DETERMINATION OF LABOUR OUTPUT ON WINDOWS AND DOORS FIXING IN KANO AND JIGAWA STATES NIGERIA

BY

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M.Sc./ENV-DESIGN/11935/2011-2012

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MARCH, 2015

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A THESIS SUBMITTED TO THE DEPARTMENT OF QUANTITY SURVEYING, FACULTY OF ENVIRONMENTAL DESIGN, AHMADU BELLO UNIVERSITY ZARIA IN THE PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN QUANTITY SURVEYING

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DECLARATION

I, declare that this Thesis entitled 'Determination of labour output on windows and doors fixing in Kano and Jigawa States Nigeria' has been carried out by me in the department of Quantity Surveying. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this project thesis was previously presented for another degree or diploma at this or any other Institution.

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Usman Musa **Date**

CERTIFICATION

This is to certify that this Thesis titled "D**etermination of labour output on windows and doors fixing in Kano and Jigawa States Nigeria**" by Usman Musa meets the regulation governing the award of the degree of Master of Science (M.Sc. Quantity Surveying) of the Ahmadu Bello University (ABU), Zaria, and is approved for its contribution to knowledge and literary presentation**.**

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DEDICATION

This work is dedicated to my late father Maina Musa Haruna for all he has done which words could hardly describe. May his gentle soul rest in perfect peace, Ameen. Also to my mother Sa'adu Muhammad Sambo for all she has, and is still doing which words could also hardly describe. My God almighty rewards both of you with Aljannatul Firdaus. Ameen.

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ABSTRACT

A major element in the success of the construction industry is the accuracy in construction project estimates. Previous researches have shown that most of the output constants used by estimators in the Nigerian construction industry are either derived from experience or are remnants of British colonial heritage. Hence, non-uniform outputs are widely used. The research is aimed at using work study approach to empirically establish labour output for doors and windows fixing in the Nigerian construction industry. A total of 30 construction sites were observed, 15 each for Kano and Jigawa States for three sizes of doors and three sizes of windows. The data collected were analyzed using inferential statistical analysis. The results of the analysis carried out established general average output values per day of; 12.00 nr, 13.00 nr and 16.00 nr casement windows sizes 1500 x 1200mm, 1200 x 1200mm and 600 x 600mm respectively. While 11.00 nr, 10.00 nr and 11.00 nr steel doors were established for sizes 1200 x 2100mm, 900 x 2100mm and 750 x 2100mm respectively. A two-tailed t-test analysis was used in assessing the influence of the labour productivity factors on the output of the workers observed. The inferential analysis revealed that mode of employment and experience, significantly affected workers output. Also the findings should serve as an effective baseline for contractors to exploit the output figures extracted according to productivity factors in order to optimize the productivity of their workers and profitability.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The efficiency of the construction industry is heavily reliant on its level of productivity. As noted by Adnan *et al* (2007), until the productivity level of construction activities is improved, the nation's economy will continue to suffer setbacks. Hence, improving productivity has become a major concern of every profit-oriented organisation (Adnan *et al,* 2007). An important component of the construction industry productivity is labour. Labour costs represent a considerable proportion of the final cost of a building, usually accounting for between 40 to 60% of the building cost (Butchan *et al*, 1993). In addition, labour is known to be the most important factor of production since it is the only factor that creates value and sets the general level of productivity (Ameh and Odusami, 2002). According to Yates and Guhathakurta (1993), labour productivity is the value of gross output per worker, referred to as man-hour or work-hour. It also could be referred to as the careful attempts to measure the physical output of labour taking into account the other factors that affect construction productivity.

Recognising its importance, several studies have focused on the factors that affect labour productivity (Oloko, 1983; Lema, 1995; Yagba and Ayandele, 1999; Ameh and Odusami, 2002; Adnan et al, 2007; Kane et al, 2007). However, none of these studies provides an empirical evaluation of the level and extent of influence of these factors on the productivity of the Nigerian construction labour. Given the importance of such an issue, this research seeks to examine the influence of some productivity factors on labour outputs that were empirically established by the authors for some selected trades, and published elsewhere.

According to Ashworth (2002), the common method of estimating the costs of construction works involves the multiplication of unit rates and the measured quantities in the Bills of Quantities (BOQ). The calculation of the unit rates for the individual measured items in a BOQ requires the collation of current cost information for labour, plant and materials, as well as overhead and profit (Ayeni, 1999). The estimation of the cost figures of materials, plant and overhead and profit has never been a point of discourse and contention. This is because they involve the quantitative estimation of the cost values for plants and overheads while market survey research for materials prices are the basis for the material cost estimation (Ashwort, 1999). The aspect of labour pricing is usually done on the basis of the output constants collected on each trade (Ayeni, 1999).

1.2 STATEMENT OF RESEARCH PROBLEM

Establishing a unit rate of construction works involves collating current information with regards to the cost of materials, labour, plants and overheads and profit. The materials, plant, overhead and profits components can be quantitatively estimated. The labour component however, cannot be precisely estimated due to variety of factors that affect the determination of the labour output. The accuracy of the labour constants commonly used in the Nigerian Construction Industry is unclear and uncertain because BESMM3 and geographical location were not considered.

A previous study conducted by Sani (2011), on determination of labour output for doors and window fixing did not take precedence of the work items in BESMM3. It has therefore become necessary to empirically determine the labour output constant for the Nigerian Construction Industry to comply with the Building and Engineering Standard Method of Measurement (BESMM3).

1.3 JUSTIFICATION FOR THE STUDY

The high degree of inaccuracy found in our BOQ estimates is mostly attributed to the uncertainty of the accuracy of the labour constants used in pricing labour costs. In Nigeria for example, most of the output constants used by estimators are either derived from experience or are remnants of British colonial heritage Abdulrazaq *et al,* 2010. Hence, non-uniform outputs are widely used across the construction industry. These outputs do not take in to account, Nigeria’s BESMM3 and geographical locations.

Furthermore, the study will afford Construction Managers the opportunity to (Gilleard, 1992):

a. Determine how effectively his or her projects are being managed;

b. Detect adverse trends quickly so that corrective action may be taken quickly;

c. Determine the effects of changed methods and conditions;

d. Identify both high and low areas of productivity and reasons for these differences;

e. Compare performance between sites.

The dangers associated with inaccurate estimate cannot be overemphasized. According to Garret (2006), the sustainability and success of the construction industry depends greatly on the level of accuracy of the project cost estimates. This is because financial commitments required for a typical construction project are very high and inaccurate cost estimates can have detrimental effects on all parties involved (Onukwube, 2002). Garret (2006) noted that if the cost estimate for a project is wrong, then financial pressures, hardship, supply chain conflict and quality problems will result. In addition, the client's vulnerability as the ultimate risk holder of the finished building can be horribly exposed and no one may possibly gain (Morledge, 2006). The accuracy of project cost estimates is an important issue to all stakeholders.

1.4 RESEARCH AIM

The aim of this research is to determine the labour outputs for fixing selected windows and doors in Kano and Jigawa states Nigeria.

1.5 RESEARCH OBJECTIVES

1. To examine the influence of labour factors on productivity.
2. To establish the labour output of some selected windows and doors fixing.
3. To investigate through literature, the sources and origin of some of the labour outputs currently in use in Nigeria.

1.6 RESEARCH HYPOTHESES

In order to conduct inferential test to determine the influence of the labour productivity factors on the labour outputs established, both null and alternative hypothesis were found deemly necessary (Abdullahi, 2009).

These hypotheses are:

- **Hypothesis (H1):** The ages of workers have a significant difference over their outputs on site.

- **Null hypothesis (H1o)**: There is no output difference between the various age groups observed.
- **Hypothesis (H2):** The outputs of workers vary with changes in the period of work.
- **Null hypothesis (H2o):** there is no output difference in all the different periods of observations.
- **Hypothesis (H3):** The level of outputs of workers depends on the type and level of payment made to them.
- **Null hypothesis (H3o)**: there is no output difference in respect of the type and level of Payment to workers under observation.
- **Hypothesis (H4):** The group of highly experienced workers has higher outputs than those with low work experience.

- **Null hypothesis (H4o)**: There is no output difference between the highly experienced groups of workers and workers with low experience level.
- **Hypothesis (H5)**: The well educated and highly qualified group of workers has higher output than those with little or no qualification.
- **Null hypothesis (H5o**): There is no output difference between the well educated and highly qualified group of workers and workers with little or no qualification.

1.7 SCOPE

The research work covers selected sizes of windows and doors for bungalow buildings.

1.8 LIMITATIONS

The following foreseeable limitations could affect the accuracy of the results:

1. Workers will tend to improve upon their natural productivity level when being directly observed.
2. The difficulty in assessing whether a worker is operating in full and natural capacity or not during the period of observations.
3. This research focused on only doors and windows on bungalow buildings.
4. The research focuses only on Aluminum windows and steel doors.
5. Windows of sizes 1500x1200, 1299x1200mm and 600x600mm high only are considered.
6. Doors of sizes 1200x2100mm, 900x2100mm and 750x2100mm high only are considered.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

In Nigeria, the construction industry contributes about 70% of the GDP (Planning Committee on National Construction Policy, 1989, cited in Ibrahim, 2008). This according to Ibrahim (2008) made the industry very strategic to Nigeria's development efforts and a major indicator of the country's wealth in social and economic terms.

2.1.1 Labour Output

Adopting a standard labour output for preparation of construction estimates require an understanding and quantification of the major factors that affect labour output. Unfortunately, many of these factors are not quantitatively understood. It is therefore important that the understanding of changes in construction productivity or site outputs cannot be achieved without site information. This information should relate both to the calculation of labour output and to the site environment in which the productivity has been achieved (Onyeagam, 2014).

The term "Labour Output" is best understood by looking at the two different words separately and critically as thus;

Labour

Kalra (2006) as in the dictionary of Economics defined labour as any physical or mental exertion that takes place with a view to earn money. Labour refers to all physical and mental work undertaken for monetary rewards (Jhingan, 1999). From this definition, workers in the factory, doctors, advocates, ministers, officers, and teachers are all included in labour (Abdullahi, 2009). Hence any work which is done for pleasure but not for earning income is not considered as labour.

Output

Oxford Advanced Learners Dictionary defined output as the rate at which a worker, a company or a country produces goods, and the amount produced, compared with how much time, work and money is needed to produce them. According to the Business Dictionary.com, output can be defined as the amount of energy, goods or services produced by machine, factory, company or individual in a period. However, the Free Dictionary defined output as simply, an amount produced during a certain time.

Adnan *et al,* (2007) postulated that when the total output is divided by the total work hours, productivity is achieved. One important index for checking the relative value between input and its final product (output) is productivity (Oforeh *et al,* 2006). Therefore, a full understanding of productivity in relation to Labour Output is explained below:

Productivity

Many definitions have been given to productivity. Nwachukwu (2007) believes that every good definition of productivity should contain three major elements, output, resources commitment and time.

Nwachukwu (2007) therefore defined productivity as the measure of how well resources are brought together in organizations and utilized for accomplishing a set of results. It involves reaching the highest level of performance with the least expenditure of resources.

Productivity is referred to as the effective use of factors of production to produce goods and services. Mali (1981) as cited in Nwachukwu (2007).

Productivity is generally defined as the ability to make something happen within a time frame. (Yagba and Ayandele (1999), cited in Abdullahi, 2009) It could be a product that is made, grown or manufactured and you now have an output or positive result that you can touch, feel or see. Abdullahi (2009).

Seeley (2003) defined productivity as a measure of the quantity of output of goods and services that can be produced for a given inputs of factors of production, such as land, capital, energy and entrepreneurial skills.

However, this has consequently made the study of productivity a very important topic to the construction industry. Through enhanced capabilities, the productivity of people must be increased so they participate fully in the process of income generation and remunerative employment thereby becoming effective agents of growth (Ojo, 1994).

In the wider context of work or motion study in management, productivity is a system technique of utilizing and analyzing ways of performing task, time studies and creating standards. This can be represented in building construction as follows (Yagba and Ayandele, 1999, cited in Abdullahi 2009).

Labour + Material + Plant + Technology + management =

Output/product i.e Building.

Therefore, productivity generally is defined as the ratio of outputs to inputs (Adnan, 2007), and is given by any of the followings below:

$$\text{Productivity} = \text{Output/Input}$$

$$= \frac{\text{Units}}{\text{Work hours}}$$

$$= \frac{\text{Total output}}{\text{Total work hours}}$$

Nwachukwu (2007) opined that since productivity is the output resulting from a given resource input at a given time, then the followings are the productivity measures:

i. *P*artial measures = output/labour= Output/machine = Output/energy

ii. Multifactor measures = (Output/labour + machine) +(Output/labour+capital+energy)

iii. Total measures = (Goods or services produced/ All inputs used to produce them)

The above formulae gave rise to the following:

- Labour productivity
- Machine productivity
- Capital productivity
- Energy productivity

International Labour Office (1996) described productivity as follows "Productivity is a comparison between how much you have put in to the projects in terms of manpower, material, machinery or tools and the result you get out of the project. Productivity has to do with the efficiency of production. Making a site more productive means getting more output for less cost in less time. Productivity covers every activity that goes into completing the construction site works, from the planning stage to the final site clearing. If the contractor can carry out these activities at lower cost in less time with fewer workers, or with less equipment then productivity will be improved" (Anderson et al, 1996).

From the above definitions it is concluded that productivity is generally defined as the ratio of outputs to inputs.

