CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

The execution of construction of projects is capital intensive and as such consume much money. The aim of every construction work is to give the client the best value for his money that is; a building that meets the user requirements at the cheapest cost according to terms of the contract. The goal of a contract or the end of a contract is that the procurement of any good or service should be successful upon completion of project.

In the construction industry, skilled workers such as masons, carpenters, iron benders, among others form a larger part of site labor workforce whose input determine the quality of the industry’s products. These skilled workers however, are most endangered in Nigeria as they lack adequate training, technical education and experience to recommend them for work. Thereby, affecting their performance and productivity on construction projects which could consequently result in cost and time overruns of projects. Productivity loss occur and when the contractor is not achieving his planned production rate, consequently, leading to efficiency losses (Gibson, 2015).

It is therefore quite daunting to quantify productivity loss caused by factors outside the contractor’s control. Calculation of efficiency losses is arguably one of the most disputable area in construction claim. “Efficiency losses unlike direct costs are usually difficult to track and cannot be discerned separately, and as a result of this, both causation and entitlement regarding efficiency loss recovery become difficult to establish” (Gibson, 2015).

Dieterle and Gaines (2010) opined that almost all projects with claims for delay and damages associated with loss of labour efficiency contributed to such delay. Therefore, it is important to carry out this study as it will investigate and describe the concept of efficiency losses as well as its effect on the time performance of construction project.

1.2 Statement of the Research Problem

Dieterle and Gaines (2010) opined that efficiency losses claims are prevalent in many construction disputes. They are of the opinion that efficiency losses are not well understood and often difficult to quantify. This was further buttressed by Egwunatum and Ovie (2015) who were of the opinion that efficiency loss calculation or estimation is one of the most contentious areas in construction industry. According to, Eze *et al*. (2020), the decline in labour productivity and efficiency of operations of the contracting organisation is a problem that has negatively influenced the industry's contribution to national economy. The declining labour productivity is due to the fact that the industry is labour-intensive, and labour productivity issue is among the critical issues facing the construction project managers and other professionals and supervisors on a regular basis, as they strive to deliver project on target (Attar *et al*., 2012). According to Gledson *et al* (2018), construction project is adjudged a success if cost, quality, time and scope are attained with any shortcoming registered in one or more of these representing a failure of sort. They further buttressed that it is observed that more recent research effort has been focused on poor time predictability but minimal attention is given to research on planning labour efficiency to facilitate timely delivery of construction projects.

1.3 Research Questions

This study attempted to answer the following questions:

i. What are the various methods of measuring efficiency losses in construction?

ii. What are the factors responsible for efficiency losses in construction projects?

iii. Is there any relationship between efficiency and time performance?

iv. Are there measures of minimizing the occurrences of efficiency losses on construction projects?

1.4 Aim and Objectives of the Study

This study aimed to assess the effect of labour efficiency losses on the performance of construction firms with the view to suggest possible solutions to minimize the occurrence of such losses.

The objectives are as follows;

i. To determine and rank methods of measuring efficiency losses by construction firms.

ii. Examine factors responsible for efficiency losses in construction projects.

iii. To examine the effect of efficiency losses on time performance of construction firms.

iv. To determine measures of minimizing the occurrence of efficiency losses on construction projects.

1.5 Justification of the Study

Ismail *et al* (2019) observed that timely delivery of construction projects lies largely on the performance of labour. Unfortunately, labour performance growths in Nigerian construction industry have been unsatisfactory. The abysmal performance of labour has remained a key problem in the construction industry as it constitutes a major claim head in the construction industry of Nigeria (Egwunatum and Ovie, 2015), especially as it has to do with the relationship between clients, consultant, and contractors. Decline in labour productivity has been claimed as responsible for the poor construction project delivery, and it has been the leading cause of claims, conflicts, quality issues and cost overrun especially in major construction projects globally (Eze *et al*., 2020). Construction productivity is dependent on labour productivity; even though labour productivity is a sub-domain of overall construction productivity (Rao *et al, 2015*). An effective management of labour in construction can lead to labour cost reduction; as labour cost constitute about 30% to 50% of total construction projects cost (Gopal and Murithi, 2017; Shashank *et al*. 2014).

It can be deduced from above that in spite of the efforts of researchers on possible ways of eliminating or minimizing cost and time overruns in construction and their devastating impacts on the parties to a construction projects, the issue has remained unchanged. Thus, the need to assess the impact of labour efficiency loss on time performance of construction projects.

1.6 Scope and Delimitations of the Study

This study covers the assessment of the impact of labour efficiency losses on the performance of building construction projects, with a particular focus on Abuja, Nigeria. The main interest is to sample the opinion of construction professionals, including (contractors, subcontractors, and consultants) on the subject under consideration.

The researcher studied projects that are 50% to 100% completed. Projects that are 100% completed would have had all disputes and claims settled. Projects that are 50% completed are at its peak and this stage has a lot of claims and disputes. Some of these claims and dispute would have been settled.

The rationale behind the choice of Abuja is considering the fact that a lot of construction and consultancy firms are in the city. Thus, there is a very high possibility of getting samples which will aid in achieving the objectives.

1.7 Hypothesis of the Study

The following are the hypotheses put forward to guide the achievement of the study objectives:

H_{01}: There is no statistically significant effect of efficiency loss on time performance of construction projects.

H_{A1}: There is statistically significant effect of efficiency loss on time performance of construction projects.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Efficiency Loss Concept

Association for the Advancement of Cost Engineering (2004) defined efficiency loss as increase in cost performance as a result of change in contractor's planned or anticipated method of works, resources or working condition. Project owners usually demand for same date of completion despite addition in scope of work. This may resultantly demand second shift work, overtime, provision of additional crafts and so on.

"The extra cost from efficiency losses are as a result of outgrowth of the change in input/output which is the difference between the baseline productivity and that which is actually achieved" Egwunatum and Ovie (2015).

i.e. Efficiency losses = $\text{productivity}_{\text{Baseline}}$ - $\text{productivity}_{\text{Actual}}$

The baseline productivity is determined through measurement of inputs and outputs in the "least impacted period of time on the project", therefore making efficiency loss the difference between the actual productivity recorded and the productivity expected if not for the unanticipated conditions.

2.2 Methods of Measuring Efficiency Losses in Construction

Nelson (2011), is of the view that there are numerous techniques for measuring efficiency losses (or lost labour productivity) in the construction industry. These methods were developed by construction organisations based on appropriate data inputs and have been classified into three broad categories. These are;

i. Project Practice Based Method
ii. Industry Based Method
iii. Cost Based Method

2.2.1 Project practice based method

These are methodologies that are project specific and the claims involved are supported by records of people (stakeholders) that were involved directly at the disputed work. The project practice based method is appealing to the tribunal because it has direct relationship with the events and work under consideration. Damages or claim calculations are made from data evolving from the project in dispute. The approaches under this method includes;

i. Measured Mile Analysis
ii. Baseline Productivity Analysis
iii. System Dynamics Modelling,
iv. Earned Value Analysis
v. Sampling studies
vi. Comparison Studies

2.2.2 Measured mile analysis

Nelson, 2011 found that the Measured Mile Method is the most preferred method and widely accepted method of determining efficiency losses (or productivity losses). This method compares the achieved productivity considering two periods for the same operation on same project; these periods are referred to as the impacted (inefficient) and the un-impacted (efficient) periods. The analysis relies on the actual time spent in carrying out the work. When productivity in the two aforementioned periods are compared it will result in calculating inefficiency factor. If:

Productivity of the un-impacted = U,

Productivity of the impacted = I,

Then;

Inefficiency Factor (IF) = U-I/U

Thus, the Inefficiency Factor represents efficiency loss in the impacted period in relation to the un-impacted period.

Measured Mile method is more preferred than other methods as a result of its reliance on actual contract performance rather than the initial estimate.

Fig 2.1 shows a non-disrupted and disrupted period of excavation. In this illustration, the quantity of excavation done per unit time have been adversely affected by access and operational restriction imposed on the contractor's activities.

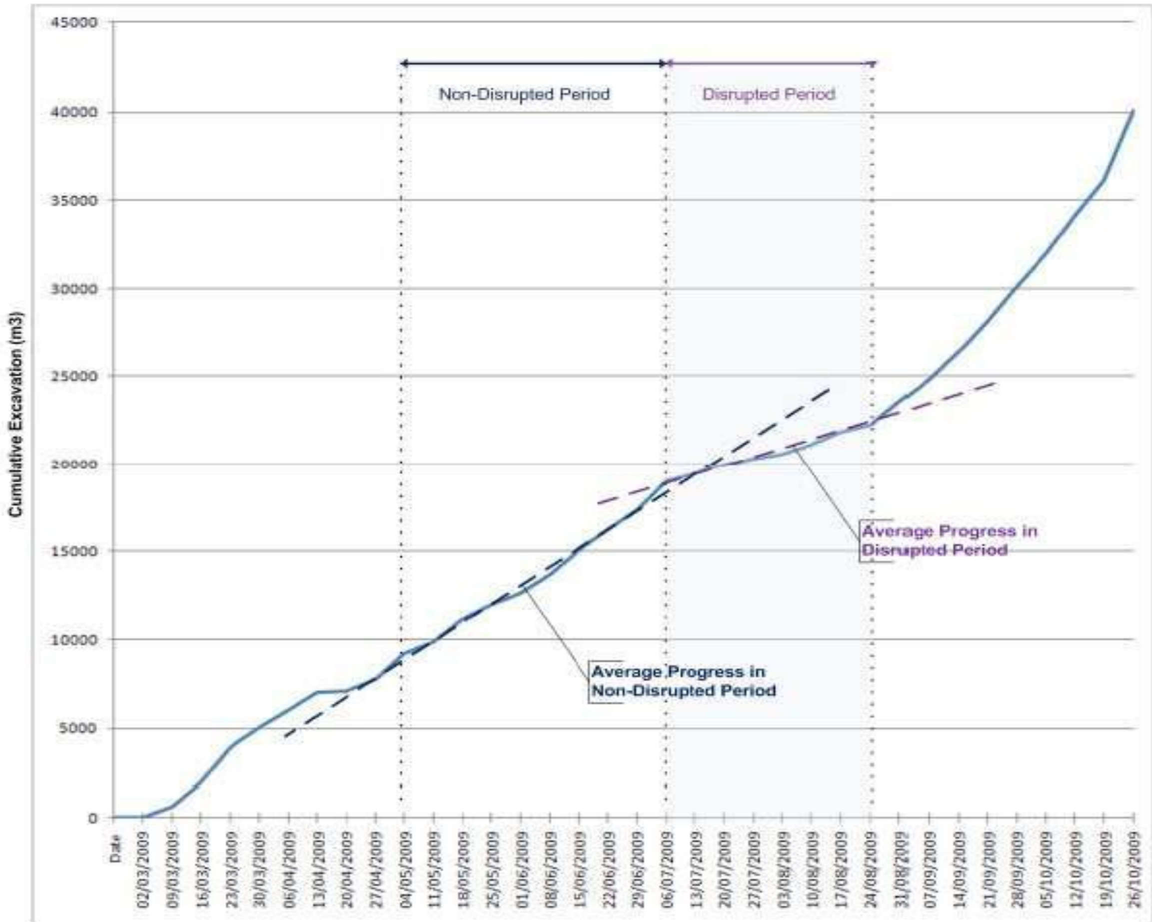

Figure 2.1: Disrupted and Undisrupted period of excavation work

Source: Nelson (2011)

