EMPIRICAL DETERMINATION OF LABOUR OUTPUTS FOR BLOCK LAYING IN F.C.T., ABUJA AND NASARAWA STATE

BY

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DECLARATION

I declare that the work in this Thesis titled EMPIRICAL DETERMINATION OF LABOUR OUTPUT FOR BLOCK LAYING INF.C.T., ABUJA AND NASARAWA STATE has been carried out by me in the Department of Quantity Surveying. The information derived from the literature has been duly acknowledged in text and a list of references provided. No part of this thesis was previously presented for another degree or diploma at this or any other institution.

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CERTIFICATION

This thesis titled EMPIRICAL DETERMINATION OF LABOUR OUTPUT FOR BLOCK LAYING IN F.C.T., ABUJA AND NASARAWA STATEby Peter Onyealilam ONYEAGAM meets the regulations governing the award of the degree of Master of Science (Quantity Surveying) of the Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This thesis is dedicated to my late father, Mr. Paul O. Onyeagam, my mother Victoria Onyeagam and my children; Chikaodinaka, Emmanuel and Chinedu.

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ABSTRACT

*The source and nature of output constants used for preparation of construction estimates should be accurate and reliable for the client to have confidence on the prepared estimates. This research is focused on using time study approach to empirically determine the outputs of block laying work items inconstruction industry. The study reviewed BESMM3 and surveyed possible block work items in construction sites. Ten work items were selected from the identified block work items in BESMM3 and construction sites for Physical observations and output measurement. A total of 105 sites were observed in F.C.T., Abuja and Nasarawa state. Data collected were subjected to statistical analysis using both the descriptive and inferential data analysis techniques. The inferential tools adopted were T-test and ANOVA statistics to assess and examine the influence of some selected labour productivity factors on the outputs of the workers observed. The inferential test revealed the following; period of observation, shape of the building and mode of employment significantly affected outputs on the ten work items. The results of the analysis carried out established mean output values per day for: 150mm thick block in foundation (**12.85m^2**); 150mm thick block in superstructure (**13.22 m^2**); 150mm thick block in superstructure overhand (**12.47m^2**); 225mm thick block in foundation (**8.90m^2**); 225mm thick block in superstructure (**11.17m^2**); 225mm thick block in superstructure overhand (**9.16m^2**); 225mm thick block isolated piers in superstructure (**5.00m^2**); 225mm thick block piers in superstructure overhand (**4.57m^2**); 225mm thick block in pit bottom plan $> 4\ m^2$ (**7.85m^2**); 225mm thick block in bottom plan $< 4\ m^2$ (**7.13m^2**). The study also identified forty-four (44) block work items not captured in BESMM3 and suggested that these work items be incorporated into BESMM3 for productive and cost implication. The research* *recommended that in compliance to BESMM3, the NIQS in collaboration with NJIC to sponsor a research on determination of labour outputs in all trades as a way to ensure uniformity in output constants. The study therefore finally concludes that SMM takes cognizance of productivity impact associated with labour and it is imperative for reliability and accuracy in block work estimate to empirically determine labour outputs on the basis of work items as stated in BESMM3.*

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LIST OF ABBREVIATIONS

A.N.O.V.A.:	Analysis of Variances.
B.E.S.M.M.:	Building and Engineering Standard Method of Measurement.
B.O.Q.:	Bill of Quantities.
B.S.:	British Standard.
C. & G.:	City and Guides of London.
C.E.S.M.M.:	Civil Engineering Standard Methods of Measurement.
C.P.:	Code of Practice.
G.D.P.:	Gross Domestic Product.
I.C.E.:	Institute of Civil Engineers.
J.C.T.:	Joint Contract Tribunal.
L.S.D.:	Least Significance Different.
N.A.B.T.E.B.:	National Business and Technical Examinations Board.
N.A.P.T.E.D.:	National Apprentice Training and Entrepreneur Development
N.D.:	National Diploma.
N.E.C.A.:	Nigerian Employers Consultative Association.
N.I.Q.S.:	Nigerian Institute of Quantity Surveyors.
N.J.I.C.:	National Joint Industrial Council
R.I.Q.S.:	Royal Institute of Quantity Surveyors.
S.F.B.C.N.:	Standard Form of Building Contract of Nigeria.
S.F.C.:	Standard Form of Contract.
S.M.M.:	Standard Method of Measurement.

S.M.M.B.W.S.: Standard Methods of Measurement of Building Works and Services.

S.M.M.I.E.: Standard Method of Measurement of Industrial Engineering.

S.O.N.: Standard Organization of Nigeria.

S.P.S.S.: Statistical Package for Social Sciences.

S.S.C.E.: Senior Secondary Certificate Examinations.

.**U.K.:** United Kingdom.

U.N.: United Nation

CHAPTER ONE

1 INTRODUCTION

1.1 Background of the Study

In Nigeria, like most developing countries, the construction industry plays a dominant role in the economic activities of the country.The efficiency of the construction industry has been established to heavily rely on its level of productivity. Construction productivity is constantly declining over a decade due to the lack of standard productivity data base system and ignorance of impact of various factors influencing labour productivity (Muqeem*et al*., 2011).The accuracy of the project cost estimates depend largely on the degree of accuracy of cost information obtained on the key components of an estimate (i.e. labour, plant, material, and profit and overhead) (Abdullahi, 2009), while the use of Standard Methods of Measurement (SMM) for the preparation of BOQ gives the quality and standard of the extent of work to be done, it also takes precedence of the cost significances of every classes of operations within a trade.

The common method of generating cost estimates for construction projects involves the multiplication of unit rate by the measured quantities in the bill of quantities (Ashworth, 2002).The unit rate is a component of labour rate (obtained from the multiplication of labour constant by all-in rate) plus cost of material and percentage allowance for profit and overhead, while the measured quantities are obtained from drawings and specifications for the works rules specified by Building and Engineering Standard Methods of Measurement (BESMM3). The inconsistency in application of a defined output constant for construction estimates has posed a serious research questions.

Labour being one of the important components of the construction industry productivity represents a considerable proportion of the final cost usually accounting for between 40 to 60% of building cost (Abdullahi*et al*., 2010 and Butchan*et al.,* 1993). The assessment of labour rate used for preparation of unit rate for Bill of Quantities requires high level of reliability and accuracy. The determination of labour output constant is affected by variety of factors which involves the quality of labour such as physical and cognitive requirements (Udegbe, 2007;Russel and skibniewski, 1990); technological factors such as design data, material properties and location factors and the administrative factors such as equipment factor, labour factor and social factor (Herbsman and Ellis, 1990). Essentially, the preparation of Bill of Quantities requires collating cost information on materials, assessing labour and plant outputs and evaluating project overheads. It is important, that cost estimates have clear indications of the level of information reliability and not subsequent explanation of inaccuracy (Morldge, 2006).

According to Abdulrazaq *et al.,* (2010) the output constants currently used for preparation of construction estimates are remnants of British colonial heritage or derived from experience of the estimators. Hence, non-uniform outputs are widely used across the industry. Olomolaiye and Ogunlana (1989) reported that six out of the seven firms surveyed based their outputs for estimating and planning purposes on experience which at best are educated guesses. Deprived of adequate knowledge of operatives output, it is difficult to draw a reliable construction programmes or make accurate cost estimates for tendering purposes.

The use of standard labour output for preparation of construction estimates is one of the quantity surveyors/estimators processes in determination of cost reliability for the clients in building industry and there has not been any quantitative study on how the standards are determined.Extensive work has only been done by the researchers in terms of identifying both the qualitative and quantitative factors influencing the productivity of labour on site such as weather, lack of equipment and material, labour skills, incompetent supervision, incomplete drawing, site construction, project location, poor communication, number of workers change orders, late payments etc. (Jilikun*et al.*, 2009andEnshassi*et al.*, 2007).These factors are very difficult to consider during the measurement and estimation of production rates due to vary and unique nature of every project.Olomoaiye*et al.*, (1998) and Hall(1972) stated that factors affecting construction productivity are rarely constant and may vary from country to country, from project to project and even on the same project depending on the circumstance.Ameh and Odusami(2004); Enshassi*et al.*, (2002) and Yates and Swegata (1993) also stated that productivity of workers is influenced by factors which varied according to geographical location.Therefore, if these factors vary intensely with location then how feasible realistic and accurate are the currently adopted British originated outputs within the Nigerian context (Abdullahi, 2009)?

According toTalhouni (1990), the British Research Establishment (BRE) studies only reported the overall labour variability for house building, but no attempt was made to quantify or explain the performance variability with regard to possible causes or factors that will affect the output of labour on the site and therefore the database used in the previous studies are questionable and are primarily based on activities sampling or data reported by tradesmen.Talhouni (1990) also reported that for the fact that the previous researches on productivity rates did not take cognizance of these factors proved it to be unrealistic. In view of the disdainful consideration of the influencing factors as relate to labour outputs and the subsequent results on empirical determination of labour constant conducted by Abdulrazaq*etal.,*(2010);Abdullahi(2009); Udegbe (2005) andAjia (2002)the source, the accuracy and the application of output constants for the preparation of cost estimates for construction projects in Nigeria have been challenged.It is therefore a fact that there are no established output figures for different construction operations in the country; it is not sufficient justification to leave production outputs in the realm of guesses (Olomolaiye and Ogunlana, 1989). According to Ayeni (1999) the cost of labour for block work operation is apportioning to 33% of total cost compared with other construction trades. The blocks components use in Nigeria are of various types and sizes and their operations are widely influenced by geographical location. Also within the trade, there are different work items that require different outputs as stated in BESMM3; therefore, this necessitates study on empirical determination of labour outputsfor block laying in F.C.T., Abuja and Nasarawastate construction industry.

1.2 Statement of Research Problem

The preparation of Bill of Quantities requires collating cost information on materials, assessing labour and plant outputs and evaluating project overheads. It is also important that the sources of these data should have clear indications of the level of information reliability and not subsequent explanation of inaccuracy (Morldge, 2006).Materials, plant, profit and overhead which are components of unit rate can be quantitatively estimated, while labour can not be precisely estimated due to varieties of factors impairing the determination of labour output. According to Olomolaiye*et al.,*(1998); Yates and Swegata (1993) andHall (1972) productivity of workers are influenced by factors varied according to geographical location and other related Construction Productivity Influencing Factors

(CPIFs).There is no justification that the labour output being used by the construction estimators for the preparation of Bill of Quantities which is British-based labour constant is reliable hence geographical location and BESMM was not taken into cognizance.

However, previous studies conducted by Abdullahi (2009); Udegbe (2005) and Ajia (2002) on empirical determination of labour outputs for block work did not take precedence of work items in BESMM3. Hence the reliability has been disdainfully impaired; it therefore becomes imperative that in compliance with Building and Engineering Standard Method of Measurement (BESMM3) to empirically determine labour output constant for Nigerian construction industry.

1.3 Justification of the Study

There have been related studies on determination of labour outputs in the construction sector in Nigeria, yet there are no reliable reference handbooks and manuals of output constants specifically to Nigerian building industry to estimate the required resources and time to control projects. Productivity standard is imperative especially now Nigeria has adopted her own SMM for construction works to reflect her cultural influence, construction method that usually affects construction productivity. There is argument that an estimator will price work quicker if constant labour rates are used for several months (Brook, 2010). In this research, due to the importance of determining a reliable labour output constants in building industry, labour productivity for block laying and factors influencing its reliability in the building construction in Nigeria has to be investigated. The operative output constants can be used by construction estimators and planners for planning, estimating, and controlling the project activities and also be used for the following management functions (Guhathakurta, 1993):

Hence the more accurate the original data, the more able the construction planners to:

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

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

c. Determine the effects of changed methods and conditions;

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

e. Determine the number of workers to be assigned for a task;

f. Determine the most economic method from alternatives;

g. Determine the unit rate of block work operation; and

i. Provide basis for cost control.

1.4 Research Aim and Objectives

1.4.1 Research aim

The aim of thisstudy is to empirically determinethe outputs for laying hollow sand crete blocks in F.C.T., Abuja and Nasarawastate construction industry.

1.4.2 Objectives of the research

The research intends to address the following objectives;

I. To identify factors and operations affecting block laying operation in construction sites

II. To identify the possible block laying operations as relate to BESMM and construction sites.

III. To analyze the effect of productivity factors on labour output.

IV. To empirically determine the labour outputs of some selected block laying work items.

1.5 Research Hypotheses

In order to achieve some of the objectives of this research, inferential test was conducted to determine the influence of the labour productivity factors on the labour outputs established.Hence, the following null hypotheses are postulated in terms of workers output and productivity factors:

- **H1o**: There is no significant output difference on the various age groups of workers observed on site.
- **H2o**: There is no significant output difference on the basis of educational qualification of workers observed on site.
- **H3o:** There is no significant output difference on the basis of mode of employment of workers observed on site.
- **H4o**: There is no significant output difference on the various years of experience groups of workers observed on site.
- **H5o**: There is no significant output difference between straight and irregular shape of buildings.
- **H6o:** There is nosignificant output difference on the period of observation on site.

1.6 Delimitation and Limitation

1.6.1 Delimitation of the study

1. This research focused on only building construction of not more than threestoreys height and other block related works of medium and large construction firms.
2. The study focused on the following work items; 150mm and 225mm thick hollow sand crete in foundation, superstructure and superstructure overhand, 225mm block isolated piers and 225 block in pit as identified in the BESMM3.
3. The study focused on work measurement aimed at establishing the time for a qualified worker/operative to carry out a task.

1.6.2 Limitation of the study

1. The fact that the study did not cover rainy season which variably has influence on temperature of the operatives might affect the outcome of the findings.
2. The difficulty in assessing whether a worker is operating in full and natural capacity or not during the period of observations might affect the outcome of the findings.
3. The total height of a building especially as regard to gang size might affect the outcome of the findings.

1.7 Basic Assumptions

1. All the sites observed had the same site condition.
2 The mortar mix used for the joints were the same.
3. The mortar thickness for bedding and perpend (vertical) joints was not more than 25mm thick.

CHAPTER TWO

2 LITERATURE REVIEW

In Nigeria, the construction industry plays a dominant role in the economic activities of the country and this is because it generates employment and income for the people (Field and Oferi 1988). The industry is regarded as an essential and highly visible contributed to the process of growth. According to Arditi and Mochtar (2000) cited in Abdullahi*etal.*, (2010), this implies that construction has a strong linkage with many economic activities and whatever happens to the industry will directly or indirectly influence other industries and ultimately, the wealth of a country. Also, Hillebrandt (2000) added that the effects of changes in the industry on the economy occur at different levels and in virtually all aspects of life (Hillebrandt 2000).

It is therefore important that the understanding of changes in construction productivity or site outputs cannot be achieved without site information. This information should relate both to the calculation of labour output and to the site environment in which the productivity has been achieved. Adopting a standard labour output for preparation of construction estimates require an understanding and quantification of the major factors that affect labour output. Unfortunately, many of these factors are not quantitatively understood. The complexity and sheer number of these factors are enough to discourage even the most passionate researcher. Therefore, this chapter is to review literature on overview of construction industry in Nigeria, overview of block laying measurement as relate to BESMM3, factors affecting productivity block laying operatives, unit rate estimating, concept of productivity,construction productivity, establishment of labour output standard in Nigeria, labour output in Nigeria and work study.

2.1 Overview of the Construction Industry

The construction industry is as old as nature itself and unlike many manufacturing industries, is concerned mostly with one-off projects. The sector covers a wide range of loosely integrated groups and organizations involved in the production, renewal, alteration, repairs and maintenance of certain capital projects (such as building, civil and industrial engineering works) (Ibironke, 2005; Barrie*and Paulson*,1992).The sector makes significant contributions to the socio-economic development process of any nation especially in expanding economy like Nigeria. Construction industry has effect on the economy because the industry is used as an economic regulator because of its size, provision of investment goods and government being the large client. It also contributes immensely to the employment, gross domestic product and gross fixed capital formation (Ibironke, 2005and Enekwachi, 1996).

Construction is a combination of organizations; engineering science, studied guesses and calculated risks. By the very nature, construction operations must be performed at project sites. Construction is a dynamic, restless and compelling business (Ibironke, 2005); the construction industry also involves a large number of varieties, the labour intensive work, the unique character and occurrence of unpredictable events (Abdel-Razek*et al.*, 2007; Ng, Skitmore*et al.*, 2004; Zayed and Halpin, 2004). Construction industry is risky, that is industry with uncertainties. The risk in construction industry may be derived from external factors which have more influences on construction industry than internal factors. In recent years, construction industry suffered from rapid decline in the growth of productivity (Abdul-Kadir *etal.,* 1995).

2.2 Overview of Sources ofEstimating Standardin Nigerian Construction Industry

The building industry has come a long way since the world wars, up to 1960, it had been British oriented both in design and operational modus (NIQS,2008).The influence of British colonialism in Nigeria is still having impact in all sphere of economic development, of which, construction industry is not left out. It is obvious most of the construction contract procurement and administrative processes are clear reflection of British standards and practices in the Nigerian construction industry.Thefollowing standards and practices are an offshoot of British source still in use in Nigerian construction industry:

1. The Standard Form of Contract (SFC)**:** JCT (1963; 1967; 1980; 1984; 2005 and 2007) are used for building procurement and administration in building industry while ICE (1973) is used for civil engineering works. However, Nigeria published contract Standard to be used for contract procurement and administration for construction works. The Standard Form of Building Contract in Nigeria (SFBCN1990).
2. The Standard Method of Measurement (SMM): The basic need for uniform method of measurement is to accord all tenderers a common basis for computing prices. These are used for both buildings works and civil engineering works. There are several editions for both building and civil engineering standard method of measurementsearly published by the Royal Institution of Charter Surveyors (RICS) of United Kingdom in 1922 and the Institution of Civil Engineers (ICE) of the UK in 1935 respectively. These documents have been used for measurement of building and civil engineering works until in 1988, Nigerian Institution of Quantity Surveyor (NIQS) published a maiden edition of Standard Method of Measurement

of Building Works and Services (SMMBWS) (an adopted British based-standard). The need to reflect certain principles peculiar to Nigerian construction industry in the document gave rise to the second edition in 1996. The committee of this second edition saw the need to use one unified standard document for building and civil engineering works and later metamorphosed into Building and Engineering Standard Method of Measurement (BESMM2) in 2003 and reproduced to BESMM3 in 2008. However, BESMM is a hybrid of the codes of measurement of building, civil and industrial engineering works i.e. the SMMBWS, CESMM3, and the SMMIEC and it is meant to be a one-stop shop for measurement all types of work in the construction industry. The standard has become universally acknowledged in the tertiary institutions of higher learning and practicing quantity surveyors for preparation of BOQ for construction works.

3. British Standard (BS): There are publications issued by British Standard Institutions. BS set out minimum performance standards which goods and services must conform to. These recommendations are not legally enforceable, but the building regulations referred to some and accept them as deemed to satisfy minimum provision (Bamisile 2004). The requirements and expectations of this standard are covered in the Standard Organization of Nigeria (SON) and National Building Code (NBC).

2.2.1 Review of block laying measurement as relate to BESMM3

According to NIQS (2008), BESMM3 under general rules 1.1 states that SMM provides a basis for measuring construction works and embodies the essential of good practices. Bill of quantities shall fully describe and accurately represent the quantity of the works to be carried out. More detailed information than required by these rules shall be given where necessary in order to define the precise nature and extent of the work required. It is suffice to say that BESMM3 provides a uniform basis for measurement and evaluation of building and engineering works with the associated trades and services.

Block work is measured under section F ‘Masonry’ as F.10 ‘Brick/Block Walling’ of BESMM3. Masonry is the art of shaping and laying blocks of stone to form walls. Masonry, which may be a separate craft elsewhere, forms an integral part of block laying and concreting in Nigeria. Although studied as a part of a trade, the class of masonry work in Nigeria is quite high (Obande 1985). The measurement of masonry as stated in BESMM involves three different components namely brick walling, block walling and glass walling and all have the same descriptive features.However, the measurement procedures and construction techniques as regards to the quantity of work may be the same. But the construction intricacies are quite different especially as the component composition varies significantly. This also implies that the productivity requirement varies. For instance, the size of sand crete block is not the same with brick and it requires more time to lay a larger units of brick in a square metre sand crete block. It is imperatives that the estimators take cognizance of productivity consideration as they prepare their estimates. it is suffice to say in as much as the SMM/BESMM take cognizance of the intricacies, the construction cost implication should as well take cognizance of the effect too. The following information provided for the measurement of block walling is relevant for blocks laying operative productivity:

a. The information that is shown either on location drawing under ‘A’ Preliminaries/ General/ Items or on further drawings which accompany the bills of quantities;

i. Plans of each floor and principal sections showing the position of and the materials used in the walls.
ii. External elevations showing the materials used.

b. The description rules require the thickness of walls be stated and block work to be measured in square meter
c. The definition rules ‘D3’ state that work is deemed vertical unless described and ‘D4’ walls include skins of hollow walls. Consideration is not given for classification of verticality as this affect productivity.65
d. The coverage rules ‘C1’ states that block work are deemed to include the following in the block laying operations;
   i. Extra materials for curved work;
   ii. All rough and fair cutting;
   iii. Forming rough and fair grooves, throats, mortises, chases, rebates and holes, stops and mitres;
   iv. Raking and joints to form a key;
   v. Labour in eaves filling;
   vi. Labour in returns, ends and angles;
   vii. Centering;

   Item C1. (i) and (v) require significant variation in labour output due to the intricacy demanded in operations.

