AN EMPIRICAL DETERMINATION OF LABOUR OUTPUT FOR WALL TILES (A CASE STUDY OF KADUNA STATE AND ABUJA)

BY

Tolani Blessing AKEREDOLU

DEPARTMENT OF QUANTITY SURVEYING
FACULTY OF ENVIRONMENTAL DESIGN
AHMADU BELLO UNIVERSITY, ZARIA NIGERIA

SEPTEMBER, 2014

AN EMPIRICAL DETERMINATION OF LABOUR OUTPUT FOR WALL TILES (A CASE STUDY OF KADUNA STATE AND ABUJA)

BY

Tolani Blessing AKEREDOLU,
PGD B.TECH(ABU ZARIA)2010
M.Sc/ENV.DES/16226/2011-2012

A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA

IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF A MASTER OF SCIENCE IN QUANTITY SURVEYING

DEPARTMENT OF QUANTITY SURVEYING, FACULTY OF ENVIRONMENTAL DESIGN, AHMADU BELLO UNIVERSITY, ZARIA NIGERIA

SEPTEMBER, 2014

DECLARATION

I declare that the work in this Project Thesis entitled "Empirical determination of labour output for wall tiles (a case study of Kaduna state and Abuja) was carried out by me in the Department of Quantity Surveying under the supervision of Dr A. D. Ibrahim and Mr Mustapha Abdulrazaq .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.

Tolani Blessing AKEREDOLU _____ _____

Signature Date

CERTIFICATION

This project thesis entitled **"AN EMPIRICAL DETERMINATION Of LABOUR OUTPUTS FOR WALL TILES (A CASE STUDY OF KADUNA STATE AND ABUJA)"** by Tolani Blessing AKEREDOLU meets the regulations governing the award of Master of Science in Quantity Surveying of the Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

Dr. A. D. Ibrahim	_____	_____
(Chairman, Supervisory Committee)	Signature	Date
Dr K. J. Adogbo	_____	_____
(Member, Supervisory Committee)	Signature	Date
Dr. Y. M. Ibrahim	_____	_____
(Head of Quantity Surveying Dept)	Signature	Date
Prof. A.Z. Hassan	_____	_____
Dean, School of Postgraduate Studies	Signature	Date

DEDICATION

Special dedication to my husband for his spiritual and financial support and encouragement to complete this course of study.

ACKNOWLEDGMENT

Praise to God Almighty who has bestowed on me the grace and enablement to complete this thesis successfully.

Firstly, I would like to convey my sincere appreciation to my supervisors, Dr A. D Ibrahim and Mr. Mustapha Abdulrazaq, for their assistance, generous advice, beneficial critics, patience and encouragement throughout the study.

I would like to take this opportunity also to express my gratitude to all my lecturers who generously spent their precious time to contribute to this work. Their contributions are really appreciated and valuable to the success to this study.

Finally, I am most thankful to my husband and my children including Christiana Lazarus for their continuous support, forbearance and encouragement given until the completion of this thesis without their support and encouragement, this thesis would not be successfully completed.

ABSTRACT

Productivity is one of the important elements in construction planning and scheduling. However, construction industries in Nigeria are currently lacking in data with regard to productivity of the building's construction activities especially in tiling works. The focus of the study was to use work study approach to empirically establish labour output for wall tiles for the Nigeria construction industry as well as to establish relationship between the influential factors and productivity. A total of 46 gang sizes of tilers for wall tiles 400mm x 300mm x 5mm, width > 300mm long side horizontal,32 gang sizes of tilers for wall skirting 400mm x 50mm high and Riser 400mm x 150mm high were observed within Kaduna state and Abuja. Physical observations and measurement of work outputs were conducted through work study approach. The data collected were analyzed using inferential data analysis techniques. The inferential tools made use of analysis of variance (ANOVA) for multiple comparison, paired sample t-test to compare two groups that are related and independent t-test to compare two group that are not related due each activities to assess and examine the influence of the various labour productivity factors on the outputs of the workers observed.. The result of the analysis carried out established general average output values per day of; 25.11m^2, 31.37m, 23.41m for wall tiles 400mm x 300mm x 5mm, width > 300mm long side horizontal with backing, wall skirting 400mm x 50mm high and riser 400mm x 150mm high ,Ceramic tile 5mm thick in tiling work respectively. However, the test of difference conducted in order to analyze and investigate the extent of influence of the productivity factor discovered that, even though differences existed between outputs for wall, skirting and riser in tiling, the tests conducted confirmed they were quite insignificant, the mode of employment of tradesman observed had a tremendous effect on their output, those on daily paid term produced more on site in their outputs. The research concluded by recommending the outputs established to Contractors so as to exploit the output figures extracted according to productivity factors in order to optimize the productivity of their workers and profitability.

TABLE OF CONTENT

LIST OF TABLE

LIST OF FIGURES

LIST OF APPENDICES

ABBREVIATION

A.N.O.V.A	Analysis of variance
ACE	Adhesive ceramic engineering
BESMM 3	Building and engineering standard method of measurement, third edition
BOQ	Bill of Quantity
B.S	British Standard
NABTEB	National business and technical examination board
NIQS	Nigeria institute of Quantity Surveyors
N.D	National Diploma
N.C.I	Nigeria construction industry
SPSS	Statistical package for social science
MCAA	Mechanical contractors association of America
SSCE	Senior Secondary Certificate Examination
SMM	Standard method of measurement
ICI	Imperial chemical industries
FCT	federal capital territory
GDP	Gross domestic product

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

A building is one of man's basic requirements after food and can be used to determine the development of any nation. Research has shown that the cost of building a house is high and principally depends on cost of labour and materials (Maloney, 1983, Omange, 2000).

Mohammed *et al* (2011) stated that the construction industry lagged due to insufficient research in the area of productivity. Methods for improving construction productivity to assist managers in identifying productivity barriers and offer solutions were limited. In contrast, there are few studies of enhanced productivity in the construction industry. In reality, increasing productivity benefits the stakeholders' in several ways: Projects are completed more quickly; Project cost is lowered; the contractor can submit more competitive bids; and the project can be more profitable.

The construction of a house is capital intensive and seems to discourage some people from building personal houses. Government concerted effort at housing provision since independence in 1960 through the various national development plans seems not successful. Labour force in the building construction industry fall into skilled and unskilled. The financial implication of using any of the trades contribute to the cost of construction. The utilization of labour force in the construction industry accounts for a significant proportion of the cost of buildings (Udegbe, 2007). Productivity improvement in the housing

construction sector may contribute to the supply of more affordable housing by Nigeria Construction Industry (NCI). A sustainable improvement in productivity, when associated with economic growth and development generates non inflationary increases in wages and salaries. As low productivity causes cost and time overruns in construction projects. Construction output is important especially in a developing country like Nigeria where most of the building construction work is still on manual basis (Faki *et al*, 2010).

Estimating is one of the key fundamental functions of the Quantity Surveyor. Estimates are very vital to clients when making decisions and therefore, client expect from estimator's useful and objective information from estimator.

The sustainability and success of the construction industry depends greatly on the level of accuracy in project estimates. The consequences of adopting inaccurate estimates are quite enormous and overwhelming (Mohammed, 2009).

1.2 Statement of the Research Problem

It is very clear that there is no known standard theoretical yardstick to determine the financial value of daily output (Udegbe, 2007).The dynamics of the factors that affect the productivity of construction workers in Nigeria are not well understood. The previous works on other trades presented reports without taking cognisance of Building and Engineering Standard Method of Measurement (BESMM) produced by Nigerian Institute of Quantity Surveyor as a guide that provide a uniform basis for measuring construction works and embodies the essentials of good practice, in order to take care of the peculiarities of the Nigerian construction industry. This study was set out to empirically determine

labour outputs for wall tiles as reviewed in BESMM in the Nigerian construction industry.

1.3 JUSTIFICATION OF THE STUDY

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 prices 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 evidence by the diverse output data collected indicates the adoption of non-uniform output in the industry, due to the importance of determining a reliable labour constants and factors influencing its reliability. The operative output constants can be used by construction estimators for planning, scheduling, estimating, controlling and management functions in building construction project.

1.4 Aim and Objectives

1.4.1 Aim

This research aims to empirically establish labour outputs for wall tiles as reviewed in BESMM in the Nigerian construction industry with the view of increasing the accuracy of construction cost estimates.

1.4.2 Objectives

i. To review the labour outputs currently in use for some selected trade.

ii. To empirically establish the labour output for wall tiles.

iii. To statistically examine the influence of labour productivity factors for wall tile on the established labour outputs.

1.5 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.

Hence, the following research hypotheses are posited in terms of workers output and productivity level:

i. **Null Hypothesis (H1o)**: There is no output difference between the various age groups observed.

   Alternate Hypothesis (H1): The ages of workers have a significant impact over their outputs on site

ii. **Null Hypothesis (H2o):** there is no output difference in all the different periods of observations.

   Alternate Hypothesis (H2): The outputs of workers vary progressively with changes in the period of work.

iii. **Null Hypothesis (H3o)**: there is no output difference in respect of the type and level of Payment to workers under observation.

   Alternate Hypothesis (H3): The level of outputs of workers depends on the type and level of payment made to them.

iv. **Null Hypothesis (H4o)**: There is no output difference between the highly experienced groups of workers and workers with low experience level.

Alternate Hypothesis (H4): The group of highly experienced workers has higher outputs than those with low work experience.

v. **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.

Alternate Hypothesis (H5): The well educated and highly qualified group of workers has higher output than those with little or no qualification.

1.6. Scope and Limitations

Scope

This research work covered the following items in wall tiles as identified in the BESMM:

i. Wall tiles 400mm x 300mm x 5mm, width > 300mm long side horizontal with backing,

ii. Wall skirting 400mm x 50mm high, ceramic tiles 5mm thick

iii. Riser 400mm x 150mm high, ceramic tiles 5mm thick

All the construction sites considered are within the Northern states.

Limitations

The following were the limitations of the study, which could affect the accuracy of the results:

i. A phenomenon whereby workers tend to improve upon their natural productivity level when being directly observed (Hawthorne effect).

ii. The difficulty in assessing whether a worker is operating in full and natural capacity or not during the period of observations.

iii. A non random probability sampling technique was used for selecting the workers considered in the research. Therefore, members of the population observed were selected with some little element of bias.

iv. A situation whereby operatives gives false information about themselves

CHAPTER TWO

LITERATURE REVIEW

2.1.0 Background

Productivity remains an intriguing subject and a dominant issue in the construction sector, promising cost savings and efficient usage of resources. Productivity is one of the most important issues in both developed and developing countries. The developed countries are aware of the importance of economic growth and social welfare. The developing countries which face unemployment problems, inflation and resource scarcity seek to utilise resources and in such a way to achieve economic growth and improve citizens' lives (Adnan *et al,* 2007).

Construction industry is the main indicator of the economic growth of the country throughout the world. Construction industry is the significant contributor in the economic growth of any country. In developed countries, the construction industry incorporates the GDP growth of 7-10% whereas in under developed countries the percentage is only 3-6% (Muqeem, 2011).

A study on productivity growth in Nigeria is important for a number of reasons. First, there is a direct linkage between productivity growth and sustained economic growth. Secondly, Nigeria's development experience shows that past growth strategy based on factor accumulation is both infeasible and sub-optimal. The economic reality facing the country today requires a shift in emphasis to factor efficiency. Finally, higher productivity is also a key to poverty reduction (Adenikinju, 2005).

Productivity growth is the foundation of improving living standards. Most of the previous studies indicated that workers on a construction project are unproductive for 50 percent of their time on site. Waiting eats up more than half of an employees' unproductive time and about one third of total project time. It can wreck a schedule and reduce the contractor's profits.

Moreover, different workers have different variables affecting their level of productivity. The most prevalent includes the following; Lack of training and retraining Poor communication , Inclement weather , Unfair wages , Lack of motivation , Negative influencing factors, Design changes, Poor specification , Late information, Out of sequence work , Recruitment of unskilled labour , Lack of investment in research and development, etc.

The production of goods and services in the most efficient manner has continued to be the only viable and reliable option for development, growth and survival of any economy. (Mohammed *et al*, 2011; Olomolaiye *et al*, 1987).

2.1.1 Productivity Defined

Many definitions have been given to productivity as cited in Mohammed (2009) believes that every good definition of productivity should contain three major elements, output, resources commitment and time.

Mohammed (2009) 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. The measure of the rate at which work is performed is called "productivity". It is a ratio of production output to what is required to produce it. John (2006) define productivity as a total output per one unit of a total input. Productivity is the average direct labour hours to install a unit of material.