2.2.2.1 Limitations of the measure mile analysis

This method has some **c**onsiderable limitations embedded in the assumptions it relies on. The Measured Mile Analysis is said to be unreliable or even become impossible when either an un-impacted period is not sizeable or does not exist. The applicability of this method can be hampered by its requirement for substantially similar activities for comparison due to the fact that the method is not appropriate for complex and unique tasks. Thomas and Savindo (2000) submitted that the reliability of the method is dependent on how accurate the project data used for the analysis are given that errors are common in project reports.

2.2.3 Baseline productivity analysis

This method was developed to mitigate some limitations of the Measured Mile approach. The bottom line of this method is to establish the productivity baseline. Baseline Productivity Analysis according to Gulezian and Samelian (2003) represent or reflects the normal contractor's operating performance.

2.2.3.1 Limitations of the baseline productivity analysis

Even though the baseline analysis proffered solutions to the problems associated with the Measured Mile Method, there are still limitations; the process is yet to obtain consensus among studies and this has been attributed to varying views on baseline productivity.

Shortcomings identified by Thomas and Savindo (2000) in relation to the application of this method are:

i. The sample used in baseline is identified according to the best daily output rather than the best daily productivity.

ii. Baseline sample size stipulated to be 10% is arbitrary and not based upon any scientific rule or principle (Ibbs and Liu, 2005)

2.2.4 System dynamics modelling

The System Dynamics Modelling method creates a computer model of the project that provide map of relationships and feedback loops in a comprehensive and dynamic model. "A key feature of System Dynamic simulation modelling is that it allows direct answering with a pool of "what if" questions such as: What if the owner's intervention had not occurred? What if one particular category of disruption had not occurred but all others had?" (Eden *et al, 2005*).

Figure 2.2 shows a typical system dynamics modelling for estimating efficiency lost using System Dynamic. The exhibited project changes, Sources, impacts, mitigations, pricing, litigation & Excellence (See next page)

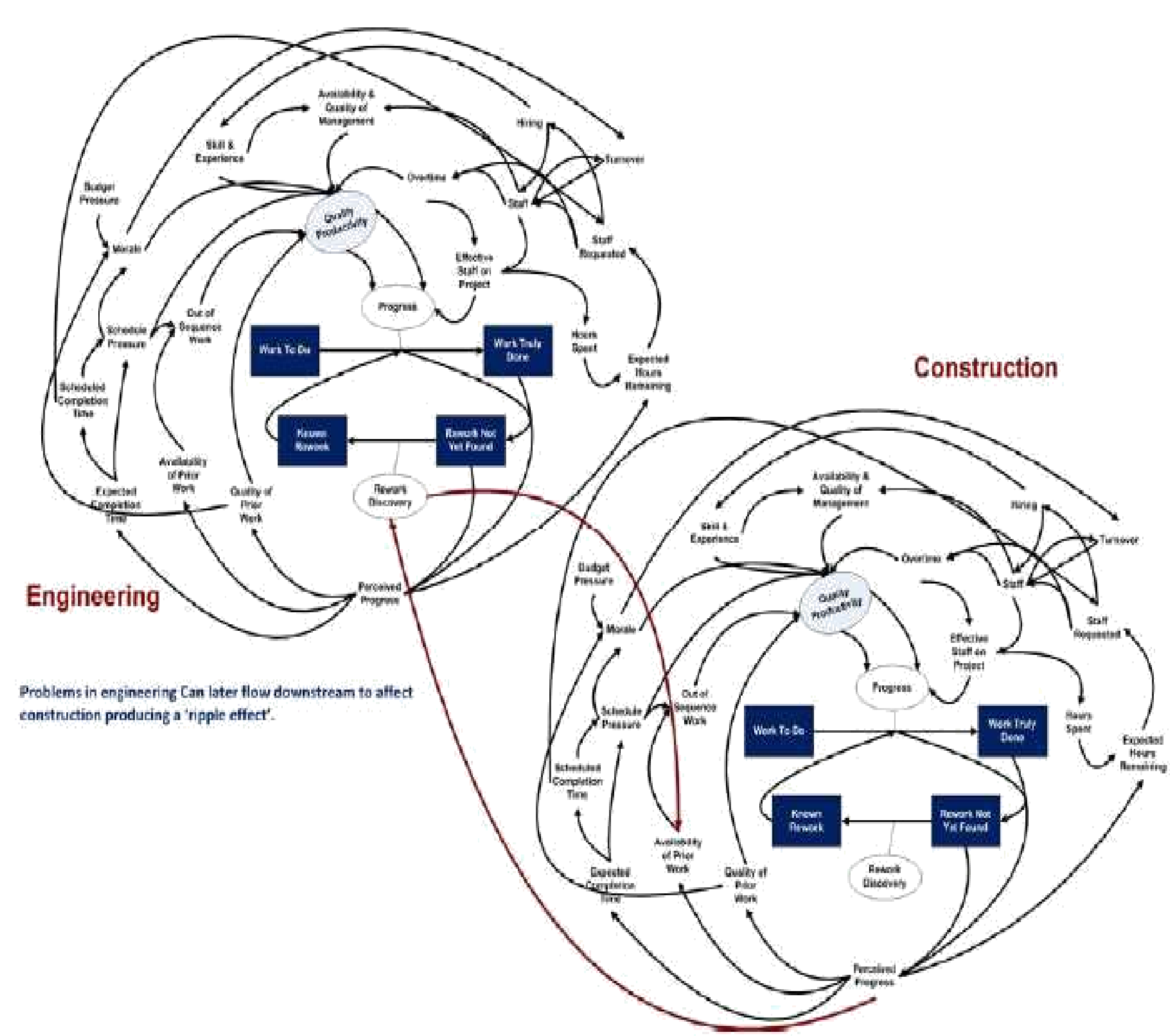

Figure 2.2: Typical system dynamics modelling for estimating efficiency loss

(**Source**: Nelson, 2011)

2.2.5 Earned value analysis method

This method is a simplistic method of calculating estimated labour hours lost which is used usually when there is insufficient data on physical works carried out thereby making productivity measurement difficult.

Earned Value Analysis (method) relies on the accuracy of associated project documentation. (Murithi *et al*, 2017).

2.2.6 Sampling methods

This method involved the estimation of efficiency loss using craftsmen questionnaire and work sampling methods.

In Work Sampling, large number of tradesmen observation is made in order to ascertain what has been done at different point in time. It involves direct observation of workers at their various places of assignment as work progresses and at the end of the tasks at varying time. (Nelson, 2011).

2.2.7 Industry based methods

This method involves the use of the results from the studies of some general and specialty industry.

This involves the employment of specific studies results (especially for specialty) which are related directly to the causes of damages. Such studies could be about learning curve, acceleration, weather, overtime, and so forth. The general study is specifically dependent on industry-wide reports and/or manuals (AACE, 2004).

2.2.8 Cost based methods

The cost based methods are used in situations where demonstration of causation and entitlement is possible but project data and information to support calculation of damages using other methods is insufficient.

This method involves the preliminary analysis of the project cost records in order to determine the actual direct labour hours and cost (excluding head office overheads, materials, consumables, small tools, etc.).

2.2.9 Expert opinion

This method encapsulates construction expert reviewing the documentation of projects so as to provide opinion that quantifies productivity loss as experienced by the contractor (Murithi *et al*, 2017). Although, this method is sometime used, its limitation lies on the fact that estimates are based on opinion and not project based analysis of supporting documents.

Table 2.1 below is a summary of the various methods of measuring the efficiency losses in a construction project.

Table 2.1: Method of measuring the efficiency losses in a construction project

Methods of measuring efficiency loss	**Sources**
Measured Mile Analysis	Murithi *et al* (2017); Nelson (2011); Insight (2019)
Baseline Productivity Analysis	Nelson (2011); Murithi *et al* (2017)
System Dynamics Modelling	Nelson (2011); Murithi *et al* (2017)
Earned Value Analysis	Nelson (2011); Murithi *et al* (2017)
Sampling Methods	Nelso (2011); Murithi *et al* (2017)
Industry Based Methods	Nelson (2011)
Cost Based Method	Nelson (2011)
Expert opinion	Nelson (2011)

Source: Author, (2020)

2.3 Factors Responsible for Efficiency Losses

2.3.1 Project and management related factors

2.3.1.1 Construction method, complexity of design and project scale: A simple, familiar work is easier to execute than unfamiliar, complex work. Management's choice of construction method also affect labour efficiency. Management may for instance have to choose between completing the structural elements of the project before commencing work on other elements or proceed in the traditional sequence from excavation to completion. The choice will depend largely on the type of project and other conditions.