The following are specifically considered to have little or significant influence on block laying productivity;

S1. Kind/quality (either solid or hollow), S1.Size of blocks (either 150 or 225mm any other size),

S2. Types of bond (stretcher bond commonly used),

S4. Types of pointing (commonly used for brick walling for its decorative features),

S5. Method of cutting blocks where not at the description of the contractor.

Other influencing factor requires specifying are location and dimensional consideration. The quantity is simply measured from the drawing while the quality is valued on the basis of the type and kind of material installed as well as the deposition of skill in installing or fixing the said material or components.General rules 4.5 states that each work section of a bill of quantities shall begin with a description stating the nature and location of the work, unless evident from the drawing information or other information required to be provided by these rules. The particular clause should as well reference in masonry trade for contractual clarity.

The indication of the nature and location of the work is to acquaint the contractor or estimator of the apparent complexity in the work to enable ascertains the cost implication. Complexity of work occurs in masonry work. According to Adrian, (1982) the productivity of a mason is greatly affected by location of masonry work to be performed. The masonry work performed at a height above ground level requires the construction of a working platform (scaffold) and the lifting of blocks to the work location; the result is lower mason productivity and higher unit labour cost. For the fact that scaffold is provided it has not taken care of dwindling labour output of the masons. This aspect has never looked upon reference to SMM and a review of SMM six edition on block work indicates that the following clauses of having cost significances as relate to block laying labour output; G.4.2

‘labour on different kinds of work shall be given separately’, G.26.1.a ‘kind, quality and size of blocks’…, G.27.1.h,’Work in raising structures stating the starting height above ground at which the block work commences’, while these cost significance clauses are considered as building over hand in BESMM1-3.However, the general rules 4.6 states that unless otherwise specifically stated in a bill of quantities or herein, the following shall be deemed to be included with items:

a) Labour and costs in connection therewith,

b) Materials, goods and all in connection therewith,

c) Assembling, fitting and fixing materials goods in position, etc.

Location of masonry work to be performed in respect to categories of work is too significant for an estimator to hide under cover of the clause believing that the operational cost implication has an insignificant impact on the construction cost. The masonry work section shows no location of categories of work in substructure or superstructure. This simply implies that the labour output for block laying in foundation, pit, basement and superstructure are the same. Operational cost significance should as well be given precedence other than quantity and quality of material.Hence there is no uniformity in application of output constant it is expected that the estimators have conventional way of computing this productivity to the disparagement in the BESMM3. A surveying of textbooks on estimating at least as a basis and operational modus to address this disdainful operational cost significance to the contractor, left one disappointed as height classification is not taken into consideration preparation for labour output constant, except Brook, (2010) that provide 30% allowance for labour in respect to high wall. While the use of SMM for the preparation of BOQ gives the quality and standard of the extent of work to be done, it also requires taking precedence of the operational cost significances of operations of every trade.

2.2.2 Bill items

There are 26 descriptive features as relate to masonry which encompasses brick/block walling and glass block walling. However, these descriptive features do not apply completely to these classes of operation and these could also generate to as many work items as possible due to so many factors such as size, thickness, location, quality etc. Critical examinations of these descriptive features need to be done to extract the related items to the classes of operation. It suffices to point out that there are possible work items in the site that are not directly captured in the BESMM. The extract of block work items in appendix 1 are the generated work items as relate to block descriptive features extracted from BESMM3 including the nature of work involved in accomplishing those items of work.

2.2.3 Unit rate estimating

The actual basic wages/salary a contractor pays to workers is not the actual cost incurs. It costs much more to maintain such operatives on site because by the workers rules and regulation, each of the workers is entitled to their items listed in NJIC rules. The operatives are expected to work for at least eight hours for five days in a week. The unit rate is derived by the basic wage plus all the allowance and divided by the number of hours in a year, having made provisions for public holiday, sick, leave and inclement weather (Aderonke,2008 andOnwusonye, 2006).Analytical estimating is a method for determining unit rates by examining individual resources and the amounts needed for each unit of work

(Brook,2010). Unit rate estimating implies unit rates to the measured quantities in bills of quantities (BOQ). Unit rates comprise all elemental cost items, namely; labour, materials, plant, subcontracts and overhead. The condition of unit rate for each item of the BOQ essentially requires collating cost information, assessing labour and plant outputs and evaluating project overhead (Ashwort,2002).BOQ is usually prepared in accordance with some agreed rules of measurement. Most countries have adopted comprehensive measuring systems for the construction projects. The Standard Method of Measurement (SMM) of building works and the Civil Engineering Standard Method of Measurement (CESMM) have been in use for the building and civil engineering projects respectively before the introduction of Building and Engineering Standard Method of Measurement (BESMM3) to be used for both building and civil engineering works. Labour productivity estimates are often performed by individual using combination of analytical techniques and personal judgment (Portas and Abdel-Rak, 1997). This process is to enable the consideration of physical and cognitive factors associated with the determination of outputs.

The assessment of labour and plant outputs is one of the most difficult tasks of unit rate estimating because it depends on the determination of realistic production standards. In principle, this is specific of each contractor's organization, because it required varying according to production means involved.Relevant data may be obtained from previous projects through the monitoring system which is normally put into practice in each construction site.The monitoring may be done for bonus or other purposes, but quantities of work and the time expended in performing construction activities are recorded, and this is the information passed back to the estimating department.In order to make this information useable for estimators, it must be formatted according to the current measuring systems adopted in the BOQ. However, according to Ashworth, (2002) information collected on construction sites may be difficult to use by estimators for the following reasons:

- It varies widely from site to site, affected by specific characteristics of each projects.
- It is often not compatible for future estimating needs because of the unique circumstances under which each task has been carried out;
- A substantial number of similar task recordings are needed for establishing reliable average labour and plant outputs; this may be difficult to achieve in small and medium companies;
- Historical data may not be easily comparable because production means change along time;
- The site recording systems may not be reliable.

Alternatively, estimators may adopt published data on production standards collected from the industry. Day is worked out from a large number of observations in several construction sites and is organized into typical construction sites according to a specified measurement system.

2.3 Productivity

Productivity is one of the most important issues in both developed and developing countries. Developing countries which face unemployment problems, inflation, and resource scarcity and growth rate decline try to utilize its resources in such way that achieve economical growth and improve citizens' life (Mostafa,2003).Productivity is one of the key components of every company success and competitiveness in the market. It translates directly into cost savings and profitability (Fati, *et al.,* 2010). In Nigeria, productivity studies are yet to become important in the building industry as ways are sought of providing labourer with incentives to work more efficiently and consistently, there have neither been any rule laid down by the Nigerian National Joint Industrial Council (NJIC) nor any guide available for productivity studies in the construction industry. Rather, Nigeria construction estimates rely on the British Standard Specification and Conduct to use in construction estimates (Alabi and Milne 1987), which is undermined the influence of geographical location and other productivity related factors. Productivity study is imperative especially now Nigeria has adopted her own Standard Method of Measurement for construction works. The main objectives of the Nigeria SMM (for Building and Civil Engineering Works) are to suit Nigerian building culture such as Nigerian market situation where cost of labour is appreciably cheaper than the cost of material (NIQS, 1988). Also, SMM2, second edition aimed at the need to introduce new principle peculiar to Nigerian construction industry. A study of determination of the Standard labour output in Nigeria has to inculcate these main objectives.

2.3.1 Definition and concept of productivity

Determinations of improving productivity has beena major concern of any profit oriented organization as representing the effective and efficient conversion of resources into marketable products and determining business profitability (Wilcox*et al.,*2000).Consequently significant effort has been focused to the understanding of productivity concept, with the different approaches taken by researchers which resulted in an extensivevariety of definitions of productivity. Some of these definitions are identified chronologically in the table 2.1.

Table 2.1: Chronological Order of Important Definitions of Productivity

S/No	Author/Reference	Definition
1	Butler, (1988)	A ratio between output and input or in other words the amount produced against the amount of the resources used in the course of production
2	Olomolaiyeand Ogunlana,(1989)	The quantity of work done over a period of time.
3	Lema(1995)	The ratio of outputs to inputs in a production process.
4	Pitcher,(1997)	The rate of producing i.e. output divided by input.
5	Gupta *etal.,* (2002)	The output in any productive work in relation to inputs.
6	Oglesby*et al*., (2002)	The ability to produce an abundance or richness of output.
7	Enshassi,(2002)	The dollar of output per dollars of impact.
8	Attoh-okine, (2003)	The output of the system per unit time.
9	Ayodeji and Olotuah (2006)	The ratio of a specific measure of output to a specific measure of input per unit of labour
10	Enshassi *etal*..(2007)	The ratio of outputs to inputs
11	Nunnally, (2011)	Output per unit input of labour.

Source: Author’s Compilation, (2013)

Critical examination of these definitions prove that they are influenced by different philosophical perspective such as ways of improving productivity, profitability, economic growth, and a way of comparison between one method to another. For these perspectives to come into play, management has an important role to play. According to Nunnully (2011) management is responsible for planning, organizing and controlling the work. If these management responsibilities were properly carried out, there would be few cases of workers standing idle waiting for job assignment, tools and instructions. The study is more or less concerned on the time to accomplish a set task within a specific operation. The definitions by Olomolaiye and Ogunlana, 1989;Attoh-Okine (2002); Ayodeji and Olotuah, (2006) and Nunnally, (2011) may be considered relevance to the study. In tis study, productivity is defined as the quantity (output) accomplished by an operative within a specific time (input) in a specific trade. From the above definitions it is concluded that productivity is generally defined as the ratioof outputs to inputs.

$$\text{Productivity} = \frac{\text{Outputs}}{\text{Inputs}}$$

It is important to specify the inputs and outputs to be measured when calculating productivity because there are many inputs, such as labor, materials, equipment, tools, capital, and design. However, Herbsman and Ellis (1990) identified the complexity associated with operation of conversion process from inputs to outputs, which are influenced by the technology used, by many externalities such as government regulations, weather, unions, economic conditions, management, and various internal environmental components.

2.3.2 Construction productivity

Construction productivity is fundamental to the value for money obtained by construction client. The productivity rates are related to many other subjects in the construction process such as cost estimating, activities scheduling, cost control, labour resources, and payroll (Herbsman and Ellis, 990). Therefore accurate determination of productivity is very important but productivity measurement in construction is a complex issue because of the interaction of labour, capital, materials, and equipment and varying effect of various site conditions on productivity rates of most standard construction items.There have been several approaches to the classifications of productivity (Kane, et al. 1980)

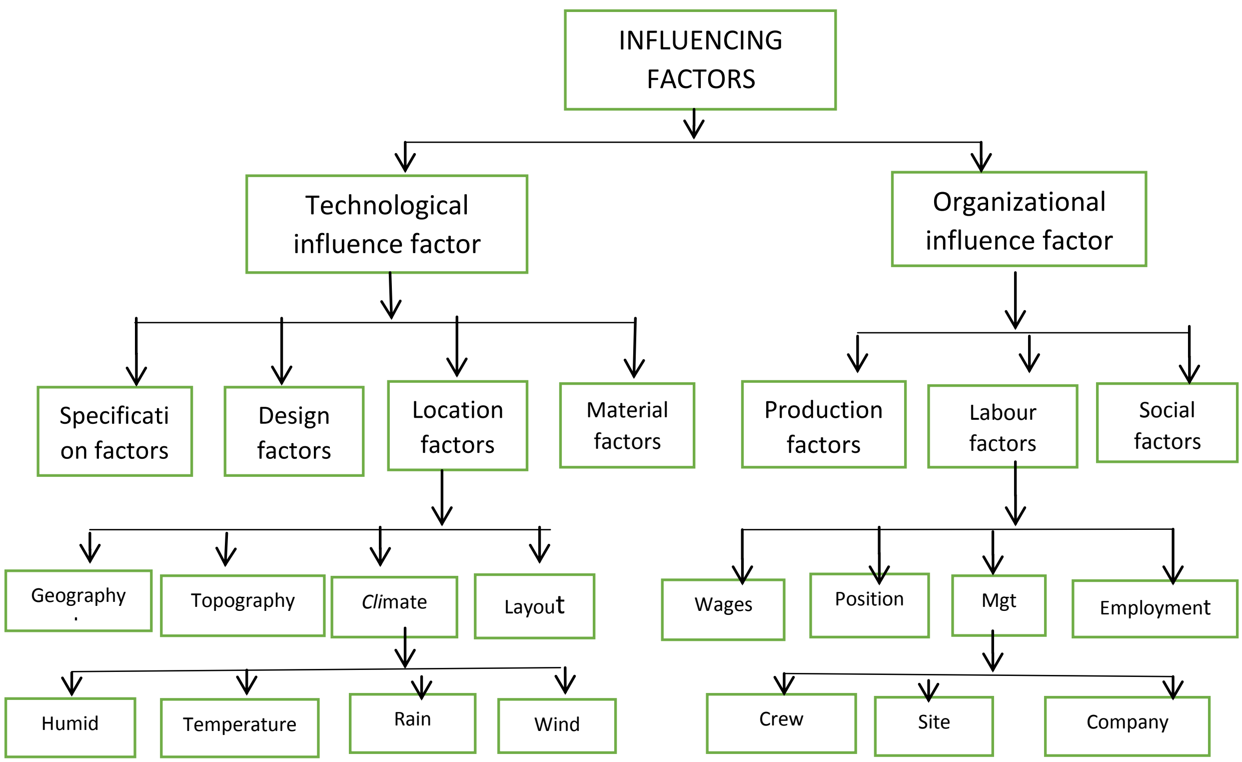


Figure 2.1: Schematic chart for classification of CPIF.

Source: Herbsman and Ellis, (1990)

According to Herbsman and Ellis, (1990) factors affecting construction productivity has been classified into two main groups: technological factors and administrative factors. The technological factors encompassed those related mostly to the design of the project. The administrative factors are related to the management and to the construction of the project.

The distinction between two groups explained from a different perspective. If the influence factors can be determined in the preconstruction stage it is likely that it will be from the first group (Technological factors). However if the value of the influence factors can not be determined in the preconstruction stage it is likely that it will be from the second group (Administrative factors). Technological factors have subgroups such as design factors, materials factors, and location factors. Administrative factors group have subgroups such as construction methods and procedures factors, equipment factors, labour factors, and social factors.

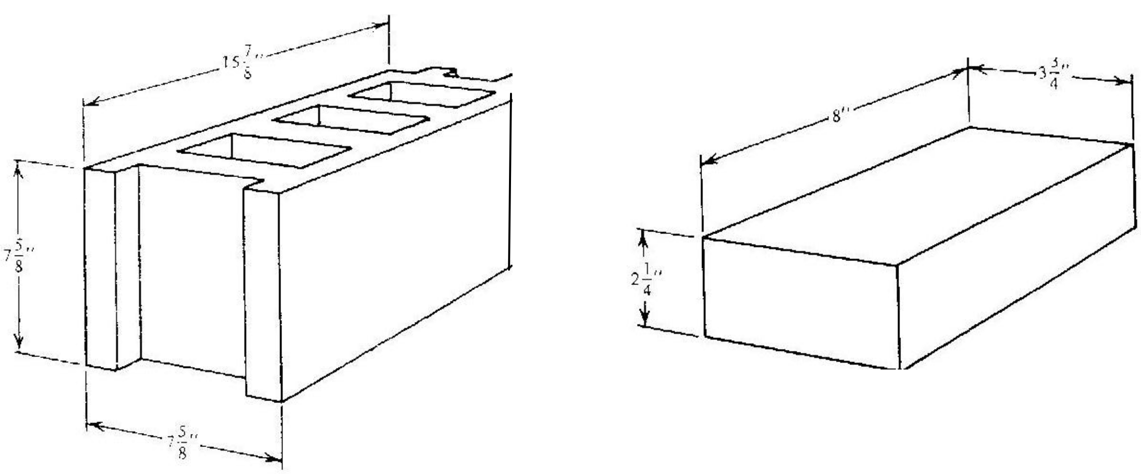
2.3.3 Factors affecting construction productivity

The factors that influence construction productivity have been the subject of inquiry by many researchers. In order to improve productivity, a study of the factors that affect it, whether positively or negatively is necessary. Making use of the factors that have a positive effect, and eliminating (or controlling) factors that have a negative effect will improve productivity. The authors/references with their aims and the identified influencing productivity factors are presented in a chronological order as shown in appendix2. In spite of such intensive investigations, researchers have not agreed on a universal set of factors with significant influence onproductivity nor has there been agreement on the classifications of these f actors.

2.3.4 Factors affecting productivity of block layer operatives

The most common and basic walling building units are masonry blocks and bricks, less common materials include various types of stone and tile. Blocks are mostly commonly used; they can be designed as part of the load-bearing foundation or as an exterior or interior load-bearing wall (Adrian, 1982). In Nigeria, like most parts of middle-east of

African and other countries of African, concrete block known as sand crete block are made from a mixture of hard, durable and clean sand, cement and water. On setting and hardening the blocks attain sufficient strength to be used as walling units. It is usually made up of (1:6) mix of sand and cement and the block can be made hallow or solid (Ayeni, 1997). Not all masonry blocks are designed to be structural members. Non-load-bearing masonry blocks, often referred to as cinder block are often used in non-bearing interior walls within a building design. In addition to the fact that many types and quantities of masonry units might be included in a specific building design; the estimating of masonry work is perhaps characterized by two additional distinguishing features. (Adiran, 1982):



Hollow Concrete Block (inches) Standard Brick (inches)

Figure 2.2: Standardized block and brick size

Source: Adrian 1982

1. The cost of masonry work especially dependent on labour productivity. Masonry works are more labour intensive; the labour cost for placing masonry units (especially brick works) can exceed the material costs of the units. This strong

dependence on labour productivity draws attention to the estimators need to focus on the collection and use of accurate mason productivity records and labour-cost data.

2. It is that seldom if ever is the actual number of masonry units delineated on the drawings. The estimator is left to determine the actual number of units, which would be needed in a specified area.

A building is commonly designed to accommodate the use of a standardized concrete block size. Unlike concrete that is designed to be shaped in numerous sizes, masonry blocks are only available in finite number of sizes and quality. The common sizes usually used for construction are 450 by 225 of 225, 150, 125, 100mm thick. A standardized concrete block is illustrated in the figure 2.2 above.

It is expected that the labour output of these various sizes and types varies, because of some factors. Thus; it will take an operative of 225 thick hallow concrete block more time to lay than an operative laying 150mm thick in terms of mortar placing and filling the joints, likewise 225 thick hallow concrete block than sand concrete block in guiding the mortar against falling into the block holes. However, Adrian (1987) identified the following factors affect labour effort and cost for placing concrete block:

a. Size or shape: A mason has to lift, set and grout each of the blocks.

b. Non-standard blocks affect labour output than standardized blocks affect: Given this variable material cost for each block, a strong argument can be made for identifying each block size or type of block i.e. a concrete block verses a cinder block as a separate work item for the quantity take off function.

c. Location of the masonry work to be performed: The productivity of a mason is greatly affected by that factors e.g. masonry work perform at a height above ground level requires the construction of a working platform (Scaffolding) and the lifting of blocks to the work location unit labour cost. Similarly, productivity for placing blocks on a first floor elevation would be lower than the third floor and so on.

d. Continuity of the masonry work to be performed. The labour effort and cost for placing masonry units also is dependent upon the continuity of the work masons can place block for straight wall with no block outs at a near optimal productivity. Hence when there are irregularities, the mason has to place the block around the opening and perhaps construct a lintel. The breaking of the continuity of the wall area, and the need to align the masonry work to the opening significantly lowers the masons productivity, perhaps representing as much as 50% of the straight wall productivity.

Because labour productivity and cost vary as function of these identified factors, it can be argued that consideration be given in defining work items.Anderson *et al.* (1996) reported that the common reasons for low productivity of masonry operation in construction sites are: Supervisors looking after too many; dissatisfied workers with a perceived grievance (for example low pay); very heavy work on a hot day; waiting for materials; waiting for tools; waiting for instruction; machine breakdown; waiting for another worker to finish so they can follow on (poor site layout); working in a confined space and getting in each others way; and working gangs are out of balance (e.g. too many laborers to one mason);In a study conducted by Enshassi *et al.,* (2011) and Abdullahi*et al*., (2010) on the impact of productivity factors on labour output for block work revealed that the following factors have significant effect on block laying productivity;

- Age of the operatives;
- Period of the work;
- Style of payment to the workers;
- Experience of the workers;
- General level of supervision;
- Tools and equipment ;
- Gang size and
- General site condition.

2.4 Review of the Sources of Output Constant in Nigeria

The British Research Establishment (BRE) studies only reported the overall labour variability for house building, but no attempt was made to quantify or explain the performance variability with regard to possible causes or factors that will affect the output of labour on the site and therefore the database used in the previous studies are questionable and are primarily based on activities sampling or data reported by tradesmen. These factors are very difficult to consider during the measurement and estimation of production rates due to vary and unique nature of every project (Mostafa,2003).