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

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

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

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

Mohammed (2009) submitted that since productivity is the output resulting from a given resource input at a given time, then the followings are the productivity measures:

i. Partial measures $= \frac{\text{Output}}{\text{Labour}} = \frac{\text{Output}}{\text{Machine}} = \frac{\text{Output}}{\text{Energy}}$

ii. Multifactor measures $= \frac{\text{Output}}{\text{Labour + Machine}} + \frac{\text{Output}}{\text{Labour + Capital + energy}}$

iii. Total measures $= \frac{\text{Goods or services produced}}{\text{All inputs used to produce them}}$

Thus, evolves the following productivity sources;

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

Therefore, productivity is often defined as a relationship between output produced by a system and quantities of input factors utilized by the system to produce that output. Here, the output can be any outcome of the process, whether a product or service, while input factors consist of any human and physical resources used in a process. It follows that, in order to increase productivity, the system must either produce more or better goods from the same resources, or the same goods from fewer resources. Stated differently, productivity improvement refers to an increase in the ratio of produced goods or services in relation to resources used (Mohammed *et al*, 2011)

2.1.2 **Productivity Enhancement Measures**

Mohammed (2009) argues that in recent times, organizations strive to improve productivity by adopting several measures such as:

i. **Downsizing/Rightsizing:** This is a planned elimination of jobs, which is achieved by encouraging early retirement of employees through sweetened voluntary retirement. Workers give out their best before reaching their retirement ages.

ii. **Re-engineering:** This is about fundamental rethinking and radical re-designing of business process to achieve dramatic improvement in cost, quality, service and speed.

iii. **Total Quality Management (TQM):** These are set of principles and practices whose core ideas includes the understanding of customers needs,

doing things right at the first time and striving for continuous improvement.

Mohammed (2009) identified seven (7) steps to be taken in order to ensure the improvement of productivity as thus;

i. Developing productivity measures for all operations

ii. Analysing the system as a whole to decide which operations are most critical.

iii. Develop methods for achieving productivity improvements, such as soliciting ideas from workers.

iv. Establishing reasonable goals for improvement

v. Making it clear that management supports and encourages productivity improvement.

vi. Measuring improvement and publishing them.

vii. Do not confuse productivity with efficiency.

Productivity is the ratio of output to all or some of the resources used to produce that output

$$\text{Productivity} = \frac{\text{Output}}{\text{Resources used}}$$

Resources comprise: labour, capital, energy, raw materials etc.

The most common single factor of productivity measure is labour productivity.

$$\text{Productivity} = \frac{\text{Output}}{\text{Labour imput}}$$

Labour can be measured as:

- persons employed
- hours worked
- labour cost

Unit labour cost = $\frac{\text{Hourly compensation}}{\text{Labour productivity}}$

2.1.3 Factors Affecting Labour Productivity

Extensive work has been done by researchers to identify factors influencing the productivity of labour on construction site such as inadequate tools, lack of material ,working on high places, inspection delay, lack of motivation etc (Olomolaiye,1987; Olomolaiye *et al*, 1989; Adnan, 2007; Zohar, 1990; Mugeem, 2011; Faki *et al*, 2010; Fagbenle *et al*, 2011; Abdulrazaq *et al;* 2010) ,It is observed that factors affecting construction productivity are rarely constant and may vary from one country to another, from project to project, and even within the same project, depending on circumstances.

There are many factors that affect the productivity of labor in construction. These are generally set forth in publications or manuals made available through associations like the Mechanical Contractors Association of America (MCAA) and other organizations. For example, the MCAA has a list called Impacting Factors on Construction Crew Productivity, and this list highlights 33 factors affecting labour productivity.

Here are some of the most recognized factors affecting labour productivity in the industry:

i. **Overtime**

Scheduling of extended work days or weeks exceeding a standard eight-hour work day or 40 - hour work week lowers work output and efficiency through physical fatigue and poor mental attitude.

ii. **Morale and Attitude**

Spirit of workers based on willingness, confidence, discipline, and cheerfulness to perform work or tasks can be lowered due to a variety of issues, including increased conflicts, disputes, excessive hazards, overtime, over-inspection, multiple contract changes, disruption of work rhythm, poor site conditions, absenteeism, unkempt workspace, and so on.

iii. **Fatigue**

Fatigue can be caused by prolonged or unusual physical exertion.

iv. **Stacking of Trades**

This occurs when operations take place within physically limited space with other contractors, resulting in congestion of personnel, inability to use or locate tools conveniently, increased loss of tools, additional safety hazards, increase visitors, and prevention of crew size optimum.

v. **Joint Occupancy**

This occurs when work is scheduled utilizing the same facility or work area that must be shared or occupied by more than one craft, and not anticipated in the original bid or plan.

vi. **Beneficial Occupancy**

This is a result of working over, around, or in close proximity to other crafts, owner's personnel, or production equipment, which may cause noise limitations, dust, or other hazardous risk. This may also prevent or cause access restrictions.

vii. **Concurrent Operations**

This is the effect of adding operations to any sequence of operations that has already been planned, without a gradual and controlled implementation of additional operations.

viii. **Absenteeism and Turnover**

There is a great deal of time and money lost associated with high turnover and absenteeism on projects. Construction projects in certain areas with low manpower and high demand for labour will usually be more impacted than others. Extreme weather conditions (such as extreme heat or cold) will also increase absenteeism and turnover. Replacement workers are usually not familiar with the work or area, and require experienced workers to stop work and show them what to do.

The impact can be up to four days of lost work for each worker.

ix. **Mobilize/Demobilize**

This relates to moving resources on and moving off to projects as a result from changes or delays, causing work disruptions. Productivity may drop during these periods as time is lost when crews move from one area or work assignment to another.

x. **Errors and Omissions**

Increases in errors and omissions impact on labor productivity because changes are then usually performed on a crash basis, out of sequence, cause dilution of supervision, or any other negative impacts.

xi. **Start/Stop**

This results from a work stoppage or suspension of work, which may cause a break in the schedule, usually triggering a start/stop of work activity. Stop-starts can have an impact on productivity and cost of a project. Work scheduled or reassigned during holidays such as thanksgiving, Christmas, New Year's, and so on are often impacted with stop-starts. Workers tend to discuss the time off and lose previous momentum with a drop in productivity before they get back in routine.

xii. **Reassignment of Manpower**

When workers are reassigned, they experience unexpected or excessive changes, losses caused by move-on or move-off, reorientation, and other issues that result in a loss of productivity.

xiii. **Late Crew Build-up**

This is caused when the planned project manpower loading is altered and causes manpower loading to build up slower than planned due to availability, shortage of resources, or competition from resources. Impacts can be in excess of 10 percent.

xiv. **Crew Size Inefficiency**

This is when the optimal crew size is altered by adding or deleting crew members. When workers are added or deleted from a crew, it breaks up the original team effort and rhythm of the crew and results in loss of productivity.

xv. **Site Access**

This is a result of interferences to the convenient or planned access to work areas. This can be due to blocked stairways, roads, walkways, insufficient man-lifts, or congested work sites.

xvi. **Logistics**

Insufficient or poor material handling, owner-furnished material, procurement practices, or a lack of controls can cause procurement or delivery problems, as well as other issues. This then prevents, delays, or disrupts the normal material workflow to a work area, warehouse, or laydown yard. This can also be a result from the additional replacement or substitution of material due to contract changes, defects, or delays at the work site.

xvii. **Security Check**

This could be caused by workers entering or leaving the area, or from "brassing" in and out, toolbox checks, transport of labor to secure area, and so on.

xviii. **Learning Curve**

When crew turnover causes new workers to be added to a crew or additional manpower is needed within a crew, a period of orientation occurs in order to become familiar with changed conditions. They must then learn work scope, tool locations, work procedures, and so on.

xix. **Ripple Effect**

This is caused when changes in other trades' work then affects other work, such as the alteration of schedule.

xx. **Confined Space**

When work is in a confined space with limitations on egress and ventilation, this can result in nonproductive labor to provide hole watch, along with other issues. Time is also lost when getting to and from the work area.

xxi. **Hazardous Work Area**

This is caused when working in an area that is classified as hazardous, requiring special safety equipment and clothing. Restrictions may limit time and exposure of workers to the area, resulting in less time on tools in the area.

xxii. **Dilution of Supervision**

This occurs when supervision is diverted from productive, planned, and scheduled work to analyze and plan contract changes, expedite delayed material, manage added crews, or other changes not in the original work scope and schedule. Dilution is also caused by an increase in manpower, work areas, or project size without an increase in supervision.

xxiii. **Holidays**

If workers work on holidays, there is not only a cost factor for holiday pay, but there is usually a loss of productivity as well. It may be addressed as a morale factor since workers are away from families and working instead of enjoying the holidays, or it can also be factored separately. Either way, there is usually a productivity loss to consider.

xxiv. **Shorter Daylight Hours**

Delays can cause work to be deferred from one time period to the next, which may involve seasonal changes. Different regions and locations around the world also have different amounts of daylight hours, depending on the season.

xxv. **Weather and Season Changes**

Performing work in a change of season, temperature zone, or climate change resulting in work performed in either very hot or very cold weather, rain or snow, or other changes in temperature or climate can impact workers beyond normal conditions.

xxvi. **Rain**

Most crafts do not work in the rain, but many do, especially those who live in wet regions of the country and must work or risk losing too much in wages. Work can, and does occur in the rain, but not without inefficiencies due to rain gear, visibility, safety, morale, discomfort, hazards, and other issues.

xxvii. **Shift Work**

This is when work is performed at any time other than the first shift or the morning shift of a work day. Work on second and third shifts are less efficient and may even be based on a shorter work period. The reduced daylight hours and problems trying to pick up where the last shift left off results in less productivity.

xxviii. **Working in Operating Area**

Inefficiencies can result when work is in close proximity to operating units such as heat from boilers, smoke from emissions, explosion zones, and so on.

This can cause work stoppages, need for protective clothing, work permits, or other requirements.

xxix. **Over-manning**

This is caused when work planners hire too many workers for the estimated work scope and duration. Sometimes, when labor in certain areas or regions is scarce or hard to get, work planners may overcompensate for potential absenteeism and turnover, which creates overstaffing. Another cause is the false assumption that increased manning will always result in increased work productivity.

xxx. **Tool and Equipment Shortage**

This is caused when there is insufficient quantity or quality of tools and equipment to meet the needs of the project.

xxxi. **Area Practices**

This can be the result of added or extended coffee breaks, unique observance or custom, or other practices unique to the craft, owner, country, project location, or other customary practices in the area.

xxxii. **Proximity of Work**

This is caused by working in a remote area, proximity of tools, break areas, material laydown yard, or other resources causing a loss of time for access.

xxxiii. **Alternating, Staggered, or Rotating Work Schedules**

This usually results in unusual or unique scheduled work periods designed to optimize craft hours worked, attract labor to remote sites, compete for labor resources, and minimize fatigue.

Examples include allowing half the work force to take every other Friday off, or staggered crews of 4-12s (working on four days and then four days off), or rotating crews to work a week and then take a week off.

2.2 Work Study

2.2.1 Definition of Work Study

Work study as a generic term for 'the study of work wherever it is done'.

The British Standards Institute Glossary of terms used in Management Services (BS3138 - 1992) defines 'Work Study' as systematic examination of activities in order to improve the effective use of human and other resources

2.2.2 Aims of Work Study

According to Barnes (1980) as cited in Mohammed (2009) 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.

2.2.3 **Objectives of Work Study**

The objectives of every work study as pointed out by Ajia (2002) in Mohammed (2009) 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.

2.2.4 **Benefits of Work Study**

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

Better job satisfaction for employees

2.2.5 Work Study Techniques

The predominating techniques in the Work Study Practitioner's portfolio are

i. Method Study

ii. Work Measurement

2.3 Method Study

Definition

According to the British Standards Institute BS3138, 1992, *Glossary of terms used in Management Services,* Term 11007, method study is "The systematic recording and critical examination of ways of doing things in order to make improvements".

2.3.1 Purposes of Method Study

The aim of method study is to analyse a situation, examine the objectives of the situation and then to synthesize an improved, more efficient and effective method or system.

2.3.2 Method Study procedure

The basic procedure was first developed and articulated by Russell Currie at Imperial Chemical Industries (ICI) and consists of six steps (**SREDIM**):

i. SELECT the work or area to be studied.

ii. RECORD all appropriate and relevant data about the current situation.

iii. EXAMINE critically, the recorded data.

iv. DEVELOP alternative approaches to making improvements and choose the most appropriate.

v. INSTALL the new method, to make the required changes to the situation.

vi. MAINTAIN that new situation.

method study procedure is thus a convenient representation of what may be a complex process.

2.4 Work Measurement

Work Measurement is defined in BS 3138 (1992) as a term which covers several different ways of finding out how long a job or part of a job should take to complete. It can be defined as the systematic determination, through the use of various techniques, of the amount of effective physical and mental work in terms of *work units* in a specified task. The work units usually are given in standard minutes or standard hours.

