ASSESSMENT OF EQUIPMENT PRODUCTIVITY IN BUILDING CONSTRUCTION PROJECTS IN UGANDA

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DECLARATION

I, Asaya Andrew Peter, hereby declare that this submission is my own work and that to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree of the University or other institution of higher learning, except where due acknowledgement has been made in the text and reference list.

Signed.. Date.....04/12/18.....................................

APPROVAL

The undersigned certify that they have read and hereby recommend for acceptance by Kyambogo University a research dissertation titled "**Assessment of Equipment Productivity in Building Construction projects in Uganda**" in partial fulfilment of the requirements for the award of the degree of Master of Science in Construction Technology and Management of Kyambogo University.

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LIST OF ACRONYMS

AHP	Analytic Hierarchy Process
ANOVA	Analysis of variance
CVI	Content Validity Index
HyPRIS	Highway Production Rate Information System
GDP	Gross Domestic Product
INDOT	Indiana Department of Transportation
KCCA	Kampala Capital City Authority
R&D	Research and Development
RII	Relative Importance Index
SPSS	Statistical Package for Social Scientists
TxDOT	Texas Department of Transportation

ABSTRACT

Management of construction equipment in building construction projects is an important factor to run projects in a successful manner. The focus of this study was to identify the factors affecting equipment productivity, to establish how these factors impacted on equipment productivity, with the aim of improving equipment productivity in Uganda. Using a cross sectional study design, data were collected from a total of 340 respondents in different construction sites in Kampala by use of questionnaires. Descriptive statistics were used to analyse the respondents' demographic characteristics and the mean and standard deviation was used to identify factors affecting construction equipment productivity. The identified factors were subjected to regression analysis and a model was developed to improve equipment productivity. The study established that human resource factors affecting equipment productivity were; technical skills of staff, experience of the operator, and motivation of staff. It was further established that equipment factors affecting equipment productivity were; equipment break down, quality of equipment, working cycle capacity, and age of equipment. With regards to the environmental factors affecting equipment productivity, the study found that weather conditions and access, were the leading factors affecting equipment productivity. It was established that holding other factors constant, environmental factors affect equipment productivity by 6.4% and the remaining 93.6% is explained by other factors. Project managers should therefore hire experienced and well-motivated equipment operators and in order to improve equipment productivity in building construction project.

Key words: Equipment Productivity, Human resource, Environment, Building construction

CHAPTER ONE

INTRODUCTION

1.0 Overview

This concerns the assessment of equipment productivity in building construction projects in Kampala, Uganda. The study focused on determining the factors affecting equipment productivity in building construction projects in Uganda, the impact of the factors affecting equipment productivity in building construction projects in Uganda, and developing a model for improving equipment productivity in building construction projects in Uganda. This section in particular addressed background to the study, statement of the problem, main purpose of the study, objectives of the study, research questions, and scope of the study, significance of the study, justification of the study, conceptual framework, and organisation of the study.

1.1 Background to the study

For any nation looking forward to great economic development, improving the efficiency of productivity in the construction industry should be a key focus area (Prachi, 2016). In a survey done by Transparency International (2015), it was established that most of the equipment in Ugandan construction industry are run on the power during constructing. It was also found out that most the construction works take place in busy towns like Kampala. Ministry of Finance, (2004) observed that power in Uganda is unreliable with outages and that this had failed the construction sector and affect equipment productivity. Quality equipments are few on the market and in service. Of recent, there has been an influx of equipment from Asian countries, specifically China, which are cheaper compared to the European or American made but are efficient in their maiden years of service. In the long run they lose the efficiency (Alinaitwe et al 2005). Examples of such machines from Asian countries to Uganda include dump trucks and the mixers.

In both developed and developing economies, the construction industry plays a very significant role (Kazaz et al., 2008). It is estimated that the construction industry contributes about 10% to the Gross Domestic Product (GDP) of most developed countries with the figures expected to be higher in developing countries (Lim, 1996). Besides its contribution to the GDP growth, the construction industry is estimated to accommodate employment rates of about 7% and 8% in Europe and USA respectively (Kazaz et al., 2016). Significantly, construction is the world's largest and most challenging industry; when appropriate investments are made, there is improved standard of living not only among citizens of the nation but it also elevates and promotes the economic growth of other sectors (Katende et al., 2011; Attar et al., 2012). In Uganda, the construction industry contributes approximately 16% of the Gross Domestic Product (GDP) and employing approximately 10% of the registered work force (MoFPED, 2017).

The progress of the construction industry is heavily influenced by construction management and technology (Remon and Sherif, 2013). Over the years, technological advancement has remained unchanged in the construction industry and in developing countries labour – intensive production is still in use (Kazaz et al., 2016). This slow pace of technological introduction has been attributed to mainly limited resource allocation to research and development (R&D),

fragmented supply chains and lack of coordination between industry and academia (Dulaimi et al., 2002). Remon and Sherif (2013) also noted that as much as new and advanced technologies are being introduced into the construction industry, efficiency in the industry remains stagnant. This has been mainly due to the fact that these technologies are unable to minimise design and construction cost while improving the construction management process. Most profit oriented companies in the construction industry aim at improving productivity as a way of effectively and efficiently converting resources into marketable products. This in the long run has a significant effect of improving the business profitability of the company (Sandbhor and Botre, 2014).

Alwi, (2003) noted that productivity in the construction industry is not only influenced by labour, but also by other factors which include equipment, materials, capital, construction methods, and site management. This study focused on equipment productivity because most contractors and researchers pay attention to labour productivity than equipment productivity (Adrian, 2015). This misguided attention likely stems from the fact that construction firms often view workers as an hourly cost. However, many types of construction equipment such as cranes, excavators, concrete pumps which have an hourly cost are always non-productive as observed by Adrian (2015). In particular, this problem is critical in developing countries (Elazouni and Basha, 1996; Parsakhoo et al., 2009).

The low productivity in the construction industry, especially the low construction equipment productivity in developing countries, is an old and well-known problem (Moavenzadeh and Rossow, 1975). There are several reasons for this issue. Both Elazouni and Basha (1996) and Alwi (2003) investigated the case of construction equipment usage in

Egypt and Indonesia, respectively suggested that the main reason for the low productivity was the poor performance of operators. Additionally, according to Anon (1997), construction equipment manufacturers are primarily from developed countries (e.g., USA and Japan), and the graphs and charts provided for productivity measurements are not completely compatible with the jobsite conditions in developing countries (Tindiwensi, 2016).

Currently, almost 70% of building construction projects in Uganda fail as a result of low construction equipment productivity compared to only 30% that is attributed to labour productivity. This status requires redress if the construction industry is to materialise into a meaningful industry benefiting all stakeholders (Alinaitwe, 2013). The study, therefore, sought to determine the factors affecting construction equipment productivity in building projects in Uganda since research in this area is still scanty.

1.2 Statement of the Problem

In Uganda, the building construction industry continues to struggle with low levels of equipment productivity thereby culminating into long project durations and increased cost of construction. Almost 70% of building construction projects in Uganda fail as a result of low construction equipment productivity compared to only 30% that is attributed to labour productivity yet; little or no attention is focused on the factors that affect equipment productivity. The limited attention paid to equipment productivity stems from the fact that most firms focus on labour productivity and yet many types of large construction equipment such as cranes, excavators, concrete pumps have an hourly cost and are always non-productive ultimately increasing construction costs. The persistence of the problem has continued to undermine the industry, evidenced through low outputs and high costs incurred in construction industry. The study, therefore sought to determine the factors affecting construction equipment productivity in building projects with a view of developing a model that will improve equipment productivity and consequently reduce construction costs.

1.3 Research Objectives

1.3.1 Main objective

The main objective of this study was to assess equipment productivity in building construction projects in Uganda

1.3.2 Specific Objectives

The specific objectives of this study were;

i. To establish the factors affecting equipment productivity in building construction projects in Uganda;
ii. To determine the impact of the factors affecting equipment productivity in building construction projects in Uganda;
iii. To develop a model for improving equipment productivity in building construction projects in Uganda.

1.4 Research Questions

i. What are the factors affecting equipment productivity in building construction projects in Uganda?

ii. What is the impact of the factors affecting equipment productivity in building construction projects in Uganda?

iii. What can be done to improve productivity in building construction projects in Uganda?

1.5 Justification of the Study

There was need to conduct a study that focuses on equipment productivity in building construction projects because little or no attention has been paid to this are (Anon and Erward, 2012). The limited attention paid to equipment productivity stems from the fact that most firms focus on labor productivity and yet many types of construction equipment such as cranes, excavators, concrete pumps have an hourly cost and are always non-productive ultimately increasing construction costs (Adrian, 2015; Parsakhoo et al., 2009). Failure to conduct this study would compromise the activities of different contractors, clients, and construction industry from contributing to the GDP of the country. This, study therefore was to determine the factors affecting construction equipment productivity in building projects with a view of developing a model that will improve equipment productivity and consequently reduce construction costs.

1.6 Significance of the Study

The model developed will provide engineers and project managers with knowledge on how to improve equipment productivity in building construction projects.

The operators will keep abreast with issues regarding construction equipment productivity and factors affecting it. It will guide them on how to improve equipment productivity while undertaking construction projects.

The study findings will be useful to senior managers who will be more informed about the different factors affecting construction equipment productivity and how the productivity of employees can be improved thereby improving the financial soundness of the organisation/construction firms.

Since this study is among the few studies on equipment productivity in Uganda, it will form a basis for future researchers. It highlighted the different factors that affect equipment productivity and this will inform and instigate further researcher in this area. Therefore, the findings will be useful to other scholars who may wish to conduct similar studies to improve on productivity in building construction projects in Uganda.

Finally, the dissertation produced at the end of this study contributes towards partial fulfilment of the award a Master of Science Degree in Construction Technology and Management of Kyambogo University.

1.7 Scope of the Study

The scope of this study covers four dimensions; content scope, geographical scope, financial scope and time scope.

1.7.1 Content Scope

This research determined the factors affecting the productivity of construction equipment in Ugandan building projects because this area has received limited attention. The study specifically was to; establish the factors affecting equipment productivity in building construction projects; determine the impact of the factors affecting equipment productivity in building construction projects and, to develop a model for improving equipment productivity in building construction projects. The study focused on building construction equipment such as earth movers, excavators, transportation and concrete transporting equipment.

1.7.2 Geographical Scope

The study was conducted in Kampala, Uganda. The five divisions that form Kampala district were considered i.e. (a) Kampala Central Division (b) Kawempe Division (c) Lubaga Division (d) Makindye Division and (e) Nakawa Division. The study focused on Kampala because it has the highest concentration of building construction projects.

1.7.3 Financial scope

The study was conducted with help of research assistant who helped in data collection. Each division was assigned a research assistant to collect data. The researcher ensured that resources were mobilized in advance to facilitate the exercise.

1.7.3 Time Scope

The study was conducted over a period of one year and half years. The study begun in August 2017 – November 2018

1.8 Conceptual Framework for the Study

The conceptual framework in Figure 1.1 outlines the various factors that affect productivity in building construction projects. These were used as a basis for identification and prioritisation of the most significant factors that affect construction equipment productivity. The study looked at factors affecting equipment productivity as the independent variables and construction equipment productivity as the dependent variable.