Yates and Swegate (1993) also stated that productivity of workers is influenced by factors which varied according to geographical factors. Reviewing further of these assertion, geographical factors are attributed to humid, temperature, rain, wind all these definitely affect the productivity of worker. In a geographical region where there are seasonal variations, productivity varies from other seasonal productivity.Olomolaiye*et al.,* (1998) added that the factors affecting construction productivity are rarely constant and may vary from country to country from project to project and even on the same project depending on the circumstance. Furthermore, the geographical location influence on labour productivity was justified by Enshassi *et al.,* (2011) in a research on labour Productivity Measurement in Building Projects in Palestine; Moreover the findings showed that skilled labour has high productivity in laying block 10 on Sunday, Monday, and Wednesday while lowest productivity of skilled labour in laying blocks 10 on Thursday. This confirmation cannot be true in Nigeria. In a study conducted by Olomolaiye*et al.,* (1987) on activity sampling study on Nigerian construction site revealed that block layers spent 51% of the day in productive work while Adnan *et al.,* (2011) revealed 77.01% on productive work spent by the Palestinian block layers. The difference in labour output might be attributed to a lot factors which geographical factors can not be ruled out either physical requirement due to dieting or cultural influence on building design and construction techniques.

A critical examination of numbers of estimating textbooks being used for teaching estimating skill in Nigeria tertiary institution of higher learning as relate tohollow sand crete block component in Nigerian building industryreveals that there is no reliable and congruent data for sand crete block component among the authors and this disparagement could be either the hollow sand crete block is not commonly available in their geographical localities of the authors or no universally quantitative research on labour output in Nigeria has been conducted. This is a clear indication that much needs to be done to incorporate certain cardinal features apparent in our designs as well be reflected in construction estimate.

Table 2.2: Examination of Inconsistency of Labour Output from Estimating Textbook Used in Tertiary Institution of High Learning

Authors	150mm thick Hollow sand crate block (m²/day)	225mm thick Hollow sand crate block (m²/day)
Bailey (1964)	NA	NA
Hall (1972)	7.78	7.0
Wainwright and Wood (1977)	NA	NA
Entenkin and Reynold (1978)	NA	NA
Adrian (1982)	NA	NA
Alabi and Milne(1987)	7.0	7.0
Ayeni (1997)	11.67	9.33
Onwusonye (2006)	8.65	8.65
Aderonke (2008)	8.00	7.00
Brook(2010)	10.5	8.24

Note:NA=Not Available.

Source: Author's Compilation (2013).

The table 2.2 above shows that almost the foreign authors did not establish labour outputs for hollow sand crete block and they rather preferred considering other walling components to block walling component .And where it is considered, it is discovered that the common sizes available in Nigeria are not considered in their studies. Also, for some of them that were able to come out with the labour output constant there values are at variance among other labour outputs determined.

However,related literature on labour output in Nigeria, the effect of labour cost on building project, though important has not been exceptionally treated because of scare literature on labour underlying forces (Udegbe, 2007).Consequently, some studies have been carried out in Nigeria for some selected trade with the aim of determining labour output, but the researchers did not based their work on BESMM.Olomolaiye and Ogunlana (1989) evaluated the production outputs in key building trades such as joinery, bricklaying, and steel fixing in Nigeria. The researcher adopted time study technique. The operations output were estimated through (claimed output) and compared with the output measured through time study. It was found out that there were varying degree of excess production capacities yet untapped in the trades. The research was not aimed at determining labour constant. It was only interested to justify that operatives were not used to the full capacity. The productivity influencing factors were not pronouncedly captured in the study.

Ajia (2002) conducted a research appraising work output on construction sites for concrete and block work in Zaria and Ilorin of Nigeria. The field surveys were carried out through the use of well structured questionnaires to collect information regarding the output constants used by contractors in preparing their estimates.Similarly, work measurement technique was used for the physical observations carried out. Standard time study sheets were prepared and used to collect 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. The results finding recorded $8m^2$ output of block work per day and further concluded that gang formations were inadequate for all trades on all the sites investigated and that is likely to affect productivity. However, productivity factors were not captured in the study.

Udegbe (2005) carried out a research determining labour output of plastering work in Edo State. It was a ten year extensive quantitative research on trends and patterns of the productivity levelof plaster. A work measurement technique was used to establish all the outputs for the study. A significant decline in output was observed over the years which were attributed to labour tactics and economy. The result also revealed an average output/day of 37.01m^2 over the years and recommended a minimum of 36m^2 of wall surface a day. However, if these outputs have been constant or fluctuate under the period revealed, it would have been a good basis for determination of labour output, though some influencing factors have been attributed for the decline.

Udegbe (2007) conducted research determining labour output on painting activity in the construction industry in Edo State, Nigeria. The study aimed at identifying factors that can affect painting activity output in building construction. The researcher adopted work measurement technique using measuring tape and stopwatch. The researcher concluded that painting should cover a minimum surface area of 76m^2. The study concentrated on the factors that can affect painting output. The output constant was not looked into and this also is an indication that different trades have different factors affecting its level of output.

Abdullahi, (2009) conducted a research on determination of labour outputs for the Nigeria construction industry (a case of Kaduna metropolitan city). The research aimed at using work study approach; to empirically establish labour output for trench excavation, 225 block work and plastering/rendering. Considering the construction productivity influencing factors the result of the analysis carried out, established general average output per day at 19m^3, 10m^3 and 30m^2 for excavation, block laying and plastering/rendering respectively. The researcher did not take cognizance of the contract employed workers whom certain welfare and motivational allowance are provided unlike the negotiated and daily paid workers. The NJIC recommends certain facilities to be provided to the workers to facilitate their efficiency. These facilities are built in the all-in labour rate used for the preparation of unit rate in bills of quantities, it therefore become obvious that the contract employed workers are the more targeted workers for labour productivity than negotiated workers and daily paid workers. And, also consideration was not given to design data (measurement factor) hence output varies with location (Thomas *et al*. 1991; Herbsman and Ellis 1990 andAdrian 1982) especially for block laying operations.However, BESMM is silent over the measurement factors in respect to height location which affects productivity. Abdulrazaq*et al*. (2010) conducted research on determining labour output on form work for construction projects in Kaduna metropolitan town based on work study technique and the research revealed an output per gang at 153.97m for formwork to sides of column and slabs and $30.91m^2$ to soffits of slab and beam. The measurement factor is not in compliance to BESMM as stated in E20.8, E20.12 and E20.13 which are the basis for preparation of bill of quantities operation cost significance to productivity.

Olatunde,*et al*. (2012) conducted research on effect of pour size on concrete placing productivity in Nigeria. The research was aimed at investigating the influence of pour size which is one of the site factors and activities on the productivity. The daily outputs of various placing concrete methods were analyzed to determine operational productivity rates. The results showed that irrespective of placing methods, productivity generally increased by $1.1m^2$ for every $10m^3$increases in pour size. However, the outputs of various techniques vary significantly and therefore the output determined can not be used as a guide for labour output constant. The technique was not suitable to determine labour output hence the aim was to determine the most efficient technique to produce high output. The established outputs of these researchers formed a basis, even though there were some lapses to challenge the reliability, the accuracy and the application of the British labour output constant being used for preparation of cost estimates for construction projects in Nigeria (Ajia 2002; Udegbe, 2005; Abdullahi, 2009 and Abdulrazaq etal. 2010).

2.5 Work Study Techniques

B.S. (1979) defines work study and organization method as a management service based on those techniques, particularly method study and work measurement, which are used in the examination of human work in all its context, and which lead to the systematic investigation of all resources and factors which affect the efficiency and economy of the situation being reviewed in order to effect improvement.Different techniques were identified such as the craftsmen survey technique (Chang, 1986), foremen delay surveys, time-lapse photography, videotaped recording snap observation (Whitehead, 1986) and time study, activity sampling, craftsman questionnaire (Enshassi*et al.*, 2011).Olomolaiye and Ogunlana (1989) stated that because of the diverse nature of the industry, there is no universally accepted technique for measuring output in construction operations.

2.5.1 Types of work study techniques

The two most commonly work study techniques are;

a. Method study

b. Work measurement

These two basic techniques are complimentary to each other (Butler, 1988; Cole, 1996 ; Pilcher, 2005) and are rarely utilized in isolation from each other.it was further added that even though either of these techniques can be applied to problem solving without the other, best values and results are obtained by carefully combining the two together. Cole (1996) further argued that the usual and best practice is that a method study to precede a work measurement. The observer should critically select and examine methods first before studying their established time at defined level of performance.

2.5.1.1 Method study

Method study is defined in BS3138 (1969) as; the systematic recording and critical examination of the factors and resources involved in existing and proposed ways of doing a work, as a means of developing and applying easier and more effective methods and reducing costs.According to Cole (1996) method study is composed of the collection of techniques, all of which systematically examine and record all the methods utilized in an operation with a view to increasing efficiency. It attempts to answer the questions;What, When, How, Who andWhere. The main objective of a method study technique is to see whether a job is being performed in the most efficient and economical manner (Cole, 1996, Pilcher, 2005; Barnes 1980, Foster *et al.*, 1991). Pilcher (2005) added that method study is objectively concerned with obtaining higher productivity by improving methods of production. And if properly used would result to higher productivity through an improved production facility layout, a better environment for work, reduction of danger for fatigue, improved quality of work and better plant and equipment design.

2.5.1.2 Work measurement

B.S. 3135 (1969) defines, work measurement as the application of the techniques designed to establish the time for a qualified worker to carry out a task at a defined level of performance. However, Gagnon (2000) reported that a qualified worker is one who is rated as having the necessary physical and cognitive attributes, and having acquired the necessary skill and knowledge to carry out the work in hand to enhance standards of safety, quantity and quality.Work measurement is described in the dictionary of management as an integral part of the work study process in which a variety of subjective methods like work sampling are used to fix a standard time for the acceptable performance of a given task by a trained worker (Hartzell, 2006).

Consequently, the above definitions generally entail the determination of standard job which is used as a vital input towards improving organizational productivity. The benefit of work measurement techniques can help managers to measure the times needed for specific tasks, essential information for planning and estimating, which helps in measuring performance at different times during construction (Ajia, 2002). Literaturereview has shown that work measurement is an excellent technique for determination of labour outputs.According to Abdullahi ,(2009) the objectives of work measurement are summarized as follows:

a. To assist in method study;
b. To assist in cost control;
c. To assist in implementing total quality management;
d. To assist in planning and scheduling of labour, plant and materials;
e. To provide a basis for incentive schemes;
f. To assist in measuring the performance of skilled labourer;
g. To compare different methods of working.

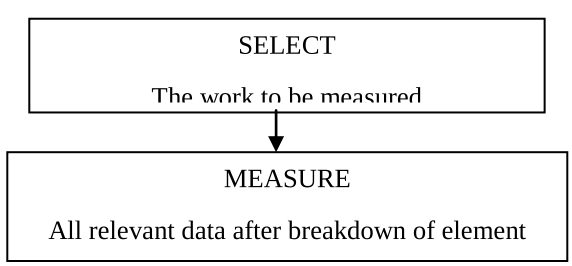
2.5.2 Procedure of work measurement

According to Cole, (1996) the main intention of a work measurement procedure is to collect actual data about actual events and such collection process undergoes a number of stages termed as work measurement procedure.However, the major stages of work measurement vary depending on nature and level of data collection and measurement, and the nature of the synthesis process and the nature and degree of analytical estimating, all work measurement systems are based on the same simple procedure (Abdullahi, 2009);

Data collection and Measurement Stage:it is essential to collect descriptive or qualitative data on the nature of the task, the conditions under which it is performed and other factors which may have influence on the time that the task takes to be completed. However, when repetitive jobs are measured, data are collected over a number of representative cycles of a job to obtain a “mean” or “typical” value.Statistical techniques are usually used to determine the number of observations that must be made to provide a given level of confidence in the final results.

Synthesis Stage: At this stage the several parts of the task and their associated basic time are combined together in correct order and with correct frequency to produce time for a complete job. The basic time during this stage will be adjusted for allowances to become the standard time for the task.

Analytical EstimatingStage: This is similar to synthesis, but where element times are not in the library they are estimated; this means that any small items of a task requires to be assessed and not the whole. This is often used in repairs and maintenance;it requires considerable skill to do satisfactorily.The simple general procedure for work measurement can be presented as shown in Fig. 2.3 below:



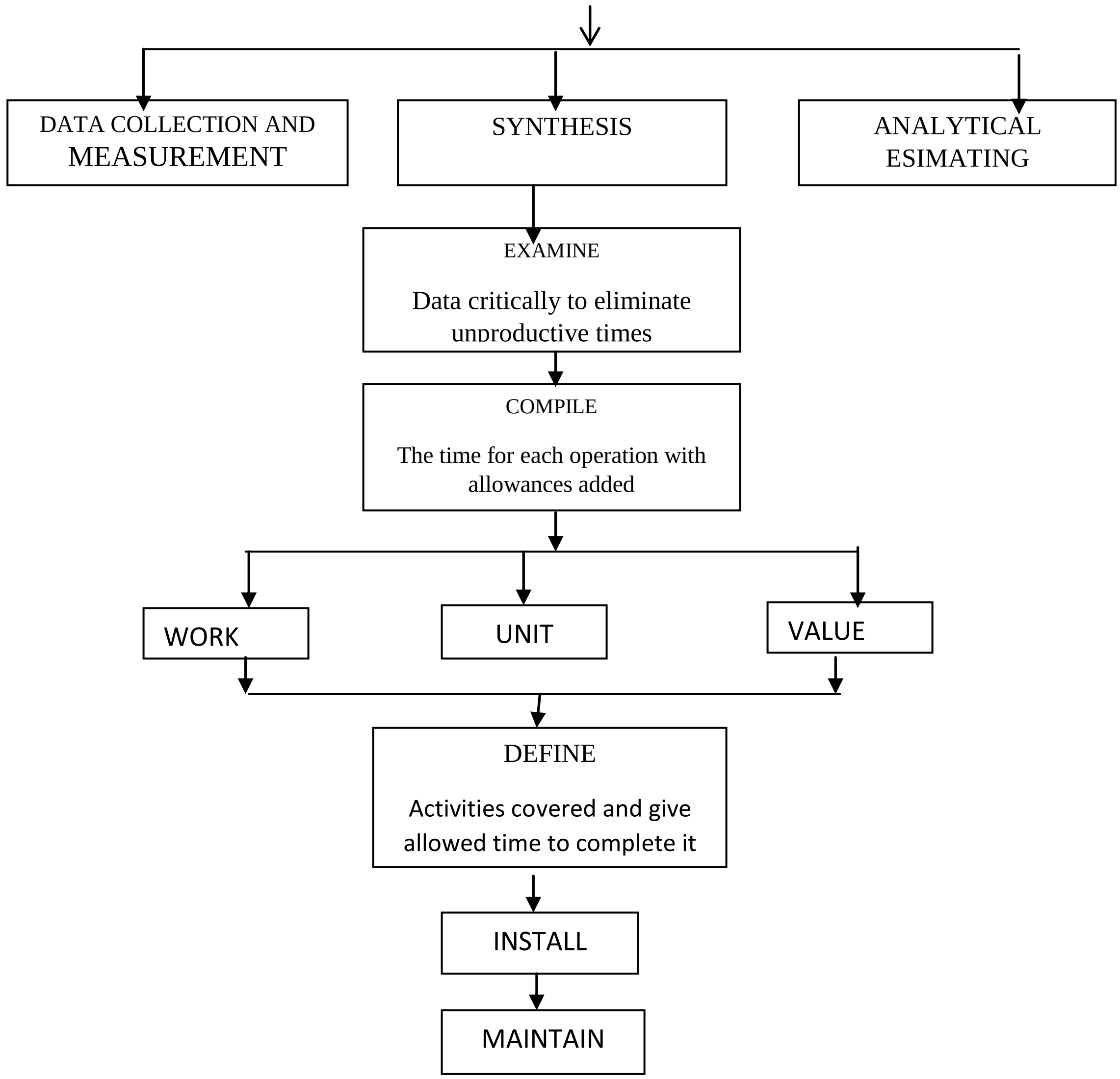


Figure 2.3: Outline Procedure of Work Measurement

Source: Butler, (1988)

2.5.3 Workmeasurement techniques

There are various techniques often used for measuring labour productivity in construction projects (Enshassi*etal.*,2011):

- Time study;
- Activity sampling;
- Foreman delay survey;
- Craftsman questionnaire;

2.5.3.1 Time study

Time study was the fundamental approach to productivity improvement introduced by Taylorand Gilbreth in the late 19th and early 20th centuries, and it is the principle technique of workmeasurement even today (Olomolaiye*et al.*, 1998). According to Barnes, (1980) time study is used to determine the timerequired by a qualified and well-trained persons working at normal pace to do a specified task.For time study to be effective,Pilcher, (1997) andOlomolaiye*et al*.,(1998) the following steps should be involved:

- Familiarization with the work to be studied;
- Timing to discover how long various operations are taking;
- Rating to assess the worker being observed against a norm;
- Building up of time standards by allowing for appropriate relaxation and contingency allowances.

The values established through time study technique provides an analytical basis for budgeting and controlling human resource costs.It can be an important aid to increase productivity by providing standards against whichperformance can be planned, monitored and improved ((Armstrong, 1990). The main difficult in using time study techniques for labour productivity studies in developing countries is the lack of work study experience not only in construction but also in manufacturing (Enshassi*et al.*, 2011). Time study is an important technique for determination of labour output constant and the procedure involves the following stages (Ajia, 2002andMostafa, 2003).

Time study equipment:

Time study requires numbers of equipment to measure and record output information and consists of stop watch,study board and pre-prepared time study sheets, hand calculator, tapemeasure, micrometer, etc. depending upon the type of work (Harris *et al.,* 1995). The stop watches are of various forms. The simplest type, with one hand is not recommended since itcan accumulate an appreciable error if the watch is stopped and read at the end of each cycleelement (Olomolaiye*et al*., 1998). The popular type has a large hand which completes oneminute per revolution and is graduated in hundredths of a minute while the small handrecords cumulative time up to 30 minutes in one minute graduations. A fly back mechanismon the large hand allows the timing of elements to start at zero for each element withoutaffecting the elapsed time shown on the small hand (Harris *et al.*, 1995).

Selection of operator to be studied:

It is important before one chooses the operative to be studied; the consent of the foreman be soughton the normal working.Ajia (2002) further argued that, although theoretically choosing the slowest or the fastest worker will not make much difference, but it will be more difficult to rate a slow worker.Preferably one should not choose a beginner, because the method or work will be different from when the person has attained greater efficiency through experience in the job.

Rating:

Since the objective of the time study is to obtain a realistic time for the element, the timestudy observer must additionally make a judgment on the effective rate of working of theoperative under observation since the elapsed time observed for one worker my be differentfrom another doing an identical task (Harris *et al.* 1995). British Standard (BS) 3138 definesrating (cited in Olomolaiye*et al.,* 1998) as "to assess the workers rate of working relative tothe observer's concept of the rate corresponding to standard rating". Thus in addition totiming the observer should also assess the rate of working for each time element. To do thisaccurately the time study expert must have correct concept of standard rating, whichcomes only from practical experience and training in judging different speeds of movement, effort, consistency, and dexterity (Olomolaiye*et al., 1998).* Also, *i*n the judgment of Barnes (1980)the weighing of these rating in comparison with the British Standard is given below;

a. 0 = inactivity
b. 50 =very slow ineffective with no real interest
c. 75 =unhurriedly, but the operator is meaningful and Producing a normal rate pay
d. 100 = Standard rate with the operative working at a speed Sufficient up to 33% bonus on top of normal earnings.
e. 150 =exceptionally fast

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

- Effectiveness. This implies application of correct and effective methods, the good signs being correct choice of tools, shortest path of movement, adherence to the best method,avoidance of unnecessary activities, tidiness and systematic arrangement of tools and materials;

- Skill. Sureness of touch or sequence, intelligent application of movements and events, effective use of both hands and so on; and
- Speed. This implies diligence, steadiness and continuity; the good signs being rhythm, speed of movement, steady effort, making the job look easy.

Basic time:

The basic time is the time in which an element is completed if it is undertaken at astandard rating. It can be calculated as follow (Pilcher, 1997):

$$\text{The basic or normal time for a job} = \frac{\text{Observed time x Observed rating}}{\text{Standard rating}}$$

Allowances:

Workers carrying out work over a complete shift or working day obviously suffer from fatigue imposed both by the workundertaken and the working conditions. And the normal practice is to make an addition to the basic time (commonly referred to as “allowance”) to allow the worker to recover from this fatigue and attend to personal needs (Lawrence, 1993).

Therefore, to produce such a realistic standard time for the proper performance of the work, the idle time and relaxation periods observed during the study but excluded is added back as allowances to give the standard time.Foster *et al.*, (1991) and Barnes (1980) showed that there are basically two types such allowances;

- Relaxation allowance and
- Contingency allowance

Relaxation Allowance: Pilcher,(1997) reported that relaxationallowance consists of two components;one is an allowance for thepersonalneeds of worker such as an occasional stretch, a visit to the toilet, and having a drink ofwater; the other is an allowance for fatigue while Olomolaiye*et al.*, (1998) added that both allowances are normally made by adding apercentage to the basic time. Allowance for the personal needs of worker can be assessedwith a reasonable degree of accuracy but allowance for fatigue is very difficult to assess butmany companies and industries make their own recommendations.Relaxation allowance according to Foster *et al., (1991)* is the time given to a worker to recover from the effects of fatigue and to attend to personal needs. It is given as a percentage of basic time and as a result of factors like; energy output, posture, motions, visual fatigue, personal needs, thermal conditions, atmospheric conditions such as ventilation, toxic air e.t.c.Other influences of environment such as dirt, noise, vibration of flows e.t.c. Foster *et al.*, (1991) indicated that relaxation allowances are not expected to be over 30%, other mechanical aids is provided or alternative methods found. However, some exceptional types of works require between 150-200% due to high temperature, excessive humidity, the need for special clothing and respiration. Care should be taken in adjusting the relaxation allowance, which is subject to judgments of the work study expert.