2.3.1.2 Clarity of project documents: An easy and accurate design should be prepared to avoid design errors as such errors delay the project construction activities thereby leading to project time overrun (Aziz, 2013)

2.3.1.3 Project characteristics (Size, layout, type, location):

This involve legal conditions (e.g noise ordinances preventing works before 7:00 am or after 6:00 pm), environmental conditions (permit prohibiting construction in some areas at certain time) and physical conditions (saturated soil).

2.3.1.4 Construction management: Lack of construction management skills and poor construction management such as inadequate scheduling and planning, delay in decision making, ineffective communication, and lack of sufficient supervisory training affect labour efficiency (Dozzi & AbouRizk, 1993).

2.3.1.5 Education and training: Skilled workers such as masons, iron benders, carpenters amongst others lack adequate training, technical education and experience thereby, affecting their performance and productivity on construction projects which in turn could lead to cost and time overruns of the project. Additionally, lack of adequate project management, management training and supervision all contribute to efficiency loss (Dozzi & AbouRizk, 1993)

2.3.2 Labour related factors

2.3.2.1 Absenteeism and turnover: Crew member's absence has significant impact on the crew's production rate considering that the crew will find it difficult to achieve same productivity with less members. Bringing new crew members will also affect such productivity because such new members will be on a learning curve thereby affecting the productivity rate of the crew.

2.3.2.2 Low level of skill and experience/learning curve: For a contractor to be productive, he must engage services of sufficient skilled labour on site. Productivity is impacted when contractor employ the services of less skilled labour as a result of unavailability of skilled labour. Such shortage of skilled labour is sometimes as a result of many construction projects running simultaneously (Sambasivan *et. al* 2007).

2.3.2.3 Inability to adapt to changes and new environment and lack of motivation:

The enthusiasm for work suffers when work is constantly changed or redone. Workers who find it difficult to learn new or alternative methods of delivery tend to cause efficiency delay. New environment also has mental effect on some workers who do not like changing environment.

2.3.2.4 Excess overtime: Previous research have identified overtime as cause of decline in productivity. Such decline is said to be caused by reduced morale, fatigue, poor workmanship leading to rework, accidents, absenteeism and so on.

2.3.2.5 Worker's lack of integrity, Number of breaks and duration: Reasonable working hours and necessary breaks are critical to achieving desired output (Jerome, 2013). Most developed countries have adopted the national laws that set weekly maximum working hours and duration for breaks during work (Sambasivan *et. al* 2007).

2.3.2.6 Strikes/disruptions by unions and political parties: Labour productivity is affected by activities such as strikes by workers, unsafe working conditions, industrial related issues, access difficulty, permits issues and others.

2.3.2.7 Adverse weather: Rashid (2015) opined that there is a relationship between climate and labour efficiency on construction industry. "It is intuitive that extreme climatic factor can affect construction projects by disrupting and impairing the project's labor efficiency" he said.

2.4 Factors of Time Performance in Construction Projects

Azizi (2013) posit that time is a major factor considered throughout the lifecycle of project management. Thus, time is identified as a critical parameter and driving force for the success of a project. According to Aziz *et al. (2016),* time is money, and any time delay on construction projects will affect money which lifeblood of any economy. Any delay of the normal process of construction work, influences labour productivity which could lead to some losses of efficiencies of construction workers. "There is a specific time frame within which a construction project is scheduled to be completed, so long as there is adequate management of time" (Kikwasi, 2012). Effective time management is a panacea for early delivery of construction project, elimination of disruptions and losses of productivity of labour and work efficiencies. The issues of delays cannot be attributed to a party but to all stakeholders concerned with construction contracts delivery.

There are a lot factors that influence construction project time performance. These factors are responsible for delays, disruption of work, labour productivity and efficiency losses, safety issues, quality problems, among others. Thapanont *et al.*

(2018) reported that in Thailand, the major time performance factors are; Project engineer's incompetence, inefficiency of equipment, unavailability of materials, traffic safety during construction, incomplete drawing and poor site management. In Pakistan, Haseeb *et al*. (2011) found that factors of time performance are natural disaster like flood and earthquake. Other factors of time performance according to the study are; financial and payment problems, insufficient experience, and improper planning. Kikwasi (2012) found that main factors of time performance are: compensation for claims, disagreement on valuation of work, delay in payment to contractors, changes in design. Marzouk and El-Rasas (2014) report that the most critical factors of time performance in Egypt include effect of subsurface condition (e.g soil, high water table, etc), unavailability of labour, variation order by owner, contractor's inability to finance project, inexperienced labour. In a different but related study by Aziz (2013) in Egypt, it was reported that time performance factors include: Poor financial control on site, bribes, rework as a result of errors, unqualified contractor, complexity of project, legal dispute between project participants, global financial crisis, conflict between joint ownership. Similar time performance factors were reported by Aziz *et al.* (2016), in a related study in Eqypt after 3 years. Ethiopian construction projects according to Gebrehiwet and Luo (2017) are influenced by time performance problems such as: Late design, poor site management, late release of fund, poor material quality, corruption, and ineffective project scheduling and planning.

Table 2.2 is a summary of the 24 selected factors of time performance on construction projects.

Table 2.2: Factors of time performance in construction projects

S/N	Factors of time performance	Sources
1	Delay in progress payments (Funding problems),	Haseeb et al. (2011);Elinwa and Joshua (2001); Kikwasi (2012) ; Gebrehiwet and Luo (2017; Aziz (2013); Aziz et al.(2016).
2	Different tactics patterns for bribes,	Aziz (2013); Aziz et al.(2016).
3	problems of funding	Haseeb et al. (2011);Kikwasi (2012); Marzouk and El-Rasas (2014);
4	Shortage of equipment and materials	Sambasivan and Soon (2007);Haseeb et al. (2011);Thapanont et al. (2018); Kikwasi (2012) ; Elinwa and Joshua (2001); Marzouk and El-Rasas (2014); Gebrehiwet and Luo (2017; ; Aziz (2013); Aziz et al.(2016).
5	Ineffective project planning and scheduling,	Sambasivan and Soon (2007);Haseeb et al. (2011);Aziz (2013); Aziz et al.(2016).
6	Poor site management and supervision,	Sambasivan and Soon (2007);Haseeb et al. (2011);Thapanont et al. (2018);Kikwasi (2012); Elinwa and Joshua (2001); Aziz (2013); Aziz et al.(2016);Gebrehiwet and Luo (2017; .
7	Poor financial control on site,	Haseeb et al. (2011); Thapanont et al. (2018);Aziz (2013); Aziz et al.(2016).
8	Rework due to errors,	Aziz (2013); Aziz et al.(2016).
9	Selecting inappropriate contractors,	Aziz (2013); Aziz et al.(2016).
10	Sudden failures actions,	Aziz (2013); Aziz et al.(2016).
11	Inadequate planning	Sambasivan and Soon (2007);Haseeb et al. (2011);Elinwa and Joshua (2001);; Aziz (2013); Aziz et al.(2016).
12	Incompetent project team,	Sambasivan and Soon (2007);Haseeb et al. (2011);Marzouk and El-Rasas (2014). ; Al-Kharashi and Skitmore (2008); Aziz (2013); Aziz et al.(2016).
13	Inadequate contractor experience,	Sambasivan and Soon (2007);Aziz (2013); Aziz et al.(2016); Gebrehiwet and Luo (2017; .
14	Frequent equipment breakdowns,	Aziz (2013); Aziz et al.(2016).
15	Design changes	Thapanont et al. (2018); Noulmanee et al (1999); Kikwasi (2012) ; Elinwa and Joshua (2001); Aziz (2013); Aziz et al.(2016).
16	Complexity of project (project type, project scale, etc.),	Aziz (2013); Aziz et al.(2016).
17	Legal disputes between project participants,	Kikwasi (2012); Aziz (2013); Aziz et al.(2016).
18	Change orders,	Kikwasi (2012); Marzouk and El-Rasas (2014); Gebrehiwet and Luo (2017); Ahmed et al. (2002); Aziz (2013); Aziz et al.(2016).
19	Inappropriate construction methods,	Aziz (2013); Aziz et al.(2016).
20	Unqualified/inadequate experienced labor,	Sambasivan and Soon (2007);Haseeb et al. (2011);Marzouk and El-Rasas (2014); Aziz (2013); Aziz et al.(2016).
21	Lack of coordination between contractor and design team,	Sambasivan and Soon (2007);Noulmanee et al (1999); Elinwa and Joshua (2001);; Aziz (2013); Aziz et al.(2016).
22	natural disasters/Acts of God	Kikwasi (2012);Haseeb et al. (2011) Thapanont et al. (2018);
23	Poor attention to health and safety	
24	lack of communication between parties, and	Sambasivan and Soon (2007);

Source: Author, (2020)

2.5 Impacts of Efficiency Losses on a Construction Project

Yap *et al*. (2020a) are of the view that efficiency losses and unnecessary delay in project delivery is a regular factor responsible for the problems and complications in construction projects. This goes beyond the level of industrialisation of a nation. That is, it cut across developed and developing countries. Among the leading effect of efficiency losses are cost overrun, time overrun, disputes, claims, poor quality, loss of profit (Mukuka *et al*., 2015).

Yap *et al.* (2020b) submitted that the attitudes of cutting corners, poor worker motivation, out-of-sequence work, and time pressure could worsen these effects and these negative repercussions. According to Yap *et al*. (2020a), education and training will go a long way in dampening the effect of efficiency losses in the countries industry. Furthermore, a continued expansion of knowledge and understanding regarding the criticality of working below expectations and planned schedules will help stakeholders reduce the consequences particularly on time, cost, quality and other key parameters of project performance measures.

2.5.1 Time overrun

"In the execution of building projects, time is the duration from the date of site possession to the date of practical completion of that particular project ususally considered in weeks (Ameh and Osegbo, 2011). Effective time control is one of basic goals of parties involved in constructing projects and such time control can be affected by efficiency loss. When there is efficiency loss, there is extended time of project delivery known as time overrun (Egwunatum and Ovie, 2015).

