MAKERERE UNIVERSITY

COLLEGE OF ENGINEERING, DESIGN, ART, AND TECHNOLOGY

SCHOOL OF BUILT ENVIRONMENT

DEPARTMENT OF CONSTRUCTION ECONOMICS AND MANAGEMENT

TOPIC: ANALYSIS OF ON-SITE PRODUCTIVITY CONSTRAINTS AND IMPROVEMENT TECHNIQUES.

CASE STUDY (KAMPALA)

BY

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A RESEARCH REPORT SUBMITTED TO THE DEPARTMENT OF CONSTRUCTION ECONOMICS AND MANAGEMENT IN PARTIAL FULFILLMENT FOR THE AWARD OF A BACHELOR OF SCIENCE IN CONSTRUCTION MANAGEMENT.

OCTOBER 2022

DECLARATION

I declare that this is my original work to the best of my knowledge and that the content of this information is a true representation of my research report and it has not been submitted for any degree award in any other University or Institution, except where due acknowledgment has been made in the text.

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APPROVAL

This is to certify that ALINAITWE SHALIFU has done this research report under my supervision. He has developed this project report and it is hereby approved for submission for partial fulfillment of the award of a Bachelor of Science in Construction management.

Signature..... **Date**..11/10/2026

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SUPERVISOR

ACKNOWLEDGEMENT

I would like to record my appreciation to my supervisor, Mr. Arinaitwe Grace for his guidance in the research process, constant encouragement, and advice. Finally, my sincere gratitude goes to my family for their prayers, unfailing faith in me, and enormous support, which contributed to the successful completion of this research report. It is dedicated to them and to all those who helped to make it a success.

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ABSTRACT

The predominant decline in on-site construction productivity in the Ugandan construction sector is a result of internal and external factors, which constrain the achievement of set building project objectives. This leads to contractors investing in a lot of money and getting less returns on investment. The main objective of this study is to identify the key constraints to on-site construction productivity based on the views of project managers, contractors and subcontractors in the Ugandan construction industry. Qualitative data collected through pilot interviews formed the basis for questionnaire surveys conducted among the target populations. Pareto analysis was used to identify priority factors that stake holders should focus on to improve on-site productivity on construction sites while the multiple regression technique was used for the tests of the research hypotheses for objective three. Feedback from the respondent interviews revealed 26 on-site construction productivity constraint factors, which were grouped under four broad categories: project finance, workforce, technology/process, unforeseen events, and other external forces. Results of the analyzed questionnaire surveys showed that reworks and late payments among project finance factors, material shortage at site and delay in delivery of materials under material related constraint factors were the most occurring constraint factors and accounted for 80% of on-site construction productivity as assumed by pareto principle. workforce turnover under workforce constraint factors also were among the 20% constraint factors accounting for 80% of the problems in on-site construction productivity. Hypothesis was tested to reveal the dependence of material related constraints on on-site construction productivity(efficiency). The hypothesis revealed that material related constraints had a significant effect on time productivity and had no significant effect on satisfaction of work or quality of works done on site. Suggestions for improving on-site construction productivity included application of new technologies and adequate planning that had a bigger percentage, proper risk management strategies, proper site management and increasing labour wages were other improvement techniques that were suggested.

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CHAPTER ONE: INTRODUCTION

1.2 Background

Productivity enables an organization to be competitive, achieve set goals, meet stakeholder value propositions and maintain strategic and financial health. At the industry level, productivity enables the sector to maintain satisfied clientele, attract investment, remain viable, and contribute to the economic growth and well-being of the nation.

The construction sector constitutes of 40%-60% of the Gross Fixed Capital Formation in developing countries. GFCF is an expenditure on fixed assets (buildings, vehicles, machineries, etc.) for either replacing or adding to the stock of fixed assets (Ganesan, 2000). These fixed assets are repeatedly or continuously used in the production process. According to Uganda Bureau of Statistics (UBOS, 2018), the construction sector directly contributes to approximately 7 per cent of gross domestic product (GDP). The Ugandan Government sees it self-industrializing the nation by the year 2040 therefore priority being given to the infrastructure development.

According to Uganda Vison 2040, the bottlenecks hindering Uganda's private sector growth include: limited access and use of modern technology; insufficient engineering manpower; negative attitude towards work leading to low on-site productivity; limited access to credit; insufficient incentives; high production costs; low productivity; and low profitability. Improvement in the productivity of Uganda construction industry is therefore of critical importance

For the nation's economy to grow, construction productivity is very important and plays a significant role in the industry (Naoum, 2016). Labour is known as the most crucial and flexible resource used in construction projects and construction productivity is directly related to labour (Muqeem et al, 2012). Construction projects hire a large number of workers, thereby, it can be stated that the workforce is the dominant productive resource; therefore, construction productivity is highly dependent on human effort, efficiency, and performance (Jarkas, 2010).

There are several definitions provided of productivity by different researchers. The term 'productivity is generally defined as the maximization of output while optimizing input ((Naoum, 2016); (Durdyev et al, 2018)). According to (Mahamid, 2016), results indicate that owners rank 'poor communication among project participants as the top severe factor affecting performance in construction projects, followed by 'poor on-site productivity and 'poor planning and scheduling respectively. In addition, productivity is one of the important aspects of the construction industry, which helps its survival and growth. Therefore, improving the productivity of the construction industry is of critical importance considering its significant contribution to the GDP (Hafez et al, 2014). According to (Mahamid IA, 2013), on-site productivity plays a key role in determining the success

of a project. However, it might be affected by many unexpected variables. These variables may include factors related to labor, materials, tools, and equipment, construction methods, politics, financing, and environment (Alinaitwe H.M et al, 2007). Poor on-site productivity is one of the main causes of cost and time overruns in construction projects.

An earlier study by (Duncan, 2002) concludes that "an improvement in the 'efficiency' of the building and construction sector defined as a reduction in the cost of work put in place will have a positive effect on every other sector, and consequently on the national economy".

Sufficient evidence suggests that on-site productivity measurements should be the basis for making productivity improvement decisions ((Carlos & Paul, 2010); (McCullouch, 2007)). This study will focus on on-site productivity constraints, since addressing these constraints will provide a much-needed improvement in the productivity and performance of the industry. The research will ascertain whether the most significant way of improving onsite productivity globally in the construction industry is technological application as it was put across by findings in the research carried out by (Kim H. et al, 2006); (Shehata et al, 2011)).

1.3 Problem Statement

Stakeholders in the construction industry are overwhelmed by the enormity of the constraint factors presented by different researches without identify priority factors. Given that the resources available for addressing the identified constraint factors are limited, a deeper level of analysis to identify the priority factors, which the stakeholders should focus on to optimize the use of scarce resources and achieve the greatest improvement in productivity and performance is required.

In doing this, the study falls back on the Pareto principle or the '80/20' rule, which assumes that 80% of the problems associated with any given phenomenon arise from 20% of the causes. The crucial question this study aims to address is, therefore, "what are the 20% constraint factors responsible for 80% of the onsite productivity problems in the construction industry of Uganda and how selected constraints affect on-site construction productivity. The study will also address the question of the key mitigation measures for addressing the identified Key Constraints.