Contingency allowance: In addition to relaxation allowances a further amount is added to the basic time to covercontingencies. Harris *et al.*, 1995) identified the following typical contingencies and can either be added as apercentage to the basic time or as absolute time itself:

i. Adjustment and maintenance of tools;

ii Waiting time caused by subcontractors, machine breakdowns, lack of materials,etc;

iii Unexpected site conditions, e.g. bad ground, high winds, and bad weather;

iv. Learning time;

v. One-off tasks; and

vi . Design changes.

Standard time:

Standard time is the appropriate time required for a qualified worker working at standard rating tocomplete a task. If this is achieved then the worker is considered to have achieved standardperformance (Olomolaiye*et al*., 1998). According to Mostafa, (2003), B.S. defines standard performance as the rate of output which qualified workers will naturallyachieve without over exertion as an average over the working day or shift provided they aremotivated to apply to their works. Thus standard time = basic time + relaxation allowances + contingency allowance.This implies that the optimum value is attained in assumption of the above attributes have been considered. Because construction work is characterized with so many variablesthat the difference between standard time and basic timefor a job can be quite large and as a consequence, most records or data banks of output times arekept as basic times, with the user applying suitable contingencies as necessary (Harris *et al.*,1995).

Number of observations:

According to Olomolaiye*et al.*, (1998), the correct sample size is difficult to determine accurately but the simplest method is to plotthe cumulative average basic time, preferably for a short succession element against the number ofobservations. When the line begins to stabilize, sufficient number of observations hasprobably been taken.

Time study procedure:

Time study procedure can be summarized as follows (Barnes, 1980):

i. Determine the objective of the study and select the operation to be observed;

ii. Divide the operation into elements;

iii. Select the time study method and equipment to be used;

iv. Make a sketch of the piece and of the work place;

v. Secure the cooperation of the workers to be observed and their Forman; and

vi. Record as much detail about work as possible**.**

When the study is completed, check to make certain that sufficient number of observationshave been taken.

Limitation of time studies:

The main difficulty in using time study techniques for labour productivity studies indeveloping countries is the lack of work-study experiences not only in construction but alsoin manufacturing (Lema, 1995). Other difficulties in using time study techniques can besummarized as follows (Olomolaiye*et al.*, 1998):

- The number of workers studied by one observer is limited which requires employment of several observers making manual study prohibitively expensive;
- The information obtained by time studies is limited to the times recorded and facts that can be interpreted from the observers notes which may not cover sufficient details such as interdependencies among components, exact reasons for taking longer or shorter elemental times. These will increase the variability and reduce accuracy; and

- The data cannot be assembled quickly especially in civil engineering where the variables on site complicate the interpretation of information as the relaxation and contingency allowances needed often considerably exceed the required basic time.

The collation of related productivity influencing factors to the specific trade may require a number of considerations during operatives' observation. Abdullahi et al., (2010),hypothesized number of indiscriminate productivity influencing factors for the three distinct operative trades observed, however, consideration was not given to the uniqueness of productivity impact on trades.

2.5.3.2 Activity sampling

Activity sampling is defined as a technique in which a large number of instantaneousobservations are made over a period of time of workers, machines, or processes. Eachobservation records what is happening at that instant and the percentage of observationsrecorded for a particular activity or delay is a measure of the percentage of time during whichthat activity or delay occurs (Thomas *et al.*, 1986). The effectiveness of activity sampling is appreciated in gang operation especially where there are distinct classes of skill. It enables to determine which workforce is at optimum production and also provides thenecessary information to help determine how time is being employed by the workforce,identify the problem area that cause the work delay, and set up a base line measure forproductivity improvement. The main advantage of using activitysampling is that it allows a larger number of machines or men to be studied at one time thatcan be managed using a continuous time study. This leads to a broader picture of theefficiency of a particular operation than that obtained from a more concentrated butcontinuous study on a smaller group (Pilcher, 1997).Activity sampling can also refer as Ratio survey;Observation ratio;Snap reading method;Random observation method; andWork sampling (Mosafa, 2003).According to Oglesby *et al. (*2002), the general rules for activity sampling to be observed in sampling constructionare:

a. The observer must be able quickly to identify the individuals to be included in andexcluded from the sampling;
b. There should be an equal likelihood of observing every worker;
c. Observation must have no sequential relationship;
d. The basic characteristics of the work situation must remain the same while theobservations are being made.

Activity sampling concepts based on two facts;First fact is a working day can be subdividedinto three major parts: productive, contributory, and unproductive time (Oglesby *et al.*, 2002):

Productive Time: time spent in elements directly involved in the actual process of puttingtogether or adding to a unit being constructed;

Contributory Time: time spent in elements not directly added to but essential to finish the unit;

Unproductive Time: idle time or time spent in not useful or all other elements.

Second fact on which activity sampling based is small number of chance occurrences tends toform the same distribution pattern as the whole operation. Thus it is a mathematical techniqueclosely associated with statistics and the theory of probability (Olomolaiye *et al.*, 1998). Activity sampling being based on a sampleof observations must adhere to certain statisticalprinciples and rules to obtain a proper representation of the studied operation.

Any samplingcarried out should be large enough to be statistically valid – can be used to predict thecharacteristics of studied operation with a desirable degree of accuracy.

2.5.3.3 Craftsman questionnaire

According to Olomolaiye et al., (1998) craftsman questionnaire (CQ) is used to examine the problems that adversely affect workersproductivity and motivation. Assessment of loss of time due to various causes, ranking the severity of the problems and provide potentialsolutions to productivity problems using questionnaire is required. The questions that are usuallyasked in this questionnaire are specific for each job site and each craft. Oglesby *et al*, (2002)identified a numbers of areas tobe covered in the questionnaire as:

- Craft area, type of work;
- Materials: availability, suitability, and conditions;
- Tool: availability, and conditions;
- Equipment: availability, and conditions;
- Rework: amount, and why necessary;
- Crew interferences: with what craft and reason;
- Causes of Overcrowded work areas;
- Availability of instructions and other information: what is missing and why;
- Inspection: reasonableness and whether or not done at proper time; and
- Hours per week lost from each of the above causes, by category

The questionnaire can be simple requiring only 15 minutes of an employee's time or longerand in depth, which takes 45 minutes or more. Careful planning,organizing, and implementation of questionnaire are required. Also,Olomolaiye*et al., (*1998) reported the need to effectively analyze the additional informationgathered. And this brings another approach to CQ which is called craftsman questionnaire sampling (CQS) whereby asample of workers selected and interviewers ask question on an activity in which theyare engaged. These questions cover the same topics as those of the CQ just described(Oglesby *etal*., 2002). The procedure of CQS is very similar to activity sampling; the CQSadministrator tours the site and randomly selects workers and supervisors by sight. According to Olomolaiye*et al.,* (1998) theselected workers are required to complete a simple questionnaire by asking them whether they were engaged in productive or unproductivework at the time they were chosen and as well as the detailed causes of unproductive work.CQ and CQS are more accurate and revealing information about production problems gathered andsince information are collected directly from the workers and not through the normalchannels of communications, where information can be lost or manipulated for the benefit ofeither the sender or the receiver but CQ and CQS have disadvantages such as (Olomolaiye*etal.,* 1998):

a. Delay time estimate in the CQ and CQS are usually requested as number of hours lost perweek and hence are subject to under or over estimating, casting doubt on the validity of theestimates; and
b. It does not provide information about the efficiency of construction methods or thecompetence of the workforce.

2.5.3.4 Foreman delay surveys

Foreman delay survey (FDS) is one such method of exposing the production problems encountered by foremen through the identification of causes and quantification of delays in the dailyroutine of their workforce (Olomolaiye*et al.,*1998). Oglesby *et al*., (2002) added that the primary purpose of this technique isto identify the problems that are outside the responsibility and control of individual foreman. Depending on circumstance FDS can be conducted in several ways such as daily, weekly, daily for several weeks, or as the need may arise. The results ofFDS shows the major causes of work delay for each craft and the number of hours lostand by comparing the reported lost time with the causes of delays, project management cantake action to resolve the problems and to eliminate the delays (Alfeld, 1988). The survey iswidely used because it is simple and foreman can complete the form in a few minutes but thepotential weakness of this technique is found in the survey reliance on gross estimates byforeman of how much time they actually lose and hence there is doubt on its validity (Alfeld,1988).

CHAPTER THREE

3 RESEARCH METHOD

Research is a diligent and systematic investigation intended to provide acceptable answers to questions by following logically designed procedures (Abdul-Maliq, 2006). Ibrahim and Abdullah (2008) referred to research methodology as the way a researcher goes about doing the research, unfolding a particular style and employing different techniques for collection. It therefore follows that research methodology is an expression of detailed research plan to provide an acceptable answers to questions in a logical design procedure and sequence.This chapter depictsevery detail of how the research was conducted, that is research design/Approach, study population, research sample and sampling techniques, validation and reliability of the instruments used, pilot survey, procedure for data collection, instrument used for data collection, and instrument for data analysis.

3.1 Research Design/ Approach

The term "Research Design" is a strategy that will guide the collection and analysis of data (Madi, 2003). Research design is an action plan for getting from "here" to "there" where 'here' may be defined as the initial set of questions to answer and there is some set of conclusions (answers) about the questions (Mostafa,2003)The research design is the logical sequence that connects the empirical data produced by researcher to the study initial research questions and ultimately to its conclusion (El Sawalhi, 2002). The research design for this study is a descriptive form of research design aimed at collecting data for the purpose of describing and interpreting the existing conditions regarding the productivity of workers on sites. It involved the survey of hundred construction sites to identify the operation of ten block work items. This research design method was adopted for this study due to the nature of the research was purely "quantitative" developed to study the natural phenomena of the productivity level of construction operatives.Therefore, absolute numerical quantitative data were collected through site observation and structural questionnaire and statistically analyzed through deductive approaches to draw conclusions. Research sequence can be presented simply in the chart indicated below.

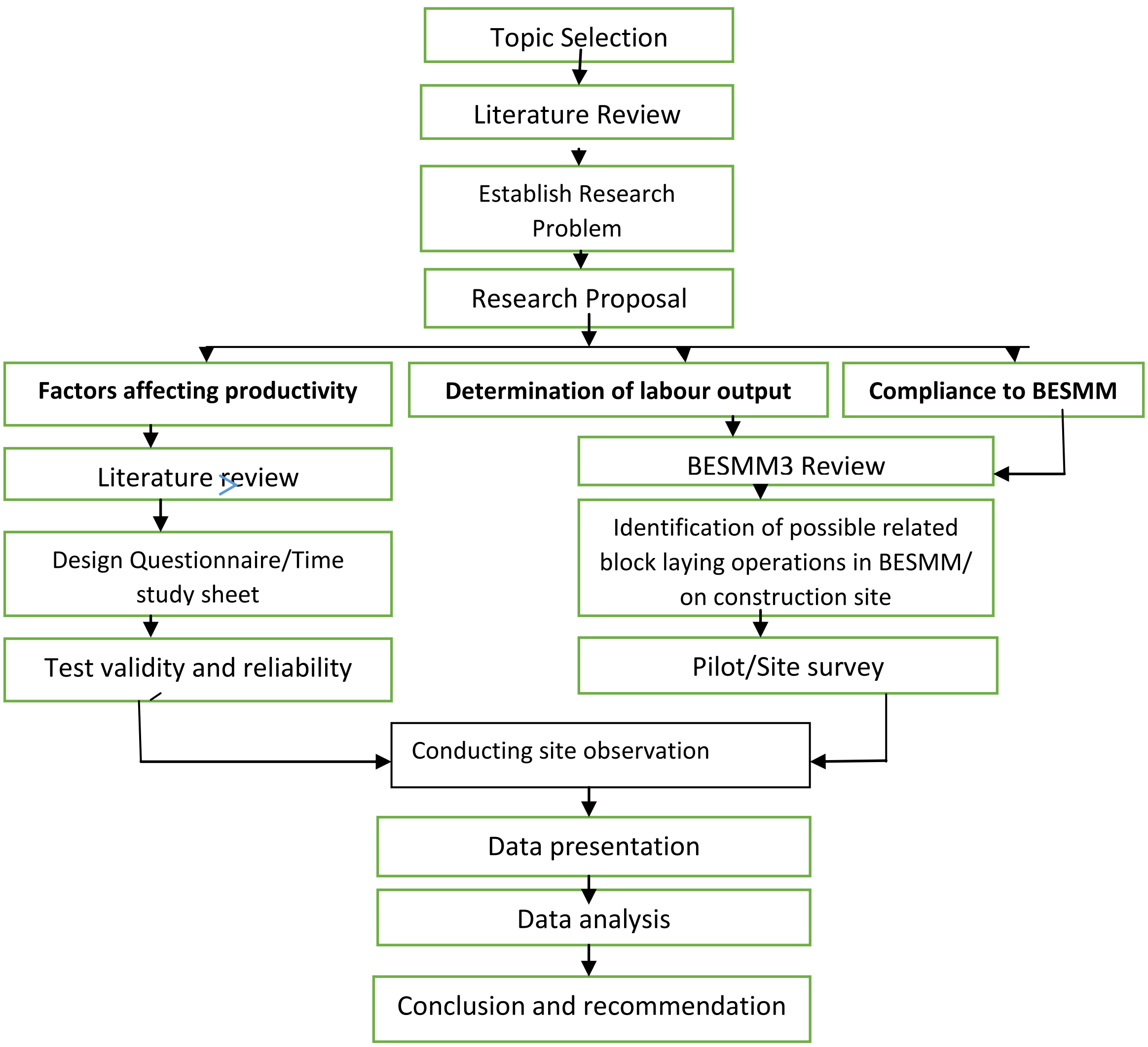


Figure 3.1: Chart showing research approach

3.2 Study Population

The research population is described as 'all conceivable elements, subjects or observations relating to a particular phenomenon of interest to the research that is, it is a totality of items objects, persons issues or observations who share at least a common attributes or characteristics on which the research is centered (Abdul-Maliq, 2006). The main objective of a study population is to define the scope of the proposed study (olufemi, 2007). The research population of interest considered in respect to this research study is the "*construction sites*" engaged in block laying operatives. The construction sites considered for this study are small, medium and large constituted mostly of building projects of residential, industrial and commercial for both public and private owners in Nasarawa state and Federal Capital Territory (FCT), Abuja. The research also captured the age distribution, gender, educational background, and experience of workers, mode of employment and all other relevant information of the population of interest.

3.3 Research Sample

Olufemi (2007) observed that every good research method should undertake a pilot survey which should enable the researcher to test and validate the entire data collection instrument to be used with the view to correcting any weakness, review the questionnaire or any other instrument used by various co-researchers or assistants. For the purpose of this research, it is relative important that the researcher anchored on the review of related trade to block work in BESMM and also possible work items as relate to block work in construction sites.

A list of work items extracted from BESMM3 as well as those possible work items in the construction sites was prepared to survey for their occurrence in 100 construction sites in

Nasarawa state and FCT, Abuja. Adopting the most frequent occurrence work items in the construction sites, ten work items were chosen for this study (See Appendix 3).

3.4 Sampling Techniques

A sample is a small amount or proportion of total selected to represent the population hence it is impossible for researcher to reach and obtain information from each and every member either due to time or logistic reason. A non-probability sampling method known as *purposive sampling* was strategically adopted in selecting all the construction sites of the study. All the sites were selected on the basis of permission granted by the site managers to have access to their sites for their workers to be observed. The sample characteristics of the operatives as relate to labour outputs were fully captured as the true representation of the study population (construction sites) and observed, thus;

Table 3.1: Sample Size of the Study

S/No	Work Items	No of gangs
1	150mm thick hollow sand crete block in foundation less than 1.00m deep.	68
2	150mm thick hollow sand crete block in superstructure	62
3	150mm thick hollow sand crete block in superstructure overhand	62
4	225mm thick hollow sand crete block in foundation.	62
5	225mm thick hollow sand crete block in superstructure	62
6	225mm thick hollow sand crete block in superstructure overhand	62
7	225mm thick hollow sand crete block isolated piers in superstructure.	55
8	225mm thick hollow sand crete block isolated piers in superstructure overhand	55
9	225mm thick hollow sand crete block in pit, plan area equal to or greater than 4 m^2 and depth 2-4m	30
10	225mm thick hollow sand crete block in pit, plan area less than $4m^2$ and depth less than 2m	30
	TOTAL GANG NUMBER	548

3.5 Validation and Reliability of the Instrument

To establish quality of any research, the researcher must deal with the validity problem. The validity of an instrument is defined as an integrated evaluative judgment of the degree to which empirical evidence and theoretical rational support the adequacy of inferences and actions based on test scores or other models of measurement (Mostafa, 2003). To improve validity, question should be worded to increase the likelihood that they will mean the same thing to each respondent. Also, interviewing the respondents during the pilot studies enable to determine where questions were unclear or misleading.While reliability concerns the consistency of a measure (Fellow *et al.*, 1997). A question is reliable if it evokes consistent response, that is, a person would answer the questions the same way in the subsequent interviews (Mostafa, 2003).For this research, the research supervisory team of the department of Quantity Surveying and some professional quantity surveyors, whom were met during the pilot survey and they are vast in labour productivity and construction estimates assessed the instrument. Each of them has full knowledge about the objectives, the scale of evaluation etc. The experts requested that inferential test be adopted for the analysis. Their criticism and comments improved the item structure and format. The validity and reliability of the instrument were determined through a pilot survey in some construction sites in FCT, Abuja.

3.6 Procedure for Data Collection

For the purpose of this research work two different methods were adopted for data collections;

3.6.1 Literature review

According to Abdul-Maliq, (2006), literature review is also called the library research, provides us with the basic concepts, laws, theories etc. that underpin the research topic as well as provides the past (distance and recent) information and knowledge available in that field and related areas. Besides enlarging and updating your knowledge about the topic, conducting a literature search lets the researcher gains and demonstrate skills in information seeking ability critical appraisal ability (Lawal and Adeyeye, 2006). It also assists in the synthesis of results into summary of what is known, and what is not known. It identifies areas of controversy in the literature as a basis for formulating questions for further research (olufemi, 2007).In this regard, a thorough and extensive literature search of both primary (that is, the knowledge gained during field study, interview etc.) and secondary (journals, articles textbooks, magazine, standard operating document (BESMM3), etc.) sources were reviewed purposely to collect relevant theory and information about labour output and productivity influencing factors on construction sites,current outputs in use both the Nigerian and British originated constants. Similarly, details about work study particularly work measurement techniques were critically reviewed for the purpose of the methodology of the study.

3.6.2 Field survey

The quantitative data used for this research work were collected personally from all the construction sites sampled except on a very few restricted and special sites where minimal assistance was obtained. The assistants employed were site foremen or consultants with considerably adequate training and experience. These assistants were well oriented and trained on the research objectives for data collection procedures before embarking for site measurements.

3.7 Instrument for Data Collection

The research instrument is the means or item through which information or data was elucidated Depending on the data collection method selected for every research investigation, varieties of data collection instruments are available. According to Abdul-Maliq, (2006) and Lawal and Adeyeye (2005), the common instruments available include; research questionnaires, interview sheets, observations (study sheets), audio player e.t.c. For the purpose of this study, a well structured "***Time study sheet***" was the major instrument for data collection. The time study sheet was divided into three different sections; **A, B, C.** Section A compiled data on the general information of the project , sheet No, operative work item location and work item description under observation. Section B encompasses the work measurement aspect of the outputs collection and records; the study No, gang size, starting, stopping, and actual time for morning and afternoon for execution of the work and also depicts morning output, afternoon output and total output while section C consist of structured closed-ended questionnaire designed to capture all relevant productivity influencing factors as relating to block work operatives outputs on site. The eight different productivity influencing factors considered for this study as observed by Fagbenle*et al.*, (2011); Ameh and Odunsami, (2002) cited in Abdullahi, (2009) and Enshassi*et al.*,(2007) were; gender, age, mode of employment weather condition, experience, quality of block used and shape of building.

3.8 Research Procedures

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

1. An introductory letter of permission to have access to the construction sites emphasizing the aim of the field work and the possible period of study on the site was delivered to the site managers.
2. The operatives to be observed were taken unaware that they were being observed by stayed away for a considerable distant from the spot the work was carried out.
3. The starting time and starting point of the operatives were noted
4. A physical measurement of the work output executed was then carried out using simple tools such as tapes. The observed output and finishing time were both recorded.
5. The actual time taken was calculated by taking the difference between the starting and the finishing time and thus the observed time was recorded.
6. The observed time was then taken as the basic time which was then transferred to the collation sheet where adjustments were made in the form of contingency allowances for delays and relaxation periods. This was then calculated as a standard time which was considered as the total time taken by an operative to deliver a given output.
7. The output/unit time was then converted to an hour job and virtually to a day

3.9 Instrument for Data Analysis

The data collected were subjected to, descriptive and inferential analysis tools as thus;

3.9.1 Descriptive Statistics

The percentage distributions of the underlying factors were determined to establish the percentage proportion of operatives within the group factors for the construction sites observed. The quantitative output values were converted into output/day and output/hour. The measure of central tendency was adopted to calculate the average outputs/day. measures of dispersion, standard deviation, variance, standard error, and the confidence using excel SPSS version 21 to describe to some extent of the validity and reliability of the descriptive output results.