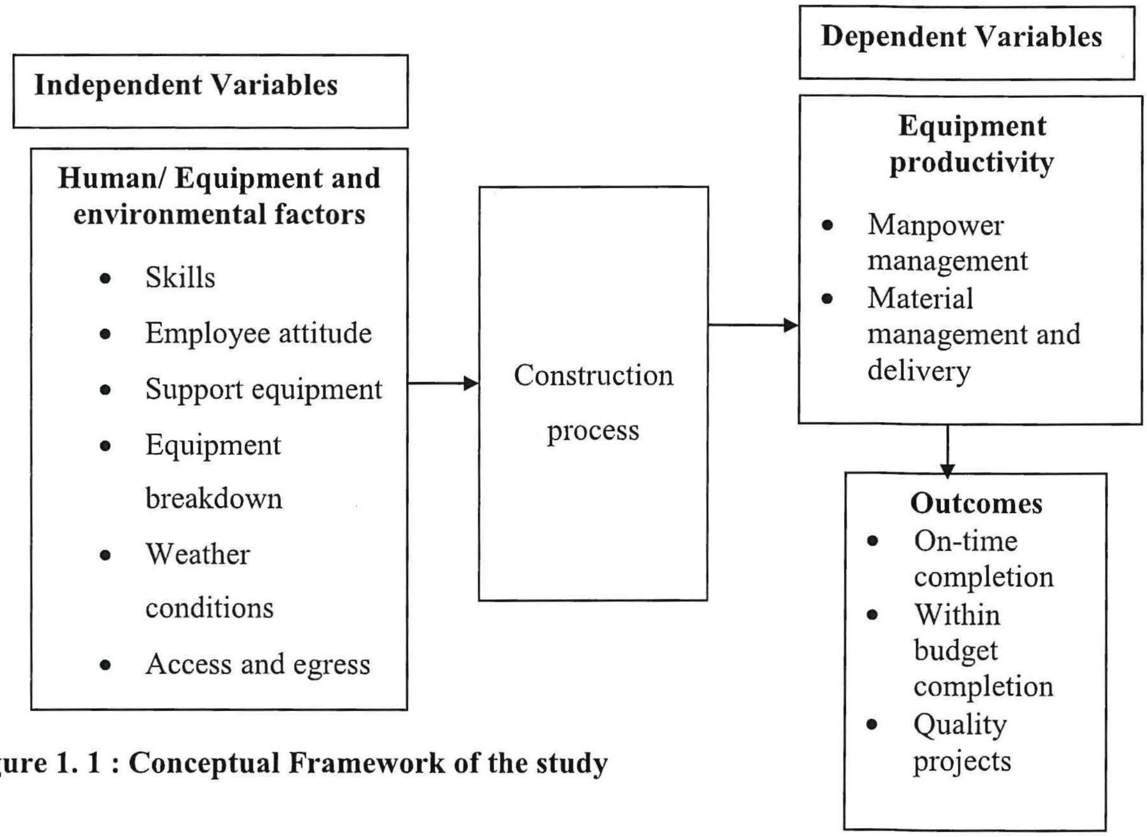


Figure 1. 1 : Conceptual Framework of the study

1.9 Organisation of the study

This thesis is composed of five chapters. Chapter one addresses introduction to the study, background to the study, statement of the problem, objectives of the study, research questions, research hypotheses, scope of the study, justification of the study, significance of the study, conceptual framework and summary of the Chapter Two.

Chapter two handled the review of related literature basing on the study objectives i.e. to establish the factors affecting equipment productivity in building construction projects in Uganda; to determine the impact of the factors affecting equipment productivity in building construction projects in Uganda; to develop a framework for improving equipment productivity in building construction projects in Uganda.

Chapter three handled the methodology employed in the study. It explained the researcher design and approach applied, study population, sample size and sampling techniques, research methods used and instruments, data quality control; how objectives were achieved, data quality control, data analysis and measurement, and ethical considerations.

Chapter four concerns presentation, interpretation and discussion of findings of the study guided by the study objectives as set in chapter one.

Chapter five addressed the summary, conclusion and recommendations of the study as they accrued from the entire study.

1.10 Chapter Summary

This chapter was an introduction to the research. It discussed and gave an overview of construction productivity specifically equipment productivity, the significance, problem statement and objectives of the research. To expound further on this concept further readings and literature from previous researchers are discussed in chapter Two.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter is a review of the concept of productivity literature. It later focuses on equipment productivity in building construction projects, the factors affecting equipment productivity in building construction projects and model development concepts.

2.2 Productivity definitions

Varying definitions and understanding of productivity have been put forward by various scholars. According to Shehata and El–Goahry (2012) productivity refers to labour productivity. Labour productivity was then defined as the units of work load produced per man – hour. Calvert et al., (1995) and Alinaitwe et al., (2006) defined productivity as the ratio of output to input (equation 2.1) weighing the end product against the effort that was put in. This study considered productivity as the overall effectiveness and efficiency of labour.

$$\text{Productivity} = \frac{Output}{Input} \quad \text{...} \quad \text{Equation (2.1)}$$

In other terms productivity is defined as how much an industry can generate per unit input (Katende et al., 2011). In a broader and wider spectrum productivity is a quotient obtained by dividing output by one of the factors of production. In this way, it is possible to speak of the productivity of capital, investment, or raw materials according to whether output is being considered in relation to capital, investment or raw materials (Deurinck, 1951; Lema, 1996).

Productivity can also be defined as the effectiveness of an individual entity in utilising resources to produce output from inputs (Katende et al., 2011). It is noted that a general consensus to the meaning or universally accepted measure of productivity has never been agreed upon. However, a number of measurement options of productivity have been adopted and each is used dependent upon the purpose and availability of data (Attar et al., 2012). In simple terms, productivity integrates both output generated from a system and input used to create the output. The inputs generally comprise of labour, capital, energy and materials which are utilised to transform resources, able to produce goods and services (Lim, 1996).

2.3 Productivity in the Construction Industry

Productivity is one of the significant indicators in measuring and determining construction performance (Lema, 1996). Increase of productivity was calculated prior to mid-1906's, in the construction industry (Stall, 1983; Gundecha, 2012). However, decline in productivity has become of great concern due to its persisting occurrence in the construction industry all over the world (Gundecha, 2012). In its entirety, productivity is one of the main issues of concern right from inception of a project and it is worth managing it effectively (Alwi, 2003).

Atditi and Mochtar (2000) and Alwi (2003) pointed out the factors influencing productivity in the construction industry include; labour, equipment, materials, construction methods and site management. Most researchers (Gundecha, 2012; Stall, 1983) and construction practices alike put a lot of effort and sole dependency on construction workers productivity as the determinant factor in measuring productivity. This tends to give a bias and yet there are other non – value adding activities known as wastes which are major factors affecting construction productivity (Alwi, 2003). Koskela (2000) carried out a number of studies and came up with a remarkable conclusion that there was a relationship between a reduction of productivity and the incidence of waste in construction. Furthermore, the non – value adding activities/waste occurs across the construction spectrum irrespective of; Size of the building, value and duration of the contract, building type and nature of the building. However, these studies did not focus on equipment productivity. There is a need to gain a deeper understanding of equipment productivity.

According to Thomas (2004), an unsatisfactory work environment can have an adverse effect on worker motivation that make minimal effort towards work thereby lowering performance. This has contributed dwindling productivity that has been a major problem confronting the construction industry today which has led to the declining productivity every year for the past decades. Aggregate productivity measurements and studies have shown long-term decline with little improvement.

In identifying sources of reduced productivity in construction works (Borcherding et al., 1986) and (Alwi, 2003) studied five categories of unproductive time that were leading to loss of productivity and these were; waiting or idle, travelling, working slowly, doing ineffective work, and doing rework. The focus of their study however, is not on equipment productivity, but rather on labour productivity.

In an effort to further contextualise productivity Sumanth, (1985) and Lema, (1996) categorised it into three distinctive groups;

- Partial productivity; Ratio of output to one type of input with labour productivity as a typical example,
- Total factor productivity; Ratio of net output to the same of total associated labour and capital input and,
- Total productivity; Ratio of total output to the sum of all inputs factors.

All these categories have their merits when dealing with the aspect of productivity and are specific to given data available and circumstances to be considered (Lema, 1996). Their focus however was not on equipment productivity, but rather on labor productivity.

2.4 Factors affecting equipment productivity in building construction projects

Lema (1996) studied exhaustively the factors affecting construction productivity and categorised them into distinctive groups to include;

Industry level factors; management, construction process, labour effectiveness, government regulations, economy, construction technology, labour supply and training.

Project level factors; geographical location, project size, building type, expected construction activities in the construction area, climate, complexity of the job material handling and construction methods, level of capital substitution, management effectiveness, extent of overtime, safety, technology usage and changes in specifications.

Crew level factors; number of disruptions, interruptions to the job, length of working day, gang composition, extent of training; crew motivation, acceleration of the work, payment, methods of employment, work rules and procedures, weather and environmental effects, experience of operatives, safety, inspection delays, materials availability, tools availability, day of the week, supervision, unbalanced crews, out of sequence work, design requirements and physical elements.

The factors that affect productivity are so diverse in nature and some may not be reflected from previous studies. However, the authors were largely silent on how these factors affect equipment productivity and how it can be improved. Thus, this was the central thrust of this study.

2.4.1 Human Factors

A number of studies have been conducted to examine human resource factors impacting on project performance in developing countries. Faridi and El-Sayegh (2006) reported that shortage of skills of manpower, poor supervision and poor site management, unsuitable leadership; shortage and breakdown of equipment among others contribute to construction delays in the United Arab Emirates. The focus was on labor productivity but not on equipment productivity hence providing a gap for this study to fill.

Hanson et al., (2003) examined causes of client dissatisfaction in the South African building industry and found that conflict, poor workmanship and incompetence of contractors to be among the factors which would negatively impact on project performance. Mbachu and Nkando (2007) established that quality and attitude to service is one of the key factors constraining successful project delivery in South Africa. The focus was on labor productivity but not on equipment productivity hence providing a gap for this study to fill.

Khahro et al., (2016) investigated the human resource factors affecting construction projects in Pakistan and found that these projects were constrained by labor frustration, staff absenteeism, and lack of experience, salary delays, poor supervision and lack of teamwork. The study, however, does not explain how labor productivity impacts on equipment productivity.

Parthasarathy (2017) investigated the human resource factors that affected manpower and equipment productivity in tall building construction projects in India and found that the productivity of equipment was constrained by human resource factors like; lack of skilled operators, lack of support staff and lack of technical staff to operate and maintain the facility. This study has a contextual gap in that it was conducted in India and on labor productivity.

Dai et al., (2009) carried out research based on industry projects across the U.S. to arrive at their result. They had identified 83 factors as factors affecting labour productivity, from which they had arrived at latent factors that affect labour productivity in a major way. These factors included, engineering drawing management, direction and coordination, project management, training, craft worker qualification, superintendent competency, and foreman competence. The focus was on labor productivity but not on equipment productivity and in this study, it is not clear how labor productivity as a factor impacts on equipment productivity.

Kaming (1997), on the other hand researched into Indonesian construction operatives and revealed that, fairness of pay, good relation with workmates, overtime payments, bonuses, and good safety programs were the motivational factors that exist on Indonesia projects. According to Thomas (2004), an unsatisfactory work environment can have an adverse effect on worker motivation that tends to make minimal effort towards work thereby lowering performance. This has contributed dwindling productivity that has been a major problem confronting the construction industry today which has led to the declining productivity in the last three decades.

Lam and Lim (1996) also noted out six key factors that are responsible for influencing manpower productivity and these include; i) Work attitudes; willingness to carry out tasks; ii) Level of skills; education and trainings acquired; iii) Labour management relations; quality control; iv) Productivity management; v) effective management of resources; vi) Manpower efficiency; planning and scheduling; vii) and Entrepreneurship; risk taking.

Organizational success is dependent upon members being motivated to use their full talents and abilities, and directed to perform well in the right areas. Lack of employee motivation can be caused by many factors (Enshassi, 2007). Empowering employees is one way to encourage employee motivation. Unmotivated workers can cause loss of productivity associated with excessive down time and lack of concentration. Every organization is concerned with what should be done to achieve sustained high levels of performance through its workforce.

2.4.1.1 Motivation

Motivation is defined by Cooper (2004)) as the process that directs the people's work energy; it is the drive behind the peoples wish to satisfy workplace wants and needs. Most successful leaders consider motivational factors such as praise, and recognition. People's behaviour is affected by motivation, which in turn results in a committed energy throughout the workplace. According to Cooper (2004), increasing motivation within the workplace may include the following: provide a safe work environment; recognize good behaviour and work; show appreciation; developing team spirit by means of co-operation and co-ordination among the workers help to satisfy their egos; Job security of people which frees them from worries and hence making them work with zeal; set attainable goals; develop a fair pay system; provide adequate training programs. Many motivational theories are used in the construction industry, in an effort to increase productivity (Enshassi, 2007).

