of specification	15	14	7	5	3	165	0.750
40	Construction Methods	23	12	4	4	1	184	0.836
41	Drawing clarity	17	9	11	3	4	164	0.745
42	Project complexity/unfamiliarity of projects to workers	19	10	9	4	2	172	0.782
43	Rework as result of poor work performance	21	9	7	6	1	175	0.795
44	Site organization problem	20	9	6	5	4	168	0.764
							mean	0.779
	f. Sub-contracting related factors						Weight	RII
45	Coordination problems of main contractor and sub-contractors	14	13	9	7	1	164	0.745
46	Communication problems between sub-contractors	14	11	12	4	3	161	0.732

47	Insufficient supervision of subcontractors	14	13	7	7	3	160	0.727
48	Relationship between workers of subcontractor and workers of main contractor	12	13	11	6	2	159	0.723
49	Lack of experience of subcontractors	21	8	5	7	3	169	0.768
							mean	0.739
	g. External factors						Weight	RII
50	Poor weather conditions	11	14	9	4	6	152	0.691
51	Local legal issues	11	6	13	8	6	140	0.636
52	Cultural and social related problems	4	13	9	7	11	124	0.564
							mean	0.630