3.9.2 Inferential analysis

A parametric test was employed for the inferential analysisof the effect (level of significance) and comparisonof labour outputswithin the underlying productivity group factors. A parametric is a standard on which other things can be judged (Abdul-Maliq, 2006). The t-testand ANOVA are parametric instruments used for this study. The t-test is used to compare the mean of two samples whilean analysis of variance (ANOVA) is used when there are more than two variances. A confirmatory test ‘Post-hoc’ (Least Significance Difference (LSD)) was also run to conspicuously identify where the significance lies on the assessed group factors.

CHAPTER FOUR

4 DATA PRESENTATION, ANALYSIS AND DISCUSSION OF RESULTS

This chapter seeks to review the approaches employed in the presentation and analysis of the data collected for the study. It describes the source and nature of the data collected and also presents the findings and analysis of the productivity level in terms of output/unit measurement. The chapter evaluates the output value of workers on general basis setting down five (5) major parameters of the productivity influencing factors of workers on site operations.Descriptive and inferential analysis tools were used to analyze the data. The central tendency and measures of dispersion were used in describing the nature and common characteristics of the data and all tests were at 0.05 significant level unless where otherwise stated.

4.1 Administration of Data

Data on output of the operatives were recorded for the ten work items of hollow sand crete block. The data collected were quantitative records of observed time per day. These observations were done at two different periods; four hours in the morning and three hours in the afternoon. This strengthened the validity of the research results, since researchers have observed obvious deviations between outputs at different time period (Adnan et al 2002).It is expected that data on the following productivity influencing factors; gender, age of workers, qualification of workers, mode of employment, weather condition, experience of workers quality of block used and shape of building as relate to the operatives outputs were to be recorded. However,data were not recorded for the following productivity influencing factors due to the following observations;

1. Gender of the workers: it was observed that no female operative was found in the 548 numbers of gangs observed as relate to block operation.That submits that 100% of the observed workers are male, which indicates the discriminatory nature of the labour construction market. Perhaps locational, cultural and religious backgrounds are the basis for that.
2. Weather condition: Two variables were considered sunny and rainy 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 and if this is to be applied, the same percentage would be deducted from the output observed through out the sunny days
3. Quality of block used: Three variables were used to assess the quality of block used; poor, fair and good and all the operatives confirmed that the quality of the blocks used were good. That also means all block used for the operation was 100% of good quality.

While the following productivity influencing factors were based on the stated grouped /classified factors;

1. 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 20 years
    - Age group, range from 20 to 35 years
    - Age group, above 35 years
2. Qualification of Workers: the study meant to observe if educational qualification has significant impact on labour productivity apart from the ordinary

apprenticeship training acquired the six classes of educational qualification of workers observed are;

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

3. 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 at the end of the day work as agreed by their employer.

4. 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 2 year.
- Operatives, ranges from 2 to 5 years
- Operatives, ranges from 6 to 10 years
- Operatives, above 10 years

5. Shape of Building: The workers were observed if the operation design shape has effect on the outputs of the operatives. Two operation design shape variables were observed;
   - Straight; that is the operatives working in a continuous process.
   - Irregular; that is the operatives confronting recess, set back, partitions etc.

4.2 Data Presentation

4.2.1 Frequencies of group productivity factors in construction site

A total number of five hundred and forty–eight (548) gang numbersof construction site were observed in Nasarawa and Abuja for this study. The tables below show the frequencies of workforce based on group productivity factors as well as the percentages of the group factors observed for the determination of labour outputs on construction sites.

4.2.2 Discussion

The Table 4.1 shows that 67.97% of the workers observed predominantly tradesmen of age range of 20-35 years, and 27.56% represents that age group of 35 years and above. The aforementioned revelation indicated that the sample of workers observed were from strong and matured men of age above 20 years. Abdullahi (2009) and Ameh and Odunsami (2002) emphasized that the most productive workers are people within the age group of 20-35 years. It suffices to justify that the low percentage of 35 years and above could be attributed to ageing and some of them might have been advanced to foreman or to supervisory cadre. The table also indicates that 45.62% of the workers observed had SSCE certificates and 33.03% had primary certificate showing that these were the predominant educational qualifications commonly found in block laying operation in addition to the apprenticeship training acquired. Therefore, it can be affirmed that the sample observed was a sample of qualified workers, because 93% of the sample had one qualification or the other.

The Table 4.2 reveals that 52.56% of the workers observed were daily paid workers indicating that workers prefer being engaged on daily basis to the other types because of prompt payment hence payment at hand worth more than payment defers. Also the table shows that 44.53% of the observed workers had 6-10 years of experience, followed by 27.56% of workers of 11 years and above of experience. However, the table reveals that 72.09% of the workers observed were of high experience.

Table 4.1: Percentage Distribution of Age and Qualification of Workers

Work Items	Age of workers (Yrs)			Qualification of workers					
	< 20	20-35	>35	PSC	S.S.C.E	C&G/ NTEB	NAP TED	ND	Others
150mm blk in Fdn ≤1.00m deep	5	45	18	30	23	10	Nil	Nil	5
150mm blk in superst< 1.5m high	4	42	16	15	31	8	Nil	Nil	8
Dittosuper/ohd< 1.5m high	3	44	15	21	28	7	Nil	Nil	6
225mm blk in Fdn ≤1.00m deep	3	44	15	23	25	9	Nil	Nil	5
Ditto in superst.< 1.5m high	Nil	43	19	23	25	10	Nil	Nil	4
Dit.super/ohd> 1.5m high	5	45	12	22	28	9	Nil	Nil	3
Ditto iso. Piers in superstruct.< 1.5m	5	29	21	13	26	10	Nil	Nil	6
Ditto iso. piers. In super./ohd.< 1.5m	4	33	18	11	35	5	Nil	Nil	4
Ditto in pit >4 m^2 .bottom plan.	Nil	21	9	11	16	3	Nil	Nil	NIL
Ditto in pit <4m^2 bottom plan	1	21	8	12	13	5	Nil	Nil	NIL
Group Frequencies	30	367	151	181	250	76	Nil	Nil	41
Total Gang No.		548				548			
% of Group	**5.48**	**66.97**	**27.56**	**33.03**	**45.62**	**13.87**	**Nil**	**Nil**	**7.48**

Key: < =less than, > = greater than, PSC= Primary School Certificate, NTEB=NABTEB.

Table 4.2: Percentage Distribution of Mode of Employment and Experience of workers

Work Items	Mode of Employment			Experience of Workers (Yrs)			
	Ct.Em	N.wk	D.P.	<. 2	2-5	6-10	>10
150mmblkin Fdn ≤1.00m deep	14	21	33	NIL	17	31	20
150mm blk in superst< 1.5m high	15	18	29	NIL	11	33	18
Dit. super/ohd> 1.5m high	9	16	37	NIL	21	27	14
225mm blk in Fdn ≤1.00m deep	5	21	36	NIL	17	25	20
Ditto in superst< 1.5m high	19	19	24	NIL	14	28	20
Ditto in super/ohd> 1.5m high	18	14	30	2	17	26	17
Ditto iso. Piers in superstruct.< 1.5m	3	21	31	2	16	22	15
Ditto iso. piers. In super./ohd.> 1.5m	3	23	29	3	15	23	14
Ditto in pit >4 m^2 .b .plan.	NIL	10	20	1	6	15	8
Ditto in pit <4m^2 b. plan	NIL	11	19	1	10	12	7
Group Frequencies	86	174	288	9	144	242	153
Total Gang No.		548			548		
% of Group	**15.69**	**31.75**	**52.56**	**1.64**	**26.28**	**44.16**	**27.92**

Key: Ct.Em.= Contract employed workers, N.wk = Negotiated workers, D.P.= Daily paid workers

4.3 Data Presentation for Output of 150mm thick Block Work in Foundation

The data was extracted from the general collation sheet in the appendix 4 and presented in appendix 5, thus;

Output 1: (Morning period of 4 hours duration)

i. Output 2:(Afternoon period of 3 hours duration)

ii. Total output/day

4.4 DescriptiveAnalyses of Productivity Factors of 150mm Thick BlockWork in Foundation.

The analysis of the effect of block related productivity influencing factors on the outputs of workers for 150mm thick hollow sand crete block in foundation are presented in the tables 4.3- 4.5. The Tables also depict the production outputs as well as the comparison of the grouped factors.

(1) **Hypothesis (H1o):** The null hypothesis states that there is no significant output difference on the various age groups of workers observed on site.

(2) **Hypothesis (H2o):** The null hypothesis states there is no significant output difference on the basis of educational qualification of workers observed on site.

Details of the Analysis of Variance (ANOVA) in Table 4.3 on the basis of total mean output of the ageof workers revealed that the calculated p (significance) value of 0.051 is higher than the alpha level of 0.05. However there was P value of 0.016 between age groups below 20 years and 20-35 years while there is no significant difference between age groups below 20 years and 36 years and above; and 20-35 years and 36years and above as indicated in the Table 4.3. Consequently, the null hypothesis which states that there is no output difference among the various age groups of workers observed on site is hereby accepted.

The results of the Analysis of Variance (ANOVA) statistics on the basis of total mean output of educational qualification of workers revealed that the calculated p (significance) value of 0.415 is higher than the (0.05) alpha level of significance. The Table also revealed no significant output difference within any of the educational classes. Consequently, the null hypothesis is hereby accepted.

Table 4.3: Inferential Analysis on Basis of Age and educational qualification for 150mm Block in Foundation

Age group	Mean± SEM	P. value	Std. Dev.	Minimum	Maximum
< 20 years	11.256 ± 0.110		0.246	10.9	11.5
20-35years	13.126 ± 0.250*	0.016	1.675.	11.5	18.16
>35 years	12.822 ± 0.373	0.057	1.582	10.92	16.75
20-35 years					
>35 years		0.494			
Education Group					
Primary sch. cert.	12.620 ± 0.284		1.553	10.9	17.82
S.S.C.E	13.327 ± 0.400	0.127	1.918	10.92	18.16
C & G/NABTEB	13.055 ± 0.493	0.473	1.558	11.2	16.15
Others	12.434 ± 0.280	0.816	0.626	11.5	13.05
S.S.C.E.					
C& G/NABTEB		0.664			
Others		0.271			
C & G/NABTEB					
Others		0.945			

Mean difference at (0.05)alpha levelis less than p. value (0.051).

3) Hypothesis (H3o): The null hypothesis states that there is no significant output difference onthe basis of mode of employment of workers observed on site.

4) Hypothesis (H4o): The null hypothesis states that there is no significant output difference on the various years of experience groups of workers observed on site.

Results of the Analysis of variance (ANOVA) statistics in Table 4.4 on the basis of total mean output for mode of employment revealed that the calculated p. level of 0.000 is lower than the alpha level (0.05) of significance. However, the p value of 0.17 between daily paid and contract employed workers is higher than the alpha value. Therefore the null hypothesis is hereby rejected.

Also in the Table, the total mean outputs on the basis of their years of experience revealed that the calculated Analysis of Variance p. value of .001 is lower than the alpha value (0.05). The mean outputs were 11.826, 12.950 and 13.768 for 2-5 years, 6 – 10 years and 11 years and above experience respectively. The Table clearly indicated that the calculated p. value of 6-10 years and 11 years and above experience workers between 2-5 years of experience are lower than the alpha value as well as had higher mean outputs than that of 2- 5 years of experience. Therefore, the null hypothesis is hereby rejected.

Table 4.4: Inferential Analysis on Basis of Mode of Employment and Experience for 150mm Block in Foundation

Group	Mean± SEM	P. value	Std. Dev.	Minimum	Maximum
Mode of Employment					
Ct.Em. Workers	11.756 ± 0.142		0.532	10.9	12.9
Negotiated workers	14.740 ± 0.397*	0.000	1.821.	12.05	18.16
Daily paid workers	12.234 ± 0.088	0.177	0.506	10.92	13.14
Negotiated workers					
Daily paid workers	*	0.000			
Experience					
2-5 years	11.826 ± 0.124		0.512	10.9	12.7
6-10 years	12.950 ± 0.286 *	0.016	1.582	11.33	17.82
Above 11 years	13.768± 0.421 *	0.000	1.881	10.92	18.16
6-10 years					
Above 11 years		0.063			

Key: Ct. Em.= Contract employed workers, *Denotes the mean difference is significance at the 0.05 level.

5)Hypothesis (H5o): The null hypothesis states that there is no significant difference in outputof workers between straight and irregular shape of building.

6) Hypothesis (H6o): The null hypothesis states that there is no significant difference in outputs in period of observations on site.

Results of the Independent t-test statistics in Table 4.5 on the basis of total mean output of operation design shape revealed that the calculated p value of 0.000 is lower than the alpha level (0.05) of significance. Also, significant difference exists between workers on straight and irregular designed operation. The workers on straight designed operation had higher mean output than those on irregular designed operation. The null hypothesis is hereby rejected.

Results of the Paired Samples Test statistics on the basis of total mean output of period of work revealed that the calculated p. value of 0.000 is lower than the alpha level of (0.05) significance. Also, significant difference exists between mean outputs of morning and afternoon as indicated in Table 4.5. The workers output in the morning were greater than afternoon outputs. Therefore the null hypothesis is here rejected.

Table 4.5: Inferential Analysis on Basis of Building Shape and Period of Work for 150mm Block in Foundation

Group	Mean± SEM	P.value	Std. Dev.	Minimum	Maximum
Building Shape					
Straight walling	14.3059 ± 0.4944		2.0386	12.05	18.16
Irregular walling	12.4441 ± 0.1674*	0.000	1.1956	10.90	16.54
Period of Work					
Morning	7.310 ± 0.104		0.855	6.35	10.28
Afternoon	5.598 ± 0.104*	0.000	0.859	4.10	8.10

*Denotes the mean difference is significance at the 0.05 level.

4.5 150mm Data for Output of Thick Block Work in Superstructure

Data collected for outputs of workers laying 150mm thick block in superstructure not greaterthan 1.5m high above over site concrete(gang size: 1 mason, 1 labourer) are shown in appendix 6.

4.6 Descriptive Analyses of Productivity Factors of 150mm thick Block in Superstructure

The analysis of the effect of block related productivity influencing factors on the outputs of workers for 150mm thick hollow sand crete block in superstructure are presented in the Tables 4.6-4.8. The Tables also depict the production outputs as well as the comparison of the grouped factors.

Details of the Analysis of Variance (ANOVA) in Table 4.6 on the basis of total mean output of age and educational qualification of workers revealed that the calculated p (significance) values of (0.125)and (0.108) respectively are higher than the alpha level of (0.05) significance. Consequently, the null hypotheses are hereby accepted. The Table indicated that all age groups has calculated p. value higher than the alpha level and 20-35 years age group has the highest mean output..

Also,the basis of educational qualification of workers, the P. value calculated is lower than the alpha value between all other levels of educational qualifications and others.

Table 4.6: Inferential Analysis on Basis of Age and Educational Qualification for 150mm Block in Superstructure

Age group	Mean± SEM	P. value	Std. Dev.	Minimum	Maximum
Below 20 years	12.613 ± 0.312		0.625	12.200	13.540
20-35 years	13.467 ± 0.165	0.102	1.067	11.890	16.650
Above 35 years	13.044 ± 0.194	0.435	0.776	11.880	14.400
20-35 years					
Above 35 years		0.148			
Education Group					
Primary sch. cert.	13.453 ± 0.290		1.121	11.880	16.650
S.S.C.E	13.383 ± 0.175	0.819	0.973	12.100	15.250
C & G/NABTEB	13.525 ± 0.369	0.866	1.043	12.290	14.950
Others	12.506 ±0.145*	0.030	0.409	11.890	13.300
S.S.C.E.					
C & G/NABTEB		0.713			
Others	*	0.027			
C & G/ NABTEB					
Others	*	0.040			

Mean difference at (0.05) alpha level is less than p. value (0.125) and (0.108).

Results of the Analysis of variance (ANOVA) statistics in Table 4.7 revealed significant difference in the total mean output level of workers on the basis of their mode of employment. The calculated p level of0.000 is lower than the alpha level (0.05) of significance. The Table revealed lower p. values than alpha value between all modes of employment as indicated in the Table. Also, negotiated workers have the highest mean output. Therefore the null hypothesis is hereby rejected.

There is no Significant Differences exist in the total mean outputs on the basis of their years of experience. The calculated Analysis of Variance p (significant) value of 0.136 is higher than the alpha value (0.05) of significance. The Table also revealed P. value (significant) lower than the alpha level exists between 2-5 years and 6 – 10 years of experience. Further more, 5-10 years of experience has highest mean output of 13.5, followed by 11 years and above with mean output of 13.24 and 2-5 years of experience is the least with mean output of 12.81. Hence, the null hypothesis is hereby accepted

Table 4.7: Inferential Analysis on Basis of Mode of Employment and Experience for 150mm Block in Superstructure

Group	Mean± SEM	P. value	Std. Dev.	Minimum	Maximum
Mode of Employment					
Ct Em. Workers	12.535 ± 0.141		0.546	11.88	13.67
Negotiated workers	14.104 ± 0.290*	0.000	1.229	12.28	16.65
Daily paid workers	13.285 ± 0.142*	0.010	0.764	12.12	15.01
Negotiated workers					
Daily paid workers	*	0.003			
Experience					
2-5 years	12.814 ± 0.182		0.605	11.89	13.80
6-10 years	13.500 ± 0.190 *	0.049	1.090	12.12	16.65
Above 10 years	13.240± 0.224	0.262	0.950	11.88	15.01
6-10 years					
Above 10 years		0.370			

Key: Ct. Em.= Contract employed workers,*Denotes the mean difference is significance at the 0.05 level.

Result of the Independent t-test and pair Sample Test statistics in Table 4.8 revealed that significant difference exist on the basis of building shape and period of work respectively with the calculated p value of 0.000lower than the alpha level (0.05) of significance. The null hypotheses are hereby rejected.The workers on straight designed operation had higher mean output than those on irregular designed operation.Also,the workers output in the morning were greater than afternoon outputs.

Table 4.8: Inferential Analysis on Basis of Building Shape and Period of Work for 150mm Block in Superstructure

Group	Mean± SEM	P. value	Std. Dev.	Minimum	Maximum
Building Shape					
Straight walling	14.803 ± 0.452		1.108	13.23	16.65
Irregular walling	13.142 ± 0.114*	0.000	0.852	11.80	15.01
Period of Work					
Morning	7.310 ± 0.104		0.855	6.91	9.85
Afternoon	5.598 ± 0.104*	0.000	0.859	4.94	6.80

*Denotes the mean difference is significance at the 0.05 level.

4.7 Data for Outputs of 150mm Thick Block Work in Superstructure Overhand

Data collected for outputs of workers laying 150mm thick block in superstructure overhand 1.5m high above over site concrete upto roof level (gang size: 1 mason, 2 labourer) are shown in appendix 7.

4.8 Descriptive Analyses of Productivity Factors of 150mm thick Block Work in Superstructure Overhand

The analysis of the effect of block related productivity influencing factors on the outputs of workers for 150mm thick hollow sand crete block in superstructure overhand are presented in the Tables 4.9-4.11. The Tables also depict the production outputs as well as the comparison of the grouped factors.

Details of the Analysis of Variance (ANOVA) in Table 4.9 revealed that there are no significant difference in the total mean output on the basis of age and educational qualification groups and hence the calculated p (significance) value of 0.097 and 0.497 are higher than the alpha level of (0.05) significance.Therefore the null hypotheses are hereby accepted. As indicated in the table, there was no lower P. value than the alpha value between any of the age groups however, the mean output of age group 20 -35 has the highest value followed by age group of 36 years and above, while on the basis of educational qualification, S.S.C.E has the highest mean value of 12.69, followed by primary school certificate (12.30) and C & G has the least mean value of 11.98.

Table 4.9: Inferential Analysis on Basis of Age and Educational Qualification for 150mm Block in Superstructure Overhand

Age group	Mean± SEM	P.value	Std. Dev.	Minimum	Maximum
Below 20 years	11.217 ± 0.268		0.465	10.70	11.60
20-35 years	12.624 ± 0.194	0.068	1.285	10.69	17.53
Above 35 years	12.089 ± 0.336	0.282	1.301	10.80	15.68
20-35 years					
Above 35 years		0.164			
Education Group					
Primary sch. cert.	12.303 ± 0.207		0.948	10.70	13.75
S.S.C.E	12.689 ± 0.312	0.310	1.649	10.69	17.53
C & G/NABTEB	11.976 ± 0.264	0.568	0.698	11.35	13.35
Others	12.158 ± 0.388	0.811	0.950	11.12	13.25
S.S.C.E.					
C & G/NABTEB		0.201			
Others		0.370			
C & G/ NABTEB					
Others		0.726			

Mean difference at (0.05) alpha level is less than p. value (0.097) and (0.497).

Results of the Analysis of variance (ANOVA) statistics in Table 4.10 revealed significant difference in the total output level of workers on the basis of their mode of employment and experience. This is because the calculated 0.000 and 0.015 p level respectively are lower than the alpha level (0.05) of significance. Therefore the null hypothesis is hereby rejected.The Tablefurther confirmed lower calculated p. value between any of the mode of employment than the alpha level, while on the basis of experience significant differences exist in the total output level between 2-5 and 6-10 years of experience workers.