As pointed out by Clarke (1980) in his study on U.S.A. workers to determine attitudes towards productivity as quoted by Rojas (2003), it was established that involvement in decision-making, recognition through financial rewards, and job security are important motivational factors for workers to work harder to give out their best and hence be more productive.

Motivation is an art targeted to getting people work willingly and inducing them to behave in a particular manner to achieve sustained high levels of performance a task or goal (Armstrong, 2006) Motivation theory examines the process of motivation. It explains why people at work behave in the way they do in terms of their efforts and the directions they are taking. It describes what organizations can do to encourage people to apply their efforts and abilities in ways that will further the achievement of the organization's goals as well as satisfying their own needs. It is also concerned with job satisfaction; the factors that create it and its impact on performance. Armstrong (2006) noted that the aim of motivation theory was to obtain added value through people in the sense that the value of their output exceeded the cost of generating it. There are several theories which have attempted to explain how motivation works in management circles.

2.4.1.2 Productivity

Therefore, in order to maximize productivity, it is necessary to enlist motivational schemes to maximize each worker's potential. The existence of demotivation factors could result in decline of workers" productivity, since workers feel they have no control over their work and what they produce. According to (Thomas, 2004), some of the demotivation factors that reduce workforce productivity are: lack of adequate planning and materials; improper scheduling; frequent delays; Constant disruption of job assignment; communication breakdown; unavailability of tools and equipment; overcrowded work areas and rework; unsafe working conditions; lack of recognition and training; disrespectful treatment; little participation in decision making; poorly trained foremen; poor supervision.

Jackson (2010) established that the riskiest and important aspect of project control is in estimating productivity. Also, Jackson (2010) mentions that "forecast is to predict the final cost and schedule outcomes on a project while the work is still in progress". So, predicting project outcomes based on the information available need special skilled & experienced managers. This point was emphasized by Kemps (2012) who says that "the human factor helps to smooth out the work's progress". Pearman (2006) announces that many UK based construction companies are sourcing experts from US and other countries. The role of experienced managers is always on demand and they contribute in planning the project and also in controlling the project. Also the project control division, engineers, managers are the medium of communication between the project manager and other corporate managers such as finance, legal, human resources and directors. So the role of the control team, managers is crucial and sensitive involving human relationship. However this aspect is required to be ascertained from the industry. This study would provide literature and evidence, so that greater importance can be made for employing managers with appropriate skills (PMI, (2007).

2.4.2 Equipment Factors

Dai et al. (2009) carried out research based on industry projects across the U.S. to arrive at their result. They had identified 83 factors as factors affecting equipment productivity, from which they had arrived at 10 latent factors that affect equipment productivity in a major way. These factors included Construction equipment, materials, tools and consumables. However, this study was silent on which exact factors affect equipment productivity and how it can be improved.

Sanders and Thomas (2010) stated that material management is one of the most important factors in construction industry. Productivity can be affected if required materials, tools, or construction equipment for the specific are not available at the correct location and time. Selection of the appropriate type and size of construction equipment often affects the required amount of time it is, therefore, essential for site managers to be familiar with the characteristics of the major types of equipment most commonly used in construction. In order to increase job-site productivity, it is beneficial to select equipment with the proper characteristics and a size most suitable for the work conditions at a construction site. Labourers require a minimum number of tools and equipment to work effectively to complete the assigned task. If the improper tools or equipment is provided, productivity may be affected (Chen 2007). Krazner (2005) mentioned that project equipment is necessity and should influence performance by saving cost; also he added that project equipment enhances increased production.

In India, a study was conducted by Mistry and Bhatt (2013) to find critical factors affecting equipment productivity. This study included a survey in cities of South Gujarat, on civil contractors. Based on analysis of their feedback using Analytic Hierarchy Process (AHP) and Relative Importance Index (RII) techniques, lack of materials and equipment was identified as the most important factor affecting productivity of building construction projects. Nguyen and Nguyen (2013) did a case study to determine the relationship between floor number and labour productivity in multi-storey structural work in Vietnam and found that lack of equipment and other machinery constrained project productivity. However Nguyen and Nguyen (2013) were silent on how the lack of equipment affects productivity. They also did not develop a model for improving productivity.

Construction equipment planning and management influence site productivity (Doloi,2007) because, as some authors reported, performance of construction works depends on equipment quality, adaptation, transportation difficulties within site, time and delivery methods (Crawford and Vogl, 2006, Dai et al., 2007, Navarro-Astor, 2008).Another important productivity factor is tool and machinery availability (Ailabouni etal., 2009; Carvajal, 2001; Dai et al., 2007; Doloi, 2008; Ng et al., 2004; Rivas et al.,2011) and the risk of not having it on site at the precise moment (González et al.,2010).

2.4.3 Environmental Factors

Several factors have been studied by various researchers in ascertaining how they influence productivity (Lim, 1996). Lawlor (1985) and Lim (1996) identified eight factors that have an influence on productivity and the greatest was the physical environment in which the equipment is operated.

Construction companies are diversified, have low fixed assets, have positive cash flow, and subcontract extensively (Gyula, 2008). Hackley (2006) says that the "strategic systems are the determinant of the success or failure of Large engineering projects". Strenman (2012) noted that "Construction projects are inherently complex and dynamic". Also, every construction project is unique having its own set of stakeholders and unique environment. Construction industry is diverse with projects ranging from small to large and very large contracts such as $14.7 billion Channel Tunnel Project and $20billion Hong Kong International Airport (Chan & Mohan 2009).

The environment governing every project changes rapidly and cannot be compared to each other. So, the governing principle connecting all construction projects can be said as 'Project Management Practice'. Collis and Hussey (2009) indicate that "Management in construction, on the other hand, has always been based on experience and organizational talent". In most of the construction projects, technicalities are frozen during design phase.

Dai, Cao and Su (2006) mentions that the important category in constructions is construction firm/contractor. They add that the contractor gives real shape to the product following the design by managing resources, material, equipment, and stakeholders effectively.

2.5 Chapter Summary

In this chapter, productivity was discussed into much detail as adopted by various researchers worldwide. Factors affecting productivity, definitions and concepts and in the general context of the construction industry were also presented. The various categories of influence factors and model development concepts were also discussed in full perspectives by the researcher. The Measurement of these factors and methods to be applied to determine their significance and ranking has been discussed in chapter three. Generally, the chapter identifies studies which focus on the factors affecting productivity in the construction industry. However as earlier mentioned, most of them are silent on the factors affecting equipment productivity and how it can be improved. Filling the above gap is the central thrust of this study. The proceeding section focuses on the methodology that was used in the study.

CHAPTER THREE
METHODOLOGY

3.1 Introduction

This chapter presents the methodology that was adopted during the study. It describes and discusses; the research design, sample size and selection, the data collection methods used and their corresponding data collection instruments, data management and analysis procedure, model used as well as steps that was taken to ensure validity and reliability during the study and measurement of variables.

3.2 Research Design

The study adopted a cross-sectional research design because it focuses on a cross section of respondents from different construction firms in Kampala at a given point in time as suggested by Amin (2005). The cross-sectional design was used because it focuses on a specific point in time thereby avoiding data loss that comes with follow up studies (Oso and Onen, 2008). Cross sectional data exhibits validity comparable to other data types, in particular, longitudinal data (Rindfleisch et al., 2008). The method addresses validity concerns related to common method variance bias and causal inferences (Rindfleisch et al., 2008).

3.3 Research Approach

The study used both qualitative and quantitative approaches. The quantitative approach was adopted because the study intended to examine the factors affecting construction equipment productivity. Such an endeavour, can best be achieved when a quantitative approach is used because it allows for collecting numeric data on observable individual behaviour of samples, then subjecting these data to statistical analysis (Amin, 2005). A qualitative approach was adopted to enable the researcher capture data that would have been left out by the quantitative approach. This was aimed at capturing more in-depth information on the topic under investigation.

3.4 Study Population

The study population constituted of project managers and site engineers working on building construction projects within Kampala divisions. These were selected due to their perceived knowledge of the study variables.

The study population comprised of construction projects approved by KCCA in the 5 divisions of Kampala City (Kampala Capital City Authority, 2018). For this study, the building construction project was the unit of analysis, and the project managers or engineers were the unit of inquiry.

3.5 Study Sample

The study sample comprised of 340 respondents. The sample size was arrived at using the predetermined table for determining sample size by Krejicie and Morgan (1970) as cited in Amin (2005) as seen in appendix III.

Table 3.1: Sample Size Determination

Category	Sites approved	Sample Size
Central	70	59
Kawempe	80	66
Nakawa	90	73
Lubaga	80	66
Makindye	95	76
Total	**415**	**340**

Source: Kampala Capital City Authority (2018)

3.6 Sampling Techniques and Procedure

Two sampling techniques were used to select respondents in the study namely; simple random and purposive sampling techniques. The construction projects were selected using simple random sampling technique. Simple random sampling was used because it ensures generalizability of findings and minimizes bias (Sekaran, 2003). The list of the construction sites was obtained from KCCA and firms selected using simple random sampling technique. After selecting the firms, purposive sampling technique was used to select the study respondents. These key informants were purposively sampled because they are believed to have technical and specialized knowledge about the topic under investigation by virtue of the offices that they hold. This sampling technique was used to collect quantitative data using the survey questionnaire. Both qualitative and quantitative data were collected and used in the study to address the research questions.

3.7 Data Collection Methods

3.7.1 Questionnaire Survey Method

The study used the questionnaire method to collect data from the project managers and site engineers. The questionnaire was used because it allows for the collection of data from a big group of respondents in a short period as suggested by Mugenda and Mugenda (1999). The questionnaire was also used because it allows busy respondents to fill it at their convenient time. It also allows respondents express their views and opinions without fear of being victimized (Oso and Onen, 2008).

3.7.2 Interview Method

The study used the interview method to collect data from the key informants. These were project managers. The method was deemed fit to collect data from them, since it allowed for probing for more data and information which could not be accessed through questionnaire

3.8 Data Collection Instruments

The instruments used in this study were the questionnaire as discussed in detail in the proceeding subsection.

3.8.1 Self-Administered Questionnaire

The study employed a questionnaire as a tool of data collection. The questionnaire was divided into four subsections. Section A focused on the demographic characteristics. Section B focused on the factors affecting equipment productivity namely human, equipment, and environmental factors. Section C focused on the impact of these factors in construction equipment productivity and Section D focused on equipment productivity. The questions were close-ended. This was developed to help respondents make quick decisions. It was also to help the researcher to code the information easily for subsequent analysis and narrow down the error gap while analysing data as observed by Sekaran (2003).

3.8.2 Interview Guide

An interview guide was used to collect qualitative data from the study respondents about the factors affecting equipment productivity and the requirements of the model for improving equipment productivity. The interview guide was used because it allows for the collection of in-depth qualitative data on the topic under investigation as suggested by Amin (2005).

3.9 Achievement of Research Objectives

3.9.1 Objective One: To establish the factors affecting equipment productivity in building construction projects in Uganda

In order to address the first objective the study adopted a cross-sectional research design that was focused on a cross section of respondents from different construction firms in Kampala at a given point in time as suggested by Amin (2005). Respondents were requested to respond to the human, equipment and environmental factors affecting equipment productivity in building construction projects in Kampala on a score scale of 1-5 (1=Strongly disagree, 2=Disagree, 3=Not sure, 4=Agree, and 5=Strongly agree). Responses of the participants were provided and presented in form of mean, standard deviation, and ranking which indicated highest and lowest factors that affect equipment productivity.

3.9.2 Objective Two: determine the impact of the factors affecting equipment productivity in building construction projects in Uganda.