Productivity = Outputs/Inputs

It is important to specify the inputs and outputs to be measured when calculating productivity because there are many inputs, such as labour, materials, equipment, tools, capital, and design.

The conversion process from inputs to outputs associated with any operation is also complex, influenced by the technology used, by many externalities such as government regulations, weather, unions, economic conditions, management, and various internal environmental components.

2.2 Differences between Productivity and production

Many people are confused between productivity and production terms. They think that the greater the production, the greater the productivity. This is not necessarily true. Production in any productive work denotes the outputs only without any reference to inputs. But productivity is concerned with the effective and efficient utilization of resources (inputs) in producing goods or services (outputs) (Gupta *et al,* 2000). If viewed in quantities terms, production is quantity of outputs produced, while productivity is the ratio of the outputs produced to the inputs used (Gupta *et al,* 2000).

Productivity measurement involves the collection of information about various activities – specifically work in place and the corresponding work-hours over a given period of time (Cox *et al,* 2003). Kempplia (2000) cited in Isa 2010 pointed out that there are different methods of measuring productivity. Most of the methods are based on quantitative data on operations. Total productivity is the most comprehensive approach to productivity at the firm level. Total productivity includes all the output generated and all the inputs used to generate output (Labour, Capital, Material, Energy etc) (Kempplia *et al*, 2000). Ideally, total productivity should be measured. However, the measurement of total productivity is not very common because it is quite difficult in practice. Most organizations have a variety of different outputs and inputs. It is difficult because converting these accurately into common units and derive a single value for both of them (Hannula, 1999) cited in (Kempplia *et al,* 2000)

Yates and Guhathakurta (1993) defined labour productivity as the careful attempts to measure the physical output of labour, taking into account other factors that affect productivity.

2.3 Productivity variables

Productivity increases exist because of the management of three variables. These productivity variables are labour, capital, and management. These three factors are critical to productivity improvement. They represent the broad areas in which managers can take action to obtain better productivity (Heizer *et al,* 1990).

A. Labour

The quality of labour is very important to improving productivity. Three traditional variables for improved labour productivity have been (Heizer *et al*, 1990).

1- Basic education appropriate for an effective labour force;

2- Diet of the labour force;

3- Social overhead that makes labour available, such as transportation and sanitation.

In developing countries these three variables are very important however, in developed nation; the critical variable is maintaining and enhancing the skill of labour.

B. Capital

Human being is a tool using animals. Capital investment provides those tools. These tools can range from desk computers to complex machinery and new airports (Heizer *et al,* 1990).

Production can often be accomplished with some trade-off between labour and capital. That is, if we want to build a road we can do so with crews of thousands using shovels or we can invest in earth moving equipment. The trade-off between capital and labour is continually in flux (Heizer *et al,* 1990).

C. Management

Management is a factor of production and an economic resource. It is responsible for insuring that labour and capital are effectively used to increase productivity. The arts and sciences of management include improvements made by technology and knowledge. Such improvement requires training and education as well as dynamic organization (Heizer *et al,* 1990).

2.4. Construction Productivity

Construction productivity is central to the value of money obtained by construction client. The knowledge of productivity is essential part of the construction management. The most application of accurate productivity measurement in the area of resource management. However productivity rates are related to many other subjects in the construction process such as cost estimating, activities scheduling, cost control, labour resources, and payroll (Herbsman *et al,* 1990). Therefore accurate determination of productivity is very important but productivity measurement in construction is a complex issue because of the interaction of labour, capital, materials, and equipment and varying effect of various site conditions on productivity rates of most standard construction items.

2.5 Factors affecting construction productivity

The factors that influence construction productivity have been the subject of inquiry by many researchers. In order to improve productivity, a study of the factors that affect it, whether positively or negatively is necessary. Making use of the factors that have a positive effect, and eliminating (or controlling) factors that have a negative effect will improve productivity.

If all factors influencing productivity are known, it would also be possible to forecast productivity (lema, 1995). Several researchers have investigated the factors that influence labour productivity. These include United Nations (1965), Kane *et al* (1980), Thomas, *et al* (1991), Yates et al (1993), Lim et al (1995), lema (1995), Olomolaiye et al (1996), Heizer et al (1996) , Olomolaiye et al (1998), Kaming, *et al* (1998), Teicholz (2001), Thomas *et al* (2001), Wachira. (2001), Rojas *et al* (2003). In spite of such intensive investigations, researchers have not agreed on a universal set of factors with significant influence on productivity nor has there been agreement on the classifications of these factors.

Several approaches have been adopted in relation to this classification of factors affecting construction productivity. A United Nation's report (1995) in Yagba and Ayandele(1999) stated that in ordinary situations two major sets of factors affect the site labour productivity requirements; organizational continuity and execution continuity. Organizational continuity encompasses physical components of work, specification requirements, design details etc. Execution continuity relates to work environment and how effectively a job is organized and managed. Management aspects include weather material and equipment availability, congestion and out of sequence work.

Andersson *et al* (1996) cited in Abo Mostafa (2003) reported that the common reasons for low productivity in construction sites are:

a. Supervisors looking after too many;
b. Dissatisfied workers with a perceived grievance (for example low pay);
c. Very heavy work on a hot day;
d. Waiting for materials;
e. Waiting for tools;
f. Waiting for instruction;
g. Machine breakdown;

h. Waiting for another worker to finish so they can follow on (poor site layout);
i. Working in a confined space and getting in each other's way; and
j. Working gangs are out of balance (e.g. too many labourers to one mason);

A study by Kane et al (cited in Adnan et al, 2007) classified factors affecting construction productivity into two main groups: technological factors and administrative factors. The technological factors encompass those related mostly to the design of the project; the administrative group factors relate to the management and construction of the project. The administrative factors compose sub-groups, such as construction methods and procedural factors, equipment, labour factors and social factors. Also, the technological factors comprise of sub-groups, such as design factors, material factors and location factors.

While Lim et al (1995) studied factors affecting productivity in construction industry in Singapore. Their findings indicated that the most important problems affecting productivity were: difficulty with recruitment of supervisors, difficulty with recruitment of workers; high rate of labour turnover; absenteeism from the work site, and communication problems with foreign workers.

2.6 Summary of factors affecting labour productivity

It is clear from the above that factors affecting construction productivity are both numerous and diverse. It is nevertheless not exhaustive. It would be unreasonable to assume that it is possible to quantify the effect of each on productivity in a predictable manner since what may be significant in one environment, may be insignificant in another situation. Nevertheless, the literature provides a pool of factors that may be considered for productivity studies. The following is a summary of factors that have been identified in literature Abo Mostafa (2003).

a. Lack of materials in local market;
b. Worker absenteeism at work site;

c. Using motivation system;

d. Lack of tools;

e. Delays in materials deliveries to working site;

f. Labour skill;

g. Area of work site;

h. Gang size;

i. Disruption of power/ water supplies;

j. Rework;

k. Interference;

l. Supervisors absenteeism;

m. Climate conditions;

n. Accidents;

o. Management practices;

p. Labour age;

q. Safety; and

r. Job size and complexity.

2.7 Introduction to work study

2.7.1 Background

Work study emerged in the early part of the 20th century as a technique aimed at rationalizing and measuring work, with the emphasis on economy of motion and movement. Because of that it was called time and motion study. Later on it began to encompass other aspects of observing and analysing works and the earlier term was abandoned in favour of "work study" (Kanawaty, 1992). Cole (2005), stated that work study was developed in the American industry in 1920s. The first known attempts to make a rational assessment of work and tasks were made by F.W. Taylor and some other scientific managers. The purpose of work study is the provision of factual data to assist management in making decisions, and to enable them to utilise with the maximum efficiency all available resources (i.e. labour, plant, materials and management) by applying a systematic approach to problems instead of using intuitive guesswork (Oxley and Poskitt, 1996).

2.7.2 Definition of work study

Work study as defined by Hartzell (2006) as a set of techniques including work measurement which analyse a given area of work to see whether performance can be made more efficient and economical. It is based on the scientific management approach to the study of the organization.

(BS 3138) British standard glossary of terms cited in (Harris and McCaffer, 2001) defined work study as a measurement service based on those techniques, particularly method study and work measurement, which are used in examination of human work in all its context and which lead to the systematic investigation of all the resources and factors which affect the efficiency and economy of the situation being revived in order to effect improvement.

Kanawaty (1992) defined work study as the systematic examination of carrying on activities so as to improve the effective use of resources and to setup standards of performance for the activities being carried out.

Cole (2005) defined work study as a term describing several techniques for examining work in all its contexts, in particular those factors affecting economy and efficiency, with a view to making improvements.

Therefore, the central objective of all the definitions and meanings given to work study is the central objective of improving productivity at reduced costs. And as well to determine the best or most effective method of accomplishing a necessary operation or function.

2.7.3 Aims of Work Study

According to Barnes (1980) in Ajia (2002) a good work study program should achieve the following:

i. Increased productivity or work men.
ii. Reduction in cost of labour
iii. Increased profit margin
iv. Makes tasks easier
v. Ensure security of operatives
vi. Lay down standards and verifies estimates against actual cost
vii. Reduce wastage of material and time
viii. Produces more efficient organization of workforce.

2.7.4 Objectives of Work Study

The objectives of every work study as pointed out by Barnes (1980) in Ajia (2002) are as follows:

i. To analyze the present method of doing a job systematically in order to develop a new better method.
ii. To measure the work content of a job by measuring time required to do the job for a qualified worker and hence to establish standard time.

iii. To increase productivity by ensuring the best use of human, machine and material resources and to achieve best quality product services at minimum possible cost.

iv. To improve operational efficiency.

2.7.5 Benefits of Work Study

Barnes (1980), Altine (1988) enumerated the following as the derivable benefits of employing work study in productivity improvement.

i. Increased productivity and operational efficiency.

ii. Reduced manufacturing cost.

iii. Improved work place layout

iv. Better manpower planning and capacity planning

v. Fair wages to employees

vi. Better working conditions to employees

vii. Improved work flow

viii. Reduced material handling costs

ix. Provides standard of performance to measure labour efficiency

x. Better industrial relations and employee morale

xi. Provides basis for sound incentive schemes

xii. Better job satisfaction for employees

2.7.6 Work Study Techniques

Work study has two main aspects Oxley and Poskitt (1996)

a. Method study

b. Work measurement

These two basic techniques are complimentary to each other (Cole, 1996; Pilcher, 2005) and are rarely utilized in isolation from each other. Cole (1996) further added that even though either of these techniques can be applied to problem solving without the other, best values and results are obtained by carefully combining the two together. Cole (1996) further argued that the usual and best practice is that a method study to precede a work measurement. The observer should critically select and examine methods first before studying their established time at defined level of performance.

2.7.8 Method Study

Method study is defined as a systematic and analytical approach to problem solving, as it enables all the relevant factors to be evaluated so that decisions may be made (Currie, 1964) cited in (Ajia, 2002). The BS3138 (1969) cited in Abdullahi (2009) defined method study as the systematic recording and critical examination of the factors and resources involved in existing and proposed ways of doing a work, as a means of developing and applying easier and more effective methods and reducing costs. According to Cole (2005), method study itself is composed of a collection of techniques, all of which systematically examine and record all the methods, existing and proposed, utilized in an operation or process, with a view of increasing efficiency. It could be said that Method Study attempts to answer the questions What? When? How? Who? and Where? In contrast to work measurement's emphasis, which asks How long? And When? The scope of method study, therefore, is considerably wider than that of work measurement (Cole, 2005). The aim of method study is to provide information that will assist management in taking decisions related to the method it is proposed to use, by making a systematic analysis of a problem and developing alternative methods, thus determining the optimum layouts and the most effective use of resources (Oxley and Poskitt, 1996). Method study is used to record work procedures, provide systems of analysis and develop improvements. Applications can assist in re-design, detailed planning, site layout, evaluation, design of temporary works, equipment selection and other resources, and re-planning and progressing of production (Harris and McCaffer, 2006). Method study can therefore be applied at all operational levels, form the narrowly defined interaction between an operative and a machine. The essence of method study is in a systematic approach, which should become an attitude of mind. It is a flexible technique embraced by work study, which has a universal application (Ajia, 2002).

2.7.9 The basic procedure for method study

According to Kanawaty (1992), there are eight basic steps in performing a complete method study. These are;

I. Selection; i.e. selecting the job or process to be measured

II. Record or collect all relevant data about the job or process, using the most suitable data collection techniques, so that the data will be the most convenient for it to be analyzed

III. Examine the recorded facts critically and challenge everything that is done, considering in turn; the purpose of the activity; the place where it is performed; sequence in which it is done; the person who is doing it; the means by which it is done.

IV. Develop the most economic method, taking into account all the circumstances and drawings as appropriate on various production management techniques as well as the contributions of managers, supervisors, workers and other specialist with whom new approaches should be explored and discussed

V. Evaluate the results attained by the improved method compared with the quantity of work involved and calculate a standard time for it

VI. Define the new method and related time present it to all those concerned either verbally or in writing, using demonstrations

VII. Install the new method, training those involved, as an agreed practice with the allotted time of operation

VIII. Maintain the new standard practice by monitoring the results and comparing them to the original target

2.8 Work Measurement

Definitions

BS 3138 cited in Harris and McCaffer, 2002) defines work measurement as the application of techniques designed to establish the time for a qualified worker to carry out a specific job at a defined level of performance. (Olomolaiye *et al*, 1998), however, pointed out that the 'qualified worker' in the definition is a worker who is physically fit and has the required level of education, intelligence, skill and knowledge for the job and the 'defined level of performance' is when the worker is brisk, skilled and motivated.