Table 4.10: Inferential Analysis on Basis of Mode of Employment and Experience for 150mm Block in Superstructure Overhand

Group	Mean± SEM	P. value	Std. Dev.	Minimum	Maximum
Mode of Employment					
CtEm. Workers	11.039 ± 0.099		0.298	10.69	11.55
Negotiated workers	13.890 ± 0.355*	0.000	1.420	12.45	17.53
Daily paid workers	12.131 ± 0.114*	0.002	0.691	10.93	13.50
Negotiated workers					
Daily paid workers	*	0.000			
Experience					
2-5 years	11.824 ± 0.144		0.659	10.69	13.00
6-10 years	12.897 ± 0.280 *	0.004	1.456	10.70	17.53
Above 10 years	12.422± 0.375	0.164	1.402	10.80	15.68
6-10 years					
Above 10 years		0.246			

Key: Ct. Em.= Contract employed workers,*Denotes the mean difference is significance at the 0.05 level.

Results of the Independent t-test statistics in Table 11 revealed that significant difference exist between workers on straight and irregular designed operation as well as on the basis of total mean output. The calculated p value of 0.000 is lower than the alpha level (0.05) of significance. The workers on straight designed operation had higher mean output than those on irregular designed operation. The null hypothesis is hereby rejected.

Also, results of the Paired Samples Test statistics on the basis of total mean output of period of work revealed that the calculated p. value of 0.000 is lower than the alpha level of (0.05) significance. The calculated p value of 0.000 on the account of morning and afternoon is lower than the alpha level of (0.05) significance. The workers output in the morning were greater than afternoon outputs. Therefore the null hypothesis is hereby rejected.

Table 4.11: Inferential Analysis on Basis of Building Shape and Period of Work for 150mm Block in Superstructure Overhand

Group	Mean± SEM	P. value	Std. Dev.	Minimum	Maximum
Building Shape					
Straight walling	13.971 ± 0.469		1.624	12.45	17.53
Irregular walling	12.056 ± 0.125*	0.000	0.886	10.69	14.28
Period of Work					
Morning	7.138 ± 0.105		0.825	5.94	10.28
Afternoon	5.598 ± 0.066*	0.000	0.517	4.54	7.25

*Denotes the mean difference is significance at the 0.05 level.

4.9 Data for Output of 225mm thick Block Work in Foundation

The data for outputs of workers laying 225mm thick block in foundation (gang size: 1 mason, 1 labourer)was extracted from the general collation sheet and presented in appendix 8.

4.10 Descriptive Analyses of Productivity Factors of 225mm Thick Block Work in Foundation

The analysis of the effect of block related productivity influencing factors on the outputs of workers for 225mm thick hollow sand crete block in foundation are presented in the Tables 4.12-4.14. The Tables also depict the production outputs as well as the comparison of the grouped factors.

Results of the Analysis of variance (ANOVA) statistics in Table 4.12 revealed significant difference in the total mean output on the basis of their age groups of workers hence the calculated p level (0.045) is lower than the alpha level (0.05) of significance. The Table further confirms that there are significant in two age groups of workers, except in age group of 20-35 and 36 years and above of workers that is not significant. Therefore the null hypothesis is hereby rejected.

Also in the Table, the results of the Analysis of Variance (ANOVA) statistics on the basis of the total mean output of educational qualification revealed that the calculated p (significance) value of 0.144 is higher than the alpha level (0.05) of significance. The table revealed significant difference between primary school certificate and S.S.C.E. of p. level lower than the alpha level. Consequently, the null hypothesis is hereby accepted.

Table 4.12: Inferential of Analysis on Basis of Age and Educational Qualification for 225mm Block in Foundation

Age group	Mean± SEM	P. value	Std. Dev.	Minimum	Maximum
Below 20 years	7.127 ± 0.234		0.405	6.80	7.58

20-35 years	9.107 ± 0.207*	0.013	1.374	6.89	12.00
Above 35 years	9.061 ± 0.294*	0.022	1.139	7.47	11.28
20-35 years					
Above 35 years	9.061 ± 0.294	0.908			
Education Group					
Primary sch. cert.	8.554 ± 0.278		1.332	6.80	10.95
S.S.C.E	9.329 ± 0.238*	0.045	1.191	7.45	12.00
C & G/NABTEB	9.453 ± 0.495	0.086	1.486	7.45	11.21
Others	8.688 ± 0.656	0.836	1.467	7.00	10.45
S.S.C.E.					
C & G/NABTEB		0.808			
Others		0.321			
C & G/ NABTEB					
Others		0.299			

*Denotes the mean difference is significance at the 0.05 level.

Results of the Analysis of variance (ANOVA) statistics in Table 4.13 revealed significant difference in the total mean outputs on the basis of mode of employment and experience of workers hence the calculated p level (0.001) and 0.024 respectively arelower than the alpha level (0.005) of significance, therefore the null hypothesis is hereby rejected.The Table 4.13 indicated that there is lowest p. value exist between contract employed and negotiated workers (0.000) than daily paid workers (0.010) and negotiated between daily paid workers (0.021), while the table further showed that the p. value calculated is lower than the alpha value between 2-5 years experience workers and 11 years and above years of experience workers.

Table 4.13: Inferential Analysis on Basis of Mode of Employment and Experience

Group	Mean± SEM	P. value	Std. Dev.	Minimum	Maximum
Mode of Employment					
Ct.Em. Workers	7.312 ± 0.188		0.421	6.89	7.85
Negotiated workers	9.646 ± 0.253*	0.000	1.157	7.49	12.00
Daily paid workers	8.857 ± 0.217*	0.010	1.304	6.80	11.28
Negotiated workers					
Daily paid workers	*	0.021			
Experience					
2-5 years	8.309 ± 0.307		1.265	6.80	10.96
6-10 years	9.075 ± 0.286	0.67	1.430	6.89	12.00
Above 10 years	9.494 ± 0.246 *	0.007	1.099	7.80	11.28
6-10 years					
Above 10 years		0.282			

Key: Ct. Em.= Contract employed workers,*Denotes the mean difference is significance at the 0.05 level.

Table 4.14 results of the Independent t-test statistics revealed that significance difference exist on the basis of total mean output of operation design shape as well as exist between mean outputs of workers on straight and irregular designed operation. The calculated p value of 0.000 is lower than the alpha level (0.05) of significance. The workers on straight designed operation had higher mean output than those on irregular designed operation. The null hypothesis is hereby rejected.

Also, the Table showed the results of Paired Samples Test statistics on the basis of total mean output of period of work revealed that the calculated p. value of 0.000 is lower than the alpha level of (0.05) significance. Also, significant difference exists between the mean outputs of morning and afternoon with the calculated p value of 0.000 is lower than the alpha level of (0.05) significance. The workers output in the morning were greater than afternoon outputs. Therefore the null hypothesis is hereby rejected.

Table 4.14: Inferential Analysis on Basis of Building Shape and Period of Work for 225mm Block in Foundation

Group	Mean± SEM	P. value	Std. Dev.	Minimum	Maximum
Building Shape					
Straight walling	10.713 ± 0.165		0.405	10.15	11.28
Irregular walling	8.816 ± 0.171*	0.000	1.282	6.80	12.00
Period of Work					
Morning	5.116 ± 0.099		0.782	3.73	6.85
Afternoon	5.598 ± 0.076*	0.000	0.600	2.94	5.15

*Denotes the mean difference is significance at the 0.05 level.

4.11 Data for Output of 225mm thick Block Work in Superstructure

The data for outputs of workers laying 225mm thick block in superstructurenot greater than 1.5m high above over site concrete (gang size: 1 mason, 1 labourer) was extracted from the general collation sheet and presented in appendix 9.

4.12 Descriptive Analyses of Productivity Factors of 225mm Thick Block Work in Superstructure

The analysis of the effect of block related productivity influencing factors on the outputs of workers for 225mm thick hollow sand crete block in superstructure are presented in the Tables 4.15 - 4.16. The Tables also depict the comparison of the production outputs of the grouped factors.

Table 4.15 results of independent sample test statistics revealed no significant difference in the total mean output on the basis of their age groups hence the calculated p level (0.540) is higher than the alpha level (0.05) of significance. However, age group of 36 years and above has higher mean output of 11.338 than 20-35 years of experience. Therefore the null hypothesis is hereby accepted

The results of the Analysis of Variance (ANOVA) statistics in the Table indicated that there is no significant difference in the total mean output on the account of the educational qualification hence the calculated p (significance) value of 0.148 is higher than the alpha level (0.05) of significance. However, the C & G has a higher mean output followed by S.S.C.E. Also, the calculated p. value did not reveal any lower value than the alpha value within the groups. Consequently, the null hypothesis is hereby accepted.

Table 4.15: Inferential Analysis on Basis of Age and Educational Qualification for 225mm Block in Superstructure.

Age group	Mean± SEM	P. value	Std. Dev.	Minimum	Maximum
20-35 years	10.921 ± 0.367		2.405	8.27	16.10
Above 35 years	11.338 ± 0.590	0.540	2.573	8.39	15.75

Education Group					
Primary sch. cert.	10.262 ± 0.448		2.147	8.27	15.65
S.S.C.E	11.475 ± 0.438	0.072	2.437	8.28	15.75
C & G/NABTEB	11.600 ± 1.052	0.162	2.975	8.32	16.10
S.S.C.E.					
C & G/NABTEB		0.847			

Mean difference at (0.05) alpha level is less than p. value (0.540) and (0.148)

Results of the Analysis of variance (ANOVA) statistics in Table 4.16 revealed significant difference in the total mean output on the basis of their mode of employment hence the calculated p. level (0.000) is lower than the alpha level (0.005) of significance. The Table further confirmed p. levels lower than alpha level within all categories of employment. Therefore the null hypothesis is hereby rejected.

Also, Table 4.16 revealed no significant differences on the basis of their years of experience. Reason being that the calculated Analysis of Variance p(significant) value of .075 is higher than the alpha value (0.05). However, table 4.7.4 showed that significant differences exist in the mean output level between 2-5 years experience workers and 11 years and above years of experience workers. However, 11 years and above years of experience workers has the highest mean output. Hence, the null hypothesis is hereby accepted

Table 4.16: Inferential Analysis on Basis of Mode of Employment and Experience for 225mm Block in Superstructure.

Mode of Employment	Mean± SEM	p. value	Std. Dev.	Minimum	Maximum

Group					
Ct Em. Workers	9.162 ± 0.243		0.421	8.27	11.60
Negotiated workers	14.093 ± 0.357*	0.000	1.157	11.55	16.10
Daily paid workers	10.220 ± 0.256*	0.009	1.199	8.65	12.10
Negotiated workers					
Daily paid workers	*	0.000			
Experience Group					
2-5 years	9.844 ± 0.467		1.746	8.33	14.70
6-10 years	11.145 ± 0.439	0.100	2.322	8.27	16.10
Above 10 years	*	0.025	2.279	8.32	15.75
6-10 years					
Above 10 years		0.383			

Key: Ct. Em.= Contract employed workers,*Denotes the mean difference is significance at the 0.05 level.

Results of the Independent t-test statistics in Table 4.17 revealed that significant difference exist between workers on straight and irregular designed operation. The calculated p value of 0.018 is lower than the alpha level (0.05) of significance. The workers on straight designed operation had higher mean output than those on irregular designed operation. The null hypothesis is hereby rejected.

Also, results of the Paired Samples Test statistics on the basis of total mean output of period of work revealed that the calculated p. value of 0.000 is lower than the alpha level of (0.05) significance. Also, significant difference exists between the mean output in the morning and in the afternoon periods with the calculated p value of 0.000 is lower than the alpha level of (0.05) significance. The workers output in the morning were greater than afternoon outputs. Therefore the null hypothesis is hereby rejected.

Table 4.17: Inferential Analysis on Basis of Building Shape and Period of Work for 225mm Block in Superstructure.

Group	Mean± SEM	P. value	Std.Dev.	Minimum	Maximum
Straight walling	12.527 ± 0.695		2..408	9.22	16.10
Irregular walling	10.694 ± 0.331*	0.000	2.339	8.27	14.35
Period of Work Group					
Morning	6.263 ± 0.175		1.375	4.64	8.86
Afternoon	4.781 ± 0.140*	0.000	1.100	3.42	7.25

*Denotes the mean difference is significance at the 0.05 level.

4.13 Data for Output of 225mm thick Block Work in Superstructure Overhand

Data collected for outputs of workers laying 225mm thick block in superstructure overhand 1.5m high above over site concrete upto roof level (gang size: 1 mason, 2 labourer) are shown in appendix 10

4.14 Descriptive Analyses of Productivity Factors of 225mm Thick Block Work in Superstructure Overhand

The analysis of the effect of block related productivity influencing factors on the outputs of workers for 225mm thick hollow sand crete block in superstructure are presented in the Tables 4.18- 4.20. The Tables also depict the comparison of the production outputs of the grouped factors.

There is no significant difference in the total mean output on the basis of age and educational qualification groups. The calculated p (significance) value of 0.517 and 0.306 respectively are higher than the alpha level (0.05) of significance. The Table also confirmed higher calculated P. value than the alpha value between any of the group. However, 20-35 years age group has the highest total output mean of 9.200 as indicated in the Table, while on the basis educational qualification nor the pair wise LSD multiple comparisons revealed significant difference within of the educational qualification; However, the S.S.C.E. has a highest mean output followed by C & G and others the least. Therefore, the null hypothesesare hereby accepted.

Table 4.18: Inferential Analysis on Basis of Age and Educational Qualification for 225mm Block in Superstructure Overhand.

Age group	Mean± SEM	P. value	Std. Dev.	Minimum	Maximum
Below 20 years	8.488 ± 0.485		1.085	6.84	9.75
20-35 years	9.200 ± 0.202	0.256	1.358	6.85	12.00

Above 35 years	8.191 ± 0.355	0.321	1.231	7.59	11.35
20-35 years					
Above 35 years		0.982			
Education Group					
Primary sch. cert.	8.926 ± 0.213		1.000	7.59	11.05
S.S.C.E	9.444 ± 0.286*	0.169	1.512	6.84	12.00
C & G/NABTEB	9.037 ± 0.461	0.831	1.382	7.21	11.15
Others	8.210 ± 0.294	0.376	0.510	7.70	8.72
S.S.C.E.					
C & G/NABTEB		0.419			
Others		0.125			
C & G/ NABTEB					
Others		0.345			

Mean difference at (0.05) alpha level is less than p. value (0.517) and (0.306).

Results of the Analysis of variance (ANOVA) statistics on the basis of their mode of employment and experience revealed that the calculated p. levels (0.000) respectively lower than the alpha level (0.005) of significance. The Table 4.19 confirmed that the calculated p. value on output between contracts employed workers and daily paid workers are higher than the alpha level while on the basis of their years of experiencefurther showed that significant differences exist in the mean output level between 2-5 years and 11 years and above years; 6-10 years experience workers. Hence, the null hypotheses are hereby rejected.

Table 4.19: Inferential Analysis on Basis of Mode of Employment and Experience for 225mm Block in Superstructure Overhand.

Group	Mean± SEM	p. value	Std. Dev.	Minimum	Maximum
Ct Em. Workers	8.519 ± 0.198		0.838	6.84	7.75
Negotiated workers	10.826 ± 0.177*	0.000	0.661	9.45	12.00
Daily paid workers		0.464	1.105	6.85	10.60
Negotiated workers					
Daily paid workers	*	0.000			
Experience Group					
Below 2 years	7.770 ±0.930		1.315	6.84	8.70
2-5 years	8.577 ± 0.285	0.616	1.176	7.21	11.31
6-10 years	9.460 ± 0.259	0.067	1.370	6.85	12.00
Above 10 years	9.368 ± 0.289 *	0.009	1.119	8.05	11.05
2-5years					
6-10 years	*	0.002			
Above 10 years	*	0.000			
6-10 years					
Above 10 years	*	0.046			

Key: Ct. Em.= Contract employed workers,*Denotes the mean difference is significance at the 0.05 level.

Results of the Independent t-test statistics Table 4.20 revealed that significant difference exist on the basis of total mean output of operation design shape as well as between workers on straight and irregular designed operation. The calculated p value of 0.000 is lower than the alpha level (0.05) of significance. The workers on straight designed operation had higher mean output than those on irregular designed operation. The null hypothesis is hereby rejected.

Also in the Table, results of the Paired Samples Test statistics on the basis of total mean output of period of work revealed that the calculated p. value of 0.000 is lower than the alpha level of (0.05) significance. Also, significant difference exists between outputs of morning and outputs of afternoon. The calculated p value of 0.000 is lower than the alpha level of (0.05) significance and the workers output in the morning were greater than afternoon outputs. Therefore the null hypothesis is hereby rejected.

Table 4.20: Inferential Analysis on Basis of Building Shape for 225mm Block in Superstructure Overhand.

Group	Mean± SEM	P. value	Std. Dev.	Minimum	Maximum
Straight walling	10.916 ± 0.205		0.648	10.05	12.08
Irregular walling	8.800 ± 0.155*	0.000	1.116	6.84	11.15
Period of Work Group					
Morning	5.147 ± 0.089		0.699	3.90	6.70
Afternoon	3.993 ± 0.084*	0.000	0.663	2.90	5.60

*Denotes the mean difference is significance at the 0.05 level.

4.15 Data for Output of 225mm thick Block Isolated Piers in Superstructure

The data for outputs of workers laying 225mm thick isolated block piers of 450mm length on plan in superstructure not greater than 1.5m high above over site concrete (gang size: 1 mason, 1 labourer) was extracted from the general collation sheet and presented in appendix 11.

4.16 Descriptive Analyses of Productivity Factors of 225mm Thick Block Isolated Piers in Superstructure

The analysis of the effect of block related productivity influencing factors on the outputs of workers for 225mm thick hollow sand crete isolated block piers in superstructure are presented in Tables 4.21-4.22. The tables also depict the comparison of the production outputs of the grouped factors.

Details of the Analysis of Variance (ANOVA) in Table 4.21 on the basis of total mean output of age of workers and educational qualification revealed that there are no significant difference hence the calculated p (significance) value of 0.162 and 0.195 respectively are higher than the alpha level (0.05) of significance. Consequently, the null hypotheses are hereby accepted.The Table also confirmed no significant difference within any of the group. However, 20-35 years age group has the highest total output mean of 5.281 as indicated in the table,while the Table did not reveal any significant difference within the education group. From the table, SSCE has the highest total output mean of 5.36 while primary school certificate is the lowest with 4.88.

Table 4.21: Inferential Analysis on Basis of Age and Educational Group for 225mm Isolated Block in Superstructure

Age group	Mean± SEM	P. value	Std. Dev.	Minimum	Maximum
Below 20 years	4.590 ± 0.220		0.4.93	4.00	5.25
20-35 years	5.281 ± 0.136	0.058	0.734	3.70	6.95
Above 35 years	5.180 ± 0.170	0.113	0.777	3.90	6.35

20-35 years					
Above 35 years		0.631			
Education Group					
Primary sch. cert.	4.881 ± 0.162		0.583	4.00	5.85
S.S.C.E	5.364 ± 0.149*	0.059	0.759	4.00	6.95.
C & G/NABTEB	5.266 ± 0.256	0.218	0.809	3.90	6.32
Others	4.887 ± 0.324	0.987	0.793	3.70	5.64
S.S.C.E.					
C & G/NABTEB		0.723			
Others		0.158			
C & G/ NABTEB					
Others		0.322			

Mean difference at (0.05) alpha level is less than p. value (0.162).

Results of the Analysis of variance (ANOVA) statistics in Table 4.22 on the basis of total mean output for mode of employment, experience and period of work revealed significant difference hence the calculated p level (0.000), (0.023) and (0.000)respectively are lower than the alpha level (0.005) of significance. The table further confirmed significant difference within all categories of employmentAlso the Table showed that significant differences exist between both below 2 years or 2-5 years experience workers and 11 years and above years of experience workers at p significant value of 0.027 and 0.009 respectively. However, the mean outputs increases as the number of years of experience increases. Hence, the null hypotheses of the three productivity factors on the basis of 225 isolated blocks in superstructure are hereby rejected.

Table 4.22: Inferential Analysis on Basis of Mode of Employment and Experience for 225mm Isolated Block in Superstructure

Mode of EmpmtGroup	Mean± SEM	P. value	Std. Dev.	Minimum	Maximum
Ct Em. Workers	3.867 ± 0.088		0.153	3.70	4.00
Negotiated workers	5.708 ± 0.132*	0.000	0.607	4.07	6.95
Daily paid workers	4.949 ± 0.104*	0.003	0.580	4.00	6.20
Negotiated workers					
Daily paid workers	*	0.000			
Experience Group					
Below 2 years	4.350 ±0.150		0.212	4.20	4.50
2-5 years	4.869 ± 0.149	0.330	0.597	3.70	5.51
6-10 years	5.229 ± 0.148	0.096	0.694	3.90	6.20
Above 10 years	5.552 ± 0.214 *	0.027	0.827	4.00	6.95
2-5years					
6-10 years		0.123			
Above 10 years	*	0.009			
6-10 years					
Above 10 years		0.175			
Period of Work Group					
Morning	3.000 ± 0.061		0.453	2.05	3.75
Afternoon	2.180 ± 0.042*	0.000	0.311	1.60	2.87

Key: Ct. Em.= Contract employed workers,*Denotes the mean difference is significance at the 0.05 level

4.17 Data for Output of 225mm thick Block Isolated Piers in SuperstructureOverhand

The data for outputs of workers laying 225mm thick isolated block piers of 450mm length on plan in superstructure overhand 1.50m above over site concrete to leveling (gang size: 1

mason, 1 labourer) was extracted from the general collation sheet and presented in appendix 12.