2.4.1 Purpose of Work Measurement

i. planning the work of a workforce,

ii. manning jobs, to decide how many workers it would need to complete certain jobs,

iii. scheduling the tasks allocated to people

iv. costing the work for estimating contract prices and costing the labour content in general

v. calculating the efficiency or productivity of workers - and from this:

vi. providing fair returns on possible *incentive bonus* payment schemes.

According to Butler (1970) in Mohammed (2009) the simple general procedure for work measurement can be presented as shown in Figure 1.

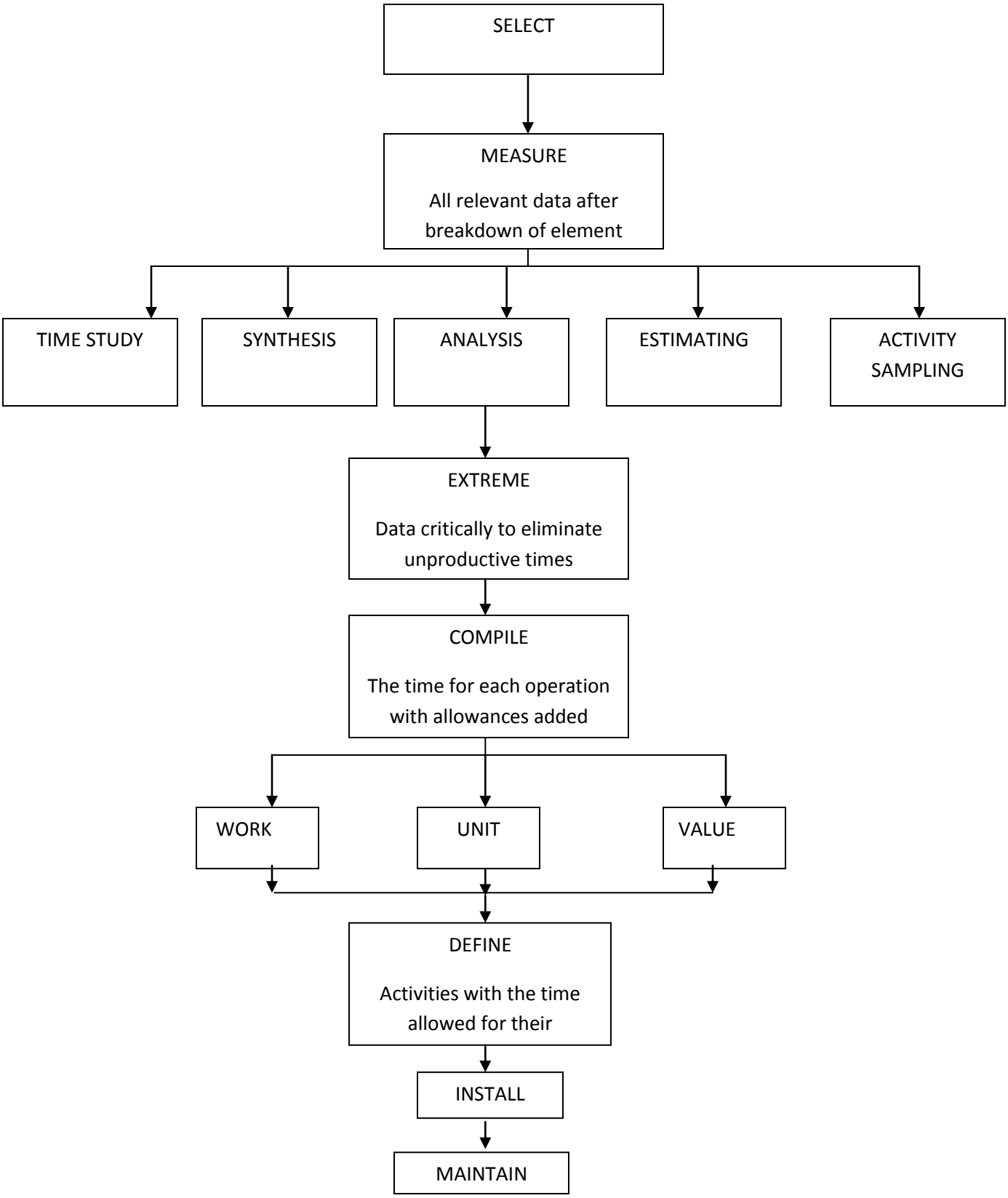

Figure 1: General procedure for work measurement

Source: Butler (2009)

However Cole (1996) in Mohammed (2009) in his book management theory described work measurement procedure using the model shown in fig. 2 below.

AIM: To measure, or assess, the performance of people

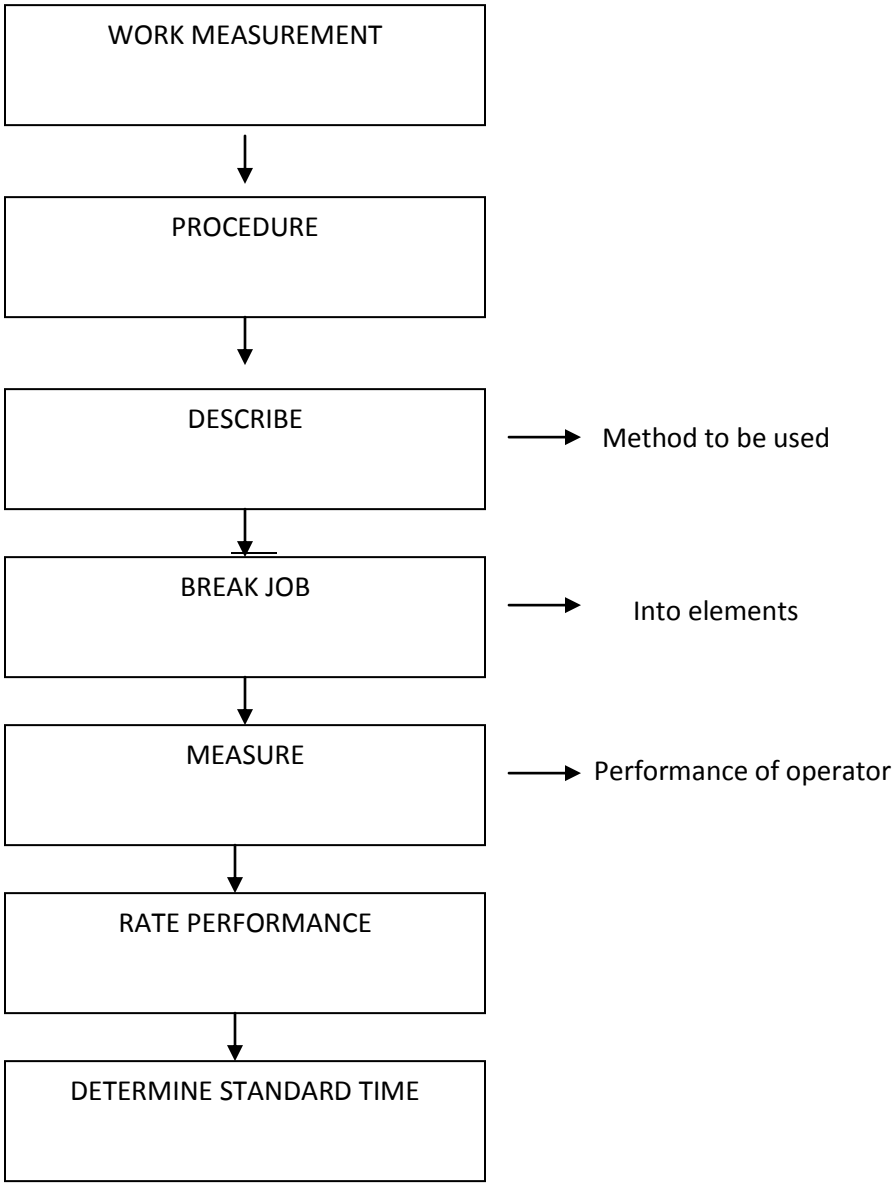

Figure 2: Work Measurement Outline

Source: Cole (1996)

Moreover, Culvert (1981) in Mohammed (2009) outlined five (5) steps as the general procedure of work measurement;

a. Select the work to be measured
b. Define the method being used and the job elements
c. Measure the quantity of work and assess the rating
d. Calculate the standard time including allowances
e. Compile and issue the allowed time with a job specification.

2.4.2 **Uses of Work Measurement**

Work measurement has been used successful in construction sites as it is very common to industrial activities (Altine, 1988). The university of Leeds (1983) working paper on work measurement, states the following as uses of work measurement:

i. To establish the most effective way of carrying out a particular operation. To be able to determine the relative efficiency and timing of alternative methods, also an aid to standardization of methods.
ii. To be able to set equitable standards of performance for labour and plant; also to provide information on which to base fair and realistic incentive schemes.
iii. To investigate, reduce and ultimately eliminate effective time.
iv. To provide elemental data for training local operatives.
v. To provide data for job departmental estimates and a basis for budgeting control.

vi. To provide reliable data for preparing schedules and programmes of operations for major items of maintenance works.

vii. To determine gang size, type of plants and material testing.

2.4.3 Work Measurement Techniques

PREDETERMINED MOTION TIME SYSTEMS (PMTS)

The British Standard Institute Glossary of terms used in Management Services available on manager-net.com stated, At the "precision" end of the scale is a group of methods known as predetermined motion time systems that use measurement units in ten thousandths (0.0001) of a minute or hundred-thousandths of an hour (0.00001 hour).

The resulting standard times can be used directly, for very short-cycle work of around one minute total duration such as small assembly work. However, they often are used to generate regularly used basic tasks such using assembling or disassembling nuts and bolts, using a screwdriver and similar. Tasks of this type are filed as standard or synthetic data-banks.

Estimating

This can exist in three main forms.

a. *Analytical estimating* relies on the experience and judgement of the estimator. It is just of case of weighing up the work content and, using this experience, stating a probable time for completion, such as "this job will take about eight days to complete".

b. *Category estimating.* This is a form of range estimating and requires a knowledge of the work. Estimators may not feel comfortable with overall,

analytical estimates upon which may depend the outlay of a great deal of money. They often prefer giving a range estimate such as "this job should take between 12 weeks and 14 weeks to complete", which provides a safety net should things go wrong. Such ranges are not just picked upon at random but are statistically calculated and based on probability theory.

c. *Comparative estimating.* This is another example of range estimating. Again, estimators rely on experience of the work in order to produce estimates. This experience can be augmented by the provision of each time-range with a few typical, descriptive, jobs that would guide estimators to the most appropriate range. The estimator would compare the work to be estimated with those in the various ranges until the most appropriate fit is found.

Timing

The intermediate method between the two groups above, is *timing* the work in some way, usually with a stop-watch or computerised electronic study board. This method is retrospective in that the job must be seen in action in order to be timed whereas the other methods are prospective and can be used for timing jobs before they start.

The observer times each element of the work and obtains times that the observed operator takes to do the elements. Each timing is *adjusted* (rated) by the pace at which the operator was working as assessed by the observer. This produces basic times for the elements and hence the whole job, which are independent of the operator and can be used as the time for a trained, experienced worker to carry out the same elements.

Rated activity sampling

This is a method based on the observer making snap observations at random or systematic sample times, observing what the operator is (or operators are) doing at the times of those observations.

Models*:*

A most useful method for standard or synthetic data-banks of job or element times is using computer models of the jobs. These are generated as mathematical formulae in which the observed data are inserted to compile a time for completion of the task or project. It is a useful method for recycling time standards for elements of basic work over and over again, only changing the values of the variables to suit each project.

2.5 Time Study

Time study is a tried and tested method of work measurement for setting *basic times* and hence *standard times* for carrying out specified work.

2.5.1 Aims of Time study

The aim of time study is to establish a time for a qualified worker to perform specified work under stated conditions and at a defined rate of working.

This is achieved by a qualified practitioner observing the work, recording what is done and then *timing* (using a time measuring device) and simultaneously rating (assessing) the pace of working.

The requirements for taking a time study are quite strict.

2.5.2 Time study Conditions:

i. The practitioner (observer) must be fully qualified to carry out Time Study,

ii. The person performing the task must be fully trained and experienced in the work,

iii. The work must be clearly defined and the method of doing the work must be effective

iv. The working conditions must be clearly defined

2.5.3 Time Study Terminology and Concepts

There are two main essentials for establishing a basic time for specified work i.e. rating and timing.

Timing

The observer records the actual time taken to do the element or operation. This usually is in centiminutes (0.01 min.) and is recorded, using a stop-watch or computerized study board.

Rating

This is due to differing speeds of movement, effort, dexterity and consistency. Thus, the time taken for one person to do the work may not be the same as that for others and may or may not be 'reasonable' anyway.