Cole (2005) defined work measurement as a collection of techniques, particularly time study, aimed at establishing the time taken by a qualified worker to complete a specified job at a defined level of performance.

Therefore, work measurement is concerned with measuring the times needed for specific tasks, essential information for planners and estimators, to help measure performance at different times during construction work (Ajia, 2002).

The aim of work measurement according to Oxley and Poskitt (1996), is to determine the time that it takes for a qualified worker to carry out a specific job at a defined level of performance, and to eliminate ineffective elements of work. It seeks to provide the standard times for jobs, and thus supplies basic, essential data for management. However, according to Harris and McCaffer (2002) the applications of work measurement data are extensive and can be used in:

I. Determining suitable labour levels on construction activities
II. Setting standards of machine utilization and labour performance
III. Providing the basis for sound financial incentive target
IV. Providing a basis for cost control by fixing standard performance targets
V. Determining the most economic from alternative methods

The objectives of work measurement as stated by Ajia (2002) cited in Mohammed (2009) includes the following:

I. To assist in method study
II. To assist in cost control
III. To assist in planning and scheduling of labour, plant and materials
IV. To assist in implementing total quality management
V. To provide a basis for incentive schemes
VI. To assist in measuring the performance of skilled labourers
VII. To compare different methods of working

2.8.1 Uses of Work Measurement Data

According to (Olomolaiye et al, 1998) the application of work measurement data resolves around how many time standards are used by management for various management functions. The main uses are:

I. As planning data
II. As estimating data

III. As controlling data

IV. As an integral part of on-site method study

2.9. Work Measurement Techniques

The work measurement techniques common in the construction industry range from the simple timing of actual jobs (for example, for constructing multiple activity charts through time study, in which the actual times are corrected by a performance rating factor) to various forms of activity sampling synthesis (Ajia, 2002).

Oxley and Poskitt (1996) stated the following as the work measurement techniques common in the construction industry:

I. Time study

II. Activity sampling

III. Synthesis from standard and synthetic data

IV. Analytical estimating

2.9.1 Time Study

Time study was the fundamental approach to productivity improvement introduced by Taylor and Gilbreth in the late 19th and early 20th centuries, and it is the principle technique of work measurement even today (Olomolaiye *et al*, 1998). Time study is the principle technique of work measurement and in its current usage, it is not simply the timing of an operation but a process designed to develop standard time and standard output for any construction operation irrespective of the rate of work being observed (Olomolaiye et al, 1998). Abdullahi (2009) citing Ajia (2002) defined time study as a technique for recording time and rates of working for elements of a specified job carried out under specified conditions and, for analyzing the data so as to obtain the time necessary for carrying out all jobs at a defined level of performance.

The stages involved in carrying out time study according to Oxley and Poskitt (1996) includes the following:

I. Selecting the work to be measured
II. Analyzing and breaking the work down into elements
III. Rating and timing each element
IV. Extending the observed time to basic time
V. Selecting basic times, allocating allowances and building up the final standard.

While (Olomolaiye et al, 1998) noted that time study involves the following:

I. Timing, to discover how long various operations are taking
II. Rating, to assess the worker being observed against a norm
III. Building up a time standards, by allowing for appropriate relaxation and contingency allowances.

According to Abdullahi (2009) citing Ajia (2002) the procedure for time study involves the following stages;

I. Timing
II. Rating
III. Normalizing
IV. Allowances

2.9.2 Timing

Timing is actual time taken to complete an operation. Timing is carried out on the field and is usually performed with a watch (Ajia, 2002). Time studies essentially involves recording of incremental times necessary to complete various activity elements that make up an operation. Unless the timing is carried out as an integral part of method study, in which case a wrist-watch with a second hand is often sufficient, accurate recording of times using a stop watch is always recommended (Olomolaiye et al, 1998). According to Oxley and Poskitt (1996) the methods of timing commonly used in the construction industry are;

I. cumulative timing
II. fly back timing

Cumulative timing is the more common, as it is better for observing a number of operatives in a gang and requires only an accurate wrist watch. The cumulative time is recorded for each element.

Fly back timing is carried out with a fly back stop watch, the observer recording the time for each element as work proceeds. The watch has a fly back button on it that returns the hands to zero when pressed; on releasing the button the watch commences timing.

2.9.3 Rating

Because the objective of the time study is to obtain a realistic time for the element, the time study observer must additionally make a judgment on the effective rate of working of the subject under observation since the elapsed time observed for one worker may be different from another doing an identical task (Harris et al, 1995). British Standard (BS) 3138 defines rating (cited in Olomolaiye et al, 1998) as "to assess the workers rate of working relative to the observer's concept of the rate corresponding to standard rating". Thus in addition to timing the observer should also assess the rate of working for each time element. To do this accurately the time study practitioner must have correct concept of standard rating, which comes only from practical experience and training in judging different speeds of movement, effort, consistency, and dexterity (Olomolaiye et al, 1998).

The BS rating scale according to Harris and McCaffer (2002) provides a suitable description for varying levels of worker performance achieved over a short period of time and is divided into five-point graduations with 100 representing the standard rating. Thus:

I. 125: very quick; high skill; highly motivated
II. 100: Brisk; qualified skill; motivated
III. 75: Not fast; average skill; disinterested
IV. 50: Very slow; unskilled; unmotivated

Abdullahi (2009) citing Cole (1996) also observed that the rating is usually done on the standard rating of 100 in the British standard 3138 which is equivalent to the average rate at which qualified workers will naturally work at a job, provided they know and adhere to the specified method and provided they are motivated to apply themselves at work.

In the opinion of Barnes (1980) cited in Abdullahi (2009) the weighing of these rating in comparison with the British standard is given below;

I. 0: Inactivity
II. 50: very slow; ineffective with no real interest
III. 75: Unhurriedly, but the operator is meaningful and producing a normal rate pay
IV. 100: Standard rate with the operative working at a speed sufficient to earn up to 33% bonus on top of normal earnings
V. 150: Exceptionally fast

2.9.4 Factors affecting rating

There are different factors affecting the rating. These factors can be summarized as follows (Olomolaiye et al, 1998):

1) Effectiveness. This implies application of correct and effective methods, the good signs being correct choice of tools, shortest path movement, adherence to the arrangement of tools and materials
2) Skill. Sureness of touch or sequence, intelligent application of movements and events, effective use of both hands and so on
3) Speed. This implies diligence, steadiness and continuity, the good signs being rhythm, speed of movement, steady effort, making the job look easy.

2.9.5 Normalizing/Basic Time

The normal time is the basic time which is the actual time according to the observer taken to finish the job (Cole, 1996) cited in Mohammed (2009) and it can be seen by;

$$\text{Normal or Basic time} = \frac{\text{Observed time x Observed rating}}{\text{Standard rating}}$$

The basic time according to Pilcher (1997) is the time in which an element could be completed if it had been undertaken at a standard rating Abo Mostafa (2003).

In practice the worker could not be expected to complete the work within this time without adequate rest or relaxation (Olomolaiye et al, 1998).

2.9.6 Allowances

Allowances are extremely difficult to assess and for construction work there appears to be no rational basis as yet for determining such (Harris and McCaffer, 2002). Mohammed (2009) citing Ajia (2002) showed that there are basically two types of such allowances';

a) Relaxation allowance
b) Contingency allowance

2.9.7 Relaxation allowance

During a time study, it is usual to exclude any elements of relaxation, idle or waiting times so that the basic time is not affected by the degree of relaxation enjoyed by any individual worker. However, an allowance must be made for relaxation as no one can be expected to work without recovering from fatigue (Olomolaiye et al, 1998). Mohammed (2009) citing Foster et al (1999) noted that relaxation allowance is given as the percentage of basic time and as a result of factors like;

I. Energy output
II. Posture
III. Motions
IV. Visual fatigue
V. Personal need
VI. Thermal condition
VII. Atmospheric conditions such as ventilation, toxic air etc
VIII. Other influences of environment such as dirt, noise, vibration of flows etc

According to Olomolaiye et al (1998), these relaxation allowances fall into two categories. They include;

I. Fixed allowance

II. Variable allowance

2.9.8 Contingency Allowance

In addition to relaxation allowances a further amount is added to the basic time to cover contingencies, which are difficult to assess but which almost certainly occur (Olomolaiye et al, 1998). Abdullahi (2009) citing Foster et al (1991) suggest that this allowance should not exceed 5% and must be applied onto to justifiable case. Harris and McCaffer (2002) pointed out the following contingencies which are typical and can either be added as a percentage to the basic time or as absolute time itself. They include the following;

I. Adjustment and maintenance of tools

II. Waiting time caused by subcontractors, machine breakdowns, lack of materials, etc.

III. Unexpected site conditions, e.g. bad ground, high winds, bad weather

IV. Learning time

V. One-off tasks

VI. Design changes.

Foster et al (1991) suggest that this allowance should not exceed 5% and must be applied only to justifiable case.

Therefore, the adjusted basic time is given as a standard time expressed in the formula below;

Standard time = <u>Basic time x 100 x Total % allowance</u>

Expressed in standard minutes

2.9.9 Standard time

Standard time is the proper time required for a qualified worker working at standard rating to complete a task. If this is achieved then the worker is considered to have achieved standard performance (Olomolaiye et al, 1998). BS 3138 defines standard performance as follows (Olomolaiye, 1998 - Harris, 1995): "The rate of output which qualified workers will naturally achieve without over exertion as an average over the working day or shift provided they are motivated to apply themselves to their work".

Thus standard time = basic time + relaxation allowances + contingency allowance

Because construction work is so variable the difference between standard time and basic time for a job can be quite large and as a consequence, most records or data banks of out times are kept as basic times, with the user applying suitable contingencies as necessary (Harris et al, 1995).

2.9.10 Time Study Equipments

Even though the result is less accurate, the simple equipments used for time study are mainly a stop watch or an electronic timer, or an ordinary watch (Lawrence, 1993). Others enumerated by Ajia (2002) are; time study sheets, a study board in place the sheets, pencil for recording, and calculator for later use in calculating the basic time.

Other more complicated equipments given by Barnes (1980) in Ajia (2002) are motion picture cameras and video equipment, electronic data collector computer, mechanical and electrical time recorder.

2.9.11 Selection of Operator to be studied

Before one chooses the operative to be studied, one needs the consent of the foreman, both Barnes and Foster (1998) in Ajia (2002) agreed that anyone with a near normal working speed could be chosen.

Ajia (2002) further argued that, although theoretically choosing the slowest or the fastest worker will not make much difference, but it will be more difficult to rate a slow worker.

Ideally one should not choose a beginner, because the method or work will be different from when this person has attained greater efficiency through experience in the job.

2.9.12 Activity Sampling

Activity sampling is also known as ***snap observation studies or random observation studies*.** It is a very useful technique in the construction industry, and is used to determine the activity levels of machines and operatives. Using this method a number of subjects can be observed concurrently (Oxley and Poskitt, 1996). Activity sampling as defined by Mohammed (2009) citing Ajia (2002) is the technique by which over a period of time, large number of instantaneous observations are made up of a group of machines, methods or operatives. Each observations records what is happening at that instance and the percentage of observations recorded and given by;

Number of occasions plant was working/Total number of observations x 100

Oxley and Poskitt (1996) enumerated the uses of activity sampling as follows:

a) To assess unoccupied time as a basis for analyzing cause
b) To find the percentage of time spent on each element of work in an operation by each operative and/or machine
c) To find the percentage utilization of machines or operatives as a basis for cutting down unoccupied time.

Activity sampling as defined by Leeds University working paper (1983) in Ajia (2002) is the technique by which over a period of time, a large number of instantaneous observations are made of a group of machines, methods or operatives. Each observations records what is happening at that instance and the percentage of observations recorded and given by:

$$\frac{\text{Number of occasions plant was working x 100}}{\text{Total number of observations}}$$

2.9.13 Synthesis from standard and synthetic data

A careful study of work measurement data indicates that there is an underlying base for repetition in many construction activities, particularly building-type work, and thus appropriate for estimating and planning purposes (Harris and McCaffer, 2006). The purpose of synthetic data according to Oxley and Poskitt (1996) is to enable time values to be compiled for jobs where direct measurement is unnecessary or impracticable. While Olomolaiye et al (1998) also noted the underlying principle of synthesis is to build up time standards for an operation to be carried out from previously conducted time studies, not necessarily from those of identical nature. The problem of synthesis as noted by Olomolaiye et al (1998) is the difficulty in obtaining synthesis for all the elements of a new operation, particularly when the synthetics library is incomplete.

2.9.14 Analytical Estimating

Analytical Estimating is defined by the University of Leeds (1983), working paper cited in Ajia (2002) as a means of assessing the time required to carry out work based on knowledge and experience of similar types of work without breakdown of the work experience into elements at corresponding times at a defined level of performance**.** According to Oxley and Poskitt (1996) in order to calculate the work content of non-repetitive jobs, the work value can be compiled by analytical estimating, using whatever information is available from past time studies or standard data and estimating the time for the remaining elements.

2.10 Review of Previously Related Works on Labour Outputs Determination

Udegbe (2005) in his 10 years extensive quantitative research on the trends and patterns on the productivity levels of plasterers observed a very significant decline in output over the years which the likely causes according to his research were attributed to labour tactics and economy. The results of the research revealed an average output/day of **37.01m^2** over the years and recommended a minimum of **36m^2** of wall surface a day. He further ascertained that if a labourer is trained and employed to serve a bricklayer on a site, the master servant inter-play would highly be boasted leading to high productivity value of about 76%.