To achieve the second objective, Pearson Product-Moment correlation coefficient was used to establish the relationship between variables. A simple bivariate correlation design was adopted to determine the relationship between the human, resource/equipment, environmental factors and the productivity of building construction equipment. A linear regression was also used to determine the intensity of the relationship between the variables. (See Chapter Four: Table 4.11, 4.12, 4.13, 4.14). This was meant to establish factors affecting equipment productivity in building construction projects in Uganda

3.9.3 Objective Three: developing a model to improve construction equipment

3.9.3.1 Process Improvement Modeling

The study used product improvement model. It was be informed by the Model Based Continuous Improvement Methodology that was suggested by Jain, et al (2013). The model involves a number of steps including: high level assessment, problem identification, and formal problem representation and process modeling, what if analysis and decision optimization, as well as implementation and evaluation/validation.

3.9.3.2 High level assessment

This step is aimed at upfront identification of the area where the improved planning effort should be focused on. This step focuses on a high level assessment of the major opportunities for improvements using identified metrics (Jain et al, 2013).

3.9.3.3 Problem identification and alternative generation

According to Jain et al (2013), this step includes the collection of data and analysis for narrowing down the area targeted for improvement effort and development of an improvement plan. The collected data relevant to the narrowed down area will help identify the problem specifically. Alternatives may be generated based on experience and knowledge of the team.

3.9.3.4 Formal data representation and process modelling

This step involves representation of the manufacturing process and facility data using proposed structures that allow capturing the current state to develop a better understanding of the underlying phenomenon and causal relationships (Jain et al, 2013). Once the requisite data is represented using proposed structures, it can be used to generate optimization and/or simulation models of the areas of interest of the construction system.

3.9.3.5 What-if analysis and decision optimization

This step will involve development of optimization and simulation models for generation and evaluation of the improvement alternatives respectively. The evaluation will include use of metrics generated by the models and business metrics such as return on investment

(Jain et al, 2013). Optimization models may be used to develop proposed solutions to achieve the desired goals. Alternatives may also be generated by the decision makers and analysed based on the past experience and the increased understanding and insights gained through the development and use of simulation models of the current processes.

3.9.3.6 Implementation

This step involves implementing the improvement plan validated through simulation as discussed in the previous step. This may involve changing parameters in the production scheduling system such that desired proportion of products flows through the alternative processes (Jain et al, 2013).

3.9.3.7 Validating the Models

Models should be evaluated comprehensively prior to being released to the environment (Hevner, 2007). Venable (2010) offers guidance concerning the evaluation activity in design science and appropriate criteria concerning various other goals to be applied in evaluation. These include validating models to ascertain their usefulness and usability. Usability focuses on the perceived ease of use of the model, while usefulness on the other hand assesses the effectiveness and relevance of the model.

The statistical analysis is the most widely used approach in analyzing collected data in determining production rates of construction activities as suggested by Nepal (2011). The study was informed by the Koss and Lewis (1993) model of measuring productivity (PR) as shown in the equation 3.1 where;

$PR = X_1+X_2+X_3... X_n$ ....Equation (3.1)

Where Xi (X_1, X_2, X_n) represents a series of individual or group of productivity factors.

When translated the study seeks to propose the following model:

$PR = h+ e + en +n$ ....Equation (3.2)

Where	PR =	Summation of factors
	h =	Human resource factors
	e =	Equipment Factors
	en=	Environmental Factors
	n =	Constant

3.10 Validity and Reliability of the Research Instruments

3.10.1 Validity

The validity of the questionnaires was established using the content validity test. Using the ratings the content validity indices were computed using the following formula (See Findings in Section 4.3.1).

$$CVI = \frac{\text{number of items declared valid}}{\text{number of items in the questionnaire}}$$ ....Equation (3.3)

3.10.2 Reliability

Gay (1996) defined reliability as the degree of consistency that the instrument demonstrates. After pilot testing in the field, reliability of the instrument, on multi-item variables (human resource, environmental and equipment factors) was tested via the Cronbach Alpha Method provided by Statistical Package for the Social Scientists (Foster, 1998). The researcher used this method because it was expected that some items or questions would have several possible answers. The researcher established reliability of the questionnaires by computing the alpha coefficient of the items (questions) that constituted the dependent variable and that of the items that constituted the independent variable. (See Findings in Table 4.2)

3.11 Data Collection Procedure

A letter of introduction from Kyambogo University was presented to the authorities in the construction firms. A list of construction sites in Kampala was obtained from KCCA. After obtaining the list of respondents to the study, respondents were purposively selected to participate in the study. A self-administered questionnaire was used to collect data and information from the above mentioned respondents.

3.12 Data Analysis

3.12.1 Analysis of Quantitative Data

The statistical package which was used for analysis of quantitative and qualitative data in this study was the SPSS version 21.0. Different statistical techniques were used namely: correlation and regression analysis. Descriptive statistics namely frequency counts, percentages was used to analyse the respondents' demographic characteristics and the mean and standard deviation was used to analyse the respondents' opinions on the factors affecting construction equipment productivity.

Data was analysed and correlated using Pearson Product-Moment correlation coefficient to establish the relationship between the human, environmental and resource/equipment and equipment productivity as suggested by Sekaran (2003), Amin (2005) and Oso and Onen (2008). For this study, the three factors were regressed against equipment productivity; this aimed at explaining the relationship between the independent and dependent variables as suggested by Sekaran (2003).

3.13 Ethical Consideration

The research process was guided by sound ethical principles which include the followings:-

3.13.1 Voluntarism: the researcher ensured that respondents were not coerced or manipulated into participating in the study. Respondents were told the purpose of the study and their consent to participate in the study was sought.

3.13.2 Objectivity: The researcher ensured objectivity when carrying out the research. Any attempt to bias results was considered unethical and was therefore avoided.

3.13.3 Confidentiality: The respondents were also assured of confidentiality and anonymity. Their names will not be written anywhere in the report and the information given was only to be used for academic purposes.

3.13.4 Respect: The researcher ensured respect for the respondents. Respect encompassed respecting the opinion of the respondents including the opinion to terminate the interview whenever they feel uncomfortable to continue.

3.14 Chapter conclusion

This chapter highlighted the different to methodical steps that were taken in conducting the study. It further explained how the objectives set in chapter one were achieved. This formed a basis for the subsequent chapters.

CHAPTER FOUR

PRESENTATION, ANALYSIS, AND DISCUSSION OF RESULTS

4.1 Introduction

The main objective of this study was to asess equipment productivity in building construction projects in Uganda. It first presents the response rates to the questionnaire, background information. Results and discussion of results on the effects and impact of the human, equipment and environmental factors on equipment productivity are presented and the model for improving equipment productivity.

4.2 Response Rates

Out of 340 questionnaires that were issued, 340 were returned, giving a response rate of 100% as in Table 4.1. According to Amin (2005) a response rate of 70% above is recommended for any research.

Table 4.1: Response Rates

Category	Sample Size	Response Rate	Percentage
Central	59	59	100%
Kawempe	66	66	100%
Nakawa	73	73	100%
Lubaga	66	66	100%
Makindye	76	76	100%
Total	**340**	**340**	**100%**

Source: Primary Data 2018

4.3 Findings on Validity and reliability

4.3.1 Validity

The validity of the questionnaires was established using the content validity test. Using the ratings the content validity indices were computed.

$$CVI = \frac{\text{number of items declared valid}}{\text{number of items in the questionnaire}} \qquad \text{.............................Equation (4.1)}$$

$$CVI = \frac{16 + 12 + 5 + 19}{18 + 14 + 7 + 22} = 0.852$$

According to Content Validity Index, the questionnaire was considered valid since all the coefficients are above 0.7 which is the least recommended CVI in survey studies.

4.3.2 Reliability

The researcher established reliability of the questionnaires by computing the alpha coefficient of the items (questions) that constituted the dependent variable and that of the items that constituted the independent variable. The results are in Table 4.2:

Table 4.2: Reliability indices for the respective sections of the questionnaire

Assessment	Human Resource Factors	Equipment Factors	Environmental Factors	Equipment productivity
Average inter-item covariance	0.47	0.41	0.39	0.48
Number of items in the scale	16	12	5	19
Scale reliability coefficient	0.868	0.822	0.796	0.895

Source: Primary Data (2018)

The reliability of the questionnaire variables was computed using SPSS 21.0 to obtain the Cronbach Alpha reliability Coefficient Test with values as indicated in the Table 4.2. The details are shown in IV. The instrument was considered reliable since all the coefficients in Table 4.2 were above 0.7 which is the least recommended coefficient in reliability studies (Amin, 2004; Gay, 1996).

4.4 Background Information of respondents

This subsection presents the background information of the study respondents in terms of division, position and length of service. The subsection also presents background information about the equipment.

4.4.1 Division of the Study Respondents

The study considered the divisions of the respondents as presented in table 4.2;

Table 4.3: Division of the Study Respondents

Category	**Frequency**	**Percentage**
Central	59	17.4
Makindye	76	22.4
Lubaga	66	19.4
Nakawa	73	21.5
Kawempe	66	19.4
Total	**340**	**100.0**

Source: Primary Data 2018

A total of 340 respondents participated in the study. These participants were selected from all the 5 Divisions of Kampala. Out of these 59 (17.4%) were from the Central Region, 76 (22.4%) were from Makindye Division, 66 (19.4%) were from Lubaga Division, 73 (21.5%) were from Nakawa Division and 66 (19.4%) were from Kawempe Division. This shows that data in the study was collected from all the 5 divisions in Kampala and thus, it is representative.

The findings indicate that almost all divisions had equal representation implying that the findings were balanced and the opinion expressed portray representation of all project managers in the divisions of Kampala.

4.4.2 Position of the Respondents

The study investigated on the position of the respondents of the respondents and the findings are presented in Table 4.4.

Table 4.4: Position of the Respondents

Position	**Frequency**	**Percentage**
Site Engineer	244	71.8
Foreman	59	17.4
In charge of equipment	36	10.6
Others	1	0.3
Total	**340**	**100.0**

Source: Primary Data 2018

Out of the 340 respondents who participated in the study, 244 (71.8%) were Site Engineers, 59 (17.4%) were Foremen, 36 (10.6%) were in-charges of equipment and only 1 (0.3%) were in the category of others. This shows that data were collected from a cross section of cadres on building construction projects and as such, the findings can be generalized to all the other cadres. The majority being site engineers was a major advantage to the researcher due to their knowledge on equipment usage.

4.4.3 Experience of respondents

The study explored on the experience of the respondents in building construction industry and the findings are presented in the Table 4.5.

Table 4.5: Experience of respondents in building construction industry

Experience of respondents	Frequency	Percentage
1-3 years	54	15.9
4-7 years	164	48.2
8-11 years	83	24.4
12 and above years	39	11.5
Total	**340**	**100.0**

Source: Primary Data 2018

Out of the sampled study respondents, 164 (48.2%) had worked for a period of between 4 and 7 years, followed by 83 (24.4%) who had worked for a period of 8 to 11 years, and then by 54 (15.9%) who had worked for a period between 1-3 years and lastly by only 39 (11.5%) who had worked for 12 years and above. This shows that most of the study respondents were experienced and could be relied on to provide adequate information on the topic under investigation.

4.4.4 Level of Education

The study explored on the level of education of the respondents of the respondents and the findings are presented in the Table 4.6.

Table 4.6: Level of education

Level of Education	**Frequency**	**Percentage**
Secondary	10	2.9
Certificate	53	15.6
Diploma	155	45.6
Degree	90	26.5
Post Graduate	29	8.5
Other	3	.9
Total	**340**	**100.0**

Source: Primary Data 2018

The results in Table 4.6 indicate that out of the 340 sampled respondents, most 155(45.6%) of the study respondents had studied up to diploma level, followed by 90(26.5%) with bachelor's degrees and by 53(15.6%) with certificates. A total of 29 participants representing 8.5% had a post graduate diploma followed by 10(2.9%) who had a secondary school certificate and lastly by only 3(0.9%) who were in the category of others. This shows that the study respondents were adequately educated and they could therefore be relied upon to provide credible information on the topic under investigation.

4.4.5 Background Information of the Equipment

This sub section presents background information of the type of equipment in terms of excavation, compacting, lifting and mixing equipment as summarized in Table 4.7.