The purpose of rating is to adjust the *actual time* to a standardized *basic time* that is appropriate and at a defined level of performance. Rating is a term used in work measurement to assess the speed and effort put into a job of work by the worker. The British Standard Institute definition of the verb “to rate” is:

To assess the worker’s rate of working relative to the observer’s concept of the rate corresponding to standard rating. The observer may take into account, separately or in combination, one or more factors necessary to the carrying out of

the task, e.g. speed of movement, effort, dexterity, consistency. (BS Term, 22056 in management services*).*

The Concept

In order to determine the time necessary to carry out a task or job it is not sufficient just to assess this by timing with a chronometer a worker carrying out the task or even estimating it. The worker might be working slowly or "extra quickly". These are vague terms but neither would be satisfactory for the purposes of obtaining some sort of "standard time" for the job. What is needed is a time the "average", trained, qualified worker would take to do the job.

This concept of the "average rate" at which the qualified worker would work is a very subjective one - it is a matter of opinion.

In essence, we do not want a time for doing a job quickly or slowly. We need a standard time for the job and *not* a time for any individual worker.

The solution is to assess the time actually taken by a qualified worker who knows the job and is properly trained to do it and then adjust this *actual* time to what it would have been had that worker been working at the standard rate. Thus, rating eliminates the need to search for that mythical standard worker and takes out of the equation the need for that worker to adjust his/her pace to the standard rate of working, something which is difficult to do.

So, to quote the BSI standard 3138 "Glossary of Terms used in Management Services" Term number 22074, standard rating is defined as

The average rate at which qualified workers will work, provided they adhere to the specified method, and are motivated, suited and accustomed to the task.

Elements

A complete job usually will be too long and variable to time and rate in one go, so it would be analysed into several smaller parts (*elements*) which, separately, will each be timed and rated.

Basic time

This is the standardized time for carrying out an element of work at standard rating.

Allowances

Extra time is allowed for various conditions which obtain, the main ones being *relaxation allowance* for:

A. recovery from the effort of carrying out specified work under specified conditions (*fatigue allowance*)
B. attention to personal needs
C. adverse environmental conditions, *plus:*
D. others concerned with machine operations

Frequency

The basic time is the time for a complete cycle to be performed but as not all elements are repeated in every cycle their times *per average cycle* must be *pro rata*. In the example which follows, element 2 only occurs once every eight cycles

so its basic time is one eighth of the element time, per cycle. Similar treatment for other element

Standard time:

Basic time + allowances.

2.6 EXTRACT OF CERAMIC TILE WORK ITEMS

Building and Engineering Standard Method of Measurement (BESMM) produced by the Nigerian Institute of Quantity Surveyor is a guide that provide a uniform basis for measuring construction works and embodies the essentials of good practice, in order to take care of the peculiarities of the Nigerian construction industry.

BESMM M40-Stone/Concrete/Quarry/Ceramic Tiling/Mosaic
The extracted items indicated below are possible and work related items to ceramic tiling.

S/No	Location	Classification	Unit
1.	Walls	Plain width > 300mm patterned details stated	m^2
		Plain width > 300mm, tiles with long side horizontal	m^2
		Plain width $\leq$ 300mm patterned details stated	m
		Plain width $\leq$ 300mm, tiles with long side horizontal	m
		Work with joints laid out to detail, width > 300mm, patterned stated	m^2
		Work with joints laid out to detail, tiles with long side horizontal width > 300mm	m^2
		Work with joints laid out to detail, width $\leq$ 300mm, patterned stated	m
		Work with joints laid out to detail, width $\leq$ 300mm, tiles with long side horizontal	m
2.	Ceilings	Plain width > 300mm, square tile patterned details stated	m^2
		Plain width > 300mm, rectangular tile	m^2
		Plain width $\leq$ 300mm patterned details stated	m
		Plain width $\leq$ 300mm, tiles with long side horizontal	m
		Work with joints laid out to detail, width > 300mm, patterned stated	m^2

		Work with joints laid out to detail, tiles with long side horizontal width > 300mm	m^2
		Work with joints laid out to detail, width $\leq$ 300mm, patterned stated	m
		Work with joints laid out to detail, width $\leq$ 300mm, tiles with long side horizontal	m
3.	Isolated beams	Plain width > 300mm patterned details stated	m^2
		Plain width > 300mm, tiles with long side horizontal	m^2
		Plain width $\leq$ 300mm patterned details stated	m
		Plain width $\leq$ 300mm, tiles with long side horizontal	m
		Work with joints laid out to detail, width > 300mm, patterned stated	m^2
		Work with joints laid out to detail, tiles with long side horizontal width > 300mm	m^2
		Work with joints laid out to detail, width $\leq$ 300mm, patterned stated	m
		Work with joints laid out to detail, width $\leq$ 300mm, tiles with long side horizontal	m
4.	Isolated column	Plain width > 300mm patterned details stated	m^2
		Plain width > 300mm, tiles with long side horizontal	m^2
		Plain width $\leq$ 300mm patterned details stated	m
		Plain width $\leq$ 300mm, tiles with long side horizontal	m
		Work with joints laid out to detail, width > 300mm, patterned stated	m^2
		Work with joints laid out to detail, tiles with long side horizontal width > 300mm	m^2
		Work with joints laid out to detail, width,$\leq$ 300mm, patterned stated	m
		Work with joints laid out to detail, width,$\leq$ 300mm, tiles with long side horizontal	m
5.	Floors	Level or to falls only $\leq 15^0$ from horizontal, plain and patterned stated.	m^2
		Level or to falls only $\leq 15^0$ from horizontal, plain floors laid on bays	m^2
		Level or to falls only $\leq 15^0$ from horizontal plain with inserts	m^2
		Level or to falls only $\leq 15^0$ from horizontal work with joints laid out to detail, patterned stated	m^2
		Level or to falls only $\leq 15^0$ from horizontal work with joints laid out in details, floors laid in bays	m^2
		Level or to falls only $\leq 15^0$ from horizontal work with joints laid out in detail with inserts	m^2
		To falls and cross falls and to slopes $\leq 15^0$ from horizontal, plain and patterned stated	m^2
		To falls and cross falls and to slopes $\leq 15^0$ from horizontal, plain floors laid in bays	m^2

		To falls and cross falls and to slopes $\leq 15^0$ from horizontal plain with inserts	m^2
		To falls and cross falls and to slopes $\leq 15^0$ from horizontal, work with joints laid out to details, pattern stated.	m^2
		To falls and cross falls and to slopes $\leq 15^0$ from horizontal work with joints laid out to details, pattern stated.	m^2
		To falls and cross falls and to slopes $\leq 15^0$ from horizontal, work with joints laid out in detail with inserts	m^2
		To slopes $> 15^0$ with horizontal, plain and pattern stated	m^2
		To slopes $> 15^0$ from horizontal, plain floors laid in bays	m^2
		To slopes $> 15^0$ from horizontal, plain with inserts	m^2
		To slopes $> 15^0$ from horizontal, work with joints laid out to details, pattern stated	m^2
		To slopes $> 15^0$ from horizontal, work with joints and floor laid in bay	m^2
		To slopes $> 15^0$ from horizontal, work with joints with inserts	m^2
6.	Treads	Width stated	m
7.	Sills	Width stated	m
8.	Risers	Plain, height stated	m
		Undercuts, heights stated	
9.	Strings		
10.	Aprons		
11.	Lining to channels	Horizontal girth on face stated	m
		To falls firth on face stated	m
12.	Skirtings	Height and pattern stated	m
		Height and insert	m
		Height and flush	m
		Height and raking	m
13.	Kerbs	Height and width and pattern stated	m
		Height, width with insert state	m
14.	Corner pieces	Dimension description	m
15.	Items extra cover the work in which they occur	Specials tiles	m
		Special slab	m
		Special block	m
		Access panels	m
16.	Accessories	Separating membranes, thickness stated	m^2
		Movement joints	m
		Cover strips	m
		Dividing strips	m
		Ornaments, in insitu	nr
		Ornaments in precast	nr

2.7 Ceramic Tiles

Ceramis tiles are similar to quarry tiles which are produced from refined natural clays, which are pressed after grinding and tempering into the desired shape before being fired at a high temperature. ceramic tiles ,being denser than quarry tiles are made as smaller and thinner units ranging from 50mm by 50mm to 300mm by 300mm in thickness of 9.5 - 13mm (BS 6431)

Ceramic tiling has a long history as an inner and outer building coating, mainly because of its versatility in terms of colour, dimension and texture. Adhesive ceramic tiling systems (ACT) have advanced significantly lately, due to stechnological innovations in the ceramic tiles and laying materials industry. Simultaneously, the range of applications where this cladding is used has grown. (Silvester *et al* , 2011).

2.7.1 Advantages of tiles

If the tiling keeps its expected performance during its life-time, many advantages arise when comparing tiling with other finishing systems. The most important advantages are:

i. Aesthetics,
ii. Geometric facility of the composition,
iii. Cleanability,
iv. Improved damp resistance,
v. General performances,
vi. Economic value, and
vii. Durability

Quality control of application is essential to the performance and durability of ceramic tiling. It involves design constructability evaluation and fulfillment of techniques and material use before, during and after the application process (Jonas, 2000)

Workmanship needs training according to the method specified in the design. Most projects involve particular techniques and therefore specific training is required. Tools are an important part of the application method and their correct utilization depends also on training. The trowel is the most important tool in ceramic tiling but mixers and brushes play an important role too. Adhesives and grouts must be mechanically mixed and joint grouting requires previous accurate cleaning. The height and shape of the teeth are important parameters for the adequate selection of the trowel

2.7.2 **Tools Used for Tilling**

i. Trowel
ii. Cutting machine
iii. Mallet
iv. Chisel
v. Plum rule
vi. Brushes
vii. Duster
viii. Tread
ix. Head pan
x. Shovel

2.8 Review of Related Works on Determination of Labour Outputs

Extensive search was made on previous work on this area, conducted by different researchers at diverse locations but none was in compliances with the BESMM. The researches are as follows:

i. Labour Output on Roof caccasing, Roof covering and Painting (Shuaibu,2010)

ii. Labour output on plastering work by Udegbe. M.I (2005)

iii. Labour output on block laying, plastering/rendering and excavation by (Muhammad, 2010)

iv. Labour output on sanitary fittings, plaster of paris and pvc ceiling (Sambo, 2010)

v. Labour output on cement sand screed and Terrazzo tile (Gide, 2011).

vi. Determination of labour output for door and window glazing in the Nigerian construction industry: a case study of Kano State (Hassan, 2011).

vii. Determination of labour output on glazing activity and electrical wiring (Saheed, 2010).

viii. Determination of labour output for concrete mixing, transporting and placing (Dallah 2011).

ix. Determination of labour output for door and window fitting (Momoh, 2011).

x. Determination of labour output for laying interlocking tiles in the Nigerian construction company (Kabir, 2012).

xi. Determination of labour output for suspended gypsum a costic ceiling (Garba, 2012)

xii. Determination of labour output for concrete work, form work and reinforcement (Abba, 2010)

xiii. Determination of labour output for concrete work for the Nigerian construction industry (Nadabo, 2010).

xiv. Determination of labour output for tilling work(Aliyu, 2010)

Shuai'bu (2009) conducted a research appraising labour outputs and workers productivity on site. The research uses physical observations of 15 construction sites selected within Kaduna metropolis. The operations observed were Roof caccassing, Roof covering and painting. Work measurement technique was used for the physical observations carried out. Standard time study sheets were prepared and used to collecting relevant data. Work operations were broken into elements and each element was observed and time was recorded. The aggregate observed time was used to determine the basic and standard times of the operations. These quantities were subjected to descriptive statistical analysis. The results obtained from the analysis gave a general output values per day of 80.99m, 302.23m^2 and 73.04m^2 to roof carpentry, roof sheeting and painting respectively. These output values were established with consideration to the effect factors affecting productivity on site that include gender, age, qualification, work experience, payment method. This implies that the outputs can only be realized with the maximization of the above conditions. Based on these findings , the researcher recommended that:A Gang of 4-5 labourers working on roof carpentry should on average achieve 81 meters of woodwork in a day. A gang of

2 labourers working on roof sheeting and painting should have an average output of 302.2m^2 and 73m^2 outputs.

Muhammad (2009) conducted an extensive research on appraising labour outputs and workers productivity on site. The researcher uses a descriptive form of research design and collected data, analysed, described and interpreted the existing conditions regarding the productivity of workers on site. It involves the survey of 15 construction sites with various tradesmen on work. The operations observed were block work, plastering/rendering and excavation work. Physical observations and measurement of work outputs were conducted through work study approach, particularly work measurement. Data collected were subjected to statistical analysis using both the descriptive and inferential data analysis techniques. The inferential tools made use of T-test statistics to assess and examine the influence of the various labour productivity factors on the outputs of the workers observed. The results of the analysis carried out established general average output values per day of; 10.68m^2 30.85m^2 and 19.04m^3 for block laying, plastering/rendering and excavating trenches i.e. 1.50m deep respectively.