Harris and McCaffer (2008) opined that the key to raising the productivity level lies in improving the performance and proportional balance of the input factors. They went further to say that productivity improvement process reduces redundant labour and other resources to meet demands for new activities and specialisations for the production of extra goods and services. They also argued that government and the construction industry has the general interest of improving productivity. This could be achieved through eliminating of excessive labour in order to improve cost effectiveness which will result to a good output and productivity. They as well said that specialisation and division of labour also lead to better output.

Chitkara (2009) in his study on Labour Productivity Control said that labour productivity achieved on the site for a given work provides a measure of the labourers' efficiency. This efficiency shows the total time for which the labourer was employed at work, the time he was productive on the work and the time he remained unproductive. He went further to suggest ways by which productive and unproductive period could be determined. And he concluded by saying that it will lead to taking remedial measures in order to improve productivity.

Abdullahi (2009) explained that several factors are inherent in the accuracy of estimates; these factors go a long way in determining the output of labour. He went further to suggest that extracted productivity figures should be exploited in order to optimise the productivity of their workers and profitability.

Ajia (2002) conducted a research appraising labour outputs and workers productivity on site. The research which was a 2 fold type consisting of field surveys and physical observations, concluded that gang formations were inadequate for all trades on all the sites investigated and that is likely to affect productivity. While Udegbe's work (2002) tried to capture some of the productivity influencing factors in establishing the output constants, Ajia (2002) did not consider any of the factors and infact was too general and unspecific.

However, Ameh and Odunsami (2004), Adnan *et al* (2002) as cited in Abdullahi (2009) in their productivity studies concluded that every productivity value is hinged to surrounding circumstances and factors which is a subject of among other geographical locations.

Horman and Kenley (2003) in their study on the *Quantity Levels of Wasted Time in Construction with Meta-analysis*, concluded that wasted time on site also affects productivity. They identified areas where improvement could be made by ascertaining the proportions of time spent on non-productive activity.

CHAPTER THREE

RESEACH METHODOLOGY

INTRODUCTION

Research methodology is referred to as the way a researcher goes about doing the research, unfolding a particular style and employing different techniques for collection Ibrahim and Abdullah (2008).

Also, Olayiwola (2007) viewed methodology as the description of what the researcher intends to do or did and the research design to adopt or adopted.

In this chapter, a description of data collection procedure adopted for this research is described. A detailed methodology and tools used are described. These according to Olayiwola (2007) include the following:

I. Research design
II. Area of study
III. Population
IV. Sample and sampling procedure
V. Instruments for data gathering
VI. Methods of data gathering
VII. Procedures
VIII. Validation and reliability of the instruments
IX. Data analyses
X. Pilot study

3.1 RESEARCH DESIGN

Research design refers to the plan or organization of scientific investigation, designing or a research study that involves the development of a plan or strategy that will guide the collection and analyses of data (Polit *et al,* 1999, cited in Madi, 2003). The research design is the logical sequence that connects the empirical data produced by research to the study's initial research questions and ultimately to its conclusions (Yin, 1989, cited in El Sawalhi, 2002). The methodology takes a descriptive and scientific methods of research approach. The research design is aimed at collecting data for the purpose of describing and interpreting the existing conditions regarding the productivity of workers on site. It involves the survey of 30 construction sites with various tradesmen on work. The nature of the research being purely quantitative, lead to the adoption of this methodology developed to study the natural phenomena of the productivity level of construction labourers and tradesmen.

A quantitative research is defined as "an enquiry into a social or human problem, based on testing a hypothesis or a theory composed of variables, measured with statistical procedures, in order to determine whether the hypothesis or theory holds true" (Fellows and Liu, 1999, cited in Abdullahi 2009).

Therefore, absolute numerical quantitative data values were collected and statistically analyzed through deductive approaches to draw conclusions.

3.1.1 AREA OF STUDY

This research study was carried out within Kano and Jigawa States. Data sets were collected only from on-going construction projects.

3.2 STUDY POPULATION

The population (N) of interest considered in respect of this research study is the "*construction sites*" within the scope and area of study earlier described for the research. These construction sites constituted mostly of building projects such as residential, industrial, and commercial buildings for both public and private owners. However, the construction sites ranging from small, medium, to large consisted of various operatives and tradesmen belonging to diverse trades such as; labourers, carpenters, masons, tillers, iron benders, fabricators, roofers, electricians, plumbers, e.t.c. The research also captured the distribution, gender, educational background, and all other relevant information of the population of interest.

3.3 RESEARCH SAMPLE AND SAMPLING TECHNIQUES

Due to time and other logistical constraints, it is difficult to consider the entire population of a sample. Therefore, 30 construction sites were considered within the scope of the area of study which consists of 15 sites each from Kano and Jigawa states. All sites selected were on the basis of availability and access for workers observation. Therefore the sampling is non-probability sampling technique called "purposive sampling" (Abdullahi, 2009).

The site selection was therefore based on the purpose of this research work. That is, only sites that have commenced the fixing of windows and doors among the various sites were selected.

From each construction site, the operations, activities or work on progress were fully observed and studied accordingly. These activities are as follows:

- Fixing of windows.
- Fixing of doors.

3.4 INSTRUMENT FOR DATA GATHERING

For the purpose of this study, a well structured "**Time study sheet**" was prepared for data gathering. It provides the format for recording the time covered in each element which constitutes the total time covered for completing an operation/activity. The study sheet comprises of three sections as follows:

SECTION A: This consists of the general information on the project and tradesman under observation, materials used, site location, activity/operation under observation.

SECTION B: This consists of the structured questionnaire for capturing operative's personal information and it is designed to accommodate the factors that affect labour productivity on site into the study and to clearly see and determine how such factors influence the output of the respective tradesmen under observation.

SECTION C: This consists of the main work measurement aspect of the data collection process. It recorded the starting, finishing, and the actual time expended in the delivery of an operation. Total output/unit observed time and basic time was also collected at the different periods of the study.

3.5 VALIDATION AND RELIABILITY OF THE INSTRUMENT

The instruments used for this research were conceptualized from the past literature (Harris & McCaffer 1995, Olomolaiye et al 1998). All necessary adjustments were made to such instruments so as to suit the irregularities with the area of study. A proper validation was made by the research supervisor and comments, criticisms and reasonable corrections were also made.

3.6 METHODS OF DATA COLLECTION

The following methods were used to collect data for the purpose of this research work:

I. Literature search

II. Field survey

3.6.1 Literature Review

A thorough and extensive literature search of both primary and secondary sources was conducted for the purpose of collecting relevant theory and information about labour productivity on construction sites. Similar research works conducted on output and productivity studies were also reviewed. Similarly, details about work study particularly work measurement techniques were critically reviewed for the purpose of the methodology of the study.

3.6.2 Field Survey

The quantitative data sets used for this research work were collected with the help of qualified assistants from all the construction sites sampled. The assistants employed were mostly site foremen with adequate training and experience. These assistants were well oriented and trained on the research objectives for data collection procedures before embarking on site measurements. Quantitative output values recorded from the work measurements conducted were the data set gathered from the field surveys carried out.

3.7 RESEARCH PROCEDURES

The procedures adopted for this research work are as follows:

i. The operative to be observed usually had a prior knowledge; this is because the purpose of the exercise (work measurement) usually had to be explained before permission be granted to carry it out on most sites.

ii. A physical measurement of the work output executed is then carried out using tools such as stopwatch. The observed output, starting time and finishing times are all recorded.

iii. The difference in start and stop times determines the actual time taken in each element and recorded as “observed time”. The summation of all observed times in the elements of an activity makes the total observed time.

iv. The observed time is then taken as the basic time which is then transferred to the collation sheet where adjustments are made in the form of contingency allowances for delays and relaxation periods. This is then calculated as a standard time which is considered as the total time taken by an operative to deliver a given output.

v. The output/unit time is then converted to an hour job and eventually to a day job.

3.8 PILOT SURVEY:

Olufemi (2007), as cited in Abdullahi, 2009 observed that every good research method should undertake a pilot survey which should enable the researcher to test and validate all the data collection instrument to be used with the view to correcting any weakness, review the questionnaire or any other instrument used by various co-researchers or assistants.

A pilot test of the instrument therefore was conducted in a sample of 4 construction sites all within Kano to enable the testing and validation of the data collection instrument to be used with the view to correcting any weakness. The data collected were analyzed using inferential statistics. All the ambiguous items and defects identified were corrected through the pilot test.

3.9 DATA ANALYSIS

The suitable design for statistical analysis of data for this research is the adoption of inferential statistical tools for the following:

3.9.1 Measurement of Outputs

The quantitative output results obtained through physical measurements on site were converted into output/hour and output/day units. The measures of central tendency such as mean, mode, median, were used by Microsoft excel 2007 to calculate the average output/unit time. Measures of dispersion such as standard deviation, variance, standard error, and the confidence level of the results were also calculated using Microsoft excel 2007 to describe to some extent the validity and reliability of the descriptive output results.

3.9.2 Test of Differences in Labour Outputs

The analysis of the relationships and differences between labour outputs obtained under some productivity factors was established using a parametric test of difference known as t-statistics. The t-statistic is parametric and is used to compare the mean of two samples. The fundamental assumptions underlying the use of the t-test according to Pagano (1981) cited in Ibrahim (2005) are:

1) The population from which the samples are taken is normally distributed.
2) The variances of the samples compared are homogenous.

Because the t-statistic is a robust test implying that it is relatively insensitive to violations of its assumptions, as reported by Ibrahim (2005), the two sample t-statistic that assumes equal variances was adopted for this research work. This is to counter the effect of the assumption of homogeneity of variance.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION OF RESULTS

INTRODUCTION

This chapter describes the results that have been obtained from field study. It seeks to review the strategies employed in the presentation and analysis of the data collected for the study. It also describes the source and nature of the data collected and also presents the findings and analysis of the productivity level in terms of output/unit measurement of tradesmen in site operations for window and door fixing. The chapter evaluates the output value of workers on general basis setting down five (5) major parameters of the factors influencing productivity of workers on site**.**

Statistical test employed is inferential analysis to analyze the data. A paired sample t-test to compare two groups that are related and independent t-test to compare two groups that are not related to each other. The central tendency and measures of dispersion were used in describing the nature and common characteristics of the data while two tailed two sample t-tests assuming unequal variances was used to test for any significant differences in outputs of workers group-wise. All tests were at 0.05 significant level unless where otherwise stated.

4.1 Nature of the Research Data

The data collected represents the absolute numerical quantities of output recorded at different times of the day, and is presented as unit output per hour and per day. These observations were done at two different periods; morning and afternoon. This is taken into consideration in order to capture the likely changes in weather and working conditions and their consequent effects on the recorded outputs.

4.2 Data presentation

A variety of tools are available for data presentation purposes typical among them are tables, charts, such as bar chart, pie chat, line diagrams e.t.c.. For the purposed of this research work, tables are used for the presentation of data.

4.3 WINDOWS

Due to time constraint and based on BESMM3 requirement for standard sizes, three sizes of aluminium windows were considered for the study. These include 1500x1200mm high, 1200x1200mm high and 600x600mm high. A total number of thirty (30) operatives for each size were observed for the study. The gang size considered for both the door and window fixing is one skilled labour and one unskilled labour. The outputs per day were extracted in accordance with the productivity factors which include; age, sex, experience, work conditions, mode of payment, period of observation, and level of supervision (Yagba and Ayandele, 1999; Ameh and Odusami, 2002; Olomolaiye et al, 1999; Adnan et al, 2002) as cited in Abdulrazaq et al, 2010. For the purpose of this work, five factors will be considered.

The study was carried out for a bill item for the supply and fixing of windows as explained in The Building and Engineering Standard Method of Measurement (BESMM3) as shown in tables A1 below:

Windows

S/no	Work Item	Relevant coverage rules	BESMM ref	Unit of Measurement
	Windows: Aluminium Casement			
	Supply and fix approved colour powder coated aluminium windows with frames and glazed with 5mm thick glass complete with ironmongery for window sizes:	C2a, C2c, C2e	L10.1.1	nr
A	1500 x 1200mm high			
B	1200 x 1200mm high			
B	600 x 600mm high			

Table A1: BESMM3 classification for window fixing

The responses gathered with simple interpretations are hereby presented below:

Table 1: Output Values for 1500 x 1200mm high Aluminium windows.

Gang Size: 1 mason, 1 labourer.