2.5.2 Cost overrun

"Cost is what must be given to obtain something valuable (John *et al.,* 2015) Efficiency loss results in extended time of delivery, and poor quality which in turn results in increased cost of project delivery.

John *et al* (2015) are of the view that it is necessary for adoption of an effective means of representing cost in order to keep the job in line with the original estimate. They went further to point out that adequate cost control and recording system provide opportunity for savings.

2.5.3 Poor quality

One of the effects of efficiency loss in a project is poor quality delivery. John *et al* (2015) found that quality is one of the most significant parameters in realizing construction project. According to them, attempts to define quality summarises its features as follows: Fitness for purpose, pleasing to look at, satisfactory durability, freedom from defects upon completion.

2.6 Measures of Minimizing the Occurrence of Efficiency Loss

A contractor must control the loss of labour productivity to avoid the risks / costs associated with any loss in this respect (Murithi *et. al* 2017). This may be done in a number of ways some of the most important of which are identified below.

i. Project Planning
ii. Project Leadership
iii. Project Resource Allocation
iv. Project Monitoring

Other measures of based on factors responsible for efficiency losses are;

i. Sufficient Management Training
ii. Incentives and Workers Motivation
iii. Sufficient Supervisory Training
iv. Effective Communication
v. Adequate Supervision
vi. Workers Training and Education
vii. Reduction in Overtime
viii. Workers' Discipline

CHAPTER THREE

3.0 RESEARCH METHODOLGY

3.1 Research Design

Research design is a framework that provide guidance to researchers in achieving their research aims (Okoko, 2002).

It assists in validating, analysing and interpreting research data. The research design adopted for this study is survey research design to aid achievement of the research aim of assessing the effect of efficiency losses on time performance of construction projects, with a view to suggesting possible solutions at minimizing their occurrences. Survey research design was selected because data was collected through the use of questionnaire. A survey research design according to Robson (2005) is a cross-sectional design where data is collected using a properly structured questionnaire or interview administered to the research objects for self-report at a time when quantifiable data are required. Survey design is quantitative in nature, as it involves the formal, objective, systematic process of describing a relationship, examining causes and effects among variables (Oladun, 2013).

3.2 Study Population

Population according to Oladun (2013) is defined as the totality of events, objects and/or individuals that satisfy the criteria required to be included in the research in order to achieve its aim. The population used for this study consist of construction professionals in both private and private and public organizations, (contractors/subcontractors and consultants) based in Abuja. Registered Architects, Builders, Engineers and Quantity Surveyors are the professionals considered. Abuja is selected for this research because higher number of privately owned consultancy and construction firms are based Abuja, giving it an edge over other locations. The choice of Abuja for this kind of research is further supported by Onyeagam *et al., 2019,* who opined that there are numerous construction projects being executed on a daily basis in Abuja. Contractors/subcontractors are considered for this research because they are the entities involved in carrying out of the actual building construction and production of the finished buildings and are involved in the management of labours (skilled and unskilled). Thus, their participation is critical to the success of this study. The population of this study is 10,300 (see Table 3.1)

3.3 Sampling Frame

"Sample frame is a list of individuals, location, institution, professional organisation, associations, ministries or other units from which samples are drawn" Cooper and Schindler (2014). For the purpose of this research, construction professionals' list were obtained from their professional bodies (Nigerian Institute of Architects, Nigerian Institute of Building, Nigerian Society of Engineers, and Nigerian Institute of Quantity Surveyors).

Table 3.1 presents the numbers of the professionals in the study area.

Table 3.1 Sample frame of respondents

Item Nr.	Respondent	Population
A	Architects (N.I.A)	625
B	Builders (N.I.O.B)	600
C	Engineers (N.S.E)	7875
D	Quantity Surveyors (N.I.Q.S)	1200
	Total	**10,300**

Source: 2020 Membership register of the NSE, NIA, NIQS and NIOB

3.4 Sample Size

Samples size is a given portion of the population from which information for analysis are obtained (Nkoli, 2011). It has a relationship with the population, and large representative samples is better (Cooper & Schindler 2014). The sample size for this study was obtained using the formula from Krejcie and Morgan (1970) at 96% confidence level, and it is 370.

Considering the formular;

$s= X^2 NP(1-P) / d^2 (N-1) + X^2 P (1-P)$ ……………………………3.1

Where;

s= sample size from finite population

X= Confidence level of 1.96

d= Precision desired which is expressed as decimal (i.e 0.05)

P= Estimated variance in population as a decimal (i.e 0.5 for this study)

N= Total number of population (10,348)

$$\mathbf{s = X^2 NP (1 - P) \div d^2 (N - 1) + X^2 P (1 - P)} \text{..........................} \quad 3.1$$

Where;

s = sample size from finite population

X = based on confidence level 1.96 for 95% confidence was used for this study

d = Precision desired, expressed as a decimal (i.e. 0.05 for 5% used for this study

P = Estimated variance in Population as a decimal (i.e. 0.5 for this study)

N= total number of population, 10,300.

Therefore;

s= $\underline{1.96^2 \text{ x } 10{,}300 \text{ x } 0.5 \text{ x } (1-0.5)}$

$(0.05^2 \times (10{,}300 - 1) + 1.96^2 \times 0.5 \times (1\text{-}0.5))$

= <u>9829.120</u>

(25.7475 + 0.9604)

= <u>9829.120;</u> s= 370.3818 26.7079

Therefore, s= 370

370 questionnaires were distributed for this study, with 159 questionnaires retrieved from respondents and 3 out of the 159 were rejected as a result of incomplete response. The remaining 156 were deemed adequate for further analysis and were therefore used for all analysis done in this study. 42.16% response rate was obtained from the number of usable and completely filled questionnaire, and based on what has been proposed in construction management literature; this response rate is considered suitable and adequate.

“a response rate of over 20-30% is ideal for good quality construction based survey” Akintoye (2000).

3.5 Sampling Technique

Sampling technique according to Oladun (2013) is the strategy adopted in selecting respondents for a study.

“The categories of sampling techniques include simple sampling systematic, stratified and clustering random sampling (Morenikeji, 2006).

Simple random sampling method was adopted for this study in the administration of questionnaires and collection of data. The essence of using this method is to provide equal opportunities for samples selected.

3.6 Data Collection Instrument

A well-structured questionnaire was used to collect primary data from respondents. "Questionnaire survey is a systematic method of obtaining data based on sample" (Tan, 2011). The questionnaire has been extensively used to solicit opinion on effects of efficiency loss from professionals and contractors in the construction industry. (Xue *et al., 2016*).

The questionnaire used in the study, is structured into five (5) sections for convenience purpose;

Section A – Questions about general information or respondents

Section B – Questions on the methods of measuring efficiency losses

Section C – Questions on the factors responsible for the occurrence of efficiency loss in construction.

Section D - Questions on the factors of time performance on construction projects.

Section E - Questions on the effects of efficiency losses on the performance of construction projects.

Section F- Questions on the measures for minimizing efficiency losses in construction.

3.7 Data Collection Procedure

Self-administered questionnaires were used to collect data through random sampling method.

Pilot study: The final draft of the questionnaire was piloted prior to final administration. The essence was to know how clear and intelligible the questionnaire was, and to ensure that respondents understand the questionnaire contents. The pilot survey also helped to shape the questionnaire contents.

3.8 Method of Data Analysis

The data collected were analysed using factor analysis and descriptive statistics.

The descriptive statistics used to present, analyse and rank variables are tables, percentages, charts, mean item score, and Relative Importance Index.

The respondent's general information was analysed using percentage and frequency. The results of the analysis were presented using tables and charts. Mean item score was used to determine the methods of measuring efficiency losses in construction and rank variables in (objectve 1), Relative Importance Index was used to assess; the factor of time performance in construction projects, the effect of efficiency losses on construction project performance (objective 3), and in determining measures of minimizing the occurrences of efficiency losses on construction projects (objective 4).

Pearson Correlation analysis was further applied to test the direction and strength of the relationship between the variables on effect of efficiency losses on construction project performance (objective 3). Factor Analysis was applied to examine the factors responsible for efficiency losses in construction projects (objective 2). The formula for Mean Item Score is

$$\text{Mean Item Score (MIS)} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{n_5 + n_4 + n_3 + n_2 + n_1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.2)$$

Fagbenle *et al.* (2004) opined that Relative Importance Index (RII) is calculated when the score given by the target respondents are summed up. The Relative Importance Index formula is written as:

$$\text{Relative Importance Index (RII)} = \frac{\sum P_i U_i}{A \times N} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.3$$

Where;

Pi = respondent rating of variables

Ui = Number of respondents placing identical weighting/rating on variables

A= highest weighting (i.e 5 used for this research)

N= Sample size

The following cut off points were adopted in this study to establish level of significance, satisfaction, importance and/or severity of factors using Relative Frequency (or percentage) Index;

i. (0-20%) – Very Low
ii. (21-40%) – Low
iii. (41-60%) – Average
iv. (61-80%) – High
v. (81-100%) – Very high

Table 3.2: Methods of Data analysis

S/N	Objectives	Analysis tools
1	To rank the methods of measuring efficiency losses in construction	Mean item score, MIS
2	To identify the major factors responsible for efficiency losses in construction projects	Factor Analysis (FA)
3	To identify the factors of time performance in construction projects	Relative Important Index, (RII)
4	To analyse the effect of efficiency losses on construction project performance	Relative Important Index, (RII) & Correlation Analysis
5	To determine measures of minimizing the occurrences of efficiency losses on construction projects	Relative Important Index, (RII)

Source: Author (2020)

3.8.1 Reliability evaluation

The reliability of the data gathered was determined by the application of Cronbach's Alpha test as shown in table 3.3 on the gathered data proved that the research instrument is reliable and have high internal consistency. This decision is supported by the submissions of (Oyedele *et al.,* 2003, Aghimien *et al.,* 2018, Kasim *et al.,* 2019).