4.18 Descriptive Analyses of Productivity Factors of 225mm Block Thick Isolated Piers in Superstructure Overhand

The analysis of the effect of block related productivity influencing factors on the outputs of workers for 225mm thick hollow sand crete isolated block piers in superstructure overhand are presented in Tables 4.23- 4-24. The Tables also depict the comparison of the production outputs of the grouped factors.

The Table 4.23 and Table 4.24 on the basis of the total mean outputs of age, educational qualification and experiences of workers revealed higher p. value of 0.232, 0.355 and 0.081 respectively than the alpha value of 0.05 and consequently the null hypotheses are hereby accepted. while the results of the analysis in Table 4.24 on the basis of the total mean outputs of mode of employment revealed significant difference hence the calculated p. values of 0.000 is lower than the alpha level of (significance) 0.05 and therefore the null hypotheses is hereby rejected.

Table 4.23: Inferential Analysis on Basis of Age and Educational Qualification for 225mm Isolated Block in Superstructure Overhand

Age group	Mean± SEM	P. value	Std. Dev.	Minimum	Maximum
Below 20 years	4.148± 0.236		0.469	3.62	4.75
20-35 years	4.736± 0.105	0.119	0.604	3.64	6.07

Above 35 years	4.812± 0.207	0.092	0.897	3.60	6.50
20-35 years					
Above 35 years		0.710			
Education Group					
Primary sch. cert.	4.468±0.169		0.561	3.68	5.29
S.S.C.E	4.837±0.124	0.136	.0.736	3.60	6.50
C & G/NABTEB	4.414±0.347	0.887	0.777	3.70	5.40
Others	4.738±0.333	0.516	0.666	3.85	6.50
S.S.C.E.					
C & G/NABTEB		0.214			
Others		0.789			
C & G/ NABTEB					
Others		0.497			

Mean difference at (0.05) alpha level is less than p. value (0.232).

Table 4.24: Inferential Analysis on Basis of Mode of Employment and Experience for 225mm Isolated Block in Superstructure Overhand

Mode of Employment Group	Mean± SEM	P. value	Std. Dev.	Minimum	Maximum
Ct Em. Workers	3.647±0.029		0.503	3.60	3.70

Negotiated workers	5.267±0.107*	0.000	0.512	4.45	6.50
Daily paid workers	4.393±0.977*	0.019	0.526	3.60	5.40
Negotiated workers					
Daily paid workers	*	0.000			
Experience Group					
Below 2 years	4.273±0.257		0.446	3.87	4.75
2-5 years	4.428±0.122	0.719	0.502	3.62	5.15
6-10 years	4.841±0.154	0.182	0.705	3.60	6.20
10 years and above	4.980±0.226	0.109	0.844	3.60	6.50
2-5years					
6-10 years		0.068			
10 years and above	*	0.029			
6-10 years					
10 years and above		0.558			

Key: Ct. Em.= Contract employed workers,*Denotes the mean difference is significance at the 0.05 level

4.19 Data for Output of 225 mm Thick Block in Pit ofPlan Bottom Greater than 4m²

Data collected for outputs of workers laying 225mm thick hollow sand crete block in pits ofdimensional area greater than 4 square metres and 2m -4m depth (gang size: 1 mason, 2 labourer) are shown in Table 4.25 depicting the morning ,afternoon and total outputs of workers observed on sites.

Table 4.25: Output for 225 mm Thick Sand Crete Block in Pit of Plan Bottom Greater than 4m² and Depth 2m -4m

Gang .No	Total observed time	Output		Total output (m²)/Day
		Morning (m²)	Afternoon	

	(hr.)		(m^2)	
1	7.00	3.90	3.25	7.15
2	7.00	4.96	4.10	9.06
3	7.00	4.64	3.75	8.39
4	7.00	4.25	3.56	7.81
5	7.00	4.21	3.25	7.46
6	7.00	4.95	3.70	8.65
7	7.00	4.75	3.50	8.25
8	7.00	4.80	3.60	8.40
9	7.00	4.25	3.33	7.58
10	7.00	3.95	3.20	7.15
11	7.00	3.85	3.75	7.60
12	7.00	4.85	4.05	8.90
13	7.00	4.68	4.15	8.83
14	7.00	4.95	4.25	9.20
15	7.00	3.85	3.12	6.97
16	7.00	4.65	3.47	6.12
17	7.00	4.35	3.50	7.85
18	7.00	4.56	3.35	7.91
19	7.00	4.20	3.10	7.30
20	7.00	4.05	2.70	7.00
21	7.00	3.90	3.05	6.95
22	7.00	4.25	2.90	7.15
23	7.00	3.95	3.05	7.00
24	7.00	3.85	2.95	6.80
25	7.00	4.65	3.55	8.20
26	7.00	4.80	4.00	8.80
27	7.00	4.80	2.65	7.45
28	7.00	4.97	2.76	7.73
29	7.00	5.20	3.80	9.00
30	7.00	4.95	3.65	8.60
Total		**133.17**	**102.09**	**235.26**
Average		**4.44**	**3.40**	**7.84**

4.20 Descriptive Analyses of Productivity Factors of 225mm Thick Block in Pitof Plan Bottom Greater than 4m²

The analysis of the effect of block related productivity influencing factors on the outputs of workers for 225mm thick hollow sand crete in pit of plan bottom greater than 4 square metres and 2-4 metres depth are presented in the Tables 4.26-4.27. The tables also depict the comparison of the production outputs of the grouped factors.

The Table 4.26 on the basis of age and educational qualification of workers revealed higher p. value of 0.099 and 0.312 respectively than the alpha value of 0.05 and consequently the null hypotheses are hereby accepted while the results of the analysis shown in Table 4.27 on the basis of the total mean outputs of mode of employment and experience of workers revealed significant difference hence the calculated p. values of 0.000 and 0.015 respectively are lower than the alpha level of (significance) 0.05 and therefore the null hypotheses are hereby rejected.

Table 4.26: Inferential of Analysis on Basis of Age and Educational Qualification

Age group	Mean± SEM	P. value	Std. Dev.	Minimum	Maximum
20-35 years	7.628±0.177		0.730	6.12	8.90
Above 35 years	8.122±0.236	0.099	0.852	6.95	9.20
Education Group					
Primary sch. cert.	7.556±0.226		0.749	6.12	8.90
S.S.C.E	7.970±0.198	0.199	0.792	6.80	9.20
C & G/NABTEB	8.210±0.634	0.222	1.098	6.97	9.06
S.S.C.E.					
C & G/NABTEB		0.639			

Mean difference at (0.05) alpha level is less than p. value (0.099) and (0.312).

Table 4.27: Inferential Analysis on Basis of Mode of Employmentand experience

Mode of Employment Group	Mean± SEM	P. value	Std. Dev.	Minimum	Maximum
Negotiated workers	8.527±0.181		0.572	7.45	9.20

Daily paid workers	7.500±0.154*	0.000	0.690	6.12	9.00
Experience Group					
2-5 years	7.281±0.204		0.612	6.12	8.25
6-10 years	7.909±0.192	0.054	0.691	6.95	8.90
Above 10 years	8.365±0.306*	0.004	0.863	7.15	9.20
6-10 years					
Above 10 years		0.169			

*Denotes the mean difference is significance at the 0.05 level

4.21 Data for Output of 225 mm Thick Block in Pit ofPlan BottomLess than 4m²

Data collected for outputs of workers laying 225mm thick hollow sand crete block in pits of dimensional area less than 4 square metres and less than 2m depth (gang size: 1 mason, 1 labourer) are shown in Table 4.28 depicting the morning ,afternoon and total outputs of workers observed on sites.

Table 4.28: Output for 225 mm Thick Sand Crete Block in Pit of Plan Bottom Less than 4m² and Depth Less than 2m

Gang .No	Total observed time (hr)	Output		Total output (m²)/Day
		Morning (m²)	Afternoon (m²)	
1	7.00	3.60	2.95	6.55

2	7.00	3.80	2.90	6.70
3	7.00	4.45	3.45	7.90
4	7.00	4.20	3.10	7.30
5	7.00	3.92	3.17	7.09
6	7.00	4.10	3.05	7.15
7	7.00	4.45	3.70	8.15
8	7.00	4.50	3.70	8.20
9	7.00	4.35	3.85	8.20
10	7.00	4.60	3.45	8.05
11	7.00	3.90	3.25	7.15
12	7.00	4.45	3.45	7.90
13	7.00	4.60	2.55	7.15
14	7.00	3.92	2.65	6.57
15	7.00	3.65	2.45	6.10
16	7.00	3.55	2.68	6.23
17	7.00	4.60	3.75	8.35
18	7.00	4.32	3.42	7.74
19	7.00	3.90	3.14	7.04
20	7.00	3.81	2.95	6.76
21	7.00	3.45	2.70	6.15
22	7.00	4.13	3.05	7.18
23	7.00	4.65	2.95	7.60
24	7.00	3.95	2.95	6.90
25	7.00	4.75	3.28	8.03
26	7.00	4.25	3.14	7.39
27	7.00	3.85	2.85	6.70
28	7.00	3.78	2.75	6.53
29	7.00	4.40	3.15	7.55
30	7.00	3.90	2.90	6.80
Total		**123.78**	**93.33**	**217.11**
Average		**4.13**	**3.11**	**7.24**

4.22 Descriptive Analyses of Productivity Factors of 225mm Thick Block in Pit of Plan Bottom Less than 4m^2

The analysis of the effect of block related productivity influencing factors on the outputs of workers for 225mm thick hollow sand crete in pit of plan bottom less than 4 square metres and 2 metres depth are presented in the Tables 4.29 - 4.30 and discussed accordingly. The Tables also depict the comparison of the production outputs of the grouped factors.

The Table 4.29 on the basis of age and educational qualification of workers revealed higher p. value of 0.136 and 0.786 respectively than the alpha value of 0.05 and consequently the null hypotheses are hereby accepted while the results of the analysis shown in Table 4.30.on the basis of the total mean outputs of mode of employment and experience of workers revealed significant difference hence the calculated p. values of 0.000 and 0.008 respectively are lower than the alpha level of (significance) 0.05 and therefore the null hypotheses are hereby rejected.

Table 4.29: Inferential Analysis on Basis of Age and Educational Qualification

Age group	Mean ± SEM	P. value	Std. Dev.	Minimum	Maximum
20-35 years	7.136±0.146		0.684	6.10	8.35
Above 35 years	7.513±0.191	0.136	0.540	6.70	8.20
Education Group					
Primary sch. cert.	7.213±0.211		0.729	6.15	8.20
S.S.C.E	7.321±0.197	0.694	0.708	6.10	8.35
C & G/NABTEB	7.078±0.174	0.713	0.390	6.70	7.60
S.S.C.E					
C & G/ NABTEB		0.503			

Mean difference at (0.05) alpha level is less than p. value (0.136) and (0.872).

Table 4.30: Inferential Analysis on Basis of Mode of Employment and Experience.

Mode of Employment Group	Mean± SEM	P. value	Std. Dev.	Minimum	Maximum
Negotiated workers	7.825±0.129		0.429	7.15	8.35
Daily paid workers	6.897±0.119*	0.00	0.520	6.10	8.03
Education Group					

2-5 years	6.751±0.136		0.450	6.10	7.60
6-10 years	7.503±0.175*	0.004	0.605	6.55	8.36
Above 10 years	7.484±0.268*	0.014	0.708	6.23	8.15
6-10 years					
Above 10 years		0.945			

*Denotes the mean difference is significance at the 0.05 level

4.23 Effect of Productivity Factors on Labour Outputs

The effect of productivity factors are elucidated in Table 4.31 shown below.

Table 4.31: Summary of Results of null hypothesis

Work item	Age $H1_0$	Qualif $H2_0$	M. of E. $H3_0$	E. of W. $H4_0$	S. ofBd $H5_0$	P.of.W $H6_o$
150mm thick in foundation.	Accepted	Accepted	Rejected	Rejected	Rejected	Rejected

150mm thick in superstructure	Accepted	Accepted	Rejected	Rejected	Rejected	Rejected
150mm thick in S. Overhand	Rejected	Accepted	Rejected	Reject	Rejected	Rejected
225mm thick in foundation.	Rejected	Accepted	Rejected	Rejected	Rejected	Rejected
225mm thick in superstructure	Accepted	Accepted	Rejected	*Accepted*	Rejected	Rejected
225mm thick in S. Overhand	Accepted	Accepted	Rejected	Rejected	Rejected	Rejected
225mm thick Iso. Pies in superstr.	Accepted	Accepted	Rejected	Rejected	NA	Rejected
225mm thick Iso. Pies in S. Overhand.	Accepted	Accepted	Rejected	*Accepted*	NA	Rejected
Ditto in pit >4 m^2.b. plan and 2-4m depth.	Accepted	Accepted	Rejected	Rejected	NA	Rejected
Ditto in pit <4 m^2 b. plan and 2m depth	Accepted	Accepted	Rejected	Rejected	NA	Rejected

Key: Qualif. = Qualification, M.of E.= Mode of employment, E. of W. = Experience of workers, S. of Bd=Shape of building, P. of W. = Period of work.

4.24 Determination of Block Layers Outputs

The mean outputsof group factors as relate to the observed productivity factors are summed upin Table 4.33to obtain the average output per day for the ten work items.

Table 4.32: Outputs in Accordance with Productivity Factors

.Work Item	Age of workers (years)			Qualification of workers					
	< 20	20-35	> 36	P S. C	S.S.C	C&G/ NAB	NAP TED	ND	Others

150mm thick in fdn.	11.26	13.13	12.82	12.62	13.33	13.06	Nil	Nil	12.43
150mm thick in superstr.	12.61	13.47	13.04	13.10	13.62	13.53	Nil	Nil	12.52
150mm thick in S. Overhand	11.26	12.50	12.58	12.34	12.67	12.58	Nil	13.20	11.95
225mm thick in fdn.	7.13	9.11	9.06	8.55	9.33	9.45	Nil	Nil	8.69
225mm thick in superstar.	Nil	10.92	11.34	10.34	11.59	11.29	Nil	Nil	11.13
225mm thick in S. Overhand	8.49	9.20	9.19	8.68	9.69	9.28	Nil	Nil	9.00
Ditto Iso .Pies in superstr.	4.59	5.28	5.18	4.88	5.36	5.27	Nil	Nil	4.89
Ditto iso.piers. insuper.ohd..	4.15	4.74	4.81	4.47	4.84	4.41	Nil	Nil	4.74
Ditto in pit >4 m².b. planand 2-4m depth.	Nil	7.97	7.55	7.56	7.97	8.21	Nil	Nil	Nil
Ditto in pit <4 m² b. plan and 2m depth	6.57	7.16	7.57	7.21	7.32	7.08	Nil	Nil	Nil

Key:< = Less than, >= greater than,P.S.C.= Primary School Certificate, S.S.C.= Secondary School Certificate, NAB=NABTEB,

Table 4.33: Outputs in Accordance with Productivity Factors

Work item	Mode of Employment			Experience of Worker (years)				Shape of building		Average
	CE	NW	DP	< 2	2 – 5	6 – 10	> 11	STR	IRR	TOP(m²)
150mm thick in fdn.	11.76	14.74	12.23	Nil	11.83	12.95	13.77	14.31	12.44	**12.85**
150mm thick in superstr.	12.53	14.01	13.29	12.29	12.73	13.38	13.68	14.59	13.08	**13.22**

150mm thick in S. Overhand	11.19	13.99	12.32	Nil	11.66	12.76	12.83	13.72	11.98	**12.47**
225mm thick in fdn.	7.31	9.65	8.86	Nil	8.31	9.08	9.49	10.71	8.82	**8.90**
225mm thick in superstar.	8.95	14.09	10.80	Nil	9.84	11.14	11.48	13.50	9.97	**11.17**
225mm thick in S. Overhand	8.52	10.83	8.73	7.77	8.19	9.30	10.01	10.92	8.80	**9.16**
Ditto Iso .Pies in superstr.	3.87	5.71	4.95	4.35	4.87	5.23	5.55	NA	NA	**5.00**
Ditto iso.piers. insuper.ohd..	3.65	5.27	4.39	4.27	4.42	4.84	4.98	NA	NA	**4.57**
Ditto in pit >4 m^2.b. plan.	Nil	8.53	7.50	7.45	7.77	7.83	7.98	NA	NA	**7.85**
Ditto in pit <4 m^2 b. plan	Nil	7.82	6.90	6.15	6.95	7.39	7.48	NA	NA	**7.13**

Key: CE = Contract employed workers,NW = Negotiated workers,DP= Daily paid workers,STR= Workers on straight walling,IRR= Workers on irregular walling, TOP = Total output.

The determined outputs per day were further divided by 7 hours (reference to output tables) to obtain output per hour as indicated in Table 4.34.

Table 4.34: Determination of Output per Day and per Hour

S/ No	Description of Work Items	Ob. Time P. Day (h)	Det. Opt.P.Day (m^2)	Opt.P. Hr (m^2/h)
1	150mm thick hollow sand crete block work in Foundation ≤ 1.00m deep. Gang size; one mason and one labourer.	7	12.85	1.84
2	Ditto in superstructure (not greater than 1.50m high above over site concrete). Gang size; one mason and			

	one labourer.	7	13.22	1.89
3	Ditto in superstructure over hand (1.5m above over site concrete up to roof level). Gang size; one mason and two labourer)	7	12.47	1.78
4	225mm thick hollow sand crete block work in Foundation ≤ 1.00m deep. Gang size; one mason and one labourer.	7	8.90	1.27
5	Ditto in superstructure (not greater than 1.50m high above over site concrete). Gang size; one mason and one labourer.	7	11.17	1.59
6	Ditto in superstructure over hand (1.5m above over site concrete up to roof level). Gang size; one mason and two labourer)	7	9.16	1.31
7	Ditto isolated piers of 450mm plan lengthin superstructure (not greater than 1.50m high above over site concrete). Gang size; one mason and one labourer.	7	5.00	0.71
8	Ditto isolated piers of450mm plan length in superstructure over hand (1.5m above over site concrete). Gang size; one mason and one labourer	7	4.57	0.65
9	Ditto in pit, bottom plan ≥ 4 m² and depth 2-4m.Gang size; one mason and two labourer	7	7.85	1.12
10	Ditto in pit, bottom plan < 4 m² and depth ≤ 2m. Gang size; one mason and one labourer	7	7.13	1.02

Key: Ob Time P. Day= Observed time per day, Det. Opt. p. Day= Determined output per day, Opt. P. Hr = Output per hour.

4.25 Summary of Major Findings

Forty-four (44) possible block work items operational in construction sites were identified but are not specifically referenced or incorporated in Section F 'Masonry' as F.10 'Brick/Block walling' of BESMM3.

The age workforce of block laying was predominantly in the category of 20-35 years, representing 67% followed by the age category of 36 years and above representing 28%

and all these age categories have mean outputs higher than the determined outputs of the work items. The dominance of 20- 35 years age category in the block laying workforce could be demonstrated that this is the working population informed by the alertness required for height and energy related work consequently have impact on the determined output. However, significant difference exists in two of the ten work items observed.

Block laying operation observed to be qualitatively dominated by secondary and primary school certificates representing 46% and 33% respectively, in addition to their apprenticeship training. However, the mean outputs of secondary and NABTEB are higher than the determined outputs of all the work items, consequently have impact on the determined output as identified by Rojas et al., (2003. These classes of educational qualification have edge in output production than the primary school because of the higher qualification. Therefore, it can be affirmed that the sample observed was a sample of qualified workers, because 93% of the sample had one qualification in addition to apprenticeship training. Educational qualification consistently had no significant difference on the determined outputs. However, this is in agreement with Abdullahi, (2009).

The block laying workforce observed was predominantly engaged by daily paid workers representing 52% followed by negotiated workers representing 32%. However, the mode of employment significantly influences the determined output in all the work items observed as confirmed by Abdullahi*et al.,(*2010) and Heizer and Render,(1996). The negotiated workers have the highest mean outputs with significant impact on the determined outputs while daily paid comes next and the contract employed workers with mean outputs less than the determined outputs.

The block laying workforce observed was characterized with workers of a minimum 6 years working experience representing 72%. 6-10 years working experience was predominantly employed representing 44% followed by 11 years and above working experience represents 28%. However, the mean outputs of these classes of working experiences are higher than the determined outputs of all the work items observed. However, significant difference exists in eight of the ten work items observed. Also, Abdullahi,(2009); Abdullahi*et al.,(*2010) and Heizer and Render,(1996) and Thomas et al.,(1991) confirmed significant difference.

The shape of buildings significantly influenced the determined outputs as workers on continuous (straight) block walling had higher mean output than their irregular operational design counterparts as well as having significant impact on the determined output. Adrian (1982) identified that the breaking of continuity of the wall areas, and the need to align the masonry work to the opening significantly lowers the mason's productivity, perhaps representing as much as 50% of the straight wall productivity. However, this study disagree with that assertion and revealed an average of 21% output difference between straight and irregular walling and 15% difference between straight and determined outputs.

The outputs determined as regard to different sizes of block and different block items location show a clear disparity as depicts in table 4.15. Also, the outputs of block work in superstructure for both 150mm and 225mm thick show a clear disparity of 6% and 25% respectively with those in foundation or superstructure overhand.

It was also discovered from the existence Bill of Quantities that there was no categorization of outputs/rates in reference to work location even though the BESMM classifies block work into; substructure, superstructure and superstructure overhand and when the determined outputs were considered at different operational levels, there are sharp disparity.