Study	**Output 1 (morning 8am-12pm)**	**Ave. output/hr**	**Output 2 (Afternoon 1-5pm)**	**Ave. Output/hr**	**Total Output/day**
1	7.00	1.75	4.00	1.00	11.00
2	8.00	2.00	4.00	1.00	12.00
3	9.00	2.25	5.00	1.25	14.00
4	7.00	1.75	5.00	1.25	12.00
5	9.00	2.25	5.00	1.25	14.00
6	8.00	2.00	5.00	1.25	13.00
7	7.00	1.75	5.00	1.25	12.00
8	9.00	2.25	4.00	1.00	13.00
9	7.00	1.75	5.00	1.25	12.00
10	8.00	2.00	4.00	1.00	12.00
11	7.00	1.75	4.00	1.00	11.00
12	8.00	2.00	4.00	1.00	12.00
13	9.00	2.25	5.00	1.25	14.00
14	7.00	1.75	5.00	1.25	12.00
15	9.00	2.25	5.00	1.25	14.00
16	8.00	2.00	5.00	1.25	13.00
17	7.00	1.75	5.00	1.25	12.00
18	9.00	2.25	4.00	1.00	13.00
19	7.00	1.75	5.00	1.25	12.00
20	8.00	2.00	4.00	1.00	12.00
21	7.00	1.75	4.00	1.00	11.00
22	8.00	2.00	4.00	1.00	12.00
23	9.00	2.25	5.00	1.25	14.00
24	7.00	1.75	5.00	1.25	12.00
25	9.00	2.25	5.00	1.25	14.00
26	8.00	2.00	5.00	1.25	13.00
27	7.00	1.75	5.00	1.25	12.00
28	9.00	2.25	4.00	1.00	13.00
29	7.00	1.75	5.00	1.25	12.00
30	8.00	2.00	4.00	1.00	12.00
TOTAL	**237.00**	**59.25**	**138.00**	**34.50**	**375.00**
AVERAGE	**7.90**	**1.98**	**4.60**	**1.15**	**12.50**

Inferential Statistics analysis

4.3.1 The effect of Productivity factor in respect of labour output for 1500 x 1200mm high window fixing.

The results of the t-test for various factors of production for 1500 x 1200mm high window fixing are as follows:

Age of Workers

Table 2 below shows the results for 18-35 years Age Group Vs Above 35 tears Age Group.

According to t-statistic, a significant difference exits between two variables if the calculated value of t (t stat) is greater than or equal to the critical value. From the results in Table 2 below, the value of the t-stat (1.085) is less than the critical value of t (2.23). Hence, it can be deduced from the results that there is no significant difference between the average output/day of the 18-35 years group with those above 35 years group. Also, the low significance value (0.30) suggests that the probability of the results being due to chance is less than 5%. We can therefore accept the null hypothesis $H1_0$ that no significant difference exists between the output level of both groups.

Table 2: 18 – 35yrs Vs Above 35yrs

t-Test: Two-Sample Assuming Unequal Variances

	18 to 35yrs	*Above 35yrs*
Mean	13	12.33333333
Variance	1.2	1.066666667
Observations	6	6
Hypothesized Mean Difference	0	
df	10	
t Stat	1.084652	
P(T<=t) one-tail	0.151766	
t Critical one-tail	1.812461	
P(T<=t) two-tail	0.303532	
t Critical two-tail	2.228139	

Mode of Employment

Table 3 below shows the results for Negotiated Vs Daily paid workers.

The calculated value of the t-statistics (3.58) is higher than the critical value of t (2.18). This suggests that there is a significance difference between the mean values of Neggotiated workers and that of daily paid workers. The negotiated workers are fully mobilized. The very low significance value (0.00) suggests that the probability of the results being due to chance is less than 5%. We can therefore conclude that the negotiated workers' output is higher than their daily paid counterparts. And hence we reject the null hypothesis $H3_0$.

Table 3: Effect of productivity factors for Negotiated Vs Daily Paid

t-Test: Two-Sample Assuming Unequal variances

	Negotiated	*Daily paid*
Mean	13	11.66666667
Variance	1	0.25
Observations	9	9
Hypothesized Mean Difference	0	
df	12	
t Stat	3.577708764	
P(T<=t) one-tail	0.00189911	
t Critical one-tail	1.782287548	
P(T<=t) two-tail	0.003798221	
t Critical two-tail	2.178812827	

Experience

Table 4 below shows the results for 2 – 5yrs Vs Above 5yrs.

The calculated value of the t-statistics (3.16) is higher than the critical value of t (2.23). This suggests that there is a significance difference between the mean values of 2-5yrs workers and that of above 5yrs workers. This suggests that the group of highly experienced workers has higher outputs than those with low experience level. The very low significance value (0.00) suggests that the probability of the results being due to chance is less than 5%. We can therefore reject the null hypothesis $H4_0$.

Table 4: Effect of productivity factors for 2-5yrs Vs above 5yrs

t-Test: Two-Sample Assuming Unequal variances

	2 to 5yrs	*Above 5yrs*
Mean	12.5	11.5
Variance	0.3	0.3
Observations	6	6
Hypothesized Mean Difference	0	
df	10	
t Stat	3.16227766	
P(T<=t) one-tail	0.00505978	
t Critical one-tail	1.812461102	
P(T<=t) two-tail	0.01011956	
t Critical two-tail	2.228138842	

Weather condition

From the results in Table 5 below, the value of the t-stat (0.00) is less than the critical value of t (2.13). Hence, it can be deduced from the results that there is no significant difference in the different period of observations (sunny Vs Windy). We can therefore accept the null hypothesis $H2_0$ that no significant difference exists between the output level of both groups.

Table 5: Effect of productivity factors for sunny Vs windy

t-Test: Two-Sample Assuming Unequal Variances

	Sunny	*Windy*
Mean	12.5	12.5
Variance	1.043478261	0.3
Observations	24	6
Hypothesized Mean Difference	0	
df	15	
t Stat	0	
P(T<=t) one-tail	0.5	
t Critical one-tail	1.753050325	
P(T<=t) two-tail	1	
t Critical two-tail	2.131449536	

Qualification

Table 6 below shows the results for primary cert. Vs. SSCE.

From the results in Table 6 below, the value of the t-stat (0.00) is less than the critical value of t (2.23). Hence, it can be deduced from the results that there is no significant difference between the level of education of the workers. We can therefore accept the null hypothesis $H5_0$ that there is no output difference between the well educated and highly qualified group of workers and workers with little or no qualification.

Table 6: Effect of productivity factors for Primary cert. Vs. SSCE.

t-Test: Two-Sample Assuming Unequal Variances

	Pri.Cert.	*SSCE*
Mean	12.33333333	12.33333333
Variance	0.25	1.75
Observations	9	9
Hypothesized Mean Difference	0	
df	10	
t Stat	0	
P(T<=t) one-tail	0.5	
t Critical one-tail	1.812461102	
P(T<=t) two-tail	1	
t Critical two-tail	2.228138842	

Table 7: Output Values for 1200 x 1200mm high Aluminium windows.

Gang Size: 1 mason, 1 labourer.

Study	Output 1 (morning 8am-12pm)	Ave. output/hr	Output 2 (Afternoon 1-5pm)	Ave. Output/hr	Total Output/day
1	10.00	2.50	5.00	1.25	15.00
2	9.00	2.25	4.00	1.00	13.00
3	7.00	1.75	5.00	1.25	12.00
4	9.00	2.25	5.00	1.25	14.00
5	8.00	2.00	4.00	1.00	12.00
6	7.00	1.75	3.00	0.75	10.00
7	8.00	2.00	4.00	1.00	12.00
8	9.00	2.25	5.00	1.25	14.00
9	8.00	2.00	5.00	1.25	13.00
10	9.00	2.25	6.00	1.50	15.00
11	10.00	2.50	5.00	1.25	15.00
12	9.00	2.25	4.00	1.00	13.00
13	7.00	1.75	5.00	1.25	12.00
14	9.00	2.25	5.00	1.25	14.00
15	8.00	2.00	4.00	1.00	12.00
16	7.00	1.75	3.00	0.75	10.00
17	8.00	2.00	4.00	1.00	12.00
18	9.00	2.25	5.00	1.25	14.00
19	8.00	2.00	5.00	1.25	13.00
20	9.00	2.25	6.00	1.50	15.00
21	10.00	2.50	5.00	1.25	15.00
22	9.00	2.25	4.00	1.00	13.00
23	7.00	1.75	5.00	1.25	12.00
24	9.00	2.25	5.00	1.25	14.00
25	8.00	2.00	4.00	1.00	12.00
26	7.00	1.75	3.00	0.75	10.00
27	8.00	2.00	4.00	1.00	12.00
28	9.00	2.25	5.00	1.25	14.00
29	8.00	2.00	5.00	1.25	13.00
30	9.00	2.25	6.00	1.50	15.00
TOTAL	**252.00**	**63.00**	**138.00**	**34.50**	**390.00**
AVERAGE	**8.40**	**2.10**	**4.60**	**1.15**	**13.00**

Inferential Statistics analysis

4.3.2 The effect of Productivity factor in respect of labour output for 1200 x 1200mm high window fixing.

The results of the t-test for various factors of production for 1500 x 1200mm high window fixing are as follows:

Age of Workers

Table 8 below shows the results for 18-35 years Age Group Vs Above 35 tears Age Group.

The calculated value of the t-stat (1.33) is less than the critical value of t (2.45). Hence, it can be deduced from the results that there is no significant difference between the average output/day of the 18-35 years group with those above 35 years group. Also, the low significance value (0.23) suggests that the probability of the results being due to chance is less than 5%. We can therefore accept the null hypothesis $H1_0$ that there is no significant difference between the age groups observed.

Table 8: Effect of productivity factors for 18-35yrs Vs. Above 35yrs.

t-Test: Two-Sample Assuming Unequal Variances

	18 to 35yrs	*Above 35yrs*
Mean	13.5	12.5
Variance	0.3	3.1
Observations	6	6
Hypothesized Mean Difference	0	
df	6	
t Stat	1.328422328	
P(T<=t) one-tail	0.116164822	
t Critical one-tail	1.943180274	
P(T<=t) two-tail	0.232329643	
t Critical two-tail	2.446911846	

Weather condition

From the results in Table 9 below, the value of the t-stat (0.00) is less than the critical value of t (2.20). Hence, it can be deduced from the results that there is no significant difference in the different period of observations (sunny Vs Windy). We can therefore accept the null hypothesis $H2_0$ that no significant difference exists between the output level of both groups.

Table 9: Effect of productivity factors for sunny Vs. Windy.

t-Test: Two-Sample Assuming Unequal Variances

	Sunny	*Windy*
Mean	12.66666667	12.66666667
Variance	1	4.75
Observations	9	9
Hypothesized Mean Difference	0	
df	11	
t Stat	0	
P(T<=t) one-tail	0.5	
t Critical one-tail	1.795884814	
P(T<=t) two-tail	1	
t Critical two-tail	2.200985159	

Mode of Employment

Table 10 below shows the results for Negotiated Vs Daily paid workers.

The calculated value of the t-statistics (2.83) is higher than the critical value of t (2.09). This suggests that there is a significance difference between the mean values of Negotiated workers and that of daily paid workers. The level of output of workers therefore depends on the type and level of payment made to them. The very low significance value (0.01) suggests that the probability of the results being due to chance is less than 5%. And hence we can reject the null hypothesis $H3_0$.

Table 10: Effect of Productivity factors for Negotiated Vs. Daily paid.

t-Test: Two-Sample Assuming Unequal Variances

	Negotiated	*Daily paid*
Mean	13.5	12
Variance	1.181818182	2.181818182
Observations	12	12
Hypothesized Mean Difference	0	
df	20	
t Stat	2.833200845	
P(T<=t) one-tail	0.005136562	
t Critical one-tail	1.724718218	
P(T<=t) two-tail	0.010273125	
t Critical two-tail	2.085963441	

Experience

Table 11 below shows the results for 2 – 5yrs Vs Above 5yrs.

The calculated value of the t-statistics (3.16) is higher than the critical value of t (2.23). This suggests that there is a significance difference between the mean values of 2-5yrs workers and that of above 5yrs workers. This suggests that the group of highly experienced workers has higher outputs than those with low experience level. The very low significance value (0.01) suggests that the probability of the results being due to chance is less than 5%. We can therefore reject the null hypothesis $H4_0$.

Table 11: Effect of Productivity factors for 2-5yrs Vs. Above 5yrs

t-Test: Two-Sample Assuming Unequal Variances

	2 to 5yrs	*Above 5yrs*
Mean	13	11
Variance	1.2	1.2
Observations	6	6
Hypothesized Mean Difference	0	
df	10	
t Stat	3.16227766	
P(T<=t) one-tail	0.00505978	
t Critical one-tail	1.812461102	
P(T<=t) two-tail	0.01011956	
t Critical two-tail	2.228138842	

Qualification

Table 12 below shows the results for primary cert. Vs. SSCE.

From the results in Table 12 below, the value of the t-stat (1.58) is less than the critical value of t (2.23). Hence, it can be deduced from the results that there is no significant difference between the level of education of the workers. We can therefore accept the null hypothesis $H5_0$ that there is no output difference between the well educated and highly qualified group of workers and workers with little or no qualification.

Table 12: Effect of Productivity factors for Primary cert. Vs. SSCE.

t-Test: Two-Sample Assuming Unequal Variances

	Prim. Cert.	*SSCE*
Mean	14	13
Variance	1.2	1.2
Observations	6	6
Hypothesized Mean Difference	0	
df	10	
t Stat	1.58113883	
P(T<=t) one-tail	0.0724638	
t Critical one-tail	1.812461102	
P(T<=t) two-tail	0.1449276	
t Critical two-tail	2.228138842	

Table 13: Output Values for 600 x 600mm high Aluminium windows.

Gang Size: 1 mason, 1 labourer.