1.4 Objectives

The main objective of this study was to identify the key constraints and establish their magnitude of effect to on-site construction productivity in the construction industry of Uganda.

1.4.1 Specific Objectives

1. To determine the frequency of occurrence of identified on-site construction productivity constraints.
2. To determine the effect of on-site key constraints on on-site construction productivity.
3. To explore innovative ways of improving on-site construction productivity in the industry.

1.4.2 Research questions

1. How often do on-site productivity constraints occur on selected sites in Uganda?
2. To what extent do on-site constraints affect on-site construction productivity?
3. What are the innovative ways of improving on-site construction productivity in the industry?

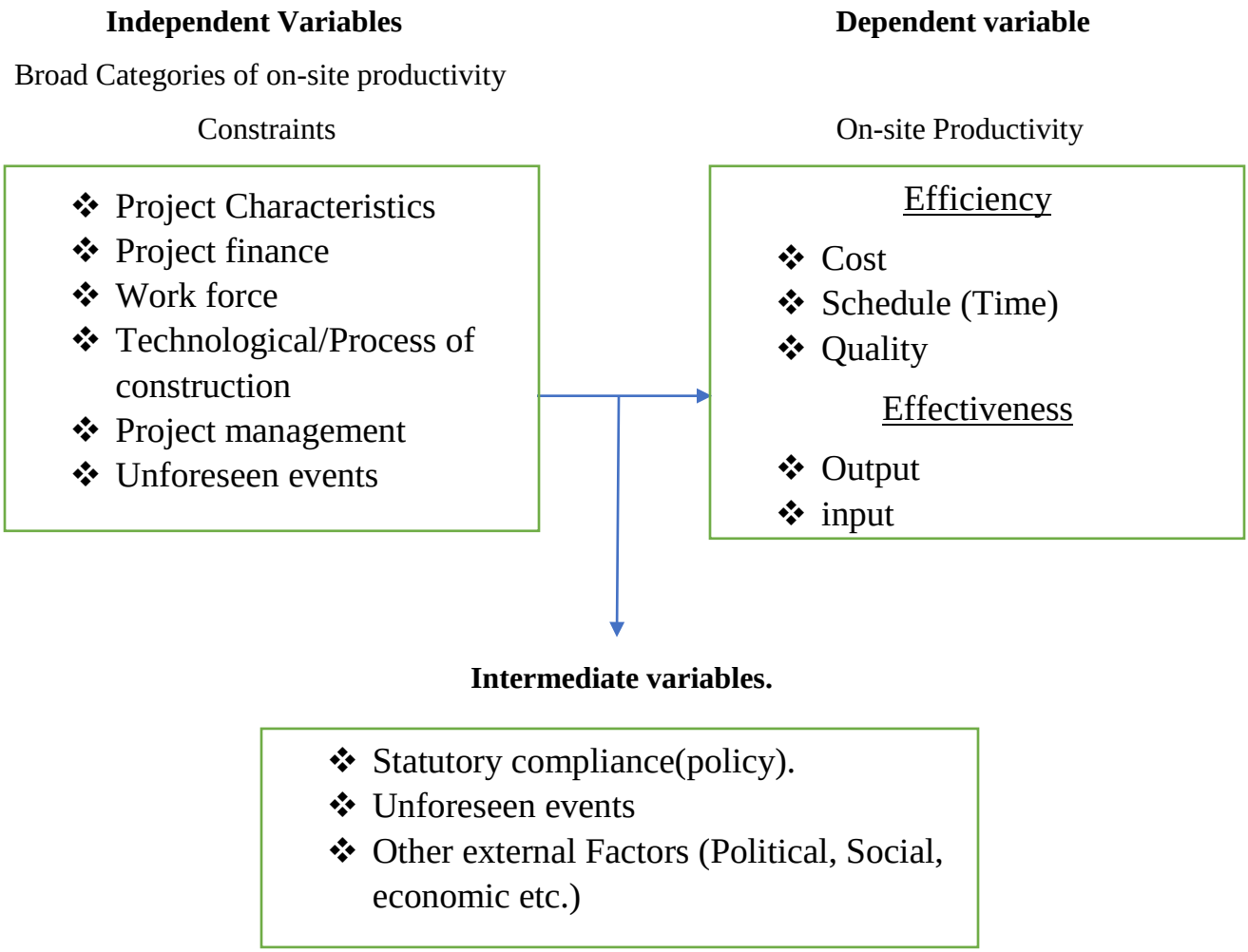
1.5 Significance of the Study

The research findings would provide the critical onsite productivity constraints, which project managers, contractors, and other stakeholders could focus on in order to achieve the greatest improvement in onsite productivity and performance in the Uganda building industry. This way, resources could be optimally disbursed to address the few causes responsible for the significant portion of the productivity issues

1.6 Justification of the study.

A study of the factors constraining onsite labor productivity in the construction industry is not new. Several studies have been carried out on this issue both in Uganda and overseas. However, the previous studies merely provided a list of constraint factors without some form of prioritization and proper segregation into controllable and uncontrollable categories. This study aims to fill this gap in the literature by not only investigating the onsite productivity constraint factors unique to the Ugandan construction industry but also analyzing their relative levels of impact with a view to identifying the key factors that are worthy of closer attention and resourcing in order to minimize wastage of resources.

1.7 Conceptual frame work



1.8 Scope of the Study.

1.8.1 Geographical Scope.

The research was conducted on selected construction sites in Rubaga Division in Kampala district.

1.8.2 Content Scope and Limitations of the Study.

The research focused on investigating the key constraints to on-site productivity on construction sites in Uganda, particularly in Kampala. The study took on the approach of reviewing literature related to the subject topic. From published and unpublished reports, conference papers, textbooks, and journals, to statute law and government policy documents. The study only addressed constraint factors in four categories; project finance, workforce, process and unforeseen events

1.8.3 Time Scope

This Research was conducted between the month of April 2022 and August 2022, approximately five months.

CHAPTER 2: LITERATURE REVIEW

2.1 Overview.

This chapter introduces the key concepts underpinning the study in the research context. It partly provides answers to the research objectives as gleaned from the literature. Specifically, it provides brief explanations of the key concepts embodied in the topic, such as productivity in general, productivity issues specific to the Uganda construction industry, Pareto analysis, on-site productivity, and some approaches used in the measurement of productivity. The chapter ends with a summary of the extent, to which the research objectives have been accomplished in earlier studies, as well as the gaps that exist and how the study aims to contribute to filling them.

2.2 Introduction to Productivity

Definition

Productivity is the measure of the rate at which work is performed. It is a ratio of production output to what is required to produce it. Productivity is measured as a total output per one unit of a total input. In construction, the output is usually expressed in weight, length, or volume, and the input resource is usually in cost of labor or person-hours. Productivity is considered a key source of economic growth and competitiveness and as such, is basic statistical information for many comparisons and industrial performance assessments.