Table 4.7: Background Information of the Equipment

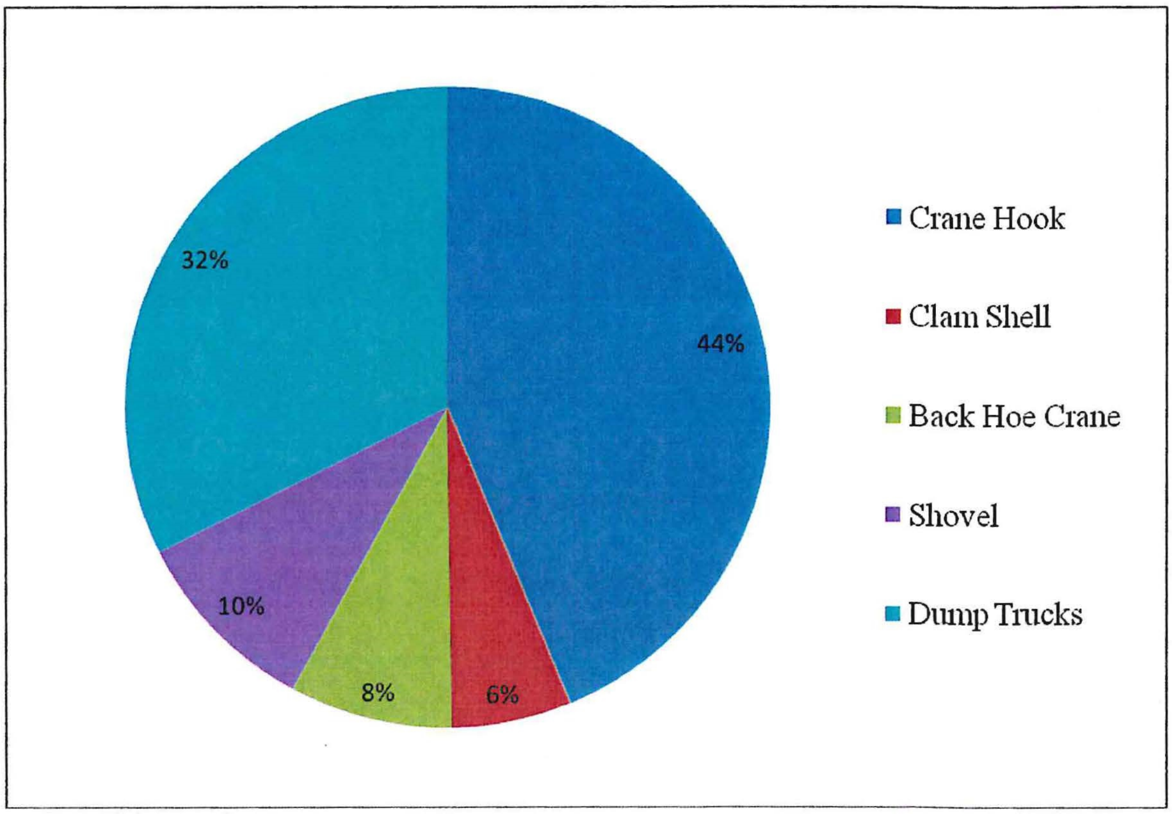
Multiple Responses Allowed

Type of equipment	Category	Frequency	Percentage
Excavation Equipment	Crane Hook	340	43.7%
	Clam Shell	47	6.0%
	Back Hoe	64	8.2%
	Shovel	75	9.6%
	Dump Trucks	252	32.4%
	Total		**100.0%**
Compacting Equipment	Towed Foot Roller	6	2.2%
	Grid Roller	144	53.1%
	Hand propelled roller	76	28.0%
	Self-propelled roller	45	16.6%
	Total		**100.0%**
Lifting Equipment	Tower cranes	39	10.5%
	Pulleys	329	88.2%
	Hoists	5	1.3%
	Total		100.0%
Mixing Equipment	Concrete mixers	143	46.3%
	Truck concrete mixers	166	53.7%
	Total		**100.0%**

Source: Primary Data

4.4.5.1 Excavation equipment

When asked what excavation equipment they used most, crane hook were the most used at 43.7% followed by crane hooks at 32.4% followed by shovels at 9.6% and then by clam shells at 60%. The findings are illustrated in the Figure 4.1.



Source: Primary data 2018

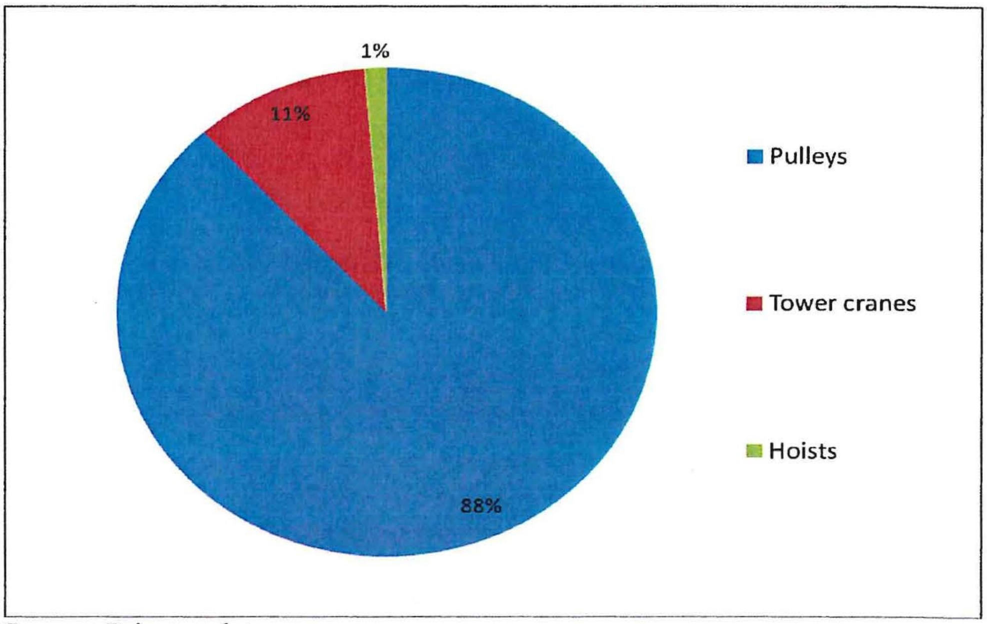
Figure 4.1: Categories of Excavation Equipment

4.4.5.2 Compacting Equipment

The most commonly used compacting equipment were grid rollers at 53.1% followed by hand propelled rollers at 28% and by self-propelled rollers at 16.6% and lastly by towed foot rollers at 2.2%.

4.4.5.3 Lifting Equipment

The most used lifting equipment were pulleys at 88.2% followed by tower cranes at 10.5% and then by hoists at 1.3%. This shows that pulleys are the most used lifting equipment at the building construction sites in Kampala, Uganda. The most available equipment in Kampala divisions is lifting equipment. It also indicates that the use of modern equipment is not much pronounced.



Source: Primary data

Figure 4. 2 : Lifting equipment

4.4.5.4 Mixing Equipment

When asked what mixing equipment they used most, Truck concrete mixers were the most used at 53.7% followed by hand operated concrete mixers at 46.3%

4.5 The Factors Affecting Equipment Productivity

The first objective of this study was to identify the human, equipment and environmental factors affecting equipment productivity within construction projects in Kampala, Uganda. To achieve this objective, the study respondents were requested to respond to the human, equipment and environmental factors affecting equipment productivity in building construction projects in Kampala on a score scale of 1-5 (5=Strongly agree, 4=Agree, 3=Not sure, 2=Disagree, and 1=Strongly disagree). Data on this objective was analysed using descriptive statistics namely the mean and the standard deviation. The mean portrays the average response on a statement and standard deviation portrays the extent to which scores deviate from the mean. The interpretation scale was; 1.00 – 1.80 (strongly disagree), 1.81 – 2.60 (disagree), 2.61 – 3.40 (moderately agree), 3.41 – 4.20 (agree) and 4.21 - 5.00 (strongly agree). The subsection below presents the respondents' opinion on the findings.

4.5.1 Human Resource Factors Affecting Equipment Productivity

This sub section presents the human resource factors affecting equipment productivity within building construction projects in Kampala District as summarized in Table 4.8.

Table 4.8: Human Resource Factors Affecting Equipment Productivity in building construction projects

Factor	Mean	Std. Deviation	Rank
Technical skills of staff	3.80	1.16	1
Experience of the operative	3.61	1.14	2
Supervision	3.60	1.25	3
Payment	3.58	1.17	4
Motivation of staff	3.34	1.15	5
Work rules and procedures	3.31	1.29	6
Staff attitude	3.29	1.23	7
Spirit of teamwork	3.27	1.15	8

Source: Primary Data

The human resource factors affecting equipment productivity included technical skills of staff (Mean= 3.80, SD= 1.16), followed by experience of the operative (Mean= 3.61, SD=1.14), supervision (Mean= 3.60, SD= 1.25) and then payment (Mean= 3.58, SD= 1.17). The other human resource factors identified were motivation of staff (Mean= 3.34, SD= 1.15), work rules and procedures (Mean= 3.31, SD= 1.29), staff attitude (Mean= 3.29, SD= 1.23) and the spirit of teamwork Mean= 3.27, SD=1.15).

For productivity to improve on construction site, there is need to have trained and experienced staff to operate the equipment and close supervision of staff. On the other hand, team work was the least rated and this could be attributed to the fact that a machine can be operated by one individual.

In a related study, Enshassi (2007) observed that labourer experiences high impact on equipment productivity. Trained and skilled staff are able to execute their duties and contribute to reasonable outputs. This is acceptable because a labourer always has low productivity when starting the career and productivity increases with experiences till certain limit.

4.5.2 Equipment Factors affecting Equipment Productivity

This sub section presents equipment factors affecting equipment productivity within building construction projects in Kampala District as summarized in Table 4.9.

Table 4.9: Equipment Factors Affecting Equipment Productivity in building construction projects

Factor	Mean	Std. Deviation	Rank
Age of Equipment	3.67	1.52	1
Equipment breakdown	3.57	1.25	2
Fuel Efficiency	3.25	1.24	1
Quality of equipment	3.51	1.26	3
Working cycle Capacity	3.46	1.27	4
Availability of adequate equipment	3.44	1.28	5
Availability of auxiliary equipment	3.30	1.17	6
Versatility of equipment	3.30	1.34	7
Easy repair and maintenance	3.24	1.16	8

Source: Primary Data

The equipment factors affecting equipment productivity were established as fuel efficiency (Mean= 3.67, SD= 1.24) in the first position, followed by equipment break down (Mean= 3.57, SD= 1.25), then by quality of equipment (Mean= 3.51, SD= 1.26) and by working cycle capacity (Mean= 3.46, SD= 1.27). The other equipment factors identified were availability of adequate equipment (Mean= 3.30, SD= 1.34), versatility of equipment (Mean= 3.30, SD= 1.34), easy repair and maintenance of equipment (Mean= 3.25, SD= 1.16) and age of equipment (Mean= 3.24, SD= 1.52).

Equipment productivity improves by use of new equipment with no frequent breakdowns. New machines will be able to deliver bigger constructional outputs, thereby reducing on construction costs. On the other hand, use of old equipment reduces productivity and increased costs of construction due to frequent breakdowns.

Ganasen and Natarajan, (1993) shared similar findings and argued that experienced personnel will execute tasks faster than new entrants as they are aware of the steps involved in undertaking the works. This can only be executed if there are no breakdowns in the machines being used to execute the work. Studies (Ganasen and Natarajan, 1993) have shown that the change in cost associated with breakdowns has a reflection on the costs to be incurred.

4.5.3 Environmental Factors Affecting Equipment Productivity

This sub section presents the environment factors affecting equipment productivity within building construction projects in Kampala District as summarized in Table 4.9 below.