Study	Output 1 (morning 8am-12pm)	Ave. output/hr	Output 2 (Afternoon 1-5pm)	Ave. Output/hr	Total Output/day
1	10.00	2.50	5.00	1.25	15.00
2	9.00	2.25	4.00	1.00	13.00
3	10.00	2.50	6.00	1.50	16.00
4	11.00	2.75	7.00	1.75	18.00
5	12.00	3.00	7.00	1.75	19.00
6	10.00	2.50	5.00	1.25	15.00
7	9.00	2.25	7.00	1.75	16.00
8	12.00	3.00	6.00	1.50	18.00
9	11.00	2.75	6.00	1.50	17.00
10	10.00	2.50	6.00	1.50	16.00
11	10.00	2.50	5.00	1.25	15.00
12	9.00	2.25	4.00	1.00	13.00
13	10.00	2.50	6.00	1.50	16.00
14	11.00	2.75	7.00	1.75	18.00
15	12.00	3.00	7.00	1.75	19.00
16	10.00	2.50	5.00	1.25	15.00
17	9.00	2.25	7.00	1.75	16.00
18	12.00	3.00	6.00	1.50	18.00
19	11.00	2.75	6.00	1.50	17.00
20	10.00	2.50	6.00	1.50	16.00
21	10.00	2.50	5.00	1.25	15.00
22	9.00	2.25	4.00	1.00	13.00
23	10.00	2.50	6.00	1.50	16.00
24	11.00	2.75	7.00	1.75	18.00
25	12.00	3.00	7.00	1.75	19.00
26	10.00	2.50	5.00	1.25	15.00
27	9.00	2.25	7.00	1.75	16.00
28	12.00	3.00	6.00	1.50	18.00
29	11.00	2.75	6.00	1.50	17.00
30	10.00	2.50	6.00	1.50	16.00
TOTAL	**312.00**	**78.00**	**177.00**	**44.25**	**489.00**
AVERAGE	**10.40**	**2.60**	**5.90**	**1.48**	**16.30**

Inferential Statistics analysis

4.3.3 The effect of Productivity factor in respect of labour output for 600 x 600mm high window fixing.

The results of the t-test for various factors of production for 600 x 600mm high window fixing are as follows:

Age of Workers

Table 14 below shows the results for 18-35 years Age Group Vs Above 35 tears Age Group.

The calculated value of the t-stat (0.49) is less than the critical value of t (2.10). Hence, it can be deduced from the results that there is no significant difference between the average output/day of the 18-35 years group with those above 35 years group. Also, the low significance value (0.23) suggests that the probability of the results being due to chance is less than 5%. We can therefore accept the null hypothesis $H1_0$ that there is no significant difference between the age groups observed.

Table 14: Effect of productivity factors for 18-35yrs Vs. Above 35yrs.

t-Test: Two-Sample Assuming Unequal Variances

	18 t0 35yrs	*Above 35yrs*
Mean	16.5	16.16666667
Variance	1.363636364	4.151515152
Observations	12	12
Hypothesized Mean Difference	0	
df	18	
t Stat	0.491689172	
P(T<=t) one-tail	0.314440659	
t Critical one-tail	1.734063592	
P(T<=t) two-tail	0.628881318	
t Critical two-tail	2.100922037	

Weather condition

From the results in Table 15 below, the value of the t-stat (4.00) is higher than the critical value of t (2.16). Hence, it can be deduced from the results that there is a significant difference in the different period of observations (sunny Vs Windy). We can therefore reject the null hypothesis $H2_0$ that no significant difference exists between the output levels of both groups.

Table 15: Effect of productivity factors for sunny Vs. Windy.

t-Test: Two-Sample Assuming Unequal Variances

	Sunny	*Windy*
Mean	17	15.66666667
Variance	0.75	0.25
Observations	9	9
Hypothesized Mean Difference	0	
df	13	
t Stat	4	
P(T<=t) one-tail	0.00075604	
t Critical one-tail	1.770933383	
P(T<=t) two-tail	0.001512079	
t Critical two-tail	2.160368652	

Mode of Employment

Table 16 below shows the results for Negotiated Vs Daily paid workers.

The calculated value of the t-statistics (5.45) is higher than the critical value of t (2.07). This suggests that there is a significance difference between the mean values of Negotiated workers and that of daily paid workers. The level of output of workers therefore depends on the type and level of payment made to them. The very low significance value (0.01) suggests that the probability of the results being due to chance is less than 5%. And hence we can reject the null hypothesis $H3_0$.

Table 16: Effect of Productivity factors for Negotiated Vs. Daily paid.

t-Test: Two-Sample Assuming Unequal Variances

	Negotiated	*Daily paid*
Mean	17.16666667	14.75
Variance	1.060606061	1.295454545
Observations	12	12
Hypothesized Mean Difference	0	
df	22	
t Stat	5.453987597	
P(T<=t) one-tail	8.83987E-06	
t Critical one-tail	1.717144335	
P(T<=t) two-tail	1.76797E-05	
t Critical two-tail	2.073873058	

Experience

Table 17 below shows the results for 2 – 5yrs Vs Above 5yrs.

The calculated value of the t-statistics (4.78) is higher than the critical value of t (2.13). This suggests that there is a significance difference between the mean values of 2-5yrs workers and that of above 5yrs workers. This suggests that the group of highly experienced workers has higher outputs than those with low experience level. The very low significance value (0.01) suggests that the probability of the results being due to chance is less than 5%. We can therefore reject the null hypothesis $H4_0$.

Table 17: Effect of Productivity factors for 2-5yrs Vs. Above 5yrs

t-Test: Two-Sample Assuming Unequal Variances

	2 to 5yrs	*Above 5yrs*
Mean	17	14.77777778
Variance	0.75	1.194444444
Observations	9	9
Hypothesized Mean Difference	0	
Df	15	
t Stat	4.780914437	
P(T<=t) one-tail	0.000121406	
t Critical one-tail	1.753050325	
P(T<=t) two-tail	0.000242812	
t Critical two-tail	2.131449536	

Qualification

Table 18 below shows the results for primary cert. Vs. SSCE.

From the results in Table 12 below, the value of the t-stat (-3.12) is less than the critical value of t (2.07). Hence, it can be deduced from the results that there is no significant difference between the level of education of the workers. We can therefore accept the null hypothesis $H5_0$ that there is no output difference between the well educated and highly qualified group of workers and workers with little or no qualification.

Table 18: Effect of Productivity factors for Primary cert. Vs. SSCE.

t-Test: Two-Sample Assuming Unequal Variances

	Pri.cert	*SSCE*
Mean	15.5	17.5
Variance	2.454545455	2.454545455
Observations	12	12
Hypothesized Mean Difference	0	
Df	22	
t Stat	-3.12694384	
P(T<=t) one-tail	0.002452908	
t Critical one-tail	1.717144335	
P(T<=t) two-tail	0.004905816	
t Critical two-tail	2.073873058	

4.4 DOORS

Due to time constraint and based on BESMM3 requirement for standard sections, three sizes of steel doors were considered for the study. These include 1200 x 2100mm high, 900 x 2100mm high and 750 x 2100mm high. A total number of thirty (30) operatives for each size were observed for the study. The gang size considered for the door fixing is one skilled labour and one unskilled labour. The outputs per day were extracted in accordance with the productivity factors which include; age, sex, experience, work conditions, mode of payment, period of observation, and level of supervision (Yagba and Ayandele, 1999; Ameh and Odusami, 2002; Olomolaiye et al, 1999; Adnan et al, 2002) as cited in Abdulrazaq et al, 2010. For the purpose of this work, five factors will be considered.

The study was carried out for a bill item for the supply and fixing of windows and doors as explained in The Building and Engineering Standard Method of Measurement (BESMM3) as shown in tables A2 below:

The responses gathered with simple interpretations are hereby presented below:

Doors

S/no	Work Item	Relevant coverage rules	BESMM ref	Unit of Measurement
	Doors: Steel Doors			
	Supply and fix the following approved steel doors complete with frames and sub frames with all necessary iron monger for doors sizes:	C2a, C2c, C2e	L20.1.1	nr
A	1200 x 2100mm high			
B	900 x 2100mm high			
B	750 x 2100mm high			

Table A2: BESMM3 classification for door fixing

Table 19: Output Values for 1200 x 2100mm high Steel Doors.

Gang Size: 1 mason, 1 labourer.

Study	Output 1 (morning 8am-12pm)	Ave. output/hr	Output 2 (Afternoon 1-5pm)	Ave. Output/hr	Total Output/day
1	9.00	2.25	4.00	1.00	13.00
2	7.00	1.75	3.00	0.75	10.00
3	8.00	2.00	4.00	1.00	12.00
4	8.00	2.00	4.00	1.00	12.00
5	7.00	1.75	3.00	0.75	10.00
6	9.00	2.25	4.00	1.00	13.00
7	8.00	2.00	4.00	1.00	12.00
8	7.00	1.75	3.00	0.75	10.00
9	8.00	2.00	4.00	1.00	12.00
10	9.00	2.25	3.00	0.75	12.00
11	9.00	2.25	4.00	1.00	13.00
12	7.00	1.75	3.00	0.75	10.00
13	8.00	2.00	4.00	1.00	12.00
14	8.00	2.00	4.00	1.00	12.00
15	7.00	1.75	3.00	0.75	10.00
16	9.00	2.25	4.00	1.00	13.00
17	8.00	2.00	4.00	1.00	12.00
18	7.00	1.75	3.00	0.75	10.00
19	8.00	2.00	4.00	1.00	12.00
20	9.00	2.25	3.00	0.75	12.00
21	9.00	2.25	4.00	1.00	13.00
22	7.00	1.75	3.00	0.75	10.00
23	8.00	2.00	4.00	1.00	12.00
24	8.00	2.00	4.00	1.00	12.00
25	7.00	1.75	3.00	0.75	10.00
26	9.00	2.25	4.00	1.00	13.00
27	8.00	2.00	4.00	1.00	12.00
28	7.00	1.75	3.00	0.75	10.00
29	8.00	2.00	4.00	1.00	12.00
30	9.00	2.25	3.00	0.75	12.00
TOTAL	**240.00**	**60.00**	**108.00**	**27.00**	**348.00**
AVERAGE	**8.00**	**2.00**	**3.60**	**0.90**	**11.60**

Inferential Statistics analysis

4.4.1 The effect of Productivity factor in respect of labour output for 1200 x 2100mm high door fixing.

The results of the t-test for various factors of production for 1200 x 2100mm high door fixing are as follows:

Age of Workers

Table 20 below shows the results for 18-35 years Age Group Vs Above 35 tears Age Group.

The calculated value of the t-stat (-2.35) is less than the critical value of t (2.07). Hence, it can be deduced from the results that there is no significant difference between the average output/day of the 18-35 years group with those above 35 years group. Also, the low significance value (0.23) suggests that the probability of the results being due to chance is less than 5%. We can therefore accept the null hypothesis $H1_0$ that there is no significant difference between the age groups observed.

Table 20: Effect of productivity factors for 18-35yrs Vs. Above 35yrs.

t-Test: Two-Sample Assuming Unequal Variances

	18 to 35yrs	*Above 35yrs*
Mean	11	12
Variance	1.090909091	1.090909091
Observations	12	12
Hypothesized Mean Difference	0	
df	22	
t Stat	-2.34520788	
P(T<=t) one-tail	0.014222001	
t Critical one-tail	1.717144335	
P(T<=t) two-tail	0.028444002	
t Critical two-tail	2.073873058	

Weather condition

From the results in Table 21 below, the value of the t-stat (1.41) is less than the critical value of t (2.12). Hence, it can be deduced from the results that there is no significant difference in the different period of observations (sunny Vs Windy). We can therefore accept the null hypothesis $H2_0$ that no significant difference exists between the output levels of both groups.

Table 21: Effect of productivity factors for sunny Vs. Windy.

t-Test: Two-Sample Assuming Unequal Variances

	Sunny	*Windy*
Mean	11.33333333	10.66666667
Variance	1	1
Observations	9	9
Hypothesized Mean Difference	0	
df	16	
t Stat	1.414213562	
P(T<=t) one-tail	0.088231598	
t Critical one-tail	1.745883669	
P(T<=t) two-tail	0.176463197	
t Critical two-tail	2.119905285	

Mode of Employment

Table 22 below shows the results for Negotiated Vs Daily paid workers.

The calculated value of the t-statistics (15.11) is higher than the critical value of t (2.31). This suggests that there is a significance difference between the mean values of Negotiated workers and that of daily paid workers. The level of output of workers therefore depends on the type and level of payment made to them. The very low significance value (0.01) suggests that the probability of the results being due to chance is less than 5%. And hence we can reject the null hypothesis $H3_0$.

Table 22: Effect of Productivity factors for Negotiated Vs. Daily paid.

t-Test: Two-Sample Assuming Unequal Variances

	Negotiated	*Daily paid*
Mean	12.22222222	10
Variance	0.194444444	0
Observations	9	9
Hypothesized Mean Difference	0	
df	8	
t Stat	15.11857892	
P(T<=t) one-tail	1.81259E-07	
t Critical one-tail	1.859548033	
P(T<=t) two-tail	3.62518E-07	
t Critical two-tail	2.306004133	

Experience

Table 23 below shows the results for 2 – 5yrs Vs Above 5yrs.

The calculated value of the t-statistics (0.79) is less than the critical value of t (2.13). This suggests that there is no significance difference between the mean values of 2-5yrs workers and that of above 5yrs workers. This suggests that there is no output difference between the highly experienced group of workers and workers with low experience level. We can therefore reject the null hypothesis $H4_0$.

Table 23: Effect of Productivity factors for 2-5yrs Vs. Above 5yrs

t-Test: Two-Sample Assuming Unequal Variances

	2 to 5yrs	*Above 5yrs*
Mean	11.33333333	10.88888889
Variance	1	1.861111111
Observations	9	9
Hypothesized Mean Difference	0	
df	15	
t Stat	0.788263423	
P(T<=t) one-tail	0.221411293	
t Critical one-tail	1.753050325	
P(T<=t) two-tail	0.442822587	
t Critical two-tail	2.131449536	

Qualification

Table 24 below shows the results for primary cert. Vs. SSCE.