Productivity = Output /Input

At the project site, contractors are often interested in labor productivity. It can be defined in one of the following ways;

Labor Productivity = Output /Labor cost = Output /Work hour.

There is no standard definition of productivity and some contractors use the inverse of the above, Labor **Productivity = labour cost/work hour Output**

In general, productivity signifies the measurement of how well an individual entity uses its resources to produce outputs from inputs.

The two most important measures of on-site productivity are:

(1) The effectiveness with which resource is used in the construction process and;

(2) The relative efficiency of resource doing what it is required to do at a given time and place (Chigara & Moyo, 2014)

2.3 Types of Productivity.

(a) Partial Productivity:

It is the ratio of output to one class of input. For example, output per person-hour is a partial productivity concept or output per ton of material and interest revenue generated per shilling of capital

(b) Total factor productivity:

It is the ratio of net output to the sum of associated labor and capital input. The net output there is sometimes called value-added output. In this ratio, we explicitly consider only the labor and capital input factors in the denominator.

(c) Total Productivity:

It is the ratio of total outputs to the sum of all input factors. This holistic measure takes into consideration the joint and simultaneous impact of all the inputs such as labor, materials, machine, capital, and energy. This measure has received much attention over the past ten years, as evidenced by many papers and case studies.

2.4 Importance of Productivity on Construction Projects.

On-site productivity is one of the most serious factors that affect the physical progress of any construction project (Durdyev et al, 2018). In order for any construction industry to keep improving project success, it first needs to improve the standard of labor productivity to reduce the cost of any construction project. The Asian Productivity Organization has argued, “Improvements in labor construction productivity would make a substantial benefit to the national economy (Intergraph, 2012).

According to (Hammad et al, 2011) an “increase in productivity may result in more growth and a positive effect on the society” An increase in productivity may reduce the overall cost of the project, which can result in more affordable houses being built. Every contractor, subcontractor, and employer have to agree to a contract for the project to start. These contracts have a start date, plan, budget, work scope, duration, finish date, and other important factors for any project. This agrees with (Hammad et al, 2011) that “Every year companies and contractors are hit with billions of dollars in construction claims as a result of lack of on-site productivity”. Improving on-site productivity in construction projects will not only result in project success but will also result in a significant impact on improving the GDP, which positively affects the economy and reputation of any country

2.5 Measuring Productivity

At the national level, the economic perspective of productivity is used, which targets contribution towards the Gross Domestic Product (GDP) as an indicator of economic well-being, growth, development, and living standards. Sullivan and Shiffrin (1996) define the gross domestic product (GDP) or the gross domestic income (GDI) as a measure of a country's overall economic output, evaluated as the market value of all final goods and services produced within a country in a given year.

The World Bank (2010) provides three approaches to determining the GDP, all of which produce the same result: they are the product (or output), income, and expenditure approaches. The product or output approach evaluates GDP by summing the national outputs in a given year. The expenditure approach sums up the total amount of consumption, investment, government spending, and net exports in a given year. The nominal or ordinary GDP figure is adjusted for inflation and changes in population relative to the figures for the base year to obtain the real, or constant, GDP per capita. This is used to compare the real GDP growth rate relative to the figures for a base year or to other countries' outputs

At the level of the individual projects executed by an organization such as a construction company or consulting firm, emphasis is placed on the achievement of the three key project objectives - time, cost, and quality targets. The measure of productivity at this level ought to be how well the targets set for those three objectives are achieved by the deployment of company resources (manpower, machinery, money, and materials), using the process or method adopted for the project, while complying with the requirements of the statutory/regulatory environment within which the project is carried out. However, to align this with productivity measures at other levels, the project level measurement may focus on the dollar value of the project per unit cost of the resource inputs.

2.6 Model of Productivity Constraints

Building on the understanding of productivity as depicted in Figure 1, the figure provides a holistic model of the internal and external productivity constraints at the individual project level. In this context, a global framework for looking at the external constraints is PESTELI (the Political, Economic, Socio-cultural, Technology, Legal/political, and Industrial constraints). The internal sources may be looked at from the perspective of the 6Ms of the business process improvement (Prasad, 1999): Money/finance, Manpower, Management (or supervision of the workforce), Machinery, Materials, and Method/process. However, this study focuses on the on-site aspects of the productivity constraints as empirically established from the feedback of consultants and contractors in the industry, drawing on their rich practical experience. Preliminary investigations involving interactions with industry operators provided leads to applicable on-site constraints in the Uganda construction

industry which graphically presents a proposition put forward in the study to guide inquiry. The model will be modified based on empirical findings

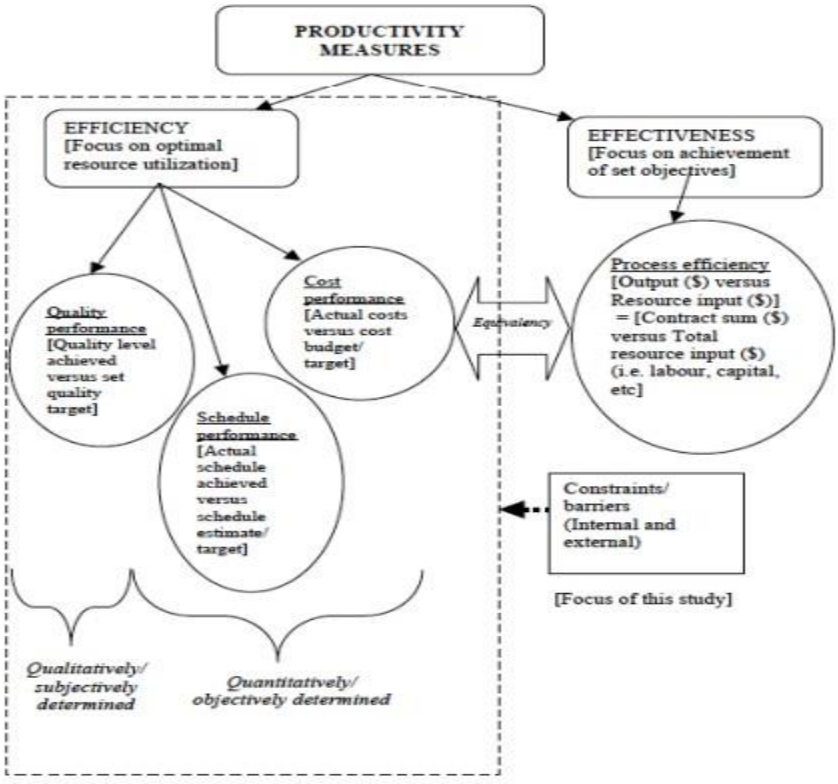


Figure 1: Model of holistic measures of productivity showing relationship with internal and external constraints used in the study ((Durdyev, 2014).