Udegbe (2005) conducted a 10 years extensive quantitative research on the trends and patterns of the productivity level of plasterers. The research covered all the 18 local governments of Edo State. Accurate work measurement technique method was used in establishing all the outputs used for the study. The work measurement was based on kind of work, skill of worker, working tools, experience, locations of site, and condition of service and time of work. Activity sheets were prepared and timing was carried out by the use of stopwatch. The

start and finish times for different activities were recorded and the corresponding output noted. The difference between the start and finish times represented the duration for the activity.

The researcher further 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 as shown on Table 2.1 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%.

Udegbe (2007) discussed on the output of painting, where he said that no matter the output of the painters', since there is no standard of payment, the client pays how much he feels should be paid, also talked of the factors that affect labour output. however, said that leadership affects both the productivity and quality of work.

Gide (2011) conducted an extensive quantitative research on the trends and patterns of the productivity level of terrazzo and cement and sand screed. stated that the sustainability and success of the construction industry depends greatly on the level of accuracy in project estimates. The consequences of adopting inaccurate estimates are quite enormous and overwhelming. This research was conducted work to empirically establish labour outputs for sceeded bed and Terrazoo Tile for the Nigerian construction industry with the view of

increasing the accuracy of construction cost estimates. A total of 37 Construction sites were sampled within Katsina State.

The results of the analysis carried out established general average output values per day of; 33.38m^2 and 30.45m^2 for cement sand screeding, and terrazzo flooring, respectively.

Nadabo (2010) stated that: the need of improving the accuracy of cost estimate in Nigeria today has been a topical issue. The used of British originated output in generating cost estimates have proven to be in ineffective affecting the overall accuracy of the estimates. Some few researchers conducted in some trades reported a very wide variation between locally established outputs and the British outputs. Thus, this research work conducts an empirical determination of labour output on concrete operations; concrete in foundation and concrete in over sites. The study was carried out within the Kaduna metropolitan area covering a total number of 15 construction sites. A time study sheet was use to collect outputs of workers observed, and also the background information meant to capture the productivity factors affecting the workers. The results of the survey shows that a gang size of 25 labourers in casting over site concrete should be able to cast 32.41m3 of concrete per day. Similarly, a gang size of 10 labourers should be able to cast 19.79m3 per day under average working conditions. However, the test of differences carried out reveied that as the productivity factors are improved, the output of the workers virtually increases.

Abba (2010) carried out a similar research on concrete work, form work and reinforcement and ascertained that for all construction projects, small or

large, heavy construction work or light construction works, it is necessary to know the probable cost which can only be known by estimating. A total of 14 construction site were sampled within Zaria and Kaduna city. Data collected were subjected to statistical analysis using both the descriptive and inferencial data analysis techniques. The inferencial tools made use of the Analysis of Variance (ANOVA) to assess and examine the influence of the various labour productivity factors on the outputs of the workers observed. The results of the analysis carried out established general average output values per day of; 153.97m, 30.91m 2,446.96kg for Formwork to sides of slabs and beams and to columns and also reinforcement work. However, the analysis of variance test conducted in order to analyze and investigate the extent of influence of the productivity factors discovered that the result revealed that, in all the trade considered in this research age has significant difference on the output of workers on site. There will be no output difference between highly experienced workers and those with little experience. After collecting and analyzing the data collected it was observed that, experience plays a significant role in the output of workers on site in all the trades except for concreting where it does not play any significant role. The method and level of payment is not a determinant factor of workers output on site. The group of highly qualified workers has higher outputs than those with little or no qualification. Therefore, it can be concluded that qualification of workers do not have a significant difference on their output on site.

Abdullahi (2011) stated that it has been shown that inaccurate project cost estimates have serious negative effects on the success of Construction projects.

And more than half of Construction projects exceed their initial cost estimates with overwhelming consequences such as hardship, conflict, quality problems and financial pressures resulting. The high degree of inaccuracy in the bill of quantities produced by Quantity Surveyors in Nigeria is attributed to the uncertainty of the labour constants used in pricing labour costs which are mostly British-based. Geographical factors do affect the productivity of workers hence the accuracy of cost estimates produced by Quantity Surveyors in Nigeria is questioned. In order to enhance the accuracy of the cost estimates, The researcher further carried out an extensive research work reporting the results of an empirical investigation based on the work study techniques, to determine workers outputs on: door and window glazing. Samples of 77 gangs from 17 construction sites within the Kano state that were considered for the study. The results of the data analysis established outputs/day/gang of 58.49m^2 for door glazing and window glazing. In addition, productivity factors were considered in relation to the outputs. The result of the data analysis revealed a positive relationship between all the productivity factors and the workers outputs indicating that any change in the factors affects the output level of workers under observation. That is to say as factors are improved, the productivity level of workers is also improved.

Garba (2012) also emphasis that the success of the industry depends greatly on the level of accuracy in project estimates. The consequences of adopting inaccurate estimates are quite enormous and overwhelming. The researcher also used work study approach to empirically establish labour outputs for fixing suspended gypsum acoustic ceiling and hard board ceiling for the

Nigerian construction industry with the view of increasing the accuracy of construction cost estimates. A total of 33 construction sites were sampled within Zaria. Physical observations and measurement of work outputs on suspended gypsum acoustic ceiling fixing and hard board ceiling fixing were conducted through work study approach, particularly work measurement. Data collected were subjected to statistical analysis using the descriptive data analysis techniques. The results of the analysis carried out established general average output values per day of; 118.5m^2 and 119m^2 respectively. Similarly, even though differences existed between outputs in suspended gypsum acoustic ceiling fixing and hard board ceiling fixing operations, the tests conducted confirmed that they were quite insignificant. The level and length of experience of tradesmen observed had a tremendous effect on their outputs. Also, those on negotiation term on site produced more in their outputs.

Kabir (2012) also ascertained that the sustainability and success of the construction industry depends greatly on the level of accuracy in project estimates. The consequences of adopting inaccurate estimates are quite enormous and overwhelming. The research presented the findings on a study to determine the daily productivity of mason on a building site in Zaria taking into consideration hammer and double T type of interlocking tiles, working under normal condition and considering all the operation involved in laying the tiles, i.e Leveling of the ground surface, spreading of the sand and laying of the interlocking tiles. The research involved field observation of 20 construction sites sampled within A.B.U and Zaria town. The results of the analysis carried out

established general average output value per day of 81.01m^2 for laying interlocking tiles by 2 skilled and 1unskilled labour.

In order to enhance the accuracy of the cost estimates, this research work reports the results of an empirical investigation based on the work study techniques, to determine workers outputs on: polyvinyl chloride ceiling finishing, plaster of paris ceiling finishing and the fixing of sanitary appliances. A sample of 77 gangs from 17 construction sites within the Kaduna Metropolitan city and Zaria were considered for the study. The results of the data analysis established outputs/day/gang of 58.49m^2 for polyvinyl chloride ceiling finishing, 6.36m^2 for plaster of paris ceiling finishing, 7.85nr for water closet, 11.52nr for bath, 8.77nr for wash hand basin and 8.50nr for sink.

In addition, productivity factors were also considered in relation to the outputs. This was to understand the dynamics of the factors in relation to productivity level of Kaduna state workers considering the areas of work. The result of the data analysis revealed a positive relationship between all the productivity factors and the workers' outputs indicating that any change in the factors affects the output level of workers under observation. That is to say as factors are improved, the productivity level of workers is also improved. (Sambo , 2010)

Momoh (2011) also stated that high degree of inaccuracy in the bill of quantities produced by Quantity Surveyors in Nigeria is attributed to the uncertainty of the labour constants used in pricing labour costs which are mostly British-based. The study reports the results of an empirical investigation based on

the work study techniques, to determine workers outputs on: doors and windows fixing. A sample of 93 gangs from 11 construction sites within the Kaduna Metropolitan city and Zaria were considered for the study. The results of the data analysis established outputs/day/gang of 3nr doors and 5nr windows. In addition, productivity factors were considered in relation to the outputs. The result of the data analysis revealed a positive relationship between all the productivity factors and the workers' outputs indicating that any change in the factors affects the output level of workers under observation. That is to say as factors are improved, the productivity level of workers is also improved.

Saheed (2010) states that the financial implications of using any of the labour force in the construction industry accounts for a significant proportion of the cost of building. Using work study approach to empirically establish labour outputs on glazing activity and electrical wiring for Nigeria construction industry with the view of increasing the accuracy of construction cost estimate also looked at the factors that affect the output of the selected trade, he conducted that average glazier should fix a minimum of 13 (900 x 900) size windows, 12 (1200 x 1200) size windows daily and an average electrician should lay a minimum of 223 meters of cable daily.

The major element of success of the construction industry is the accuracy in construction project estimates. The Nigerian construction industry lacks the uniformity of estimation basis especially in labour output which is a vital ingredient in project cost estimation. This research established the labour output for tiling trade for the Nigerian construction industry. A sample of 120 work men

were observed in floor tiling, wall tiling and skirting works comprising of 60 gangs of a tiler and a labour in each setting from 18 construction sites within Zaria, Jaji, Hunkuyi and Kaduna metropolitan city. The general average output of a gange per day was obtained from the analyses as: 18.55m^2, 12.60m^2 and 133.11m in floor tiling, wall tiling and skirting length respectively. The negotiation level of payment was observed throughout the study. Working period as well as tools availability and functionality were found to have influence on the workers' output (Aliyu, 2010).

Research works conducted by Abdulrazaq' et al (2010) established quantitative labour output constants in trades such as block work, plaster work, trench excavation, tiling work, plaster of Paris (POP) ceiling finishes, concrete work among others. It clearly showed that the labour output in practice are at sharp variance with the empirical outputs established and strongly demands similar studies in all the building trades. Hence, this study reports the results of a similar empirical investigation based on work study techniques, to determine workers outputs on formwork to sides of columns and slabs, and formwork to soffits of slabs and beams. A sample of 66 workmen from 15 construction sites within Zaria and the Kaduna metropolitan city considered for the study. The results of the data analysis established outputs per gang of: 153.97m for formwork to sides of columns and slabs and 30.91m^2 for formwork to soffits of slabs and beams.

CHAPTER THREE

RESEARCH METHOD

3.1 Introduction

Mohammed (2009) described a research process to involve any of the followings:

i. Research as a careful search/investigation.

ii. Research as a contribution to knowledge.

iii. Research as a learning process.

This means that a research process is a learning process considered as a voyage of discovery that makes an original contribution (incremental) to knowledge.

This chapter described the activities taken place in this research and shall include the following:

i. Research design/Approach

ii. Area of study

iii. Study population

iv. Sample and sampling techniques

v. Instrument used for data collection

vi. The validation and reliability of the instruments used

vii. Method of data collection

viii. Research procedures and

ix. Statistical analysis of the data

3.2 Research Design/ Approach

The research design for this study is a inferencial form of research design aimed at collecting data for the purpose of describing and interpreting the existing conditions regarding the productivity of workers on site. This research design method is being adopted for this study due to the nature of the research being purely "quantitative" developed to study the natural phenomena of the productivity level of construction labourers and tradesmen.

Therefore, absolute numerical quantitative data values were collected and collated given to the Analyst who statistically analyzed then the interpretation and conclusions was done by the researcher.

3.2 Area of Study

This research work was carried out within Kaduna state and Abuja (FCT) in Nigeria. Data sets were collected only from on-going construction projects of the geographical location for the purpose of the study.

3.3 Study Population

The population 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. The research also captured the distribution, gender, educational background, and all other relevant information of the population of interest.

3.4 Research Sample and Sampling Techniques

A non-probability sampling method known as *purposive sampling* was strategically employed in selecting all the construction sites of the study. All the sites were selected on the basis of availability i.e. those willing to give access of their sites and construction workers to be observed. The sample characteristics were fully captured as the true representation of the study population (construction sites).

From construction site, the operations and the activities of tilers were fully observed and studied accordingly. The tiling works were of these locations:

i. Walls

ii. Skirting

iii. Risers

a. Instrument for Data Gathering

A well structured "*Time study sheet*" was prepared for data gathering. The time study sheet was divided into three different sections; A, B, C. Section A compiled data on the general information of the project and tradesmen under observation. Section B consists of a structured closed ended questionnaire designed to capture all relevant background information relating to the operative and work in progress. This background information was 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. The five different influencing productivity factors observed were:

i. Age of workers: This was aimed at determining the impact of age group on the labour output. The three categories of age groups are:

- Age group below 19 years
- Age group range from 29 – 39 years
- Age group, above 39 years

ii. Working condition: Three variable were considered sunny, rainy and winding days. However, through out the period of study it was sunny. According to Onwusonye (2006) and Ayeni (1997) inclement weather is allowed approximately 8 and 6% respectively.

iii. Qualification of workers: The study meant to observe if educational qualification has significant impact on labour productivity. The six classes of educational qualification of workers observed are:

- Primary certificate
- S.S.C.E
- NABTEB
- Diploma (ND) (that related to building construction)
- Others (other qualification apart from those mentioned above)

iv. Mode of employment: The study meant to observe the influence of categories of engagement on productivity of workers. The three categories of workers considered were:

- Contract employed workers: those enjoyed certain incentives and job security such as annual leaves, medical allowance, transport and housing allowances, maternity leaves etc. as recommended by NJIC, and this

category of workers receives full wages even when there are disruptions such as inclement weather, force majeure, perils etc.