Oyedele *et al.* (2003) opined that an alpha value of 0.70 and above mean higher and reliable internal consistent of the research instrument. According to Aghimien *et al*. (2018), Cronbach’s normal range value is between 0 and 1, and the degree of internal consistency increases as the value increases. An alpha value than 0.70 indicates a good internal consistency and reliability (Kasim *et al*., 2019).

Table 3.3: Reliability evaluation

Assessed variables	Cronbach's Alpha	Nr. of items
Methods of measuring efficiency losses in construction	0.964	14
Factors responsible for efficiency losses in construction projects	0.845	25
Factors of time performance in construction projects	0.955	24
The effects of efficiency losses on time performance of construction project	0.714	11
Measures of minimizing the occurrences of efficiency losses on construction projects	0.754	12

Source: Author (2020)

The entire methodology for the study is summarised in the methodology flow chat in Figure 3.1 (See next page).

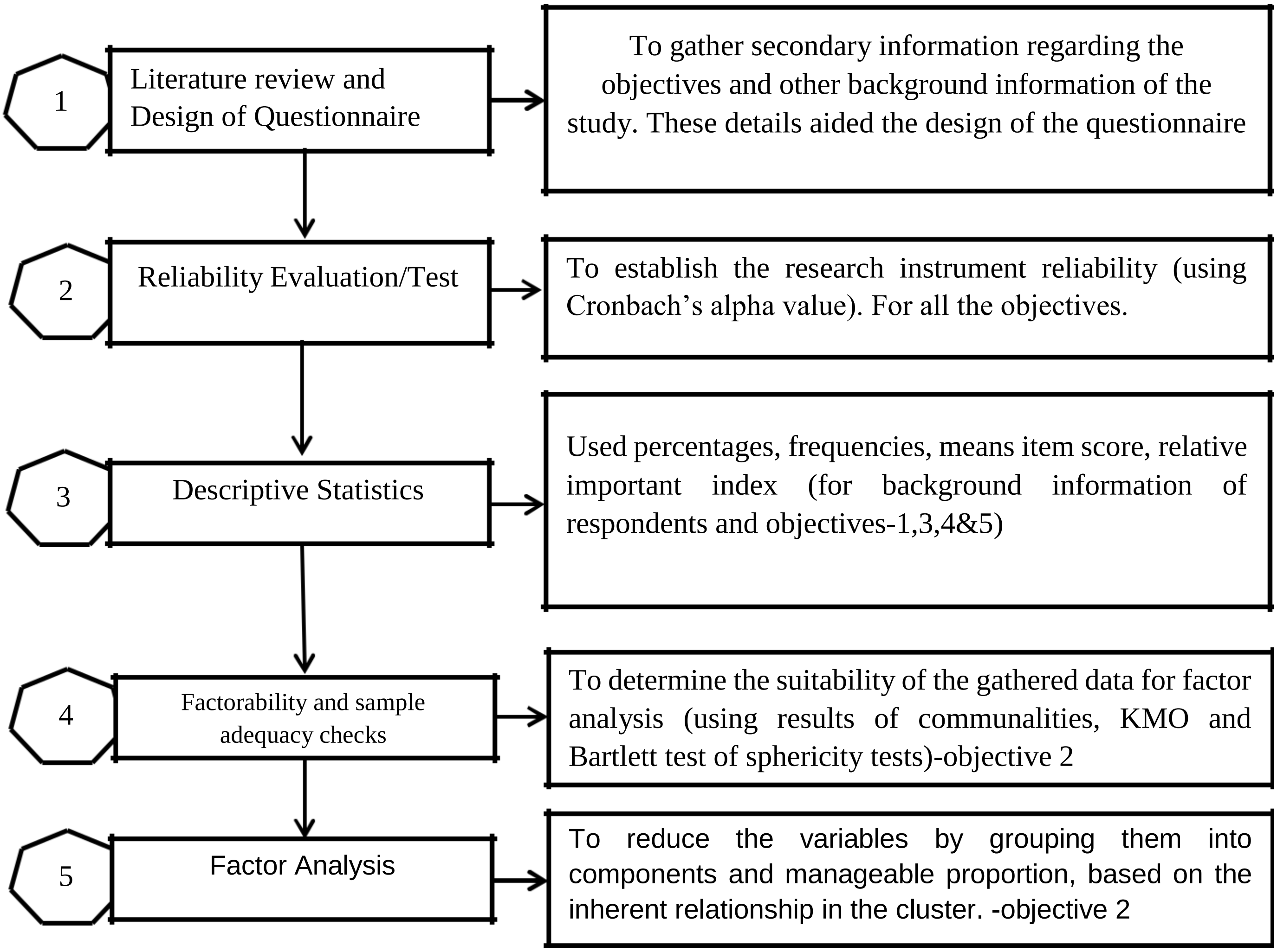

Figure 3.1: Methodology flow chart

Source: Author (2020)

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1: Respondents Background Information

In Table 4.1, 64.74% of the respondents work with private organisations and 35.26% work with public organisations. In terms of professional background, 22.44% of the respondents are registered Architects, 17.95% are Builders, 30.77% are Engineers, and 28.85% are Quantity Surveyors, thus making a fair representation of the key construction professionals. From the data obtained, the highest educational qualification of the respondents shows that 1.28% have PhD, 26.28% are MSc/MTech holders, 35.26% are BSc. /BTech holders,13.47% have PGD, and 23.7% hold HND. This proves that the respondents are academically qualified to give valuable information to achieve the aim of the study.

The years of experience show that 11.56% have spent 1-5 years in the construction industry, 32.69% have spent 5-10 years, 37.18% spent 11-15 years, 12.18% had spent 16-20 years and 6.41% have spent over 21 years in the industry. This further prove that the respondents are experienced enough to provide reliable and dependable information needed to carry out this research. In terms of professional affiliation, the data shows that 88.46% of the respondents are corporate members of their various professional organisations and only 11.54% are still probationer members of their professional organisation. This therefore show that the respondents are professionally qualified to give quality information on the subject of this study. In terms of organisational size, 36.54% of the participants' organisations are large size, 22.44% are medium organisations and 41.67% are small organisations.

The 36.54% large organisation could be attributed to the number of participants from the public sector organisations. However, the small and medium size organisations are 64.10%, indicating that they are SMEs

Table 4.1: Background information on Respondents

Variables	**Classification**	**Freq.**	**%**
Ownership of Organisation	Public organisation	55	35.26
	private organisation	101	64.74
	TOTAL	**156**	**100.00**
Respondents' Profession	Architecture	35	22.44
	Building	28	17.95
	Engineering (Civil & Services)	48	30.77
	Quantity surveying	45	28.85
	TOTAL	**156**	**100.00**
Highest educational qualification	Higher national Diploma (HND)	37	23.7
	Postgraduate Diploma (PGD)	21	13.46
	Bachelor of Science/technology (B.Sc/B.Tech)	55	35.26
	Master's Degree (MSc./M.Tech	41	26.28
	Doctorate degree (PhD)	2	1.28
	TOTAL	**156**	**100.00**
Years of experience	1-5years	18	11.54
	5-10 years	51	32.69
	11-15 years	58	37.18
	16-20 years	19	12.18
	21-above	10	6.41
	TOTAL	**156**	**100.00**
Professional affiliation	MNIA	28	17.95
	NIOB	23	14.74
	NSE	45	28.85
	NIQS	42	26.92
	Probationer	18	11.54
	TOTAL	**156**	**100.00**
Size of organisation	Small	65	41.67
	Medium	35	21.79
	Large	57	36.54
	TOTAL	**156**	**100.64**

Source: Author (2020)

4.2 Projects upon Which Assessment Was Based

The respondents were asked to nominate a project among those handled by their organisation to base their assessment on. The summary of the projects undertaken is shown in (figure 4.1). It can be seen that construction of shopping mall is 25 (16.03%), Construction of residential building projects duplex was 35(22.44%), Construction of office building/complex was 10 (6.41%), Construction of housing estate project was 8(5.13%), Construction of estate road and drainages was 8 (5.13%), renovation of public schools was 21(13.46%), construction of public school was 34 (21.79%) and construction of hotel projects were 15(9.62%).

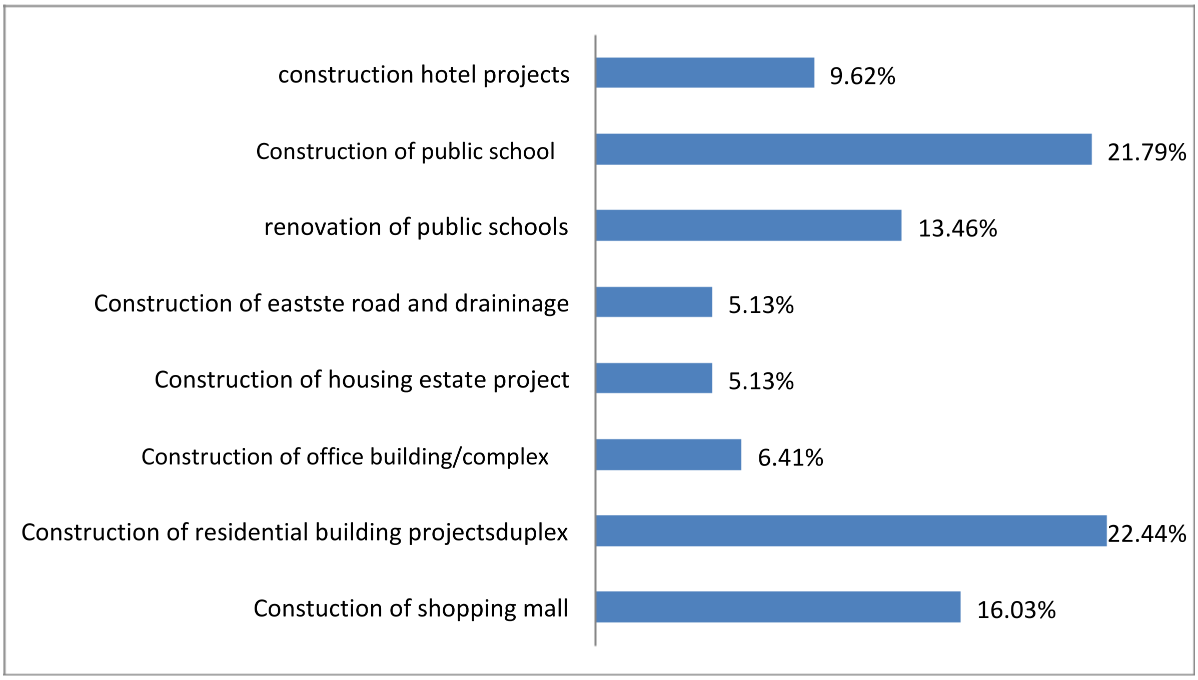

Figure 4.1: Project upon which assessment was based

Source: Author (2020)