2.7 Factors/constraints to Construction Productivity

Several studies have been done to identify the most significant factors influencing construction productivity. For instance (Wilkinson & Scofield, 2010), identify the choice of procurement system as having a significant impact on the achievement of cost, time, and quality targets for a project (Mbachu & Nkado, 2007) carried out a study and identified factors relating to the acts of commission and omission of the key role players including clients, consultants, and contractors, as well as project characteristics and external factors.

(Enshassi et al, 2007) demonstrated the need to establish the way factors affect construction productivity in positive or negative manner. The researcher classified factors affecting on-site productivity into 10 groups: workforce, leadership, motivation, time, materials/tools, supervision, project, safety, quality, and external factors. On the other hand, (Kazaz et al, 2008) identify sub-factors influencing construction productivity under four main headings, which are Organizational, Economic, Physical, and Socio-psychological factors.

(Attar et al, 2012) carried survey of building projects in Sangli, Kolhapur and Pune districts, where an increase in productivity is being sought. He identified ten most significant factors affecting on-site productivity for

small, medium and large companies. The groups of factors, which are highly effective, were supervision, material, execution plan, and design. He said that for large companies, equipment factors have also highly effective. While in small and medium companies, owner/consultant factors also need special attention.

(Vekaria, 2012) concluded that project management skills were acceptable as the most important factor that influenced the productivity among the labour a part of the other factors such as technology exploration, skill and training, labour organization, project uniqueness and wage trends. He strongly agreed that technology exploration would increase the productivity. He said that explorations of new technology or transfer technology are very essential to develop better performance of project in line with globalization in construction industry

(Ameh et al, 2011) established the relationship between time overrun and on-site productivity on construction sites in Lagos, Nigeria. He concluded that factors cause time overrun are inadequate fund for the project, inadequate planning of project before take-off, inadequate tools and equipment, delay in delivery of materials, subcontractors incompetency and design changes during project execution.

(Ng et al, 2004) put emphasis on several predominant de-motivators affecting the productivity of civil engineering projects, which are rework, over-crowded work areas, crew interfacing, tool availability, inspection delays, material availability, and supervisor incompetence. More so, (Mojahed & Aghazadeh, 2008) found major productivity factors, which have an impact on productivity. The top five are skills and experience in the workforce, management, job planning, motivation, and material availability.

(Alinaitwe H.M et al, 2007) administered questionnaires to 137 contractors to identify the most important factors by ranking them according to time, cost, quality, and a combined importance index. The five most significant factors were; incompetent supervisors, lack of skills among the workers, rework, lack of tools/equipment, and poor construction methods.

According to (Karthik & Rao, 2019), on productive task motions and on Non-Productive task activities 83% & 17% average time was spent. This leads to decreases in on-site productivity by 15% (considering factors like work characteristics, assured and safety work and workers management, organizational characteristics). It is observed that a higher value of Cronbach's α is observed as 0.787 for Work Delay group and the highest factor calculated using RII is observed for Unsafe working conditions (0.809)

(Chigara & Moyo, 2014), carried out their work at building projects in Zimbabwe and found that major factor influence LP was from Material related factors group. (Unavailability of material). They considered 40 factors for their study. Accordingly, strong & Positive correlation (Spearman's rank correlation) was observed between the views of consultants and the contractors. They recommended that rewards should be given to the labors for exceptional work, & market-based wages to attract them towards the work.

Sufficient studies exist to suggest that construction on-site productivity measurement should be the basis for decisions to improve productivity ((Carlos & Paul, 2010); (McCullouch, 2007)). With reference to those studies, we can understand that on-site productivity factors have critical importance as they contribute to the bulk of the sources of productivity constraints in the construction sector.

2.3 Pareto Analysis

As above-mentioned, this study aimed at establishing key construction on-site productivity constraints based on the Pareto principle. The Pareto principle provides rational grounds for optimum disbursement of resources to address the 20 percent of the factors causing 80 percent of the productivity problems.

(Haughey, 2011) defines Pareto analysis as a statistical technique in decision-making that is used for the selection of a limited number of tasks that produce a significant overall effect. It uses the principle that by focusing on the most crucial 20% of the causes of a problem, 80% of improvement can be achieved in the process.

(Karuppusami & Gandhinathan, 2006) provided insights into the application of the concept by defining it as a quality control tool that rank-orders the data classifications from the highest to the lowest frequencies of occurrence or magnitude, with the 'vital few' items occupying a substantial amount or 80% of cumulative percentage of occurrences or impact, while the 'useful many' occupy only the remaining 20 percent (p.376).

As a formal technique, it is useful where many possible courses of action are competing for one's attention. It consists of estimating the benefit delivered by each action with subsequent selection of a number of the most effective actions that deliver a total benefit reasonably close to the maximal. The operational procedure for the application of the technique involves the following steps.

1. Form a table listing the causes along with their frequency as a percentage in descending order
2. Add a cumulative percentage column to the table.
3. Plot a graph with causes on the x- and cumulative percentage on the y-axis, join points to form a curve
4. Draw a line at 80% on the y-axis parallel to the x-axis. Then drop a line from its point of intersection with the curve, to the x-axis. This point on the x-axis separates the important causes and trivial causes.

2.4 Summary of Literature Review

The reviewed literature has provided insights into the current trends and thinking in the field of construction productivity. In addition, related works of researchers in the past have been studied with a view to identifying gaps in the literature, which the current study may contribute to fill.

2.5 Hypothesis

The following propositions provided directions for the research design, data gathering, and data analysis with a view to meeting specific objective two.

Ho-on-site constraints do not have a significant effect on on-site construction time productivity.

H_1-on-site constraints have a significant effect on on-site construction time productivity.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Overview

This chapter discusses the Research methodology, this refers to the principles and procedures of logical thought processes which are applied to a scientific investigation (Fellows, 2008), research design, target population, Sampling Strategies, Data Collection Methods, Data Quality Control and Data Processing and Analysis.

3.2 Research Design

The research design was determined by considering how to link the research questions with data collection and analysis of the results. Research design is the program that guides the investigator in the process of collecting, analyzing and interpreting observations. Generally, the kind of data to be used in this study will be both quantitative and qualitative. The research methodology adopted in this study is the descriptive survey method comprising qualitative data gathering reviewing on-site records and quantitative data gathering through questionnaire survey with closed ended questions.

3.4 Target Population and sample size

The target populations of respondents for the study were the representatives of project management consultants, contractors and sub-contractors on selected construction sites within Rubaga division. Different professionals were target depending on their roles on sites. These included; Site Engineers, Project Manager, Quantity Surveyors, Foramens, Site agent, safety personnel. The sites that were sampled were obtained from KCCA data base. Slovin's formulae of random sampling was used to calculate the sample size of respondents for this research.

$$n = \frac{N}{(1 + Ne^2}$$

*w*here n=sample size

N=population

E=error of 0.05 at 95% confidence interval.