- Negotiated workers: this category of workers has no time regulation. They start or stop operation at any time they desire.
- Daily paid workers: This category of workers receives their wages according to the surface areas covered at the end of the day work as agree by their employer

v. Experience of workers: The study also aimed at observing the influence of experience on productivity of workers. Four categories of years of experience were observed.

- Operatives, below 1 year.
- Operatives, ranges from 2 to 5 years
- Operatives, ranges from 6 to 10 years
- Operatives, above 11 years

Section C constitutes the work measurement aspect of the data collection process. It recorded the starting, stop, and the actual time expended in the delivery of an operation. Total output/unit time observed was also collected at the different periods of the study.

3.5 Methods of Data Collection

Two different data sets were collected for the purpose of this research work through the following methods;

i. Literature search

ii. Field survey

3.5.1 Literature Review

In that regards, a thorough and extensive literature search of both primary and secondary sources was conducted purposely to collect relevant theory and information about labour productivity on construction sites. Similar research works conducted on output and productivity studies were reviewed. Also factors affecting labour productivity in Nigeria were searched and evaluated to be employed in setting down background for the data collection system used.

3.5.2 Field Survey

The quantitative data set used for this research work were collected personally from all the construction sites sampled in Kaduna state and Abuja except on few where minimal assistance was obtained. The assistants employed were site foremen or project manager with training and experience. These assistants were well oriented and trained on the research and data collection procedures before they proceeded to collect the measurements. Quantitative output values recorded from the work measurements conducted were the data set gathered from the field surveys carried out.

3.6 Research Procedures

In order to attain the objectives set out for this research investigation the following steps were taken:

i. Various specification was derive from the BESMM
ii. A well structured time study sheet was prepared for data gathering
iii. The operative to be observed is initially taken unaware by taking note of the particular spot or point at which the work was started and the starting time is also

taken. The recording of time starts from the point of placing the tiles on the wall. It does not include time used for preparing backing.

iv. A physical measurement of the work output executed is then carried out using simple tools such as tapes. The observed output and finishing time are both recorded.

v. The actual time taken is calculated by taking the difference between the starting and the finishing time and thus the observed time is recorded.

vi. 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.

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

3.7 Data Analysis

The data collected was subjected to inferential analysis tools by an Analyst which are available as thus;

3.7.1 Test of Significant Differences in Labour Outputs

The analysis of the relationship and differences between labour output and the underlying productivity group factors was established using ANOVA, paired sample test and 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 assumption underlying the use of the t-test according to Mohammed (2009) are:

i. The population from which the samples are taken is normally distributed.

ii. The variances of the samples compared are homogenous.

The data sets tested were assumed to satisfy the underlying assumption of normality. This is because Mohammed (2009) confirmed that the t-statistic is a robust test implying that it is relatively insensitive to violations of its assumptions. However, in order to counter the effect of the assumption of homogeneity of variance, the statistics employed was the two sample t-statistic that assumes unequal variances.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION OF RESULTS

4.1. Introduction

This chapter reviewed the strategies employed in the presentation and analysis of the data collected for this study, evaluates the output value of workers on general basis setting down four (5) major parameters of the factors influencing productivity of workers on site operations, and also presents the findings and analysis of the productivity level in terms of output/unit measurement of tradesmen in site operations.

Statistical tests employed inferential analysis tools to analyze the data i.e Analysis of Variance (ANOVA) for multiple comparison, paired sample t-test to compare two groups that are related and independent t-test to compare two group that are not related due each activities. The results are presented according to the activities involved in the study. The statistical package for social science (SPSS) was used for the analysis of variance. All tests were at 0.05 significant level unless where otherwise stated.

4.2 Nature of the Research Data

The data required for the study takes the form of absolute units of work output observed at various period of day operation on sites. The data collected were quantitative records of observed time per hour of the 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. This will

strengthen the validity of the research results, since researchers have observed obvious deviations between outputs at different time periods (Olomolaiye et al 1998, cited in Adnan et al, 2007) .

Principally, the data collected represents the absolute numerical quantities of output recorded at different times of the day, and presented as unit output per hour and per day.

4.3 Data Presentation

A variety of tools are available for data presentation purposes typical examples are tables, charts, such as the bar chart, pie chart, line diagrams e.t.c. Therefore, for the purpose of this research work tables are used for the presentation of data. Below expanciate the responses gathered with simple interpretations:

Table 1: The output values for wall tiles 400mm x 300mm x 5mm, plan width > 300mm tiles with long side horizontal with backing

Gang size: 1 tiler, 1 labourer

Total observed time: 8 hours/day with break time

	Output (m^2)				
	Morning		Afternoon		Total output (m^2) per day
Gang No.	(8am to 12noon)	Avg/hr	(1pm to 4pm)	Avg/hr	
1	14.40	3.60	10.80	3.60	25.20
2	15.36	3.84	11.52	3.84	26.88
3	12.00	3.00	8.00	2.67	20.00
4	12.00	3.00	8.00	2.67	20.00
5	23.60	5.90	17.70	5.90	41.30
6	10.10	2.53	7.50	2.50	17.60
7	9.60	2.40	7.20	2.40	16.80
8	23.60	5.90	17.70	5.90	41.30
9	16.00	4.00	12.00	4.00	28.00
10	10.00	2.50	7.50	2.50	17.50

11	23.20	5.80	17.40	5.80	40.60
12	16.80	4.20	12.60	4.20	29.40
13	10.00	2.50	8.00	2.67	18.00
14	25.00	6.25	18.00	6.00	43.00
15	35.00	8.75	20.00	6.67	55.00
16	14.70	3.68	11.00	3.67	25.70
17	16.00	4.00	12.00	4.00	28.00
18	11.00	2.75	8.30	2.77	19.30
19	10.40	2.60	7.80	2.60	18.20
20	17.50	4.38	13.20	4.00	30.70
21	16.00	4.00	12.00	4.00	28.00
22	8.60	2.15	6.40	2.13	15.00
23	7.50	1.88	5.60	1.86	13.10
24	7.50	1.88	5.60	1.86	13.10
25	7.50	1.88	5.60	1.86	13.10
26	10.00	2.57	7.50	2.50	17.50
27	15.00	3.75	11.30	3.77	26.30
28	17.50	4.38	13.20	4.40	30.70
29	24.00	6.00	18.00	6.00	42.00
30	18.00	4.50	13.50	4.50	31.50
31	15.60	3.90	10.50	3.50	26.10
32	10.00	2.50	10.00	3.33	20.00
33	10.00	2.50	10.00	3.33	20.00
34	12.00	3.00	8.00	2.67	20.00
35	10.00	2.50	8.00	2.67	18.00
36	10.00	2.50	8.00	2.67	18.00
37	10.00	2.50	8.00	2.67	18.00
38	13.40	3.35	4.50	1.50	17.90
39	10.00	2.50	10.00	3.33	20.00
40	12.00	3.00	7.00	2.33	19.00
41	15.00	3.75	10.00	3.33	25.00
42	25.00	6.25	15.00	5.00	40.00
TOTAL	**610.86**	**152.72**	**443.92**	**147.97**	**1054.78**
AVERAGE	**14.54**	**3.64**	**10.57**	**3.52**	**25.11**

The outcome of the Paired Samples Statistics shows that the sig (P) value is less than 0.05 calculated, this implies there is statistical significant difference between morning and afternoon output/day for wall tilling as shown in Table 2. This capture the likely changes in weather and working conditions and their consequent effects on the recorded output

Table 2: Paired Samples Statistics for wall tiles output value

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Morning	14.54	42	6.01	.93
	Afternoon	10.57*	42	3.96	.61

*denote there is statistical significant difference ($p < 0.05$)

r=o.934

The paired samples correlations (r) calculated which shows the correlation between morning output and afternoon output shows there is strong positive correction , implies that as the morning output increases afternoon output also increases

4.6 **Productivity factor effect in respect to labour output for wall tiling 400mm x 300mm x 5mm, plain width >300mm, tiles with long side horizontal with backing.**

The Inferential Statistics Analysis

ANOVA

Result of the Analysis of Variance (Anova) statistics as shown in Table 3 revealed the calculated mean value for workers,18-35years group and those above 35years of age are 21.30,26.09 and19.30 respectively is greater than sig(p) 0.05

level of tolerance, . This implies that even though the outputs were different, the difference by inference is quite insignificant ,this conform with the previous result obtained in some other trades

Thereby, null hypothesis is hereby accepted/retained.

Table 3: Inferential Statistics Analysis for Age of workers in wall tiling

Age of Workers	Mean ± SEM	Minimum	Maximum
Below 19 years	21.30±2.81	18.00	26.90
19 – 39 years	26.09±1.76NS	13.10	55.00
Above 39 years	19.30±0.70NS	17.90	20.00

NS denote there is no significant difference (P > 0.05).

Practically, the mean value for Contract employed workers, and Daily paid workers which are 27.94, 29.07 has a greater value than that of Negociated workers which is 21.27as shown in Table 4,this implies that those of the higher value had higher output than the other,on the contrary, the sig (P) value calculated is greater than 0.05, i.e no statistical significant difference between Contract, Negociated and Daily paid mode of employment for wall tillingThis shows that the statistical outputs in practice are faulty and inefficient. hence, null hypothesis is accepted.

Table 4: Inferential Statistics Analysis for Mode of employment in wall tiling

Mode of employment	Mean ± SEM	Minimum	Maximum
Contract Employed Workers	27.94±2.97	17.90	55.00
Negociated Workers	21.27±1.64NS	13.10	31.50
Daily Paid Workers	29.07±3.50NS	13.10	42.00

NS denote there is no statistical significant difference (p> 0.05)

Result of the independent t-test statistics as shown in Table 5 revealed that weather condition does significantly affect work output in wall tiling. This is because in each case the calculated mean value for sunny, and windy weather are, 25.20 and 13.10 respectively, all data collected for wall tiling was during dry season therefore there is no output value for raining option and since the $P < 0.05$, it implies there is significant effect of weather condition on the work outputs for wall tilling.

The null hypothesis is hereby rejected

Table 5: Inferential Statistics Analysis for Weather condition in wall tiling

Independent Samples Test /Group Statistics

	Group 2	N	Mean	Std. Deviation	Std. Error Mean
Weather	Sunny	25	25.20	8.04	1.61
condition	Windy	2	13.10	.00	.00

Result of the Analysis of Variance (Anova) statistics as shown in Table 6 revealed that the level of qualification does not significantly affect the total output, the calculated mean value for primary school certificate holder workers, SSCE,

NABTEB, ND and others is 00.00, 25.62, 17.50, 22.90 and 25.36 respectively, hence, sig (P) is greater than 0.05 level of tolerance, confirming that there is no significant effect of level of educational qualification on the total outputs this may be due to the fact that tilling works requires no skill or qualification, also many of the previous work ascertain it. The null hypothesis is hereby confidently accepted/retained

Table 6: Inferential Statistics Analysis for Qualification of workers in wall tiling

Qualification of Workers	**Mean ± SEM**	**Minimum**	**Maximum**
Pry Cert	0.00±0.00	0.00	0.00
SSCE	25.62±1.97	13.10	55.00
NABTEB	17 50±0.00NS	17.50	17.50
ND	22.90±3.26NS	19.30	29.40
Others	25.36±4.36NS	17.50	41.30

NS denote there is no significant difference (P > 0.05).

Result of the Analysis of Variance (Anova) statistics as shown in Table 7 revealed that years of experience does not significantly affect the output in wall tiling . calculated mean value for workers experienced below 1year, 2-3years,5-11years and above 11years are 26.10,25.00,24.09and25.18 respectively,since the P > 0.05, it implies there is no significant effect of level of years of experience on the total output produced. Expectedly,experience factor should suggest a possitive relation between outputs and length of experience or the effect of

quality of work should be considered which is not covered in this study, despite that null hypothesis will be accepted

Table 7: Inferential Statistics Analysis for Experience of workers in wall tiling

Experience of Workers	Mean ± SEM	Minimum	Maximum
Below 1year	26.10±5.63	17.50	41.30
2 – 5 years	25.00±2.90NS	13.10	43.00
5 – 11 years	24.09±2.43NS	13.10	55.00
11 years above	25.18±4.09NS	17.90	40.00

NS denote there is no significant difference (P > 0.05).