4.3: Methods of Measuring Efficiency Losses in the Construction Industry

Table 4.2 results show the analysis of data gathered on Methods of Measuring Efficiency Losses in Construction. The top most used methods are; Total Cost Method (RII=0.883), Baseline Productivity Analysis (RII=0.872), Measured Mile Method (RII=0.865), Expert Opinion (RII=0.865), Published Inefficiency Factor (RII=0.852) and Earned Value Analysis Method (RII=0.852). The least 3 most used methods of measuring efficiency losses in construction are; Industry-Based Method (RII=0.767), System Dynamics Modelling (RII=0.732), Physical Measurement Method (RII=0.730).

The maximum and Minimum RII of the methods are 0.883 and 0.730 respectively, and with an average RII of 0.816. This shows that the variables are used for measuring efficiency losses on construction projects.

Table 4.2: Methods of measuring efficiency losses in construction

S/No	methods of measuring efficiency losses	RII	Rank
1	Total Cost Method	0.883	1st
2	Baseline Productivity Analysis	0.872	2nd
3	Expert Opinion	0.865	3rd
4	Measured Mile Method	0.865	3rd
5	Published Inefficiency Factor	0.852	5th
6	Earned Value Analysis Method	0.852	5th
7	Jury Verdict	0.816	7th
8	Comparing Actual Productivity from the Subject Project to Different Project	0.815	8th
9	Comparing Actual Productivity to the Contractor's Bid	0.805	9th
10	Sampling Method	0.795	10th
11	Revenue/Work Per Hour Approach	0.776	11th
12	Industry-Based Method	0.767	12th
13	System Dynamic Modelling	0.732	13th
14	Physical Measurement Method	0.730	14th

Source: Author (2020)

4.4 Factors Responsible for Efficiency Losses in Construction Projects

Factor Analysis (FA) was conducted with the use of Principal Component Analysis (PCA) using varimax rotation method of extraction. The essence is to group assessed variable reagarding the cause of efficiency lossess into more manageable and significant portion. Factoriability and suitability evaluation of the gathered data is usually the first step towards performing factors analysis. This evaluation was done by looking at the number of variables, size of sample, Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, commonalities and Bartlett’s Test of Sphericity.

The sample size of 156 and 25 variables are considered adequate and satisfactory for analysis. The decision is based on the reports of (Tabachnick and Fidel, 2007; Pallant, 2005; Mundfrom *et al.*, 2005). The KMO value is 0.8853, and this is higher than the range of 0.5- 0.7 which is adequate and consequently suitable for Factor Analysis. With a Bartlett’s test of sphericity using p-value (or sig.) of 0.0000, df=300, this shows that the variablea are adequate for FA. The significance is below 0.05 and this is the condition that shows that variables involved are patterned relationships (see Table 4.3)

Table 4.3: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.8853
Bartlett's Test of Sphericity	Approx. Chi-Square	4817.4669
	df	300.0000
	Sig.	0.0000

After KMO and Bartlett’s tests, the next is to consider the communalities values. With a amximum and minimu commonalities of 0.553 and 0.976 respectivcely, with an average commonalities of 0.783. this shows that there a relationship among the variables (see Table 4.4). This high commonalities shows that the model errors are low, and the sample size is of no relevance (Preacher and MacCallum, 2002; Zhao, 2008).

4.4.1 Factor analysis of the variables on the causes of efficiency losses

Table 4.5 shows that 4 components with eight values which are greater than 1 were extracted with the use of factor loading of 0.50 as cut-off point (suggested by Spector, 1992). The following are the total variance as explained by each component extracted; Component 1 has 53.41%, component 2 has 9.05%, component 3 has 7.02%, component 4 has 4.52% and component 5 has 4.52%. The extracted components and the final statistics of the PCA account for approximately 78.26% of the total cumulative variance, thus fulfilling the criterion as proposed by Pallant (2007) for factors explaining at least 50% of the variation.

Table 4.4 Total Variance Explained of the causes of efficiency losses

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	13.352	53.408	53.408	13.352	53.408	53.408	5.587	22.347	22.347
2	2.262	9.048	62.456	2.262	9.048	62.456	5.473	21.891	44.238
3	1.755	7.019	69.475	1.755	7.019	69.475	4.174	16.696	60.934
4	1.129	4.517	73.992	1.129	4.517	73.992	2.180	8.722	69.656
5	1.068	4.270	78.262	1.068	4.270	78.262	2.152	8.607	78.262

Source: Author (2020)

Table 4.6 result summerise the factor loading on each of the five extracted factors and their variables. The table contains variables with a significant factor loading greater than 0.50. This is in line with the submission of Spector (1992), who submitted that clear component structure is present when a variable has significant factor loading >0.50 on the component only.

4.4.2 Naming of extracted causes of efficiency losses

4.4.2.1 Construction method and poor documents.

The first component has a factor loading of 6 and account for about 53.41% of total variance. The variables under this component are; use of unfamiliar construction methods reduces productivity, clarity of drawings and project documents, absenteeism and turnover, change in construction method due to design complexity, formwork installation takes longer time owing to complexity of design, and lack of supervision. These variables are observed to be associated with method of construction and documentation issues, and based on this, the components were named '*Construction method and poor documents'*.

4.4.2.2 Communication and materials related causes

The second principal component account for 9.05% of the overall variance explained, and 7 variables are loaded under it. These variables are; ineffective communication, unavailability of materials, number of break and resting period, project characteristics (size, layout, type and location), low level of skills and experience/learning curve, lack of management training and lack of motivation. Following a critical examination of the features of these variables, the component was named '*Communication and materials related causes'*.

4.4.2.3 Poor supervision and planning

The third component has 6 variables loading under it, and they account for 7.02% of the total variance explained. The causes are; lack of sufficient supervisory training, inadequate planning schedule, excessive overtime poor management, workers' lack of integrity, and errors in dimension prefabricated components can cause installation delays.

4.4.2.4 Equipment installation related causes

This account for 4.52% and the factors loaded include; installation difficult of equipment, difficulty in procuring specialist contractor, and scarcity of highly-skilled workmen. After critically examining the latent features of these variables, it is shown that they are related to equipment installation issues. The component on this premise was therefore named *'Equipment installation related causes'.*

4.4.2.5 Industrial action and weather related causes

This principal component accounts for about 4.27% of the overall variance explained. The factors loaded on this component include; strikes/disruptions by unions and others, adverse weather, and inability to adapt to change and new environment. These variables are closely related to workers' unrest and strike and natural causes. The component was on this basis named '*Industrial action and weather related causes'.*

Figure 4.2 summarises the key causes of efficiency losses on construction projects (See next page).

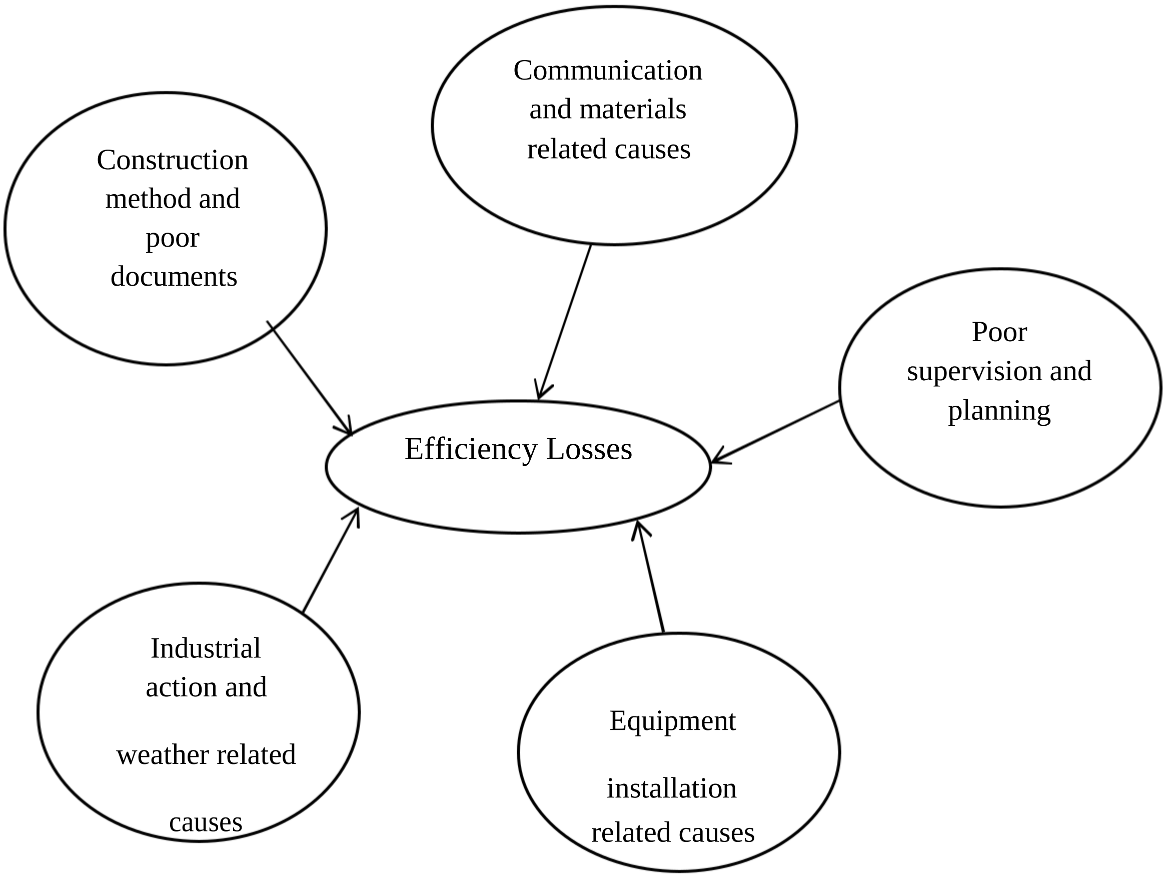

Figure 4.2: Major groups of factors causing efficiency losses

Source: Author (2020)