Table 1:Summary of the sampling

Number of Sites in Rubaga Division=289 sites Criteria for selection (site has; at least contractor and consultant)	
Active Sites meeting the criteria for selection	**33**
Active sites that don't meet criteria	**98**
Abandoned and inactive	**58**
Completed with a few workers at site.	**52**
Small sites	**48**

3.5 Data Collection

3.5.1 Secondary data

The secondary data for the study was sourced from relevant literature including journals, conference proceedings, and other documents existing in the public domain. Completed theses and research reports from reputable tertiary institutions were also consulted. Information from these sources helped in putting the current research into context and providing part answers to the research objectives.

3.5.2 Primary data

The primary data for the study comprised of the opinions and data from records from project management consultants, contractors and sub-contractors on construction sites. These will be obtained through surveys involving the use of self-administered close-ended questionnaires.

3.6 Research Methods for each objective

This section entails the different methods that were used to achieve each of the objectives in this research. The research used both qualitative and quantitative approach. Objective one and three were achieved using qualitative methods whereas objective two was achieved using quantitative methods as shown in table 1

Table 2: Research methods for each Objective

Objective	Method to achieve each objective
To determine the frequencies of occurrence of the identified on-site construction productivity constraints.	Qualitative
To determine the extent of effect of workforce related constraints on on-site productivity	Quantitative
To explore innovative ways of improving on-site productivity in the industry.	Qualitative.

3.7 Data measurement

Measurement is a process of mapping aspects of a domain onto other aspects of a range according to some rule of correspondence. In measuring some form of scale in the range that assigns numbers to objects or observations, the level of measurement being a function of the rules under which the numbers are assigned. (Kothari, 2005). In this research the ordinal level of measurement that will be used are numbers that will represent the scale basing from the highest value to the lowest value. Hence, a Likert scale as the rating scale for the respondents where a

series of statements will be provided for in the questionnaire and the respondents will choose a response from the categories on a scale of 1-5 as shown below in table 2.

Table 3: Likert scale for objective 2

Item	Very frequently	frequently	Occasionally	Rare	Very Rarely
Scale	5	4	3	2	1

The multi- attribute used in this study was based on the recommendations of change and Ive (2002); the method involves finding the mean rating of the Likert scale of factors with in the broad categories of constraints. The factor with the highest mean rating was used to represent the broad categories with in each.

3.9 Data Analysis plan.

This section entails the different analysis methods that were used to analyze each of the objectives in this research. Objective one was analyzed using pareto analysis (Vilfredo pareto principle) whereas objective two was analyzed using multiple regression technique to ascertain the contribution of each of the factors to an-site construction productivity. Objective three was analyzed using descriptive statistics.

Table 4: Data analysis plan for each objective

Objective	**Analysis Technique**
To determine the frequency of occurrence of identified on-site construction productivity constraints.	Pareto Analysis
To determine the effect of material related constraints on on-site productivity.	Multiple Regression Analysis
To explore innovative ways of improving on-site productivity in the industry.	Frequency Distribution table

Ethical Issues in the Research

In order for the research to be conducted effectively without resistance from the contractors, an introductory letter will be obtained by the researcher from the Head of the Department at the University was presented to the respondents before they reply to the questionnaire that was provided to them so that they provide the necessary information to the researcher. The researcher considered the confidentiality of the respondents.

CHAPTER 4: PRESENTATION AND DISCUSSION OF RESEARCH FINDINGS

4.1 Overview

In this chapter, data obtained from the questionnaire survey is presented and analyzed. The chapter subsections include the questionnaire survey and factors, which were ranked according to their levels of impact on the construction on-site construction productivity. The demographic data serves not only to classify the responses along demographic profiles, but also to ensure that responses were from the target populations delineated for the study. Preliminary analyses were carried out on the usable data to obtain variables for testing the research hypothesis.

4.2 Response rate of Questionnaires

According to the survey,90 Questionnaires were prepared and distributed to 30 selected construction sites.75 Questionnaires were answered from 25 sites. 5 Sites did not participate in the survey due to ethical issues. This implies that the response rate was 83%. The response rate of the questionnaires is summarized below;

Table 5: Response rate for Questionnaires

Respondents	**Number issued**	**Number Returned**	**Return rate (%)**
Site engineer	35	29	83
Quantity Surveyor	11	11	92
Project manager	18	14	78
Safety engineer	9	7	78
Foreman	16	14	88
Total	**90**	**75**	**83**

From table 4 above ,17% of the total questionnaires issued were not returned where as 83% of the total questionnaires issued were returned. This implies a good response rate above 75% thus accepted for this study.

4.3 Length of Experience of the Respondents in above Capacity

The lengths of experience of the respondents in their key roles as project team members are presented. The figure shows that 73 percent of the respondents have at least 4 years of experience in the construction industry. This profile means that the respondents` extensive experience contributes to the quality of the responses received, and to the reliability of the conclusions drawn from the research findings

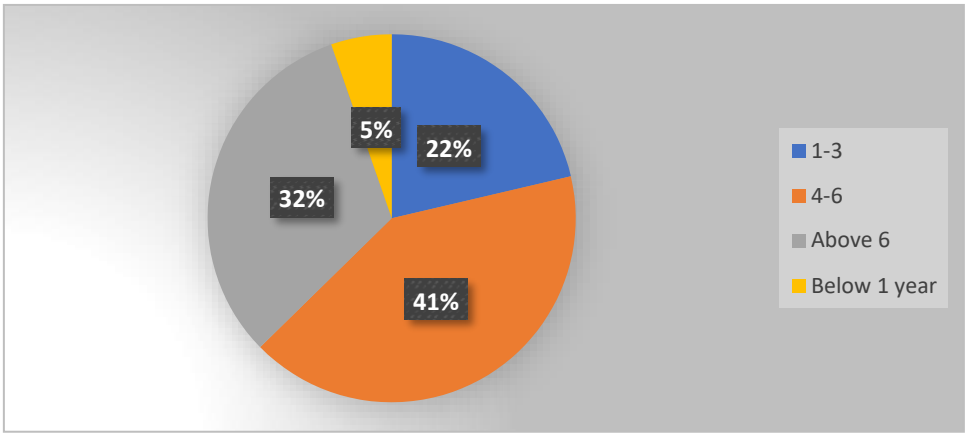


Figure 2: Pie chart showing level of experience

4.4 Presentation and discussion of Objective results

Specific Objective One: To determine the frequencies of occurrence of the identified on-site construction productivity constraint

The pareto chart was plotted to analyze the cumulative percentages of overall constraint factors in five Broad categories namely; Project finance constraints factors, Workforce related constraint factors, Material related constraint factors, Building process related constraints and Unforeseen events.

From the principal rule of 20% to 30% accounting for 80% problems in the phenomenon being investigated, it was found out that project finance, workforce and material factors surfaced in the 20%-30% zone. It should be further observed that material factors dominated the 20% zone. This implies that material related constraints i.e., material shortage at site with a percentage of 10.84%, delay in delivery of materials with a percentage of 9.35 % have much bigger account for 80% of the on-site construction productivity problems. This could be an indicator that resources have been allocated to solving other constraints of on-site construction productivity yet materials take up a bigger percentage and are used through the project implying that constraints related to materials can happen from kickstarting the project till completion if not given attention. These results deviate from the results of (Alinaitwe et al, 2007) who found that lack of tools and equipment, lack of supervision skills etc., were the most frequent factors affecting most building projects.