From the results in Table 12 below, the value of the t-stat (-1.41) is less than the critical value of t (2.11). Hence, it can be deduced from the results that there is no significant difference between the level of education of the workers. We can therefore accept the null hypothesis $H5_0$ that there is no output difference between the well educated and highly qualified group of workers and workers with little or no qualification.

Table 24: Effect of Productivity factors for Primary cert. Vs. SSCE.

t-Test: Two-Sample Assuming Unequal Variances

	Pri. Cert	*SSCE*
Mean	10.66666667	11.33333333
Variance	1	1
Observations	9	9
Hypothesized Mean Difference	0	
df	16	
t Stat	-1.41421356	
P(T<=t) one-tail	0.088231598	
t Critical one-tail	1.745883669	
P(T<=t) two-tail	0.176463197	
t Critical two-tail	2.119905285	

Table 25: Output Values for 900 x 2100mm high Steel Doors.

Gang Size: 1 mason, 1 labourer.

Study	**Output 1 (morning 8am-12pm)**	**Ave. output/hr**	**Output 2 (Afternoon 1-5pm)**	**Ave. Output/hr**	**Total Output/day**
1	7.00	1.75	3.00	0.75	10.00
2	8.00	2.00	3.00	0.75	11.00
3	9.00	2.25	3.00	0.75	12.00
4	7.00	1.75	3.00	0.75	10.00
5	6.00	1.50	3.00	0.75	9.00
6	9.00	2.25	4.00	1.00	13.00
7	8.00	2.00	3.00	0.75	11.00
8	7.00	1.75	3.00	0.75	10.00
9	8.00	2.00	4.00	1.00	12.00
10	6.00	1.50	3.00	0.75	9.00
11	7.00	1.75	3.00	0.75	10.00
12	8.00	2.00	3.00	0.75	11.00
13	9.00	2.25	3.00	0.75	12.00
14	7.00	1.75	3.00	0.75	10.00
15	6.00	1.50	3.00	0.75	9.00
16	9.00	2.25	4.00	1.00	13.00
17	8.00	2.00	3.00	0.75	11.00
18	7.00	1.75	3.00	0.75	10.00
19	8.00	2.00	4.00	1.00	12.00
20	6.00	1.50	3.00	0.75	9.00
21	7.00	1.75	3.00	0.75	10.00
22	8.00	2.00	3.00	0.75	11.00
23	9.00	2.25	3.00	0.75	12.00
24	7.00	1.75	3.00	0.75	10.00
25	6.00	1.50	3.00	0.75	9.00
26	9.00	2.25	4.00	1.00	13.00
27	8.00	2.00	3.00	0.75	11.00
28	7.00	1.75	3.00	0.75	10.00
29	8.00	2.00	4.00	1.00	12.00
30	6.00	1.50	3.00	0.75	9.00
TOTAL	**225.00**	**56.25**	**96.00**	**24.00**	**321.00**
AVERAGE	**7.50**	**1.88**	**3.20**	**0.80**	**10.70**

4.4.2 The effect of Productivity factor in respect of labour output for 900 x 2100mm high door fixing.

The results of the t-test for various factors of production for 900 x 2100mm high door fixing are as follows:

Age of Workers

Table 26 below shows the results for 18-35 years Age Group Vs Above 35 tears Age Group.

The calculated value of the t-stat (-3.59) is less than the critical value of t (2.20). Hence, it can be deduced from the results that there is no significant difference between the average output/day of the 18-35 years group with those above 35 years group. Also, the low significance value (0.23) suggests that the probability of the results being due to chance is less than 5%. We can therefore accept the null hypothesis $H1_0$ that there is no significant difference between the age groups observed.

Table 26: Effect of productivity factors for 18-35yrs Vs. Above 35yrs.

t-Test: Two-Sample Assuming Unequal Variances

	18 t0 35yrs	*Above 35yrs*
Mean	9.666666667	11.22222222
Variance	0.25	1.444444444
Observations	9	9
Hypothesized Mean Difference	0	
df	11	
t Stat	-3.585032638	
P(T<=t) one-tail	0.002140364	
t Critical one-tail	1.795884814	
P(T<=t) two-tail	0.004280727	
t Critical two-tail	2.200985159	

Weather condition

From the results in Table 27 below, the value of the t-stat (-3.72) is less than the critical value of t (2.16). Hence, it can be deduced from the results that there is no significant difference in the different period of observations (sunny Vs Windy). We can therefore accept the null hypothesis $H2_0$ that no significant difference exists between the output levels of both groups.

Table 27: Effect of productivity factors for sunny Vs. Windy.

t-Test: Two-Sample Assuming Unequal Variances

	Sunny	*Windy*
Mean	9.75	11.5
Variance	0.204545455	2.454545455
Observations	12	12
Hypothesized Mean Difference	0	
df	13	
t Stat	-3.717595032	
P(T<=t) one-tail	0.001290995	
t Critical one-tail	1.770933383	
P(T<=t) two-tail	0.002581989	
t Critical two-tail	2.160368652	

Mode of Employment

Table 28 below shows the results for Negotiated Vs Daily paid workers.

The calculated value of the t-statistics (5.32) is higher than the critical value of t (2.11). This suggests that there is a significance difference between the mean values of Negotiated workers and that of daily paid workers. The level of output of workers therefore depends on the type and level of payment made to them. The very low significance value (0.01) suggests that the probability of the results being due to chance is less than 5%. And hence we can reject the null hypothesis $H3_0$.

Table 28: Effect of Productivity factors for Negotiated Vs. Daily paid.

t-Test: Two-Sample Assuming Unequal Variances

	Negotiated	*Daily paid*
Mean	11.33333333	9.5
Variance	1.151515152	0.272727273
Observations	12	12
Hypothesized Mean Difference	0	
df	16	
t Stat	5.321573915	
P(T<=t) one-tail	3.44161E-05	
t Critical one-tail	1.745883669	
P(T<=t) two-tail	6.88322E-05	
t Critical two-tail	2.119905285	

Experience

Table 29 below shows the results for 2 – 5yrs Vs Above 5yrs.

The calculated value of the t-statistics (-1.33) is less than the critical value of t (2.23). This suggests that there is no significance difference between the mean values of 2-5yrs workers and that of above 5yrs workers. Therefore there is no output difference between the highly experienced group of workers and workers with low experience level. We can therefore reject the null hypothesis $H4_0$.

Table 29: Effect of Productivity factors for 2-5yrs Vs. Above 5yrs

t-Test: Two-Sample Assuming Unequal Variances

	2 to 5yrs	*Above 5yrs*
Mean	9.666666667	10.33333333
Variance	0.25	2
Observations	9	9
Hypothesized Mean Difference	0	
df	10	
t Stat	-1.333333333	
P(T<=t) one-tail	0.105999066	
t Critical one-tail	1.812461102	
P(T<=t) two-tail	0.211998131	
t Critical two-tail	2.228138842	

Qualification

Table 30 below shows the results for primary cert. Vs. SSCE.

From the results in Table 12 below, the value of the t-stat (0.17) is less than the critical value of t (2.16). Hence, it can be deduced from the results that there is no significant difference between the levels of education of the workers. We can therefore accept the null hypothesis $H5_0$ that there is no output difference between the well educated and highly qualified group of workers and workers with little or no qualification.

Table 30: Effect of Productivity factors for Primary cert. Vs. SSCE.

t-Test: Two-Sample Assuming Unequal Variances

	Pri. Cert.	*SSCE*
Mean	10	9.666666667
Variance	0.75	0.25
Observations	9	9
Hypothesized Mean Difference	0	
df	13	
t Stat	1	
P(T<=t) one-tail	0.167780639	
t Critical one-tail	1.770933383	
P(T<=t) two-tail	0.335561278	
t Critical two-tail	2.160368652	

Table 31: Output Values for 7500 x 2100mm high Steel Doors.

Gang Size: 1 mason, 1 labourer.

Study	Output 1 (morning 8am-12pm)	Ave. output/hr	Output 2 (Afternoon 1-5pm)	Ave. Output/hr	Total Output/day
1	7.00	1.75	4.00	1.00	11.00
2	9.00	2.25	4.00	1.00	13.00
3	8.00	2.00	5.00	1.25	13.00
4	7.00	1.75	4.00	1.00	11.00
5	9.00	2.25	4.00	1.00	13.00
6	8.00	2.00	4.00	1.00	12.00
7	7.00	1.75	3.00	0.75	10.00
8	9.00	2.25	3.00	0.75	12.00
9	8.00	2.00	4.00	1.00	12.00
10	7.00	1.75	3.00	0.75	10.00
11	7.00	1.75	4.00	1.00	11.00
12	9.00	2.25	4.00	1.00	13.00
13	8.00	2.00	5.00	1.25	13.00
14	7.00	1.75	4.00	1.00	11.00
15	9.00	2.25	4.00	1.00	13.00
16	8.00	2.00	4.00	1.00	12.00
17	7.00	1.75	3.00	0.75	10.00
18	9.00	2.25	3.00	0.75	12.00
19	8.00	2.00	4.00	1.00	12.00
20	7.00	1.75	3.00	0.75	10.00
21	7.00	1.75	4.00	1.00	11.00
22	9.00	2.25	4.00	1.00	13.00
23	8.00	2.00	5.00	1.25	13.00
24	7.00	1.75	4.00	1.00	11.00
25	9.00	2.25	4.00	1.00	13.00
26	8.00	2.00	4.00	1.00	12.00
27	7.00	1.75	3.00	0.75	10.00
28	9.00	2.25	3.00	0.75	12.00
29	8.00	2.00	4.00	1.00	12.00
30	7.00	1.75	3.00	0.75	10.00
TOTAL	**237.00**	**59.25**	**114.00**	**28.50**	**351.00**
AVERAGE	**7.90**	**1.98**	**3.80**	**0.95**	**11.70**

Inferential Statistics analysis

4.4.3 The effect of Productivity factor in respect of labour output for 750 x 2100mm high door fixing.

The results of the t-test for various factors of production for 900 x 2100mm high door fixing are as follows:

Age of Workers

Table 32 below shows the results for 18-35 years Age Group Vs Above 35 tears Age Group.

The calculated value of the t-stat (-0.19) is less than the critical value of t (2.13). Hence, it can be deduced from the results that there is no significant difference between the average output/day of the 18-35 years group with those above 35 years group. Also, the low significance value (0.23) suggests that the probability of the results being due to chance is less than 5%. We can therefore accept the null hypothesis $H1_0$ that there is no significant difference between the age groups observed.

Table 32: Effect of productivity factors for 18-35yrs Vs. Above 35yrs.

t-Test: Two-Sample Assuming Unequal Variances

	18 to 35yrs	*Above 35yrs*
Mean	11.66666667	11.77777778
Variance	1.75	1.194444444
Observations	9	9
Hypothesized Mean Difference	0	
df	15	
t Stat	-0.194257172	
P(T<=t) one-tail	0.424290443	
t Critical one-tail	1.753050325	
P(T<=t) two-tail	0.848580887	
t Critical two-tail	2.131449536	

Weather condition

From the results in Table 33 below, the value of the t-stat (-1.26) is less than the critical value of t (2.22). Hence, it can be deduced from the results that there is no significant difference in the different period of observations (sunny Vs Windy). We can therefore accept the null hypothesis $H2_0$ that no significant difference exists between the output levels of both groups.

Table 33: Effect of productivity factors for sunny Vs. Windy.

t-Test: Two-Sample Assuming Unequal Variances

	Sunny	*Windy*
Mean	11	11.66666667
Variance	2.25	0.25
Observations	9	9
Hypothesized Mean Difference	0	
df	10	
t Stat	-1.264911064	
P(T<=t) one-tail	0.117292457	
t Critical one-tail	1.812461102	
P(T<=t) two-tail	0.234584914	
t Critical two-tail	2.228138842	

Mode of Employment

Table 34 below shows the results for Negotiated Vs Daily paid workers.

The calculated value of the t-statistics (7.18) is higher than the critical value of t (2.14). This suggests that there is a significance difference between the mean values of Negotiated workers and that of daily paid workers. The level of output of workers therefore depends on the type and level of payment made to them. The very low significance value (0.01) suggests that the probability of the results being due to chance is less than 5%. And hence we can reject the null hypothesis $H3_0$.

Table 34: Effect of Productivity factors for Negotiated Vs. Daily paid.

t-Test: Two-Sample Assuming Unequal Variances

	Negotiated	*Daily paid*
Mean	12.44444444	10.33333333
Variance	0.527777778	0.25
Observations	9	9
Hypothesized Mean Difference	0	
df	14	
t Stat	7.181324987	
P(T<=t) one-tail	2.34979E-06	
t Critical one-tail	1.761310115	
P(T<=t) two-tail	4.69959E-06	
t Critical two-tail	2.144786681	

Experience

Table 35 below shows the results for 2 – 5yrs Vs Above 5yrs.

The calculated value of the t-statistics (1.41) is less than the critical value of t (2.45). This suggests that there is no significance difference between the mean values of 2-5yrs workers and that of above 5yrs workers. Therefore there is no output difference between the highly experienced group of workers and workers with low experience level. We can therefore reject the null hypothesis $H4_0$.

Table 35: Effect of Productivity factors for 2-5yrs Vs. Above 5yrs

t-Test: Two-Sample Assuming Unequal Variances

	2 to 5yrs	*Above 5yrs*
Mean	11.5	10.5
Variance	2.7	0.3
Observations	6	6
Hypothesized Mean Difference	0	
df	6	
t Stat	1.414213562	
P(T<=t) one-tail	0.103515625	
t Critical one-tail	1.943180274	
P(T<=t) two-tail	0.20703125	
t Critical two-tail	2.446911846	

Qualification

Table 36 below shows the results for primary cert. Vs. SSCE.