Table 4.10 : Environmental Factors affecting Equipment Productivity in Building Construction Projects

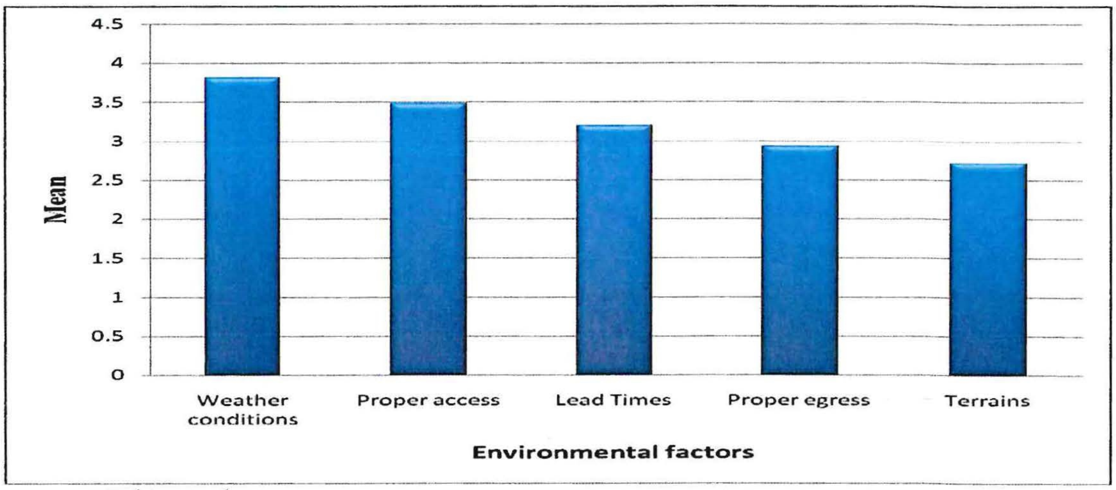
Factor	Mean	Std. Deviation	Rank
Weather conditions	3.81	1.27	1
Proper access	3.48	1.26	2
Lead Times	3.19	1.45	3
Proper egress	2.93	1.29	4
Terrains	2.72	1.50	5

Source: Primary Data

The environmental factors that were identified included weather conditions (mean= 3.81, SD= 1.27), proper access (Mean= 3.48, SD=1.26), lead times (Mean= 3.19, SD= 1.45), proper egress (Mean= 2.93, SD= 1.29) and terrains (Mean= 2.72, SD= 1.50).

From the Table 4.9, it is indicated that weather conditions affect equipment productivity the most. When it rains, most of the construction sites are closed and as such there is no productivity. Heavy rain also may affect accessibility of sites in addition to poor road network. It is common knowledge that construction sites which can be accessed easily facilitate faster delivery of construction materials.

The findings are supported by Kwakye (2000) who argues that construction firms adjust to avoid certain effects that relate weather conditions as it affects equipment productivity. This reflects greatly on the nature of outcomes that the contractor desires to get.



Source: Primary data

Figure 4.3 : Environmental factors affecting equipment productivity in building construction projects

4.6 Perceived levels of equipment productivity

This subsection presents the perceived levels of equipment productivity as mentioned by the study respondents. The results are summarized in Table 4.5. The interpretation scale was; 1.00 – 1.80 (Very low), 1.81 – 2.60 (Low), 2.61 – 3.40 (moderate), 3.41 – 4.20 (High) and 4.21 - 5.00 (Very High). The subsection below presents the respondents opinion on productivity.

Table 4.11 : Levels of building construction projects equipment productivity

Factor	**Mean**	**Std. Deviation**	**Rank**
Equipment reliability	3.89	.94	High
Equipment efficiency	3.48	1.10	High
Equipment capacity	3.44	1.06	High
Fuel efficiency	3.42	1.19	High
Meets job and operational requirements	3.34	1.24	High
Easy repair and maintenance	3.25	1.16	High
Versatility of equipment	3.16	1.14	Low
Equipment operating life	3.14	1.14	Low
Engine value	2.99	1.15	Low
Aggregate	**3.35**	**1.12**	**Moderate**

Source: Primary Data

The research team was interested in finding out the extent to which the building construction projects were productive with respect to the study objective. According to the results in Table 4.5, the study respondents mentioned that the equipment were reliable

(Mean= 3.89, SD= 0.94), efficient (Mean= 3.48, SD= 1.10) and had high capacity (Mean= 3.44, SD=1.06). The study respondents also noted that the equipment were fuel efficient 9 (mean= 3.42, SD= 1.19), met operational requirements (Mean= 3.34, SD= 1.24) and that they were easy to repair and maintain (Mean= 3.25, SD= 1.16). The study respondents however rated the equipment as low on versatility (Mean= 3.16, SD= 1.14), operating life (Mean= 3.14, SD=1.14) and engine value (Mean= 2.99, SD= 1.15). Generally, the above results indicate that equipment productivity in the construction projects is generally low.

The findings imply that equipment reliability, efficiency and capacity constitute great percentages on how the equipment delivers. Reliable equipment is likely to deliver much output compared to one that is not. Equipment that has capacity to deliver in a timely manner can as well give reasonable outcomes. This may be easy to repair and with fuel efficiency. These views are supported by Barrie and Banny, 2010) who found out that equipment productivity may fluctuate widely due to numerous factors that affect it. Many of the factors are highly qualitative in nature and may include the effect of location and regional variations. Others are quantitative and may include fuel, repair and maintenance.

4.7 The impact of Human, Equipment and Environmental Factors on Equipment Productivity

The second objective of this study was aimed at determining the impact of the human, equipment and environmental factors on equipment productivity on building construction projects in Kampala. To achieve this objective, regression analyses were conducted. The results are presented in the proceeding subsection.

4.7.1. The impact of Human Resource Factors on Equipment Productivity

Table 4.12: Model Summary Table showing the effect of Human resource factors on Building Construction Equipment productivity.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.248[a]	.062	.042	.33974

a. Predictors: (Constant), Experience of the operative, Spirit of teamwork, Payment , Motivation of staff, Technical skills of staff, Supervision of staff, Staff attitude

From the Table 4.10, it is shown that the adjusted R square 4.2% of the total variation in equipment productivity can be explained by experience of operatives, spirit of teamwork, payment, motivation, technical skills, supervision of staff and staff attitude. The rest of the percentage is attributed to other factors which this study did not investigate.

Table 4.13: Coefficients on the effect human resource factors on equipment productivity

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.938	.142		20.718	.000
	Technical skills of staff (TS)	.026	.016	.087	1.594	.112
	Motivation of staff (Ms)	.045	.016	.150	2.737	.007
	Spirit of teamwork (St)	.016	.016	.054	.973	.331
	Staff attitude (Sa)	.004	.016	.015	.277	.782
	Supervision of staff (Ss)	.008	.016	.027	.481	.631
	Payment (P)	-.026	.016	-.087	-1.585	.114
	Experience of the operator (Eo)	.041	.018	.135	2.330	.020

a. Dependent Variable: Equipment productivity

Where; standard error is used for testing whether the coefficient is significantly different from 0 by dividing the coefficient by the standard error to obtain a t value,

The values beta compares the strength of the effect of individual independent variable to the dependent variable

A variable was considered significant if the sig ≤ 0.05

According to this table 4.11, the regression equation is;

PR=2.938+0.87 ts+0.150ms+0.054st+0.015sa+0.027ss-0.087p+0.135EO+e...equation (4.2)

Where PR=F (Ts, Ms, St, Sa, Ss, P, Eo, O)

According to the results in Table 4.11, motivation of staff was found to have the most significant impact on building construction equipment productivity ($\beta = 0.150$, t=2.73, p<0.05), followed by experience of the operator ($\beta = 0.135$, t= 2.33, p<0.05). Technical skills of staff, teamwork, staff attitude, supervision and payment were not found to be significant because they had a p value of above 0.05. From the findings, payment was found to be significant with p value (-.087). The above results mean that the most significant determinants of building construction equipment productivity in Kampala are motivation of staff and experience of the operator. It also indicates that payment does not determine productivity of equipment.

The findings relate to the views of Enshassi (2007), who noted that the major different human resource factors on equipment processes are cited as: technical skills, spirit of team work, supervision of staff and payment. These factors are critical to productivity outputs and represent the broad areas in which Project managers can take action to obtain better productivity (Heizer, 1990).

4.7.2 The Effect of Equipment Factors on Equipment productivity

Table 4.14: Model summary table the Effect of Equipment Factors on Productivity

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.486[a]	.236	.220	.30659

a. Predictors: (Constant), Age of Equipment, Fuel efficiency, Working cycle , Equipment breakdown , Availability auxiliary equipment , Availability of adequate equipment , Quality of equipment

Source: Primary Data

The R^2 results of 0.236 in the regression analysis in Table 4.12 above, indicates that the overall variance in equipment productivity among building construction projects in Kampala that is explained by equipment factors is 23.6%. This means that holding other factors constant, equipment factors affect equipment productivity by 23.6% and the remaining 76.4% is explained by other factors which were not considered under the current study.

Table 4.15: Coefficients Table showing the effect of the different equipment factors on equipment productivity

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	3.053	.128		23.796	.000
	Availability of auxiliary equipment	-.036	.016	-.122	-2.274	.024
	Fuel efficiency	.073	.016	.263	4.484	.000
	Equipment breakdown	.025	.015	.089	1.645	.101
	Quality of equipment	-.057	.016	-.206	-3.515	.001
	Availability of adequate equipment	-.010	.016	-.038	-.644	.520
	Working cycle Capacity	.082	.014	.302	5.792	.000
	Age of Equipment	-.001	.012	-.007	-.124	.901

a. Dependent Variable: Equipment productivity

Source: Primary Data

According to the results in Table 4.13, working cycle capacity which was more significant at (β = 0.302, t=5.792, $p<0.05$). This was followed by fuel efficiency (β = 0.263, t= 4.84, $p<0.05$).). The quality of the equipment (β = -0.206, t= -3.515, $p<0.05$) came third. Availability of auxiliary was the fourth factor (β =-.122), t=-2.274, $p<0.05$). Equipment breakdown was found to be not a major factor in determination of building construction equipment (β =0.089, t=1.645, $p<0.05$). The age of equipment was not significant (β =-.007,t=-.124, $p>0.05$). Availability of equipment was equally insignificant (*β=-.038, t=-.644, p>0.05).* The above findings indicate that equipment cycle working capacity, fuel efficiency, and quality of equipment and availability of auxiliary equipment are the equipment factors affecting equipment productivity in building construction projects in Kampala, Uganda.

The findings above are in line with Assaf (1996), who observed that equipment breakdown is one of the factors that contributes to decline in productivity of equipment, for example in the situation that newly acquired contracts need to be accomplished, breakdowns normally delay the starting of projects. It is it is also likely that working cycle capacity, fuel efficiency, quality of equipment, and availability of auxiliary equipment can affect greatly the equipment productivity.

4.7.3 Impact of Environmental Factors on Equipment Productivity

Table 4.16: Model Summary of the impact of Environmental Factors on Equipment Productivity

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.253[a]	.064	.053	.33780

a. Predictors: (Constant), Lead Times, Weather conditions, Proper access, Proper egress
Source: Primary Data

The R^2 results of 0.064 in the regression analysis in Table 4.14, indicates that the overall variance in equipment productivity that is explained by environmental factors is 6.4%. This means that holding other factors constant, environmental factors affect equipment productivity by 6.4% and the remaining 93.6% is explained by other factors which were not considered under the current study.

Table 4.17: Coefficients Table on the effect of Environmental Factors on Equipment Productivity

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.126	.089		35.274	.000
	Weather conditions	.012	.015	.344	5.822	.000
	Proper access	.012	.015	.044	.809	.419
	Proper egress	.065	.015	.243	4.425	.000
	Lead Times	-.022	.013	-.092	-1.659	.098

a. Dependent Variable: Equipment productivity
Source: Primary Data

According to the results in Table 4.15, weather conditions were found to be most significant on building construction equipment productivity ($\beta = 0.344$, t=5.822, $p<0.05$), followed by proper egress ($\beta = 0.243$, t= 4.425, $p<0.05$). Lead times ($\beta = -0.092$, t= -1.659, $p>0.05$) and proper access ($\beta = 0.44$, t=0.809, $p>0.05$) were found not to be significant. The above findings indicate that weather conditions, proper egress are the most significant determinants of building construction projects equipment productivity in Kampala compared to lead times and proper access.