Project finance related constraints also appeared in 20%-30% zone of the pareto chart. Late payments with a percentage of 10.41% was one of the constraints that mostly affected on-site construction productivity. This could imply that clients and contractors put most of the efforts on realizing projects objectives i.e., seeing the dream ideas come true and forgetting the key determinant of finances in the project. Without on time release of funds, the project lags behind because almost 80% of the trades on site involve finances. Reworks with a percentage of 7.12% also appeared in the 20% zone as a factor that needs keen attention on a construction site.

This could be a pointer that most construction companies don't focus on ensuring proper quality management measures are in place and also skilling of workers to curb problems arising from quality of materials and workmanship on construction sites. These findings concur with the research by (Webber: Robert, 2022) that indicated that reworks occurred mostly on construction sites in the USA and had a significant impact on construction productivity. To minimize the problem of rework on construction projects, (Webber: Robert, 2022) suggests the use of quality management systems and improvement in skills training, particularly for onsite management and the management of multi-projects at the firm level.

Workforce related constraints i.e., workforce turnover with a percentage of 9.88% appeared in the 20% zone of the pareto chart. This could imply that construction contractors only focus on output per input (work done on hourly rate without considering the working conditions of workers and their welfare forcing them to frequently leave those construction sites to other better places where their efforts are equally appreciated.

Table 6: Frequency distribution for all constraints

All constraint factors	Freq.	Percent	Cum.
Delay in delivery of materials	88	9.35	9.35
Disputes and Litigation Costs	16	1.70	11.05
Distance from material storage	23	2.44	13.50
Energy costs/crisis	2	0.21	13.71
Frequent changes in government policies impacting on construction	3	0.32	14.03
Health of work force	16	1.70	15.73
Inappropriate plant and Equipment	14	1.49	17.22
Inappropriate method of construction	11	1.17	18.38
Lack of training and education to implement and operate new technologies	7	0.74	19.13
Lender's high interest charges	7	0.74	19.87
Level of familiarity of current job and conditions	15	1.59	21.47
Level of familiarity with current job and condition	7	0.74	22.21
Level of motivation	40	4.25	26.46
Level of skill and experience of workforce	38	4.04	30.50
Market conditions and level of competition in the industry	23	2.44	32.94
Material shortage at site	102	10.84	43.78
Poor site layout management	24	2.55	46.33
Quality of materials delivered at site	75	7.97	54.30
Reluctance to adopt new technologies	71	7.55	61.85
Reworks	67	7.12	68.97
Under-valued work	14	1.49	70.46
Workforce Absentisms	14	1.49	71.94
change in material type and specifications during construction	5	0.53	72.48
health of workers	6	0.64	73.11
high insurance premiums	4	0.43	73.54
inflation/fluctuation of material prices	34	3.61	77.15
late payment	98	10.41	87.57
level of training	15	1.59	89.16
site conditions	9	0.96	90.12
workforce turnover	93	9.88	100.00
Total	941	100.00	

An analysis using a pareto principle revealed that material related factors had the most significant effect on- site construction productivity as compared to other factors in this study. However, these results deviate from the results of (Alinaitwe et al, 2007) who found that lack of tools and equipment, lack of supervision skills etc., were the most significant factors affecting most building projects and not material related factors as indicated by this research.

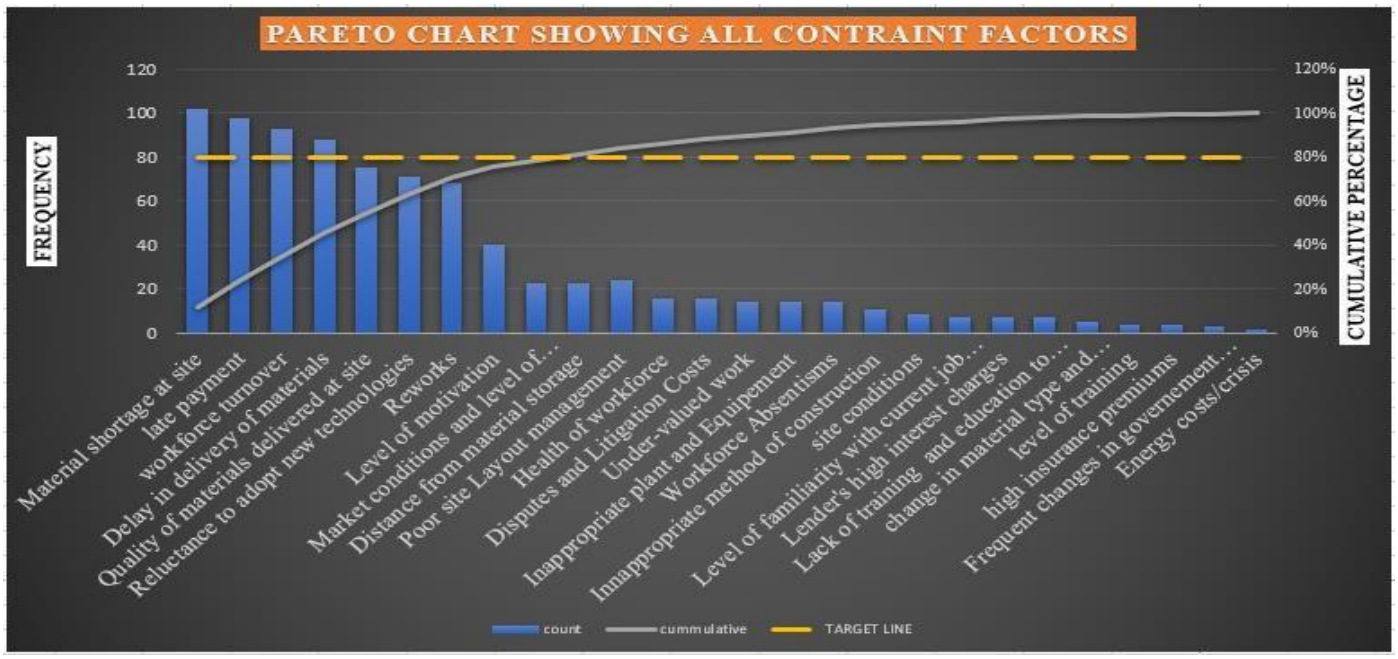


Figure 3: Pareto Chart showing 20% and 80% zone

4.5 Testing Hypothesis: specific objective two

Constraint factors that were identified in Objective one was further studied to establish the extent of effect of these constraint factors on on-site productivity. For this research, only efficiency was studied i.e., schedule (time), and Satisfaction of work on site.

A multiple regression analysis was used to determine the extent of effect of broad groups of constraint factors on each of the efficiency parameters. The hypothesis below was formed to guide the study.