Table 8: The Output values for wall tiles skirtings 400mm x 50mm x 5mm thick.

Gang size: 1 tiler, 1 labourer

Total observed time: 8 hours/day with break time

	Output (m^2)				
	Morning		Afternoon		Total
Gang No.	(8am to 12noon)	Avg/hr	(1pm to 4pm)	Avg/hr	output (m) per day
1	14.00	3.50	13.00	4.33	27.00
2	14.00	3.50	13.00	4.30	27.00
3	13.00	3.25	7.00	2.33	20.00
4	8.00	2.00	7.00	2.33	15.00
5	12.00	3.00	8.00	2.66	20.00
6	37.00	9.25	35.00	11.66	72.00
7	8.50	2.13	6.40	2.13	14.90
8	8.50	2.13	6.40	2.13	14.90
9	8.50	2.13	6.40	2.13	14.90
10	30.00	7.50	22.50	7.50	52.50
11	17.50	4.40	13.20	4.0	30.70
12	8.00	2.00	6.00	2.00	14.00
13	10.00	2.50	7.50	2.50	17.50
14	9.00	2.25	6.80	2.26	15.80
15	4.80	1.20	3.60	1.20	8.40
16	40.00	10.00	20.00	6.30	60.00
17	40.00	10.00	20.00	6.30	60.00
18	50.00	12.25	30.00	10.00	80.00
19	14.70	3.70	12.30	4.10	27.00
20	42.00	10.50	38.00	12.66	80.00
21	9.00	2.25	5.00	1.66	14.00
22	5.10	1.30	3.30	1.10	8.40
23	35.00	8.80	25.00	8.30	60.00
24	8.90	2.23	6.00	2.00	14.90
25	17.80	4.45	12.90	4.30	30.70
26	9.90	2.50	5.90	1.96	15.80
27	9.90	2.50	7.60	2.53	17.50
28	8.60	2.10	6.30	2.10	14.90
29	9.00	2.25	6.00	2.00	15.00
30	11.00	2.75	9.00	3.00	20.00
31	39.00	9.75	33.00	11.00	72.00
32	8.60	2.15	6.30	2.10	14.90
33	15.00	3.75	12.00	4.00	27.00
34	29.00	7.25	23.50	7.67	52.50
35	12.00	3.00	8.00	2.67	20.00

36	40.00	10.00	20.00	6.67	60.00
TOTAL	**657.30**	164.33	**471.90**	157.30	**1129.20**
AVERAGE	**18.26**	4.57	**13.11**	4.37	**31.37**

The mean value for morning and afternoon output is 18.26 and 13.10 respectively, outcome of the Paired Samples Statistics as shown inTable 9 that the sig (P) value is less than 0.05 this implies, there is statistical significant difference between morning and afternoon output/day for wall skirting tilling.

Table 9: Paired Samples Statistics for wall skirting tiles output value

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Morning	18.25	36	13.23	2.20
	Afternoon	13.11*	36	9.55	1.59

*denote there is statistical significant difference ($p < 0.05$)

$r = 0.93$

The paired samples correlations (r) calculated which shows the correlation between morning output and afternoon output shows there is strong positive correction , implies that as the morning output increases afternoon output also increases

4.7 The effect of Productivity factor in respect to labour output for wall skirting, 400mm x 50mm high,ceramic tile 5mm thick.

The Inferential Statistics Analysis

Result of the analysis of independent t-t statistics as shown in Table 10 revealed that the age of worker does not significantly affect work output in wall

skirting tiling. This is because in each case the calculated mean value for workers between18-35years group and those above 35years of age is 29.17and42.33 respectively is greater than sig (p) 0.05 level of tolerance, this implies that there is no significant effect of age of workers on the total outputs.

The null hypothesis is hereby accepted/retained.

Table 10: Inferential Statistics Analysis for Age of workers in wall skirting

Group Statistics

	Group 3	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Age of workers 3	19 - 35 yrs	30	29.17	20.99	3.83266
	36 yrs and above	6	42.33	27.72	11.31862

NS denote there is no significant difference (P > 0.05).

The mean value for Contract employed workers, Negociated workers and Daily paid workers is 42.15,29.26 and21.37 respectively as shown in Table 11 and the sig(P) value is greater than 0.05 this implies, there is no statistical significant difference between Contract, Negotiated and Daily paid mode of employment for wall skirting tilling.

However, dependant variable revealed that between contract paid workers and Daily paid workers there is significant difference P < 0.05, hence, null hypothesis is rejected

Table 11: Inferential Statistics Analysis for Mode of employment in wall skirting

ANOVA

Mode of employment	Mean ± SEM	Minimum	Maximum
Contract Employed Works	42.15±6.98	14.90	80.00
Negotiated Workers	29.26±6.04NS	8.40	80.00
Daily Paid Workers	21.37±4.67*	8.40	60.00

NS denote there is no statistical significant difference ($p< 0.05$)

*denote there is significant difference ($p>0.05$)

Result of the analysis independent t-test as shown in Table 12 revealed that weather condition does not significantly affect work output in wall skirting tiling. This is because in each case the calculated mean value for sunny, and windy weather is 24.83 and16.20 respectively, since all data collected for wall skirting tiling was during dry season, there is no output value for raining option and the $P > 0.05$, it implies there is no significant effect of weather condition on the work outputs for wall skirting tilling. Null hypothesis retained

Table 12: Inferential Statistics Analysis for Weather condition in wall skirting tiling

Independent sample test

Group Statistics

	Group 3	N	Mean	Std. Deviation	Std. Error Mean
Quality of Surface 3	Sunny	18	24.83	18.04	4.25
	Windy	2	16.20NS	1.84	1.30

NS denote there is no significant difference (P > 0.05).

Result of the Analysis of Variance (Anova) statistics as shown in Table 13 revealed that the level of qualification does not significantly affect the total output, this is because in each case the calculated mean value for, SSCE, NABTEB, ND and others is 32.51, 35.88, 25.85 and 17.70 respectively, hence, sig (P) is greater than 0.05 level of tolerance, confirming that there is no significant effect of level of educational qualification on the total outputs. The null hypothesis is hereby accepted/retained.

Table 13: Inferential Statistics Analysis for Qualification of workers in wall skirting

Qualification of Workers	Mean ± SEM	Minimum	Maximum
Pry Cert	0.00	0.00	0.00
SSCE	32.57±4.52	14.00	80.00
NABTEB	35.88±12.25NS	17.50	72.00
ND	25.85±11.63NS	8.40	60.00
Others	17.70±9.30NS	8.40	27.00

NS denote there is no significant difference (P > 0.05).

Result of the Analysis of Variance (Anova) statistics as shown in Table 14 revealed that years of experience does not significantly affect the output in wall skirting tiling because the calculated mean value for workers experienced below 1year,2-3years,5-11years and above 11years is 17.70,34.23,26.55 and34.68 respectively, since the P > 0.05 ,it implies there is no significant effect of level of years of experience on the total output produced.

Table 14: Inferential Statistics Analysis for Experience of workers in wall skirting tiling

Experience of Workers	Mean ± SEM	Minimum	Maximum
Below 1year	17.70±9.30	8.40	27.00
2 – 5 years	34.23±6.57	14.90	72.00
5 – 11 years	26.55±5.21	14.00	80.00
11 years above	34.68±9.70	8.40	80.00

NS denote there is no significant difference (P > 0.05).

Table 15: The output values for riser tiling, plain 400mm x 150mm x 5mm thick

Gang size: (1 tiler and 1 labourer)

Total observed time: 8 hours/day with break time

	Output (m^2)				
	Morning		Afternoon		Total
Gang No.	(8am to 12noon)	Avg/hr	(1pm to 4pm)	Avg/hr	output (m^2) per day
1	12.00	3.00	9.00	3.00	21.00
2	16.00	4.00	12.00	4.00	28.00
3	32.00	8.00	24.00	8.00	56.00

4	4.00	1.00	2.60	0.87	6.60
5	3.10	0.78	2.40	0.80	5.50
6	7.20	1.80	9.00	3.00	16.20
7	10.90	2.73	12.00	4.00	22.90
8	12.00	3.00	3.90	1.30	15.90
9	8.00	2.00	4.40	2.47	12.40
10	29.00	7.25	20.60	6.87	49.60
11	15.00	3.75	13.00	4.33	28.00
12	11.00	2.75	10.00	3.33	21.00
13	3.10	0.78	2.40	0.80	5.50
14	14.00	3.50	12.60	4.20	26.60
15	22.00	5.50	14.00	4.67	36.00
T0TAL	**199.30**	49.83	**151.90**	50.63	**351.20**
AVERAGE	**13.29**	3.32	**10.13**	3.38	**23.41**

The mean value for morning and afternoon output is 7.52 and 4.49 respectively as shown in Table 16 ,outcome of the Paired Samples Statistics shows that the sig (P) value is less than 0.05 this implies, there is statistical significant difference between morning and afternoon output/day for risers in tilling.

TABLE 16: Paired Samples Statistics for riser output value

		Mean	**N**	**Std. Deviation**	**Std. Error Mean**
Pair	Morning	7.52	60	.32	.04
1	Afternoon	4.50*	60	.33	.04

*denote there is statistical significant difference ($p < 0.05$)

$r = 0.73$

The paired samples correlations (r) calculated which shows the correlation between morning output and afternoon output shows there is strong positive

correction , implies that as the morning output increases afternoon output also increases

4.8 Effect of Productivity factor in respect to labour output for Risers in tiling, 400mm x 150mm high,ceramic tiles 5mm thick,

The Inferential Statistics Analysis

ANOVA

Result of the Analysis of Variance (Anova) statistics as shown in Table 17 revealed that the age of worker does not significantly affect work output in riser. This is because in each case the calculated mean value for workers below18 years of age, 18-35years group and those above 35years of age is 21.73, 25.80 and 23.97 respectively is greater than sig (p) 0.05 level of tolerance, this implies that there is no significant effect of age of workers on the total outputs.

The null hypothesis is hereby accepted/retained.

Table 17: Inferential Statistics Analysis for Age of workers in Riser

Age of Workers	Mean ± SEM	Minimum	Maximum
Below 19 years	21.73±3.43	16.20	28.00
19 – 39 years	25.80±15.39NS	5.50	56.00
Above 39 years	23.97±2.09NS	21.00	28.00

NS denote there is no significant difference (P > 0.05).

Result of the Analysis of independent sample test statistics as shown in Table 18 revealed that years of experience does not significantly affect the output in floor tiling because the calculated mean value for workers experienced between 2-5years and 5-11years and is 22.85 and 25.80 respectively, since the P > 0.05, it implies there is no significant effect of level of years of experience on the total output produced. Null hypothesis is accepted

Note: There is no option under mode of employment and weather condition that was collected, for qualification of worker it was only the same option which is SSCE, therefore no variables to be compare.

Table 18: Inferential Statistics Analysis for Experience of workers in riser Independent t-test

	Group	N	Mean	Std. Deviation	Std. Error Mean
Experience of workers	2.5 yrs	6	22.85	4.56	1.86
	6-10 yrs	3	25.80NS	26.67	15.40

NS denote there is no significant difference (P > 0.05).

4.xx SUMMARY OF MAJOR FINDINGS

The age of workforce for tiles laying indicates that tilers in the age group 19- 39 years outperform those below19years and above 39 years group, having a mean output greater than the other categorie. The results observed is in agreement with the point observed by Ameh and Odunsami (2002) that the most productive age group is 18-35 years. The dominant of 19-39years category in tiles laying could be demonstrated that this is the working population having the alertness and

energy required for work, consequently have impact on the determined output. However, statistical significant difference does not exists the groups. This implies that even though the outputs were different, the difference by inference is quite insignificant. This agrees with the previous result obtained in some other trades.

The tiles laying workforce observed was predominantly engaged by daily paid workers followed by contract workers. The mode of employment significantly influences the determined output in all work items observed. This is similar to the findings reported by Abdullahi *et al*.,(2010).The daily paid workers have the highest mean outputs with significant impact on the determined outputs while contract employed workers comes next and the negociated workers with mean less than the determined outputs.

Result of the independent t-test statistics revealed that weather condition does significantly affect work output in wall tiling but stated otherwise in wall skirting. All the data collected for wall tiling was during dry season therefore there was no output value for raining option.

The workforce with Secondary and NABTEB qualifications have a higher determined outputs of all the work items. A similar finding was reported by Rojas *et al (2003).* had also reported that educational qualification consistently had no significant difference on the determined outputs. The results also contradict the generalization made by Ameh and Odunsami (2002), Yates and Swagata (1993) that labour productivity increases with improvement in the quality of labour.