The above findings indicate that equipment cycle working capacity, fuel efficiency, and quality of equipment and availability of auxiliary equipment are the equipment factors affecting equipment productivity in building construction projects in Kampala, Uganda.

Relatedly, Kwakye (2000) noted that the managers on a construction site often have severe environmental constraints and problems that constrain equipment productivity. There are few in number generally resulting in lack of proper access and weather conditions. Consequently, decline of weather conditions reflects negatively on equipment productivity.

4.8: A Regression Analysis Model for Improving Equipment Productivity

The third objective of this study was aimed at developing a model for improving building construction equipment productivity. To achieve this, the study used a multiple linear regression analysis to develop a model.

Table 4.18: Model Summary on the effect of human resource, equipment and environmental factors on equipment productivity

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.216[a]	.047	.038	.34039

a. Predictors: (Constant), Environmental factors, Equipment Factors, Human resource factors

Source: Primary Data

According to the results in Table 4.16 above, the R^2 value of 0.047 indicates that the three variables combined explain 4.7% of the variation in equipment productivity and the remaining 95.3% are explained by other variables which were not considered in this study.

Table 4.19: Coefficients Table showing the relationship between human resource, equipment and environmental factors on equipment productivity

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.542	.203		12.510	.000
	Human resource factors	.073	.043	.098	1.692	.092
	Equipment Factors	.100	.039	.139	2.548	.011
	Environmental factors	.058	.027	.126	2.143	.033

a. Dependent Variable: Equipment productivity

Source: Primary Data

A mathematical model to improve equipment productivity was developed using the standardized coefficients as presented in the equipment productivity (Y) equation 4.3.

Y=2.542+0.098Hrf+0.139Eqf+0.126Enf+E... (Equation 4.3)

Where,

2.542 = constant

Hrf = Human resource factors

Ef = Equipment factors,

Enf = Environment factors

E = Standard error of estimate

According to the results in Table 4.17, equipment factors were significantly positively related with equipment productivity (β = 0.126, $p<0.05$). This means that having in place auxiliary equipment, quality equipment, equipment with good cycle capacity and fuel efficient equipment as seen in the preceding sub section will improve equipment productivity. This, therefore, implies that equipment productivity improves with having in place efficient and effective equipment. Thus, the study argues that in order to improve equipment productivity, there is need to have in place effective and efficient equipment.

According to the results in Table 4.18, environmental factors were significantly positively related with equipment productivity (β = 0.139, $p<0.05$). This means that the better the environmental factors in terms of favourable weather conditions and egress, the better the equipment productivity. This, therefore, implies that equipment productivity improves with better environmental conditions.

Human resource factors and equipment productivity were found to have less significant positive relationship (β = 0.98, $p>0.05$). This means that having in place experienced and motivated personnel as seen earlier in this study will improve building construction project equipment productivity but not to a greater extent.

The findings are similar to what Pedler (2012) found out that, an organization that encourages reflection on lessons learnt attempts to understand the dynamics of its operating environment and anticipates likely changes to that environment so as to cope with opportunities and challenges thus becoming more competitive.

4.8.1 Model validation

The statistical validity of the models and the significance of the variables were verified through different validity checks with standard parameters like ''t'' values and ''p values'' for each of independent variable considered in the models (Table 4.17). The acceptable student ''t'' statistic value for 95% confidence level is 12.5. The coefficients in Table 4.17 have a positive sign implying increase in dependent variable. This implies a normal distribution across observations. Further, ''p'' values are less than 0.05, which implies that the variables included for model development are significant for the model. Regression statistics are shown in Table 4.16.

4.9 How the model will improve equipment productivity

The model is important in improving equipment productivity in building construction industry. From the findings, it was indicated that most equipment factors connoted a significant positive relationship. This implies that effective management of equipment factors like use of new equipment and training of operators substantially increases productivity. Increase in productivity indicates that firms that are undertaking the projects will have more profits from the projects.

From the study findings, it was found out that easy access to the construction sites is important in equipment productivity. It reduces the time to access the sites, thereby allowing activities to be executed in a timely fashion. The model will thus, inform different construction specialists to appreciate the importance of environmental factors and how it affects the construction industry.

The model further indicates that human resource, equipment, and environmental factors play a significant role in ensuring that there is equipment productivity. No single factor alone can contribute to the effectiveness of the equipment. Managers and all practitioners in the construction industry ought to treat such factors as such, if the industry is to realise progress and steady growth.

The model developed in this study for equipment productivity in building construction projects was evaluated using statistical parameters. Their effectiveness was tested by a validation process and the accuracy was demonstrated by the comparison of actual values with predicted values.

From Equation 4.3, A positive unit variation in the independent variables results into an improvement in equipment productivity and vice versa. Meanwhile zero variation in the three variables results into constant productivity at 2.542.

4.10 Chapter summary

In this chapter, discussion and analysis of results of the data generated from SPSS on the various factors affecting equipment productivity were presented. The significance of these factors on building equipment productivity and ranking has also been presented. The model for improvement of equipment productivity has been developed. The proceeding section focuses on summary, conclusion and recommendation to the study

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary, conclusion and recommendations arising out of the study findings. It addresses them basing on the study findings as guided by the objectives set for the study in chapter one.

5.2 Summary

5.2.1 The Factors Affecting Equipment Productivity

The first objective of this study was aimed at identifying the human, equipment and environmental factors affecting equipment productivity within construction projects in Kampala, Uganda. To achieve this objective, the study respondents were asked to respond to the human, equipment and environmental factors affecting equipment productivity in building construction projects in Kampala. The findings are summarized in this subsection.

5.2.1.1 Human Resource Factors Affecting Equipment Productivity

The human resource factors affecting equipment productivity included technical skills of staff followed by experience of the operator, supervision and then payment. The other human resource factors identified were motivation of staff, work rules and procedures, staff attitude and the spirit of teamwork.

5.2.1.2 Equipment Factors Affecting Equipment Productivity

The equipment factors affecting equipment productivity were identified as fuel efficiency, equipment break down, quality of equipment and working cycle capacity. The other equipment factors identified were availability of adequate equipment, versatility of equipment, easy repair and maintenance of equipment and age of equipment.

5.2.3 Environmental Factors Affecting Equipment Productivity

The environmental factors that were identified included; weather conditions, proper access, lead times, proper egress and terrains.

5.2.2 The Effect of Human Resource, Equipment and Environmental Factors on Equipment Productivity

The second objective of this study was aimed at determining the effect of the human, equipment and environmental factors on equipment productivity on building construction projects in Kampala. To achieve this objective, regression analyses were conducted. The results are presented in the proceeding subsection.

5.2.2.1 The effect of human resource factors on equipment productivity

According to the results of this study, motivation of staff was found to be the most significant determinant of building construction equipment productivity (β=0.150, t=2.73, $p<0.05$), followed by experience of the operator (β = 0.135, t= 2.33, $p<0.05$). Technical skills of staff, teamwork, staff attitude, supervision and payment were not found to be significant because they had a p value of < 0.05.

5.2.2.2 The effect of equipment related factors on equipment productivity

In this study, working cycle capacity was found to be most significant determinant of building construction equipment productivity (β = 0.302, t=5.792, $p<0.05$), followed by fuel efficiency (β = 0.263, t= 4.84, $p<0.05$) then by quality of the equipment (β = -0.206, t= -3.515, $p<0.05$) and lastly by availability of auxiliary equipment (β = -0.122, t= -2.274, $p<0.05$). The above findings indicate that equipment cycle working capacity, fuel efficiency, and quality of equipment and availability of auxiliary equipment are the equipment factors affecting equipment productivity in building construction projects in Kampala, Uganda.

5.2.2.3 The effect of Environmental Factors on Equipment Productivity

According to the results of this study, weather conditions were found to be the most significant determinant of building construction equipment productivity (β = 0.344, t=5.822, $p<0.05$), followed by egress (β = 0.243, t= 4.425, $p<0.05$) and then by lead times (β = -0.092, t= -1.659, $p<0.05$). The above findings indicate that weather conditions, egress and lead times are the most significant determinants of building construction projects equipment productivity in Kampala.

5.3 A regression analysis model for improving equipment productivity

According to the results of this study, equipment factors were significantly positively related with equipment productivity (β = 0.126, $p<0.05$). This means that having in place auxiliary equipment, quality equipment, equipment with good cycle capacity and fuel efficient equipment as seen in the preceding sub section will improve equipment productivity.

In this study, environmental factors were significantly positively related with equipment productivity (β = 0.139, $p<0.05$). This means that the better the environmental factors in terms of favourable weather conditions and egress, the better the equipment productivity. This therefore implies that equipment productivity improves with better environmental conditions like employing weather proof equipment and proper access and egress.

According to the results of this study, human resource factors and equipment productivity were significantly positively related (β = 0.98, $p<0.05$). This means that having in place experienced and motivated personnel as seen earlier in this study will improve building construction project equipment productivity.

5.3 Conclusions

From the study findings, it can be concluded that equipment productivity in building construction is affected by human resource, environmental and equipment factors. This implies that absence a well-structured and managed human resource with requisite skills to perform necessary tasks, productivity can be compromised. It was also indicated from the study that environmental factors are of essence in the construction industry. It was observed that proper egress and weather can either support or frustrate construction operators. Equipments that are built to work in harsh conditions can influence productivity compared to those that succumb to such conditions.

From the study, it emerged that working cycle capacity, fuel efficiency, quality of equipment can contribute to equipment productivity. It was therefore, concluded that having efficient machines in place, not only facilitates construction works in time, but also saves resources. With improvement in the construction industry, manifested through improved equipment, leads to increased GDP of the country and improves the building sector of the country.

A positive unit variation in the independent variables results into an improvement in equipment productivity and vice versa. Meanwhile zero variation in the three variables results into constant productivity at 2.542.

5.4 Recommendations

5.4.1 Factors Affecting Equipment Productivity

5.4.1.1 Human Resource Factors

Since motivation of staff was found to be a significant determinant of equipment productivity on building construction projects, there is need for management of these sites to motivate their employees better using financial and non-financial rewards.

Using experienced manpower was found to be a significant determinant of equipment productivity. There is therefore need for management of building construction projects to hire experienced manpower to manage equipment.

5.4.1.2 Equipment Factors

Since equipment cycle capacity and fuel efficiency were found to be significant determinants of equipment productivity, there is need to deploy equipment with adequate cycle capacity and with fuel efficiency as a way of improving equipment productivity.

Quality equipment was found to be a significant determinant of equipment productivity. There is therefore need for management of building construction project sites to provide quality equipment as a way of enhancing equipment productivity.

5.4.1.3 Environmental Factors

Since weather conditions were a significant determinant of equipment productivity, there is need to employ weather proof equipment as a way of enhancing productivity. There is also need to improve egress within the construction sites in order to improve equipment productivity.

5.4.2 A model to improve equipment productivity

In order to improve equipment productivity, there is need to improve human resource, equipment and environmental factors. In terms of human resource, there is need to hire experienced and motivated employees. In terms of equipment, there is need to use fuel efficient equipment alongside having in place auxiliary equipment to support existing equipment. There is also need to use weather proof equipment and improve access and egress within the building construction projects sites.

The study recommends that in order to improve equipment productivity, government should have deliberate effort to train a pool of equipment operators for the industry and building construction project managers should hire personnel who are well motivated to operate building construction equipment.

5.5 Recommendations for further Research

Due to limited time and scope of the study, the study could not tackle different areas related to the study and as such, recommendations are hereby made for further research. Study could be conducted on other factors that affect equipment productivity, other than the ones covered by this study. These could include material delivery and availability on site. An attempt could be made to examine management strategies that can enhance construction site labour productivity in Uganda.

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APPENDICES

Appendix I: Questionnaire

Dear Participant,

My name is Asaya Andrew Peter, a student of Masters of Science of Technology and Construction Management. I am conducting a study on the improvement of equipment productivity in building construction projects in Uganda. You have been selected to participate in the study through random sampling. Please feel free to tick or write down your answers where necessary. The research work will be purely for academic purpose only

Signature of the Respondent.................... Date of Data Collection.....................