H_0=Time or schedule productivity does not depend on on-site constraint factors. **H_1**=Time

or schedule productivity depends on on-site constraint factors.

Time productivity vs On-site constraint factors.

Table 7: Time Productivity vs On-site constraint factors

VARIABLES	(1) Time-on-site productivity
Workforce Related constraint factors	0.814***
	(0.0789)
Building Process related constraint factors	0.0246
	(0.0730)
Unforeseen events related constraint factors	0.0145
	(0.0596)
Project Finance constraint factors	0.265***
	(0.0876)
Material related constraint factors	-0.126***
	(0.0454)
Constant	-1.005**
	(0.478)
Observations	75
R-squared	0.806

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

From table 8, the following observations were made; material related constraint factors at site had a p value less than 0.05 at 95% confidence interval implying it had a significant effect on the schedule of the project. Similarly, workforce related constraint factors and project finance related constraint factors on site also had a p value less than 0.05 at 95% confidence interval implying that the two have a significant effect on schedule of a project. The overall p value being less than 0.05(i.e., p=0.0000), H_0 was rejected and H_1 accepted.it was concluded that schedule efficiency depends on on-site constraint factors. More so, the model indicates that on-site constraint factors account for 81% variance or change in schedule of the project., it is indicated by the Adjusted R-square value of 0. 806.

The following equation indicates the effect of individual constraints to predict change in schedule.

$Y = MX + C$ (Where Y is the schedule, X are predictor variables and M and C are constants)

Schedule(time)=0.814**D**+0.02**C**+0.0145**di**+0.265**Q**-0.126**M**-1.005,

where, D= Workforce Related constraint factors, C=Building Process related constraint factors, di= Unforeseen events related constraint factors, Q= Project Finance constraint factors= Material related constraint factors

From the model above, it is observed that workforce related constraint factors had a greater effect on schedule of construction activities indicated by a p value less 0.05 at 95% confidence interval. A unit decrease in workforce related constraint factors at site increases efficiency in schedule by 81%. The findings in this study tally with the findings of the research made by (Abushaban & Saleh, 2013) which revealed that Workforce related factors accounted for 50% of construction problems in Gazi strip. More so the results of the research by (Chigara & Moyo, 2014) carried out at building projects in Zimbabwe indicated that the major factor that had a greater effect on construction Productivity was from Workforce related factors group. Factors like lack of enough skills and experience among workforce, level of motivation become a common cause of disturbance in the working process. Workers work long hours and sometimes others work overtime and earn less compared to the time worked, this causes lack of motivation to continue working. Increasing demand for skilled labour due to adoption of new technologies at construction sites such as computerized machines and plant would help to increase productivity. The study by (Shriyank & sandeep, 2018) indicated that exhaustion of workers was due to long working hours, poor health which decreases their concentration on work which in turn decrease on-site productivity.

Results indicate that project finance constraint factors had a significant effect on on-site productivity, this is shown by a p value less than 0.05 at 95% confidence interval. From the model, A unit decrease in project finance related constraints, increases efficiency in schedule by 30%. The results on Project finance constraint factors in this study tally with the findings of a research by (Shriyank & sandeep, 2018) indicated that productivity relies on the finance factors and therefore had a very high significant effect on on-site construction productivity. This was also pointed out by Uganda National Association of Building and civil engineering contractors in its article (UNABCEC, 2022) that indicated financial factors like delayed payments high costs of financing projects and other cashflow problems as major constraints to on-site productivity of construction companies in Uganda.

Material related factors

Satisfaction of work (Quality) vs On-site constraint factors.

H_0=Satisfaction of work does not depend on the selected constraint factors.

H_1=Satisfaction of work depends on selected constraint factors.

Table 8: Satisfaction of work vs on-site constraint factors.

VARIABLES	(1) quality
Workforce Related constraint factors	0.0546
	(0.175)
Building Process related constraint factors	0.0999
	(0.161)
Unforeseen events related constraint factors	-0.138
	(0.132)
Project Finance constraint factors	0.187
	(0.194)
Material related constraint factors	-0.000706
	(0.100)
Constant	1.294
	(1.058)
Observations	75
R-squared	0.027

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

From table 7, the model indicates that material related constraint factors have no significant effect on satisfaction of work, this is indicated by a P value greater than 0.05 at 95% confidence interval. The null hypothesis H_0 was supported and H_1 rejected.

4.6 Improvement techniques: specific objective three (3)

The third objective of the study was to explore innovative ways of improving on-site construction productivity in the Uganda construction industry. Based on an outcome of some literature survey, a proposition was formulated to assume that the application of technology represents the most significant way of improving on- site productivity. In the questionnaire surveys, respondents were asked to suggest innovative ways of improving on-site construction productivity in the industry. Out of the 75 respondents, only 61 gave feedback on this aspect. The frequencies of mention are summarized in the table below.

Table 9: A table showing proposed on-site productivity improvement techniques

Improvement techniques	Freq.	Percent	Cum.
Adequate planning	7	11.48	11.48
Application of new technologies	18	29.51	40.98
Continuous on-site and off-site training of workers	5	8.20	49.18
Increasing wages of workers	4	6.56	55.74
Proper material management	12	19.67	75.41
Proper risk management strategies	9	14.75	90.16
Proper site management	6	9.84	100.00
Total	61	100.00	

The results showed that application of new technologies, with a frequency count of 18 out of 61 or 30 percent, was believed by most of the respondents to be the most appropriate way of improving onsite construction productivity. The initial proposition that suggested its application, as the most significant way of improving onsite productivity was therefore supported. This finding tallies with those of other studies (Kim et al., 2006; Shrestha et al., 2009), which suggested that technological application is the most effective way of improving on-construction productivity in the industry. This result could be attributed to the rapid growth of the construction industry and increased efforts to find cost effective and sustainable methods of construction in the industry of Uganda.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

Productivity is in essence the backbone that makes or breaks a company in the construction industry, as it is the key-determining factor in performance and success. Therefore, one must understand the factors that raise or lower productivity. Given the reported steady decline in on-site construction productivity trends in construction industry of Uganda, the main objectives of this study have been to identify the key constraints to on-site productivity and to establish their effect on on-site productivity, based on the views of project manager consultants, contractors and subcontractors. In total 26 constraint factors were identified in five broad categories of project finance, Workforce, building process, materials and unforeseen events.

Results from pareto analysis indicated that, reworks, material shortage on site, Quality of materials delivered at site, Workforce turnover, Reluctance to adopt new technologies, late payments were the most significant internal constraint factors and accounted for 60% of On-site construction productivity issues. Among the external constraints, Market conditions and material price fluctuations were found to be the most influential sub-factors affecting construction productivity of the Uganda construction industry. In addition to addressing the key constraints found in the study, it is recommended that construction companies hold meetings with all engineers to manage the preconstruction phase, to avoid rework and also to determine an adequate method of construction during project implementation.