4.5 Factors of Time Performance in Construction Projects

Table 4.7 show result of analysed data on factors of time performance on construction projects. The top most important factors of time performance are; problems of funding (RII=0.931), Frequent equipment breakdowns (RII=0.923), Incompetent project team (RII=0.912), Inadequate contractor experience (RII=0.908), Rework due to errors (RII=0.903), Poor site financial control (RII = 0.900), Sudden failures actions (RII = 0.886), Ineffective project planning and schedule (RII = 0.885), Progress payments delay (RII = 0.882), and Equipment and materials shortage (RII = 0.882). The least vital factors of time performance are; Selecting inappropriate contractors (RII = 0.837), Lack of coordination between contractor and design team (RII = 0.847), Inadequate planning (RII = 0.796), Legal disputes between project participants (RII = 0.849), Unqualified labour (RII = 0.849)

Regardless of the ranking of the factors, they are all relevant factors of time performance of construction projects. This is evident in the score of the maximum RII of 0.931 and minimum RII of 0.796, with an average RII of 0.875.

Table 4.5: Factors of time performance in construction projects

S/No	Variables	RII	Rank
1	Delay in progress payments (Funding problems)	0.882	10th
2	Different tactics patterns for bribes	0.869	13th
3	problems of funding	0.931	1st
4	Shortage of equipment and materials	0.882	10th
5	Ineffective project planning and scheduling	0.885	9th
6	Poor site management and supervision	0.864	15th
7	Poor financial control on site	0.900	6th
8	Rework due to errors	0.903	5th
9	Selecting inappropriate contractors	0.837	23rd
10	Sudden failures actions	0.886	8th
11	Inadequate planning	0.796	24th
12	Incompetent project team	0.912	3rd
13	Inadequate contractor experience	0.908	4th
14	Frequent equipment breakdowns	0.923	2nd
15	Design changes	0.872	12th
16	Complexity of project (project type, project scale, etc.)	0.863	16th
17	Legal disputes between project participants	0.849	20th
18	Change orders	0.900	6th
19	Inappropriate construction methods	0.851	19th
20	Unqualified/inadequate experienced labour	0.849	20th
21	Lack of coordination between contractor and design team	0.847	22nd
22	natural disasters/Acts of God	0.869	13th
23	Poor attention to health and safety	0.862	17th
24	lack of communication between parties	0.858	18th

Source: Author (2020)

4.6 Effect of Efficiency Losses on Time Performance of Construction Project

Results in Table 4.8 show that with regards to the time effects of efficiency loses, time loss in late delivery of materials, approved instructions (RII=0.886) is ranked highest, followed by Unavailability of materials in the market leading to time loss (RII=0.849), Time loss in rectifying errors/poor quality work (RII=0.836), and Payment delays lead to suspension of work/loss of schedule time (RII=0.805). With regards to the impact of efficiency loses on cost, extra cost in redoing poor delivered work (RII=0.867) is ranked highest, followed by cost of poor communication efficiency (RII=0.857), Cost of unproductive/poor supervision (RII=0.846), and Cost of labour for waiting time for the needed materials and equipment (RII=0.733). With reference to quality, the impact of efficiency loses on quality are; Dissatisfaction of clients and loss of potential clients (RII=0.855), Increased demolition waste/materials losses (RII=0.782), and Lead to rejection of deliverables (RII=0.740).

Overall, the effect of efficiency losses on time, cost and quality is centred around; Time loss in late delivery of materials, approved instructions (RII=0.885), Extra cost in redoing poor delivered work (RII=0.867), Cost of poor communication efficiency (RII=0.857), Dissatisfaction of clients and loss of potential clients (RII=0.855), and Unavailability of materials in the market leading to time loss (RII=0.849).

Table 4.6: Impact of efficiency losses on the performance of construction projects

S/No	Impact of efficiency loses	RII	Rank	Overall Rank
	Time overrun			
1	Time loss in rectifying errors/poor quality work	0.836	3rd	7th
2	Payment delays lead to suspension of work/loss of schedule time	0.805	4th	8th
3	Time loss in late delivery of materials, approved instructions	0.885	1st	1st
4	Unavailability of materials in the market leading to time loss	0.849	2nd	5th
	Cost overrun			
5	Cost of unproductive/poor supervision	0.846	3rd	6th
6	Extra cost in redoing poor delivered work	0.867	1st	2nd
7	Cost of poor communication efficiency	0.857	2nd	3rd
8	Cost of labour for waiting time for the needed materials and equipment	0.733	4th	11th
	Loss of Quality			
9	Increased demolition waste/materails losses	0.782	2nd	9th
10	Lead to rejection of deliverables	0.740	3rd	10th
11	Dissatisfaction of clients and loss of potential clients	0.855	1st	4th

Source: Author (2020)

4.7 Correlation analysis results of the impact of efficiency losses on project performance

Following the RII evaluation of the effects of efficiency losses, a further correlation analysis was carried out to determine strength and direction of the linear relationship that exist among the constructions (time overrun, cost overrun and Loss of quality), and among other variables. Correlation analysis was executed to determine the nature (strength and direction) of the relationships that exist between the variables (Pallant, 2007). The 11 variables correlated significantly with each other and with at least one other variable (see table 4.6 and detail in Appendix A).

With regards to the direction of the correlation, 31(81.58%) of the assessed variables in Table 4.9 correlated positively with major constructs. While, 7(18.42%) correlated negatively with the major constructs. This 81.58% positive correlation among the variables showed that efficiency losses have a retarding impact on project performance, especially on the key performance measurement parameters of time, cost and quality.

Cohen (1988) suggested a guideline for interpreting the strength of correlation coefficient. Based on this guideline, 60.53% of the assessed variables have small correlation, 31.58% have medium correlation, and 7.89% have large correlation. This result reflects the understanding of the respondents on the variables assessed and they are impacted by efficiency losses. It can be concluded that regardless of the size of the strength of correlation, a change caused by efficiency losses on labour could impact on time of performance of a deliverable, and this could further impact on the cost and quality should there be a delay. Therefore, when project delivery time is delayed due to inefficiency of labour, the projects is most likely to suffer cost overruns and quality of deliverables would suffer (i.e. poor quality of work). Therefore, efficiency losses impact negatively on construction project performance and this could impact on the contractor's profit, relationship with clients and other critical stakeholders.

Table 4.7: Correlation analysis results (See next page).

Table 4.7: Correlation analysis results

Constructs		Variables	Correlation coefficient
Time loss in rectifying errors/poor quality work	1	Payment delays lead to suspension of work/loss of schedule time	.493**
	2	Time loss in late delivery of materials, approved instructions	.425**
	3	Unavailability of materials in the market leading to time loss	.423**
	4	Cost of unproductive/poor supervision	.303**
	5	Extra cost in redoing poor delivered work	.298**
	6	Cost of labour for waiting time for the needed materials and equipment	.134**
	7	Increased demolition waste/materials losses	-.189**
	8	Lead to rejection of deliverables	.177**
	9	Dissatisfaction of clients and loss of potential clients	-.032**
Payment delays lead to suspension of work/loss of schedule time	1	Time loss in late delivery of materials, approved instructions	.322**
	2	Unavailability of materials in the market leading to time loss	.465**
	3	Cost of poor communication efficiency	.206**
	4	Increased demolition waste/materials losses	.175**
	5	Lead to rejection of deliverables	.400**
Time loss in late delivery of materials, approved instructions	1	Unavailability of materials in the market leading to time loss	.280**
	2	Cost of poor communication efficiency	-.173**
	3	Cost of labour for waiting time for the needed materials and equipment	-.009**
	4	Lead to rejection of deliverables	-.023**
Unavailability of materials in the market leading to time loss	1	Cost of unproductive/poor supervision	.228*
	2	Extra cost in redoing poor delivered work	.217*
	3	Cost of poor communication efficiency	.011**
	2	Cost of labour for waiting time for the needed materials and equipment	.131**
	3	Increased demolition waste/materials losses	.073**
	4	Dissatisfaction of clients and loss of potential clients	.042*

**. Correlation is significant at the 0.01 level (2-tailed); *. Correlation is significant at the 0.05 level (2-tailed); N =156

Table 4.7: Correlation analysis results (CONT'D)

Constructs		Variables	Correlation coefficient
Cost of unproductive/poor supervision	1	Extra cost in redoing poor delivered work	.438**
	2	Cost of poor communication efficiency	.521**
	3	Lead to rejection of deliverables	-.106*
Extra cost in redoing poor delivered work	1	Cost of poor communication efficiency	.435**
	2	Lead to rejection of deliverables	.075*
	3	Dissatisfaction of clients and loss of potential clients	.185**
Cost of poor communication efficiency	1	Cost of labour for waiting time for the needed materials and equipment	.504**
	2	Increased demolition waste/materials losses	.338**
	3	Lead to rejection of deliverables	-.034**
	4	Dissatisfaction of clients and loss of potential clients	.060**
Cost of labour for waiting time for the needed materials and equipment	1	Increased demolition waste/materials losses	.355**
	2	Lead to rejection of deliverables	.099**
Increased demolition waste/materials losses	1	Lead to rejection of deliverables	.279**
Lead to rejection of deliverables	1	Dissatisfaction of clients and loss of potential clients	.418*

**. Correlation is significant at the 0.01 level (2-tailed); *. Correlation is significant at the 0.05 level (2-tailed); N =156

SOURCE: Author (2020)

4.8 Means of minimizing the occurrences of efficiency losses on projects

Table 4.10 show the ranking of the Measures of minimizing the occurrences of efficiency on construction projects. It can be seen that the top five measures of minimizing the occurrences of efficiency losses on construction projects are; Project Leadership (RII=0.836), Effective Communication (RII=0.836) Adequate Supervision (RII=0.835), Project Monitoring (RII=0.823), and Workers Training and Education (RII=0.822). While the least 3 measures are; Sufficient Management Training (RII=0.781), Incentives and Workers Motivation (RII=0.781) and Reduction in Overtime (RII = 0.691).