The output result in level of experience showed that determined output difference exists between the groups. The highly experience perform better than others,

but not statistically significant. This results contradict the propositions made by Abdullahi *et al* (2010), Adnan (2007). Practically, the level of experience of the workforce should have positive relationship with the amount of output observed or the quality of the work. The quality of the work output was not considered in this study. Despite that, null hypothesis was accepted. This is where statistical output in practice is faulty and inefficient making what were as if they were not.

The results which were quite different from the submissions made by previous researchers are strongly attributed to variations in locational factors which have been shown to exert influence on worker's productivity. The implication is that output constants do vary according to locations. Therefore, it would be erroneous for contractors to base their cost estimates on uniform outputs for different locations. This clearly shows the need for further investigation into all other trades so as to evolve fair labour outputs that will guarantee accurate cost estimates to all stakeholders in the industry.

Summary of Output

Table 19: General Outputs

Operation	**Average Output/Hour**	**Average Output/Day**
Wall width > 300mm long side horizontal	7.16	25.11
Skirting 50mm high	8.94	31.37
Riser 150mm high	6.70	23.41

Table 20: Summary of Null Hypothesis

Operation	Age	Period	Payment	Experience	Qualification
Wall width > 300mm long side horizontal	Accepted	Rejected	Rejected	Accepted	Accepted
Skirting 50mm high	Accepted	Accepted	Accepted	Accepted	Accepted
Riser 150mm high	Accepted	Accepted	Accepted	Accepted	Accepted

ble 21: Output According to Production Factors

Operations	Age			Payment			period			Qualification				
	Bel 19	19-35	Abv 36yr	Cont	Neg wks	Daily pd	Sunny	Windy	Raining	Pry sch ct	SSC E	Nabt eb	ND	Othe
Wall width > 300mm long side horizontal	31.0	26.0	19.3	27.94	19.94	29.07	25.19	13.1	0	0	25.62	17.5	22.9	25.3
Skirting 50mm high	29.17	42.30	42.15	29.26	21.37	24.82	16.20	0	0	0	32.6	35.87	25.85	17.7
Riser 150mm high	21.7	26	24								23.8			

CHAPTER FIVE

5.1 Conclusion and Recommendation

This chapter entails the conclusion of the results based on the information obtained throughout the process of the research work and appropriate recommendations are made.

5.2 Conclusion

The aim of the study was to empirically establish labour outputs for tilling work in Nigerian construction industry with the view of increasing the accuracy of construction cost estimates. The first objective was to review the current labour outputs in use for some selected trade within the industry, their basis and reliability. 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 prices 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 evidence by the diverse output data collected indicates the adoption of non-uniform output in the industry.

The second objective was to empirically establish the output for the selected trade using BESMM. The results established general average output values per day of; 25.11m^2 (for wall tiles 400mm x 300mm x 5mm, plain width >300mm, tiles with long side horizontal with backing), 31.37m (for wall skirting, 400mm x 50mm x 5mm thick) and 23.41m (for riser 400mm x 150mm x 5mm

thick). The implications of these results is that these output values considered average situations and conditions based on the productivity factors of sex, age, payment, qualification, experience and working 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 sought to investigate the extent of influence of the productivity factors considered over the resulting labour of each activity. Meeting this objective required the test of the following hypotheses:

Null hypothesis (H1o): the age of a worker on site has no positive relationship and influence over his output/productivity. The output values of workers of different age groups were collected for all operations analyzed and tested using the test-statistics to investigate whether to accept or reject the Null hypothesis H1o. The results of the test revealed that, though there was difference between the various group of age but the difference is insignificant, therefore Null hypothesis was accepted for all operations implying that age has no significant influence over productivity levels. This may attribute to the fact that, tiling works has a pattern-based to follow requiring little or no amount of skills no matter the age, you produce almost the same result.

Null hypothesis (H_2O): there is no output difference in all the period of observation.

The work output values collected for the two different period of observation (morning and afternoon) considered, when tested accept the Null hypothesis H_3O for all the operation studied. This simply means that the level of output/productivity does not dependent on the period of work, it could be because all observed work were indoor at the normal weather condition. Hence the null hypothesis H_30 is accepted.

Null hypothesis (H_3O): payment type and level have no effect over the outputs of workers

The results of the test-statistics conducted to test H_2O also rejected it on only one cases of the operation studied; wall tiling but the different was not significant in the others

The results accepted the research hypothesis H_2 and finally conclude that the type, mode and style of payment to workers positively affects their outputs.

Null hypothesis (H_4O): there is no output difference between the highly experienced group of workers with workers with low level of experience.

The test of difference between the all experience groups accepted H_4O for wall, skirting and riser tiling. This leads to the acceptance of H_40 that length of experience of workers does not dictates their level of outputs

Null hypothesis (H_5O): Educational background visa-vis the quality of labour has no effect on output levels.

The results of the test statistics conducted between the different certificate holders observed in wall, skirting and riser accepted H_5O. Implying that even

though output difference exists between the groups, the extent is quite insignificant, and hence rejected the research hypothesis H_5.

5.3 Recommendations

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

i. A tiler and a labourer should fix a minimum of 25.11m^2 of wall tiles 400mm x 300mm x 5mm n.e 3.00m high per day, the average output for **wall skirting, 40mm x 50mm high is** 31.37m and for riser tiling, 400mm x 150mm high is 23.41m /day.

ii. Contractors 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 and study;

i. Similar study should be conducted using any of the probability sampling techniques for more accuracy and reliability.

ii. As indicated by literature and the results of this research work, the outputs in practice are faulty and inefficient. Therefore, similar works should be conducted on all other trades.

iii. Similarly, outputs should be investigated on the basis of standard gang size formations.

iv. Better and more scientific ways of rating workers performance should be deviced so as to eliminate the subjectivity nature of the current rating style.

References

Abba, I. (2010): Determination of labour outputs for the Nigerian constructions industry;. An unpublished B.Sc Thesis, Department of Quantity Surveying, Faculty of Environment Design, A.B.U. Zaria.

Abdukrazaq, M., Muhammad, A and Abba, I. department of quantity survey, Ahmadu Bello, University, Zaria. Empirical determination of labour outputs on formwork for construction project. Construction Focus, vol 3, no. 1 pp 62-69.

Abdullahi, M. (2009). *Determination of Labour Output for the Nigeria Construction: a case study of the Kaduna construction Labour Market*, unpublished (BSc.) thesis. Department of Quantity Surveying, Ahmadu Bello University, Zaria

Adenikinju F. Adeola (2005). Productivity performance in developing countries.

Adnan, E. Sheriff, M. Zaid, A.M., and Peter, E.M. (2007). *Factors Affecting Labour Productivity In Building Projects In The Gaza Strip*. Journal Of Civil Engineering And Management, 13(4), 244-246

Akipekuri, H.H. Maila, H.(2011) International journal of performance measurement, vol, 29, 58 productivity and performance management – managerial practices in the construction industry.

Aliyu, M. (2010): Determination of Labour outputs for tiling works in Kaduna, Unpublished B.Sc. thesis, Department of Quantity Surveying, Ahmadu Bello University. Zaria.

Altine, S.Y. (1988): Works Measurement Techniques in Use in the Zaria construction Industry. An unpublished B.sc Thesis Submitted to the Department of Building, Faculty of Environmental Design, Ahmadu Bello University Zaria

Ameh , O.J. and Odunsami, K.T (2002): Factors Affecting Labour Productivity in the Nigerian Construction Industry, The Quantity Surveyor; Journal of the Nigerian Institute of Quantity Surveyors , 40 ,116-915x, 14-18.

Fagbenle O. I, Ogunde A.O. Owolab. J. D. Factors Affecting the performance of labour in Nigerian construction sites, department of building technology, Covenant University otaogunstate, Nigeria Mediterranean journal of social sciences (2011) vol 2,No2

Faki A.I. Abdulsalam .D, Okoli O.G and Zubairu I.K. (2010). An assessment of craftsmen productivity in the Nigerian construction focus, vol, 3. No 1, pp 87 – 95.

Garba, J. (2012). Determination on labour output on suspended gypsium acoustic ceiling fixing and hard board ceiling fixing. Unpublished B.Sc. thesis, Department of Quantity Surveying, Ahmadu Bello University, Zaria.

Gide, A. (2011): Determination of Labour outputs for terrazzo and cement sand screed in Katsina state, unpublished B.sc thesis, Department of Quantity surveying, Ahmad Bello University, Zaria

Hassan, A.S., (2011) Determinations of labour output for door and window glazing in the Nigerians construction industry: a case study of Kano State. Unpublished B.Sc. thesis, Department of Quantity Surveying, Ahmadu Bello University, Zaria.

James D. W, 11, PE, 2006 AACE International.

Jonas S.M, (2000). Why does Façade ceramic tilling fail? Department of Civil Engineering construction polytechnic school of the university Sau Panlo-Brazil.

Kabir, L. (2012). Determinations of labour output for laying intertocking tiles in the Nigeria construction company. Unpublished B.Sc. thesis, Department of Quantity Surveying, Ahmadu Bello University, Zaria.

Maloney, W.F. 1983."Productivity Improvement: The Influence of Labour." *Journal of Contractor Engineering and Management*, 18: 2-18.

Manager-Net. Work study. Available at: http:// www.manager-net.com/workstudy.html. Cited on 24/07/2014.

Mohammed, A. (2009): Emprical Determination of Labour outputs for selected trades in Kaduna State, Unpublished B.Sc. thesis, Department of Quantity Surveying, Ahmadu Bello University, Zaria.

Mohammed, S.H, Abdulnaser, O.A, Hamed, K.P, (2011) Identifying ways to improve productivity at the construction industry Bulletin of engineering.

Momoh,, O.D. (2011). Determinations of labour output for door and window fitting. Unpublished B.SC. THESIS, Department of Quantity Surveying, Ahmadu Bello University, Zaria.

Muqeem, S. (2011). Predicting modeling of construction labour productivity rate using articial neural network, 2nd international conference on environmental science and technology. IPC BEE vol. 6.

Muqeem. S, Idrus, A, Khamidi, M.F, Hamad J.B,(2012). Predicting construction labour productivity using artificial neural network. Procedia-social and Behavioural sciences, vol 48,pg 3871- 3680.

Nadabo,A. (2010). Determination of Labour output for concrete work for the Nigeria construction industry. Unpublished B.Sc. thesis, Department of Quantity Surveying, Ahmadu Bello University, Zaria.

Olomolaiye P.O, Ogunlana, S.O. (1989). An evaluation of production output in key building trades in Nigeria. Construction Management and Economics.

Olomolaiye, P.O., Wahab, K.A., Prince, A.D.F (1987). Problems influencing cratfmen's productivity in Nigeria. Construction management and Economics.

Omange, G.N. 2000. *Local Construction Materials for Low Cost Housing in Nigeria.* Lagos, Nigeria: Jolly Amin Press,.

Resli Azha, B.M (2011). Productivity of rendering and Tiling works for Building projects scheduling. Faculty of Civil Engineering, University Technology Malaysia.

Rojas, M.E. and Aranvereekul, P. (2003). Labour productivity drives and opportunities in the construction industry. Journal of Management in engineering 19(2), 78-82.

Saheed, A. (2010): Determination of labour outputs for the Nigerian constructions industry; An unpublished B.Sc Thesis, Department of Quantity Surveying, Faculty of Environment Design, A.B.U. Zaria.

Sambo, B. (2010): Determination of Labour outputs for selected trades in Kaduna State, Unpublished B.Sc. thesis, Department of Quantity Surveying, Ahmadu Bello University, Zaria.

Shuaibu A (2010): Determination of labour outputs for roof covering and painting in the Nigerian construction industry, Unpublished B.Sc. thesis, Department of Quantity Surveying, Faculty of Environmental, Ahmadu Bello University, Zaria.

Silvestre, J.D., Brito, J. (2011). Construction and building materials, ceramic tiling in building facades, inspection and pathological characterization using an expert system. Department of Civil Engineering Technical University of Lisbon, Portugal.

Udegbe, M.I (2005): Labour output on painting activity in the construction industry Ondo state, Nigeria, Journal of social sciences,14(2),179-187.

Udegbe, M.I.(2007): Labour Output on Painting Activity in the Construction Industry in Edo State Nigeria, Department of Building, Faculty of Environmental Studies, Ambrose Alli University, Ekpoma. J. Social. Sciences 14(2) 174-184.

University of Leeds Working Paper (1983), Department of Civil Engineering U.K.

Yates , .J.K. and Guhathakurta .S. (1993): International Labour Productivity in Cost Engineering, in the Journal of cost estimation, cost/schedule control, and project management , 35 ,1,15-25.

Zohar, H. and Ralph, E. (1990). Research of factors influencing construction productivity. Construction Management and Economics.