5.2 Recommendations for further research

This study focused on constraints to construction on-site productivity; however, there are several aspects to construction productivity. Future studies should explore other influencing factors affecting construction productivity at all stages of the procurement process and pre-construction phase. The respondents in the responses were largely from contractors and project management consultants. The results include few inputs of subcontractors. It may be necessary to aim for representative feedback from subcontractors in future studies, as they are the key players on construction sites. Also, there was absence of feedback from clients and designers. Further studies should also seek to capture opinions of these stakeholders as they significantly influence on-site procurement processes and performance outcomes. Because construction operation methods are dynamic due to changing advancements in technology worldwide, construction companies should focus on sourcing the most modern methods of executing construction projects to improve their productivity on site.

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APPENDIX 1

MAKERERE UNIVERSITY

COLLEGE OF ENGINEERING, DESIGN, ART AND TECHNOLOGY

SCHOOL OF BUILT ENVIRONMENT

DEPARTMENT OF CONSTRUCTION ECONOMICS AND MANAGEMENT

BACHELOR OF SCIENCE IN CONSTRUCTION MANAGEMENT

TOPIC: ANALYSIS OF ON-SITE PRODUCTIVITY CONSTRAINTS AND ITS IMPROVEMENT TECHNIQUES.

This questionnaire is designed to collect data about my research on the Analysis of on-site productivity constraints and improvement techniques in Uganda, as a partial fulfilment of the requirement for an award of Bachelor of Science in construction management. The questionnaire is required to be filled with exact information as much as possible. All the information onto the questionnaire by all the respondents will be very and highly confidential and used for academic purposes only.

Submitted by:

Alinaitwe Shalifu

BIO DATA OF THE RESPONDENT

Representative on site

1. Consultant ☐
2. Contractor ☐
3. Sub-contractor ☐

Respondent's role on the site

1. Site Engineer ☐
2. Site agent. ☐
3. Safety engineer. ☐
4. Project manager. ☐
5. Quantity surveyor. ☐
6. Site Manager ☐
7. Foreman ☐
8. Helper ☐

Years of working experiences

1. Less than one year ☐
2. 1-3 ☐
3. 4-6 ☐
4. Above 7 years ☐

OBJECTIVE 1

Which of the following constraint factors do you experience on your site under each category.

Tick

PROJECT FINANCE from:

Late Payments.	
Reworks.	
Under-valued Work.	
Disputes and litigation costs.	
Lender's high interest charges.	
High insurance premiums, bond/retentions.	
High cost of need resources.	

WORKFORCE CONSTRAINTS from:

Level of motivation/commitment.	
Level of training.	
Level of skill and experience of the work force.	
Level of familiarity with current job and conditions	
Workforce Absentisms	
workforce turnover, recruitment and changing crews	
Health of workforce	

BUILDING PROCESS CONSTRAINTS from:

Inadequacy of the method of construction	
Lack of training and education to implement and operate new technologies	
Inadequacy of site layout	
Inadequate IT infrastructure and application in construction.	
Reluctance to adoption of new technologies	
Inappropriate plant and equipment employed	

MATERIAL RELATED CONSTRAINTS from:

Material Shortage at site	
Delay in delivery of materials	
Quality of materials delivered at site	
Distance from location of material storage	
Change in material type and specifications during construction	

OBJECTIVE 2

Instructions.

The following broad categories of internal and external constraints have been identified as key limitations to achievement of on-site construction productivity. Under each category, sources of the constraints are listed. Using a 5-point Likert scale provided, please you are required to rate the level of impact and frequency of occurrence of each constraint source based your experience.

Frequency rating scales: Very Frequent (VF)=5; Frequent(F)=4; Occasional(O)=3; Rare(R)=2; Very rare (VR)=1.

1. INTERNAL CONSTRAINTS

The following broad categories of internal constraints have been identified as key restraints to achievement of on-site construction productivity. Under each category, sources of the constraints are listed. Using a 5-point Likert scale provided, please you are required to rate the frequency of occurrence of each constraint source based your experience.

A: PROJECT FINANCE: Cash flow problems arising from:						**Frequency of occurrence of constraints**				
						VF	F	O	R	VR
						5	**4**	**3**	**2**	**1**

1	Late Payments.										
2	Reworks.										
3	Under-valued Work.										
4	Disputes and litigation costs.										
5	Lender's high interest charges.										
6	High insurance premiums, bond/retentions.										
7	High cost of need resources.										
8											
9											

B. WORK FORCE: Productivity constraints arising from:						Frequency of occurrence of constraints				
						VF	F	O	R	VR
						5	**4**	**3**	**2**	**1**
1	Level of motivation/commitment.										
2	Level of training.										
3	Level of skill and experience of the work force.										
4	Level of familiarity with current job and conditions										
5	Workforce Absentisms										
6	workforce turnover, recruitment and changing crews										
7	Health of workforce										
8											
9											

C. TECHNOLOGY /BUILDING PROCESS: Productivity constraints arising from:						Frequency of occurrence of constraints				
						VF	F	O	R	VR
						5	**4**	**3**	**2**	**1**
1	Inadequacy of the method of construction										
2	Lack of training and education to implement and operate new technologies										

3	Inadequacy of site layout										
4	Inadequate IT infrastructure and application in construction.										
5	Reluctance to adoption of new technologies										
6	Inappropriate plant and equipment employed										
7											

D. MATERIALS. Productivity constraints arising from:						**Frequency of occurrence of constraints**				
						VF	F	O	R	VR
						5	**4**	**3**	**2**	**1**

1	Material Shortage at site										
2	Delay in delivery of materials										
3	Quality of materials delivered at site										
4	Distance from location of material storage										
5	Change in material type and specifications during construction										

E. UNFORESEEN EVENTS:

External constraints							**Frequency of occurrence of constraints**				
							VF	F	O	R	VR
							5	**4**	**3**	**2**	**1**
1	Ground conditions										

2	Inclement weather										
3	On-site accidents										
4											
5											
6											
7											

F. OTHER EXTERNAL FORCES.

External constraints							**Frequency of occurrence of constraints**				
							VF	F	O	R	VR
							5	**4**	**3**	**2**	**1**
1	Market conditions and level of competitions in the industry										
2	Inflation/Fluctuation in material prices										
3	Frequent changes in government policies impacting on construction										
7	Energy costs/crisis										
8											
9											

RATE PERFORMANCE OF YOUR PROJECT IN TERMS OF TIME AND QUALITY.

SCHEDULE PERFORMANCE (TICK APPROPRIATELY)

On schedule	
Average	
Behind schedule	
Far behind schedule	

SATISFACTION OF WORK(QUALITY)

Satisfied	
Neutral	
Unsatisfied	

OBJECTIVE 3

IMPROVEMENT TECHNIQUES

What possible advice would suggest to be employed in order to improve on-site productivity in the construction industry of Uganda? (You can give more than one if any).

i. _____

ii. _____

iii. _____

_____

APPRECIATION.

Thank you for your time. If you have any comments regarding the aspects of this questionnaire or if any advice to improve the outcome of this project, you may contact the researcher via Tel:0778709964/0757886589.

Please state the overall comments if any;

_____