Name of Data Collector and Signature..

SECTION A: DEMOGRAPHICS INFORMATION.

Please Tick In The Appropriate Box For Each Question.

Location of the Construction Site

1. Central Division
2. Makindye Division
3. Lubaga Division
4. Nakawa Division
5. Kawempe Division

Information of the Respondent

Position held

Site Engineer	Foreman	In charge of equipment

Experience

1 – 3 years	4 – 7 years	8 – 11 years	12 years and above

Level of Education

Secondary	Certificate	Diploma	Degree	Post Graduate	Any Other

Information on the equipment

Type of Equipment Used (Multiple Answers allowed)

Excavation and Loading Equipment (Multiple Answers allowed)

1. Crane hook
2. Clam shell
3. Backhoe Crane
4. Shovel
5. Dump trucks
6. Any other (Please Specify)...

Compacting and Grading Equipment (Multiple Answers allowed)

1. Towed Sheep Foot Roller
2. Grid Roller
3. Hand propelled Roller
4. Self-Propelled Roller
5. Any other (Please Specify)...

Lifting and Erecting Equipment (Multiple Answers allowed)

1. Tower cranes
2. Pulleys
3. Any other (Please Specify)...

Mixing and Paving Equipment

1. Concrete Mixers
2. Truck Concrete Mixers

Estimating Equipment Productivity

This subsection is aimed at helping the researcher calculate the actual equipment productivity at this construction site. Please provide the appropriate estimated answers in terms of cycle capacity and cycle time (The cycle capacity of a piece of equipment is defined as the number of output units per cycle of operation under standard work conditions on the other hand, the cycle time T refers to units of time per cycle of operation).

Excavation and Loading Equipment (Multiple Answers allowed)

Equipment	**Cycle Capacity**	**Cycle Time**
Crane hook		
Clam shell		
Backhoe Crane		
Shovel		
Dump trucks		
Any other (Please Specify)......		

Compacting and Grading Equipment (Multiple Answers allowed)

Equipment	**Cycle Capacity**	**Cycle Time**
Towed Sheep Foot Roller		
Grid Roller		
Hand propelled Roller		
Self-Propelled Roller		
Any other (Please Specify)...........		

Lifting and Erecting Equipment (Multiple Answers allowed)

Equipment	**Cycle Capacity**	**Cycle Time**
Tower cranes		
Pulleys		
Any other (Please Specify).................		

Mixing Equipment (Multiple Answers allowed)

Equipment	**Cycle Capacity**	**Cycle Time**
Concrete Mixers		
Truck Concrete Mixers		
Any other...		

SECTION B: FACTORS AFFECTING EQUIPMENT PRODUCTIVITY

Section B1: Human Resource Factors

This subsection aims at determining the human resource factors affecting construction equipment productivity. The following statements can be answered on a 5 point scale with 5= Strongly Agree, 4=Agree, 3= Not Sure, 2= Disagree 1=Strongly Disagree. Please tick or circle appropriately

Strongly Disagree (SD)	Disagree (D)	Not Sure (NS)	Agree (A)	Strongly Agree (SA)

	Statement	SD	D	NS	A	SA
1	Technical skills of staff	1	2	3	4	5
2	Motivation of staff	1	2	3	4	5
3	Spirit of teamwork	1	2	3	4	5
4	Staff attitude	1	2	3	4	5
5	Supervision of staff	1	2	3	4	5
6	Payment	1	2	3	4	5
7	Experience of the operative	1	2	3	4	5
8	Length of working day	1	2	3	4	5
9	Interruption to the job	1	2	3	4	5
10	Inspection delays	1	2	3	4	5
11	Material availability	1	2	3	4	5
12	Design requirements	1	2	3	4	5
13	Supervision	1	2	3	4	5
14	Methods of employment (directly employed versus hired)	1	2	3	4	5
15	Work rules and procedures	1	2	3	4	5
16	Day of the week	1	2	3	4	5

Section B2: Equipment Factors

This subsection aims at determining the equipment factors affecting construction equipment productivity. The following statements can be answered on a 5 point scale with 5= Strongly Agree, 4=Agree, 3= Not Sure, 2= Disagree 1=Strongly Disagree. Please tick or circle appropriately

Strongly Disagree (SD)	Disagree (D)	Not Sure (NS)	Agree (A)	Strongly Agree (SA)

	Statement	SD	D	N	A	SA
1	Availability auxiliary equipment	1	2	3	4	5
2	Availability of fuel	1	2	3	4	5
3	Regular maintenance of equipment	1	2	3	4	5
4	Equipment breakdown	1	2	3	4	5
5	Quality of equipment	1	2	3	4	5
6	Availability of adequate	1	2	3	4	5
7	Specification of equipment	1	2	3	4	5
8	Working cycle	1	2	3	4	5
9	Fund shortage to procure	1	2	3	4	5
10	Handling of equipment	1	2	3	4	5
11	Age of Equipment	1	2	3	4	5
12	Any other/ specify	1	2	3	4	5

Section B3: Environmental Factors affecting Equipment Productivity

This subsection aims at determining the environmental factors affecting construction equipment productivity. The following statements can be answered on a 5 point scale with 5= Strongly Agree, 4=Agree, 3= Not Sure, 2= Disagree 1=Strongly Disagree. Please tick or circle appropriately

Strongly Disagree (SD)	Disagree (D)	Not Sure (NS)	Agree (A)	Strongly Agree (SA)

	Statement	SD	D	N	A	SA
1	Weather conditions	1	2	3	4	5
2	Proper access	1	2	3	4	5
3	Proper egress	1	2	3	4	5
4	Lead times	1	2	3	4	5
5	Terrains	1	2	3	4	5

SECTION C: LEVEL OF IMPACT OF THE FACTORS AFFECTING EQUIPMENT PRODUCTIVITY IN BUILDING CONSTRUCTION

Section C1: Human Resource Factors

This subsection aims at determining the level of impact of human resource factors on construction equipment productivity. The following statements can be answered on a 5 point scale with 5= Strongly Agree, 4=Agree, 3= Not Sure, 2= Disagree 1=Strongly Disagree. Please tick or circle appropriately

Strongly Disagree (SD)	Disagree (D)	Not Sure (NS)	Agree (A)	Strongly Agree (SA)

	Statement	SD	D	NS	A	SA
1	Technical skills of staff	1	2	3	4	5
2	Motivation of staff	1	2	3	4	5
3	Spirit of teamwork	1	2	3	4	5
4	Staff attitude	1	2	3	4	5
5	Supervision of staff	1	2	3	4	5
6	Payment	1	2	3	4	5
7	Experience of the operative	1	2	3	4	5
8	Length of working day	1	2	3	4	5
9	Interruption to the job	1	2	3	4	5
10	Inspection delays	1	2	3	4	5
11	Material availability	1	2	3	4	5
12	Design requirements	1	2	3	4	5
13	supervision	1	2	3	4	5
14	Methods of employment (directly employed versus hired)	1	2	3	4	5
15	Work rules and procedures	1	2	3	4	5
16	Day of the week	1	2	3	4	5

Section C2: Equipment Factors

This subsection aims at determining the level of impact of equipment factors on building construction equipment productivity. The following statements can be answered on a 5 point scale with 5= Strongly Agree, 4=Agree, 3= Not Sure, 2= Disagree 1=Strongly Disagree. Please tick or circle appropriately

Strongly Disagree (SD)	Disagree (D)	Not Sure (NS)	Agree (A)	Strongly Agree (SA)

	Statement	SD	D	N	A	SA
1	Availability auxiliary equipment	1	2	3	4	5
2	Availability of fuel	1	2	3	4	5
3	Regular maintenance of equipment	1	2	3	4	5
4	Equipment breakdown	1	2	3	4	5
5	Quality of equipment	1	2	3	4	5
6	Availability of adequate equipment / over worked	1	2	3	4	5
7	Specification of equipment	1	2	3	4	5
8	Working cycle	1	2	3	4	5
9	Fund shortage to procure	1	2	3	4	5
10	Handling of equipment	1	2	3	4	5
11	Age of Equipment	1	2	3	4	5
12	Any other/ specify	1	2	3	4	5

Section C3: Environmental Factors affecting Equipment Productivity

This subsection aims at determining the level of impact of environment factors on building construction equipment productivity. The following statements can be answered on a 5 point scale with 5= Strongly Agree, 4=Agree, 3= Not Sure, 2= Disagree 1=Strongly Disagree. Please tick or circle appropriately

Strongly Disagree (SD)	Disagree (D)	Not Sure (NS)	Agree (A)	Strongly Agree (SA)

	Statement	SD	D	N	A	SA
1	Weather conditions	1	2	3	4	5
2	Proper access	1	2	3	4	5
3	Proper egress	1	2	3	4	5
4	Lead times	1	2	3	4	5
5	Terrains	1	2	3	4	5

SECTION D: PERFORMANCE OF BUILDING CONSTRUCTION EQUIPMENT

This subsection aims at assessing the level of performance of building construction equipment at the construction sites. The following statements can be answered on a 5 point scale with 5= Strongly Agree, 4=Agree, 3= Not Sure, 2= Disagree 1=Strongly Disagree. Please tick or circle appropriately

Strongly Disagree (SD)	**Disagree (D)**	**Not Sure (NS)**	**Agree (A)**	**Strongly Agree (SA)**

	Statement	**SD**	**D**	**N**	**A**	**SA**
1	Equipment efficiency	1	2	3	4	5
2	Equipment capacity	1	2	3	4	5
3	Equipment productivity	1	2	3	4	5
4	Equipment reliability	1	2	3	4	5
5	Equipment operating life	1	2	3	4	5
6	Fuel efficiency	1	2	3	4	5
7	Equipment age	1	2	3	4	5
8	Structure and suspension system	1	2	3	4	5
9	Power train system	1	2	3	4	5
10	Traction system	1	2	3	4	5
11	Implement system	1	2	3	4	5
12	Control and information system	1	2	3	4	5
13	Machine standardization	1	2	3	4	5
14	Easy repair and maintenance	1	2	3	4	5
15	Meets job and operational requirements	1	2	3	4	5
16	Compliance with site operating conditions	1	2	3	4	5
17	Versatility of equipment	1	2	3	4	5
18	Meet haul road conditions	1	2	3	4	5
19	Engine value	1	2	3	4	5

What can be done to improve equipment productivity in building construction projects? (Mention as many as possible)____

Thank you for your cooperation

Appendix II: Table for determining sample size from a given population

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	246
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	351
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	181	1200	291	6000	361
45	40	180	118	400	196	1300	297	7000	364
50	44	190	123	420	201	1400	302	8000	367
55	48	200	127	440	205	1500	306	9000	368
60	52	210	132	460	210	1600	310	10000	373
65	56	220	136	480	214	1700	313	15000	375
70	59	230	140	500	217	1800	317	20000	377
75	63	240	144	550	225	1900	320	30000	379
80	66	250	148	600	234	2000	322	40000	380
85	70	260	152	650	242	2200	327	50000	381
90	73	270	155	700	248	2400	331	75000	382
95	76	270	159	750	256	2600	335	100000	384

Note: "N" is population size "S" is sample size.

Appendix III: Reliability Test

Human Resource Factors Reliability

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	340	100.0
	Excluded[a]	0	.0
	Total	340	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.868	.884	16

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Covariances	.47	.911	.676	1.587	.742	.061	16

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
53.93	30.051	5.482	16

Equipment factors

Case Processing Summary

		N	%
Cases	Valid	340	100.0
	Excluded[a]	0	.0
	Total	340	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.822	.823	11

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Covariances	.41	-.594	.951	1.545	-1.603	.134	11

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
38.72	23.988	4.898	11

Environmental Factors

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.796	.769	5

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Covariances	0.39	.362	.436	.798	1.206	.068	5

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
16.13	12.797	3.577	5

Equipment productivity

Case Processing Summary

		N	%
Cases	Valid	340	100.0
	Excluded[a]	0	.0
	Total	340	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.895	.882	19

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Covariances	0.48	-1.067	1.186	2.253	-1.111	.160	19

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
62.83	27.969	5.289	19