Irrespective of the ranking of the measure, they are all relevant in minimizing the occurrences of efficiency losses on construction projects. This is premised on the maximum RII of 0.836 and minimum RII of 0.691, with an average RII of 0.801 obtained.

Table 4.8: Measures of minimizing the occurrences of efficiency losses on construction projects

S/No	Measures for minimizing efficiency losses	RII	Rank
1	Project Planning	0.818	6th
2	Project Leadership	0.836	1st
3	Project Resource Allocation	0.797	7th
4	Project Monitoring	0.823	4th
5	Sufficient Management Training	0.781	10th
6	Incentives and Workers Motivation	0.781	10th
7	Sufficient Supervisory Training	0.794	9th
8	Effective Communication	0.836	1st
9	Adequate Supervision	0.835	3rd
10	Workers Training and Education	0.822	5th
11	Reduction in Overtime	0.691	12th
12	Workers' Discipline	0.797	7th

Source: Author (2020)

4.9: Discussion of results

4.9.1 Methods of measuring efficiency losses in construction

The study revealed that the top most used methods of measuring efficiency losses in construction are; Total Cost Method, Baseline Productivity Analysis, Measured Mile Method, Expert Opinion, Published Inefficiency Factor and Earned Value Analysis Method. This result is in line with the submissions of (Egwunatum *et al,* 2015). In the total cost method, the estimated labour cost is subtracted from the actual costs incurred to get overrun upon which the inefficiency claims are based (Jones, 2003; Klanac and Nelson, 2004). According to Egwunatum *et al* (2015), baseline productivity is determined by measuring input and output in the least impacted or un-impacted periods of the time of the projects. This therefore make efficiency loss the difference between the productivity actually observed and that expected if the unanticipated condition had not occurred.

Baseline Productivity Analysis represents or reflects the normal contractor's operating performance (Gulezian and Samelian, 2003; Thomas and Završki,1999). The Baseline Productivity method is also dependent on the analysis of the actual performance of the contractor on the projects (Nelson, 2011). It was submitted by Nelson (2011) and Nelson (2011) that this method is the most preferred method and widely accepted method of determining efficiency losses (or productivity losses).

The expert opinion method according to Nelson (2011), rely on the opinion of construction expert reviewing the project documentation to quantify the productivity loss as experienced by contractor on the operation in dispute. Thus, according to Sanders and Nagata (2003), a significant portion of productivity loss calculation is primarily based on an expert's testimony. The limitation of expert opinion is that it relies on the fact that estimates are based on opinion and not project based analysis of supporting documents.

4.9.2 Factors responsible for efficiency losses in construction projects

Based on the analysis carried out, it was found that the causes of efficiency losses are Construction method and poor documents, Communication and materials related causes, Poor supervision and planning, Equipment installation related causes, and industrial action and weather related causes. Education and upgrading of the experts' skills of workers is a key to ensuring that work is carried out without efficiency losses. This is among the key cause of poor supervision, inadequate knowledge of modern construction methods. Dozzi and AbouRizk (1993) found that the top among the causes of efficiency losses are ineffective communication, inadequate scheduling and planning, and insufficient supervisory training. Also, lack of adequate management training and supervision and project management deficiencies contributes greatly to efficiency losses construction projects.

4.9.3 Factors of time performance in construction projects

The most important factors of time performance revealed by the study are; problems of funding, frequent equipment breakdowns, inadequate contractor experience, incompetent project team, change orders, sudden failure actions, poor site financial control, errors resulting in rework, delay in payments, materials and equipment shortage, and ineffective project scheduling and planning. These results support findings from existing studies such as (Aziz, 2013; Gebrehiwet and Luo, 2017; and Thapanont *et al., 2018*).

Among the key factors of time performance reported by (Gebrehiwet and Luo, 2017) are lack of quality materials, late material delivery, increase in price of materials, poor site management, late design, and late release of funds

Thapanont *et al.* (2018) found that equipment inefficiency, contractor's financial status, incomplete drawing, inadequate engineer's experience, delay in relieving environmental impact, poor site management, and inadequate safety at site are all factors of time performance.

4.9.4 Effect of efficiency losses on time performance of construction projects

The study revealed that efficiency losses have impact on cost, time and quality, especially in the areas of; Time loss in late delivery of materials, approved instructions, Extra cost in redoing poor delivered work, cost of poor communication efficiency, Dissatisfaction of clients and loss of potential clients, and Unavailability of materials in the market leading to time loss. This is synonymous with the findings of (Chan and Kumaraswamy, 2002; and John *et al., 2015*).

According to John *et al* (2015), inefficiency in the management of key organisational resources could impact negatively on these 3–key projects success measurement parameters. Chan and Kumaraswamy (2002), "project time is of increasing importance due to the fact that it serves as a vital benchmark for assessing project performance and project organisation efficiency". Efficiency loss results in extended time of delivery, and poor quality which in turn results in increased cost of project delivery.

4.9.5 Measures of minimizing the occurrences of efficiency losses on construction projects

It was revealed that the most important Measures of minimizing the occurrences of efficiency losses on construction projects are; Project Leadership, Effective Communication, Adequate Supervision, Project Monitoring, and Workers Training and Education. This supports the submission of (Murithi et al., 2017). This finding underscores the importance of leadership and management, communication, supervision, monitoring and education on the delivery of construction projects. To avoid the risks and /or costs associated with labour lost productivity, Murithi et al. (2017) suggested that there should be sufficient management Training, incentives and Workers Motivation, Sufficient Supervisory Training, effective Communication, adequate Supervision, workers Training and Education, reduction in Overtime, and workers' Discipline

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The aim of carrying out this research is to assess the effect of efficiency losses on time performance of construction projects, with a view to suggesting possible solutions at minimizing their occurrences. As part of achieving this aim, the study objectives are; to identify the methods of measuring efficiency losses in construction, to identify the factors responsible for efficiency losses in construction projects, to identify the factors of time performance in construction projects, to analyse the effects of efficiency losses on time performance of construction project, and to determine measures of minimizing the occurrences of efficiency losses on construction projects.

With the aid of a well-structured questionnaire developed from a detailed literature review, and utilizing a simple random sampling of construction professionals, the study was able to achieve its aim.

The study found that major methods of measuring efficiency losses in construction are; Total Cost Method, Baseline Productivity Analysis, Measured Mile Method, Expert Opinion, Published Inefficiency Factor and Earned Value Analysis Method. Also, the causes of efficiency losses are Construction method and poor documents, Communication and materials related causes, Poor supervision and planning, Equipment installation related causes, and industrial action and weather related causes. Furthermore, the most important factors of time performance are; problems of funding, frequent equipment breakdowns, incompetent project team, inadequate contractor experience, poor site financial control, rework due to error, change orders, sudden failures actions, ineffective project planning and scheduling, delay in progress payment, and materials and equipment shortage. Efficiency losses was found to have positive correlation on project performance. This research therefore establish that labour efficiency losses affect time performance as a result of time loss in late delivery of materials, extra cost in redoing poor delivered work, poor communication, unavailability of materials in the market leading thereby leading to dissatisfaction of clients and loss of potential clients.

The most important Measures of minimizing the occurrences of efficiency losses on construction projects are; Project Leadership, Effective Communication, Adequate Supervision, Project Monitoring, and Workers Training and Education.

5.2 Recommendation

The study, from the findings and conclusion make recommendation as follows;

i. Clients should ensure adequate provisions for funding are made prior to embarking on construction projects. This is because poor financial standing has a demotivating effects on capital projects performances.

ii. The period of construction should be properly timed and schedule to avoid the negative effects of inclement weather.

iii. Adequate provision of materials, equipment and tools is required to ensure timely delivery of construction projects and improved productivity of labour.

iv. Efficient communication is a key to successful delivery of construction projects. Top management should provide the needed environment for the free flow of information and exchange of ideas. Communication flow should be seamless and timely for efficient labour productivity and reduce claims.

v. Experienced supervisory staff should be engaged to ensure that works are discharged as planned. Adequate and sound supervision of labour is a key to ensure that deliverables meets quality specifications.

vi. Staff training and retraining on modern construction methods is important to ensure that construction experts are update with the trends in the construction industry.

5.3 Contribution to Knowledge

The contribution of the research to knowledge based on its findings are as follows;

i. This study will aid construction managers to come up with approach regarding appropriate supervision, staffing and management of both human and materials resources of construction projects for better performance with regards to time, cost, and quality.

ii. The study has provided further understanding of efficiency losses on labour lost claims as well as productivity on construction projects.

iii. The study has added to the existing body of knowledge on the effect of construction labour inefficiencies and the key contributing factors.

5.4 Area for Further Study

The following areas are recommended by the study for further research;

i. Other state/s region/s or geo-political zones, should also be considered for similar research. This is for data to be made available for comparison purposes

ii. Further study could also be conducted to empirically examine the relationship between efficiencies losses and cost performance of construction projects.

iii. A comparative study of the conventional construction methods and sustainable construction methods in the production of inefficiencies in labour should be embarked upon.

iv. The contribution of efficiency losses to unsuitable construction as it's pertain to the environment, economic and social well-being of the community should be assessed.