From the results in Table 12 below, the value of the t-stat (-0.48) is less than the critical value of t (2.07). Hence, it can be deduced from the results that there is no significant difference between the level of education of the workers. We can therefore accept the null hypothesis $H5_0$ that there is no output difference between the well educated and highly qualified group of workers and workers with little or no qualification.

Table 36: Effect of Productivity factors for Primary cert. Vs. SSCE.

t-Test: Two-Sample Assuming Unequal Variances

	Prim. Cert.	*SSCE*
Mean	11.5	11.75
Variance	1.363636364	1.840909091
Observations	12	12
Hypothesized Mean Difference	0	
df	22	
t Stat	-0.483779447	
P(T<=t) one-tail	0.316661483	
t Critical one-tail	1.717144335	
P(T<=t) two-tail	0.633322966	
t Critical two-tail	2.073873058	

4.5 SUMMARY OF OUTPUTS

TABLE 37: GENERAL OUTPUT – WINDOWS

Operation	Average Output/Day
1500 X 1200mm High	12.00
1200 x 1200mm High	13.00
600 x 600mm High	16.00

TABLE 38: GENERAL OUTPUT – DOORS

Operation	Average Output/Day
1200 X 2100mm High	11.00
900 x 2100mm High	10.00
750 x 2100mm High	11.00

4.6 DISCUSSION OF RESULTS

The study revealed a rejection of the research hypothesis on the age of the work force. This means that there is no significant difference between the workers with ages 18-30 years versus above 30 years in all the sizes of windows and doors observed. This is in agreement with Abdullahi (2009). Therefore age has no significant influence over productivity.

However, on the mode of employment of the workers the study has revealed a significant difference between the negotiated workers and daily paid workers. Negotiated workers produce more output on site than their daily paid counterparts. This also agrees with Abdullahi (2009) and Enhassi *et al.* (2011).

The qualification of workers and period of observation according to the study, do not have any effect on the productivity of the workers. Workers with primary certificate and those with senior secondary certificate of education (SSCE) were considered. This shows that fixing of windows and doors does not require any educational qualification. For the period of observation, the sunny Vs windy weather conditions have no significant difference on the output of workers on site except in 600 x 600mm high windows.

The study however revealed a significant difference on the experience of the workers. It concludes that workers with high level of experience produce more in output than those with low level of experience.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 SUMMARY OF MAJOR FINDINGS

This chapter deduce the conclusions derived from the results of this research work. Appropriate recommendations as to how the findings of the research can be applied effectively are offered and the direction on further research.

5.2 CONCLUSIONS

The aim of the study was to determine the labour outputs for fixing selected windows and doors in Kano and Jigawa states. The study was able to achieve the aim through accomplishing the stated objectives;

The first objective was to investigate the extent of influence of the productivity factors considered over the resulting labour output of each activity. Meeting this objective required the test of the research hypothesis as follows:

Null hypothesis (H1o): There is no output difference between the ages of workers observed.

The output values of workers for different age group of workers were tested using the t-statistics in order to investigate whether to accept or reject the null hypothesis (H1o). The results of the test revealed that in all the sizes of windows and doors observed, there is no significant difference between the two age groups of 18-35 years and those above 35 years observed. This implies that age has no influence over productivity levels. Therefore the null hypothesis is accepted.

Null hypothesis (H2o): There is no output difference in all the different periods of observations.

The output values for the two periods observed (windy and sunny) accepted H2o in all the operations of windows and doors studied except in 600 x 600mm high windows. This implies that the output of workers do not depend on the period of observations. Hence the null hypothesis (H2o) is accepted.

Null hypothesis (H3o): There is no output difference in respect of the type and level of payment to workers under observation.

The results of the t-test conducted to test H3o rejected it in all the operations studied for the various sizes of windows and doors. The results therefore accepted the research hypothesis H3. It can be concluded that the type, mode and level of payment to workers determine their output.

Null hypothesis (H4o): there is no output difference between the highly experienced groups of workers and workers with low work experience.

The results of the t-test conducted to test H4o rejected it in all the operations studied for the various sizes of windows and doors. The results therefore accepted the research hypothesis H4. It can be concluded that the length of experience of the workers determine their output.

Bull hypothesis (H5o): There is no output difference between the well educated and highly qualified group of workers and workers with little or no qualification.

The results of the t-test conducted between the workers with primary certificate and those with SSCE accepted H5o in all the operations studied for the various sizes of windows and doors. The results therefore rejected the research hypothesis H5. This implies that qualification of workers do not have any impact on the output of the workers.

Below is a summary of the hypothesis:

TABLE 39: SUMMARY OF NULL HYPOYHESIS – WINDOWS

Operation	Age	Qualification	Employment	Experience	Weather
1500 x 1200mm	Accepted	Accepted	Rejected	Rejected	Accepted
1200 x 1200mm	Accepted	Accepted	Rejected	Rejected	Accepted
600 x 600mm	Accepted	Accepted	Rejected	Rejected	Rejected

TABLE 40: SUMMARY OF RESEARCH HYPOYHESIS – WINDOWS

Operation	Age	Qualification	Employment	Experience	Weather
1500 x 1200mm	Rejected	Rejected	Accepted	Accepted	Rejected
1200 x 1200mm	Rejected	Rejected	Accepted	Accepted	Rejected
600 x 600mm	Rejected	Rejected	Accepted	Accepted	Accepted

TABLE 41: SUMMARY OF NULL HYPOYHESIS – DOORS

Operation	Age	Qualification	Employment	Experience	Weather
1200 x 2100mm	Accepted	Accepted	Rejected	Rejected	Accepted
900 x 2100mm	Accepted	Accepted	Rejected	Rejected	Accepted
750 x 2100mm	Accepted	Accepted	Rejected	Rejected	Accepted

TABLE 42: SUMMARY OF RESEARCH HYPOTHESIS – DOORS

Operation	Age	Qualification	Employment	Experience	Weather
1200 x 2100mm	Rejected	Rejected	Accepted	Accepted	Rejected
900 x 2100mm	Rejected	Rejected	Accepted	Accepted	Rejected
750 x 2100mm	Rejected	Rejected	Accepted	Accepted	Rejected

The second objective was to quantitatively measure the productivity and output levels of doors and windows fixing operations on site using work study approach. This study applied work measurement techniques to collect absolute numerical quantitative output of values on doors and windows fixing on site. The results established general average output values per day of; **12.00 nr** (for 1500 x 1200mm high window), **13.00 nr** (for 1200 x 1200mm high window), and **16.00 nr** (for 600 x 600mm high window). While **11.00 nr** (for 1200 x

2100mm high door), **10.00 nr** (for 900 x 2100mm high door) and **11.00 nr** (for 750 x 2100mm high door) were established.

The implications of these results is that these output values considered average situations and conditions based on the productivity factors of age, qualification, mode of employment, experience and whether condition. These set of productivity factors are just but a few out of the many that affect labour productivity in the Nigerian context. Therefore, such output values determined can only be attained when average conditions of these factors are prudently maximized.

The third objective was to investigate through literature, the sources and origin of some of the labour outputs currently in use in Nigeria. A review of literature revealed that no single and uniform collection of labour constants is used within the construction industry. It was found that even though, the Nigerian labour output are published in Nigeria building price books, the basis, origin and degree of reliability of these constants are yet to be unveiled. Some contractors adopt the British originated outputs while others use the output which they establish base on their personal work experience. The review of literature as evidenced by the diverse output data collected indicates the adoption of non-uniform output in the industry.

5.3 Recommendations

Based on the findings of this research effort the following recommendations are put forward:

i. A mason and a labourer should fix a minimum of 12 windows and 10 doors per day.

ii. Contractors/project managers should exploit the output figures extracted according to productivity factors so as to optimize the productivity of their workers and profitability.

5.4 Areas for further study

The followings are areas recommended for further research work;

i. Similar study should be conducted for pointing and bedding frames as in BESMM3.
ii. A better and more scientific ways of rating workers performance should be used so as to eliminate the subjective nature of the current rating style.
iii. Similar study should be conducted considering different sizes of doors and windows.

5.5 Contributions to Knowledge

The research has shown that BESMM should be a basis for determination of the output for fixing windows and doors in the Nigerian construction industry. It has also been shown that the British outputs cannot provide a realistic basis for windows and doors estimates in the Nigerian Construction Industry due to difference in geographical locations. The study also provided that within the trade, there are different work items like bedding and pointing frames that require different output as stated in BESMM.

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APPENDIX 1:

SPECIFIC REFERENCE IN BESMM3

L1O WINDOWS/ROOF LIGHTS/SREENS/LOUVRES BASED ON BESMM3.

S/No	Description of work ITEMS	UNIT
	Sliding windows (L10.1.0.1)	
1	Approved coloured powder coated framed aluminium sliding window glazed with 5mm thick glass including pinning or building in lugs to block work or concrete, Size 1500x1200mm high	Nr
2	Ditto size 1200x1200mm high	Nr
3	Ditto size 600 x 600mm high	Nr
	Casement windows (L10.1.01)	
4	Approved coloured powder coated framed aluminium casement window glazed with 5mm thick glass including pinning or building in lugs to block work or concrete, Size 1500x1200mm high	Nr
5	Ditto size 1200 x 1200mm high	Nr
6	Ditto size 600 x 600mm high	Nr
	Projected windows (L10.1.0.1)	
7	Approved coloured powder coated framed aluminium projected window glazed with 5mm thick glass including pinning or building in lugs to block work or concrete, Size 1500x1200mm high	Nr
8	Ditto size 1200 x 1200mm high	Nr
9	Ditto size 600 x 600mm high	Nr

L20 DOORS/SHUTTERS/HATCHES BASED ON BESMM3

S/NO	DESCRIPTION OF WORK ITEMS	UNIT
	<u>Steel Doors</u> (L20.1.0.1)	
1	Purpose made steel door with frames and 5mm thick plate complete with iron mongery with and including pinning in lugs, Size 1200 x 2100mm high	Nr
2	Ditto size 900x 2100mm high	Nr
3	Ditto size 750 x 2100mm high	Nr
4	Steel door complete with frame and iron with and including pinning in lugs, Size 1200 x 2100mm high single leaf double swing	Nr
5	Ditto size 900 x 2100mm high.	Nr
6	Ditto size 7500 x 2100mm high.	Nr

APPENDIX 2: TIME STUDY SHEET FOR WINDOWS FIXING.

DEPARTMENT OF QUANTITY SURVEYING

FACULTY OF ENVIRONMENTAL DESIGN

AHMADU BELLO UNIVERSITY, ZARIA NIGERIA

TIME STUDY REPORT SHEET

STUDY 1: WINDOW FIXING

SECTION A: BACKGROUND INFORMATION

1. Date:…………………………………………. Sheet No:…………………………………
2. Project:………………………………………………………………………………………
3. Project Location:…………………………………………………………………………..
4. Window size:…………………………………………………………………………………
5. Window type:…………………………………………………………………………………
6. Gang size:…………………………………………………………………………………….

SECTION B: OPERATIVES PERSONAL INFORMATION

7. Gender: Male ( ) b. ( ) Female

8. Age: a. Below 18 years ( ) b. 187-35 years ( ) c. above 35 years ( )

9. Mode of employment: a. contract employed worker) b. negotiated worker ( ) c. daily paid worker ( )

10. Experience: a. below 1 year ( ) b. 2-5 years ( ) c. above 5 years ( )

11. Weather conditions: a. sunny ( ) b. windy ( ) c. rainy

12. Qualification of worker: a. primary certificate ( ) b. SSCE( ) c. NABTEB ( ) d. ND ( ) e. other specify…………………………………………………………………………………

Morning				Afternoon				Total observed time	Basic time	Out put		Total out put
Start time/temp	Stop time/temp	Average temperature	out put	Start/temp	Stop/temp	Average temp	out put			Morning	Afternoon	

APPENDIX 3: TIME STUDY SHEET – DOORS FIXING

DEPARTMENT OF QUANTITY SURVEYING

FACULTY OF ENVIRONMENTAL DESIGN

AHMADU BELLO UNIVERSITY, ZARIA NIGERIA

TIME STUDY REPORT SHEET

STUDY 2: DOOR FIXING

SECTION A: BACKGROUND INFORMATION

1. Date:…………………………………………… Sheet No:……………………………………
2. Project:…………………………………………………………………………………………
3. Project Location:…………………………………………………………………………..
4. Door size:……………………………………………………………………………………
5. Door type:……………………………………………………………………………………
6. Gang size:…………………………………………………………………………………….

SECTION B: OPERATIVES PERSONAL INFORMATION

7. Gender: Male ( ) b. ( ) Female

8. Age: a. Below 18 years ( ) b. 187-35 years ( ) c. above 35 years ( )

9. Mode of employment: a. contract employed worker) b. negotiated worker ( ) c. daily paid worker ( )

10. Experience: a. below 1 year ( ) b. 2-5 years ( ) c. above 5 years ( )

11. Weather conditions: a. sunny ( ) b. windy ( ) c. rainy

12. Qualification of worker: a. primary certificate ( ) b. SSCE( ) c. NABTEB ( ) d. ND ( ) e. other specify……………………………………………………………………………………

Morning				Afternoon				Total observed time	Basic time	Out put		Total out put
Start time/temp	Stop time/temp	Average temperature	out put	Start/temp	Stop/temp	Average temp	out put			Morning	Afternoon	