The output production of workers is higher in the morning period than in the afternoon period as also reported by Abdullahi, (2009) and this is because the workers could be energetically refreshed in the morning operation than the afternoon operation which they might be exhausted.

The outputs stated under isolated piers were based on 450mm plan length and upon increase in plan length; the unit output per day or per hour will be pro-rata. Also, the study discovered that there was significant change in output of work in compartments of bottom plan greater than $4m^2$ with 2-4m depth and compartment of bottom plan less than $4m^2$ with a depth less than 2m.

Comparison revealed that the offhand and the sourced B.S. outputs are at variance to each other, also Ajia (2002); Abdullahi, (2009) ;Abdullahi*et al*., (2010) and Abdulrazaq*et al.*, (2010) reported same, thus;

Table 4.35: Comparison of the Determined Labour Output with Other Adopted Labour Outputs and B.S. Outputs.

S/ No	Work Item	Prof. based Experience output (m^2)	British Standard output(m^2)	Determined Output (m^2)
1	150mm blk in Fdn ≤ 1.00m deep			12.85

2	Ditto blk in superst. ≤ 1.50m above over site concrete	8.5 -10.00	7.78* 10.5**	13.22
3	Ditto in super. Overhand > 1.50m –roof. Level.			12.47
4	225mm blk in Fdn ≤ 1.00m deep			8.90
5	Ditto blk in superst. ≤ 1.50m above over site concrete	7.00-8.50	7.0* 8.53**	11.17
6	Ditto in super. Ohd>1.50m –roof. Level.			9.16
7	Ditto isolated Piers in superst.of 450mm plan length.	Meas.as applied in 225mm block wall	No reference and unabletobe sourced	5.00
8	Ditto iso. piers in super. Ohd of 450mm plan length.			4.57
9	Ditto in pit, bottom plan > 4m² and 2-4m depth.	6.5- 7.50	No reference and unable to be sourced	7.85
10	Ditto in pit, bottom plan < 4m² and 2m depth.			7.13

Key: Prof. denotes Professional, * denotes B.S based outputs sourced through Hall (1972), ** denotes B.S. based outputs sourced through Brook (2010)

CHAPTER FIVE

5 CONCLUSION AND RECOMMENDATIONS

This chapter presents the conclusion of the results relating to the research problem propounded and the hypotheses postulated. It unveils the effects of the findings. The chapter also relates the output data obtained from previous research works with those obtained in this study to deduce its conclusion. It also highlights the areas of contention especially as relate to BESMM3 compliance between the results obtained and those of previous work.The chapter concludes by giving general recommendation as to how the findings of the research can help in the production of fair and accurate Bills of Quantities which is non-detrimental to either party. However, directions for future research are recommended.

5.1 Conclusion

The aim of the study was to empirically determine the outputs for ten hollow sand creteblock laying work items in F.C.T., Abuja and Nasarawastate construction industry. The study was able to achieve the aim through accomplishing the stated objectives; the first objective was to identify factors and operation affecting block laying. Critical examination of masonry section of BESMM as relate to construction implication of work items on workers' productivity reviewed that certain factors such as locational factor, work in compartment presumably to have been included in the masonry section, but no specific reference or guide as where to locate them in the section Locational factor and work in compartment have productivity effects on the outputs of workers. Previous researchers never taken BESMM into cognizance or comply with operational sequence or techniques in construction sites prior to the determination of output constant.

The second objective was to identify the possible block laying work items as relate to BESMM and construction site. 125 possible work items as relate to block laying operation were identified of which 44 items were not specified in BESMM. Certain work items measurable under block work were distinctly identified from the masonry. The identification was based on distinct operation techniques and approaches which could not be executed under the same techniques. Also, certain possible work items operational in construction site which are not captured in the masonry trade as relate to block work were identified. These work items are presumably to have been captured in the trade, but there is no definite step as where to locate them in themasonry section of BESMM. It is imperative that all possible work items of distinct execution in construction site be clearly defined in BESMM hence it is a standard document upon which BoQ is reliably prepared.

The third objective was to analyze the effect of productivity factors on labour output. The test of difference conducted in order to analyze and investigate the extent of influence of the productivity factors revealed aconsistent significant difference in output of workers on the period of observation, shape of the building and mode of employment in the ten work items analyzed while experience of workers revealed in eight and age of workers in two work items respectively.It was concluded that negotiated workers were always most productive in the ten work items observed than other workers employed in different agreement.This is a clear indication that negotiated workers instillthe spirit of self motivation to maximize effort in order to maximize payment.

Workers with long working experience produce more output than workers with low working experience especially where the age group of the worker is within 20-35 years. The study concluded that complexity of the design features also affect the productivity as workers on straight block walling require higher outputs than their counterparts on irregular walling operations.It was concluded that educational qualification of workers had no significant impact on output determination of block laying operatives provided that the workers undergo apprenticeship training. The age category of workers 20-35 had highest output than those of below 20 years and 36 years and above categories and there was no significant difference among the age categories.

The fourth objective was to determine the empirically the labour outputs of ten selected block laying work items. The outputs of workers for ten work items were determined as stated in the table 4.14b and 4.15. The outputs were determined in compliance with BESMM as well as taken cognizance of the locational factor and work in compartment. The three locational considerations were; block work in foundation, block work in superstructure and block work in superstructure overhand. However, in estimating practice, Bills of Quantities are not reliably prepared on the three locational considerations, in construction techniques, these have effect on the outputs of the workers as it was observed on 150mm and 225mm thick block a sharp difference between superstructure and foundation or superstructure overhand in difference operational location.

The determined outputs were compared with the B.S., professional based experience and those of previous research and there were clear evidence of sharp differencesand their application were not sequences to BESMM. The study therefore finally concludes that SMM takes cognizance of productivity impact associated with labour and it is imperative for reliability and accuracy in block work estimate to empirically determine labour outputs on the basis of work items as stated in BESMM3.

5.2 Recommendations

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

I. A block layer should lay a minimum output of the following work items per day;

Table 5.1: Minimum Output Hollow Sand Crete Block Per Day and Per Hour

S/ No	Blkthick ness (mm)	Description of item	Gang size	Optper day(m^2)	Opt per hour(m^2)

1	150	Wall in foundation ≤ 1.00m	1 mason and 1 labour	12	1.71
2	150	Wall in superstructure > 1.5 above over site concrete.	Ditto	13	1.86
3	150	Wall in superstructure overhand (1.5m above over site concrete up to roof level	1 mason and 2 labourers	12	1.71
4	225	Wall in foundation ≤ 1.00m	1 mason and 1 labour	8	1.14
5	225	Wall in superstructure > 1.5 above over site concrete.	Ditto	10	1.43
6	225	Wall in superstructure overhand 1.5m above over site concrete up to roof level	1 mason and 2 labourers	9	1.29
7	225	Isolated piers of 450 plan length in superstructure > 1.5 above over site concrete.	1 mason and 1 mason	5	0.71
8	225	Isolated piers of 450 plan length in superstructure overhand 1.5m above over site concrete up to roof level	1 mason and 1 mason	4	0.57
9	225	Wall in pit, bottom plan ≥ 4(m^2) and depth 2-4m.	1 mason and 2 labourers	7	1.00
10	225	Wall in pit, bottom plan <. 4(m^2) and depth ≤ 2m.	1mason and 1 labourer	6	0.86

The research suggested the following additional recommendations:

II. The forty-four (44) block work items not captured in BESMM should be incorporated and adopted in BESMM3 for productive and cost implication.

III The contractors should exploit the output figures determined as relate to productivity factors so as to optimize the productivity of their workers.

IV For optimum productivity in block laying operations, workers within the age category of 25- 45 years, 6 years of experience and above and of educational qualification of S.S.C.E./NABTEB and above should be employed.

V For exigency reason, employer should employ workers on the term of negotiated agreement.

VI Workers on block laying of straight wall should be capable of producing 10% above the expected outputs levels.

VII Contractors/clients should take cognizance of construction cost implication of abandoning block operation before superstructure overhand especially where the agreement is to execute the entire block laying operation.

VIII The Nigerian Institute of Quantity Surveyors (NIQS) is advised to review the BESMM so as to reflect some indispensable factors that have impact on labour productivity and also incorporate those possible work items operational in construction sites.

IX In compliance to BESMM, the NIQS in collaboration with NJIC should sponsor a research on determination of labour outputs in all trades as a way to ensure uniformity in estimating and enhance professional integrity rather than resorting to mere guesstimates.

5.3 Suggestions for Further Study

The followings are areas recommended for further research and study;

- Similar works in compliance with BESMM be conducted on all other trades.
- Outputs should be investigated on the basis of standard gang size formations using activity sampling techniques.
- A study on investigating into the adequacy of work items in BESMM as applied to construction sites should be conducted.

- An evaluation of the relationship between the output of any of the grouped factors and any of the studied factors of productivity.
- Comparative analysis of labour outputs of various total height of building.
- Comparative analysis of the quality of work of various mode of employment.

5.4 Contribution to Knowledge

The following knowledge is expected to be gained from this study;

- The study has provided that BESMM3 should be a basis for determination of block layers outputs in the Nigerian construction industry.
- The study has provided that within the trade, there are different work items that require different outputs as stated in BESMM3
- The study also provided that the British outputs cannot provide a realistic basis for block work estimates in the Nigerian construction industry.

REFERENCES

Abdel-Razek, R. H., AbdElshakour, H. and Abdel-Hamid, M. (2007). Labor productivity: benchmarking and variability in Egyptian projects. *International Journal of Project Management*, 25,189-197.

Abdul-Kadir, M. R. (1995). Conceptual phase of construction projects.*International Journal of Project Management***.***13***(** *60), 387-393*.

Abdul-Maliq, O.Y. (2006). *Research methodology in business and the social sciences.* Al-Maliq andCompany, Garki Abuja.

Abdullahi, M., Ibrahim, A.D. and Ibrahim, M.Y.(2010).Impact of productivity factors on labour outputs for selected building trades. *Construction Focus, 3*(1), 106-117.

Abdullahi, M. (2009). Empirical determination of labour outputs for selected trades in Kaduna State. An Unpublished B. Sc. Project, Department of Quantity Surveying, Faculty of Environmental Design, ABU Zaria.

Abdulrazaq, M., Muhammad, A. and Abba, I. (2010).Empirical determination of labour outputs on formwork for construction projects.*Construction Focus,3*(1), 62-69.

Adamu, K.J., Dzasu,W.E., Haruna, A. and Balla,S.K. (2011).Labour productivity constraints in the Nigerian construction industry.*Continental Journal of Environmental Design and Management, 1*(2), 9-13
.

Aderonke, O. (2008). *Consol's Nigerian building price book for builders and developers* (2nd ed.).DamataPrintas and Publishas, Lagos.

Adrian, J.J. (1982). *Construction estimating: An accounting and productivity approach*, Reston Publishing Company, New York.

Aiyetan, O .A and Olotuah, O. A. (2006).Impact of motivation of workers productivity in the Nigeria construction industry.Proceedings of 22nd AnnualConference.pp239-248 Organized by Association of Researchers in ConstructionManagement.

Ajia, J.B. (2002).An Appraisal of work output on construction sites.An Unpublished B. Sc.Project, Department of Building, Faculty of Environmental Design, ABU Zaria.

Alabi, O. and Milne, A. J (1987).*Builders pricing and tendering procedures in Nigeria*, Julab Publishers Limited, Ibadan, Nigeria.

Ameh, O.J.,andOdusami, K.T. (2002). Factors affecting labour productivity in Nigerian construction industry: A case study of indigenous contracting organizations in Lagos. *Jourrnalof Quantity Surveyor, 40,*(3), 14-18.

Ameh, O.J.,andOsegbo, E.E, (2011). Study of relationship between Time overrun and productivity on construction sites.*International Journal of Construction Supply Chain Management, 1*(1),56-67.

Andersson, C. A., Miles D., Neale, R. and Ward, J.(1996). *Site management handbook*. International Labour Office, Geneva.

Arditi, D.and Mochtar, K. (2000).Trends in productivity improvement in the United State Construction Industry.*Journal of Construction Management and Economics. 18(2), 15-27*

*Arms*trong, M. (1990).*Handbook of human resource Management*,Kogan Page Limited, London.

Ashworth, A. (2002). *Pre-contract Studies Development Economics, Tendering and Estimating*(2nd ed.). Blackwell publishing, London

Ashworth, A. (2006). *Pre-contract Studies, Development Economics, Tendering and Estimating.*(3rd ed.). Blackwell publishing, London.

Ashworth, A. and Hogg, K. (2007).*Willis Practice and Procedure for the Quantity Surveyor*(12th ed.). Blackwell Publishing, London.

Attoh-okine, O.N.(2003). Rule induction in productivity analysis: A rough set approach. *Engineering Construction and Architectural Management.10(.6) 413-417.*

Ayeni, I. O. (1997).*Principles of Estimation and Tendering*. Builders Magazine Limited, Lagos.

Bamisile, A. (2004). *Building Production Management*.Foresight Press Limited, Lagos, Nigeria.

Barnes, M.R. (1980). *Motion and Time study design and measurement of work*. John Wiley and Son Publishers, New York.

B.S.3138 (1979).*A Glossary of terms used in work study and organization and management*.The British Standards Institute.

Barrie, D. and Paulson B. (1992).*Professional construction management*. McGraw-Hill, Inc.

Bailey,G.R.(1964). *Principles of builders' estimating and final accounts*(Rev.3rd ed.), Crosby Lockwood and Son Limited, London.

Brook, M. (2010). *Estimating and tendering for construction work*(3rd.ed.). Butterworth Heinemann Publications, London.

Butchan, R.D., Fleming, F.W. and Kelly, J.R. (1993).*Estimating for Builders and Quantity Surveyors.* Butterworth Heineimann, Oxford.

Butler, T.J.(1988).*Element of administrations for building students* (4th ed.).Hutchinson London,

Chang Luh-Maan (1985). Inferential statistics for craftsman questionnaire.*Journal Construction Engineering and Management,112*(4), 492-499.

Cole, G. A. (1999). *Management:Theory and practice*(5th ed.).AsfordColour Press Gosport, Great Britain.

Cole, G. A. (2005). *Management Theory and Practice (6th*ed.).Book power, London.

Cox, A. and Thompson, I. (1997). _Fit for purpose-contractual relations: Determining a theoretical framework for construction projects.*European Journal of Purchasing & SupplyManagement, 3*(3), 127-135.

Dunlop, P. and S.A. Smith, (2004). Planning, estimation and productivity in the lean concrete Pour,*Journal of Engineering Construction and Architectural Management*, *11*(1),*55-64.*

Enekwachi, C. (1996,August). The survival of quantity surveyors of other professionals in the constuctionindustry, in a dwindling economy.*Building Magazine,5(4), 9-11*

Enshassi, A., Mohammed, S., Al- Halag, K. and Mustafa, Z.A.(2011). Labour productivity measurement in building projects.*Islamic University Journal, 19*(1), 103- 119

Enshassi, A., Mohammed, S., Mustafa, Z.A. and Mayer, P. E. (2007). Factors affecting labour productivity in building projects in the Gaza Strip.*Journal of Civil Engineering and Management*, *13(*4), 245-254.

Enshassi, A. ,Sherrif, M. and Ibrahim .M. (2002): Factors affecting the accuracy of cost estimation of building contracts in the Gaza Strip.*Journalof Financial Management of Property and Construction, 10(2), 115-125.*

Enterkin, H. and Reynolds, G. (1978).*Estimating for builders and surveyors*(2nd ed.). William Heinemann Limited, London.

Fagbenle, O.I., Adeyemi ,A.Y. and Adesanya,D.A. (2011). Factors affecting the performance of labour in Nigeria construction sites. *Mediterranean journal of social science,2(2),51-57*

Faki,I.A., Abdulsalam, D., Okoli, O. G and Zubairu, I.K.(2010). An assessment of craftsmen productivity in the Nnigeria construction industry.*Construction Focus, 3*(1), 87-95

Fellows, R. and Liu, .A. (1999): *Research methods for constructions.* Blackwell Science, Oxford London.

Field, B. and Ofori, G. (1988).Construction and economic development; A case study third world planning review.10(1) 4150 .

Foster, G. (1991). *Construction site studies: Production administration and personnel*, Longman, New York.

Hall, M.S.D.(1972). *Elements of estimating.*C.tinling and Co.Limited,Prescot, Lancashire Great Britain.

Harris F. C. and McCaffer R. (1995).*Modern construction management (4th*.ed.). Oxford,Blackwell Science.

Hartzell, D. (2006). *Dictionary of management*.Academic Publishers, New Delhi.

Heizer, J. and Render, B. (1990).P*roduction and operations management-strategic and tactical decisions*. Prentice Hall, New Jersey.

Herbsman, Z. and Ellis, R. (1990).Research of factors influencing construction productivity.*Journal of Construction Management and Economics, 8,* 49-61

Hillebrandt, P. (2000). E*conomic theory and the construction industry*, Macmillan, London.

Husseini, A.A. (1991).The importance of manpower training and management to the construction industry.*Proceedings of the National Seminar on Effective Contract Management in the Construction Industry, pp*119-131.Organized by the Nigeria Institute of Builders, 22nd to 23rd August.

Ibironke, O.T. (2005). *Essential of quantity surveying*.Timlab Quant Cost, Birnin Kebbi.

International Labour Office (1964).Introduction to Work study.Atar Geneva.

Jilikun, D, Paul M. G. and William F. M. (2009).Construction crafts workers' perceptions of the factors affecting their productivity. *Journal of Association of Society of Civil Engineers, 135*(3), 217

Kane (1980).An examination of factors influencing productivity in the highway construction industry. Proceedings of the C.I.B. W65 .Third Symposium on Organization and Management of Construction, Doblin: Pp 181-194

Lawal, A. and Adeyeye, V. A. (2006).*Essentials of research methodology*,Olas Ventures, Nigeria.

Lema, N. M.(1995). *Construction of labour productivity modeling*.University of Dar Elsalaam.

Lim, E. C. and Alum, J.(1995). Construction productivity: Issues encountered by contractors in Singapore.*International Journal of Project Management,13(* 1), 51-58.

Lowe, J.(1987). The measurement of productivity in the construction industry.*Journal of Construction Management and Economics.29(5).101-113.*

Madi, I. M.(2003). Essential factors affecting accuracy of cost estimation of building contractors.Msc Thesis, Islamic University - Gaza (Unpublished).

Morledge, R.(2006). Estimates or Guesstimates?,*The Journal of the Royal Institute of Chartered Surveyors Construction, 58, 365-671.*

Mostafa, A.A.Z. (2003). Study of the measurement of labour productivity in the Palestinian construction industry, The Gaza Strip. MSc Thesis, Faulty of Engineering, Higher Education Deanship, IslamicUniversityGaza (http://www.google.com)

Muqeem, S., Arazi B. I., Mohd, F. K. and Mohd, S. Z. (2011).Construction labour production rates using artificial neural network.*Journal of Information Technology in Construction.16,713-723*

Ng, S. T., Skitmore, R. M., Lam, K. C. and Poon, A. W. C (2004). Demotivating factors influencing the productivity of civil engineering projects.*International Journal of Project Management*, 22(2),119-131,139-146.

NIQS,(2008). *Building and engineering standard of method of measurement*(3rd ed.).

Nunnally, W.S.(2011). *Construction methods and management*(8th ed.). Pearson Education International.

Obande, O.M.(1985). *Blocklaying and Concreting*(3rd ed.).Longman Group Limited,Ikeja, Nigeria.

Oglesby, C., Parker, H. and Howell, G. (2002).*Productivity improvement in construction.* McGraw-Hill, Inc, United States of America.

Olaloku, F.A. (1987). The quantity surveyor, Thesecond Tier Foreign ExchangeMarket and the construction industry in Nigeria; Options and challenges,Construction in Nigeria. *Journal of the Federation of Building and Civil Engineering Contractors in Nigeria 4*(1), 4-8.

Olaoluwa, O., Ojo,S.O. and Adesanya,D.A.(2012).Effect of pour size on concrete placing productivity in Nigeria.*Research Journal of Applied Sciences, Engineering and Technology.4(12),* 1649-1658

Olomolaiye, O.P.and Ogunlana, O.S. (1988).A survey of construction operative motivation on selected sites in Nigeria.*Building and Environmental,23(3),* 179-185

Olomolaiye, O.P. and Ogunlana, O.S. (1989). An Evaluation of production outputs in key building trades in Nigeria.*Construction Management and Economics.* 7, 75-86.

Olomolaiye, P., Kaming, P., Holt, G. and Harris, F. (1996).Factors influencing craftsmen's productivity in Indonesia.*International Journal of Project Management,15(1), 21-30.*

Olomolaiye, P., Jayawardane, A. and Harris F. (1998).Construction ProductivityManagement.*Chartered Institute ofBuilders, England, 31, 22.*

Olowo – Okere, E.O. (1988). Problems of construction management in Nigeria', *Paper presented to the workshop on National Construction Policy, ASCON*, Badagry - Lagos, Nigeria.

Olufemi, A. O. (2007.*Procedures in educational research,* kingo Nigeria limited, Kaduna.

Onwusonye, S.I.J.(2006). *Tendering, estimating and contractual arrangement in building projects (Principles and Practice*) (Rev. ed.). Inter Continental Education Books and Publishers, Owerri.

Portas, J. and AbouRizk, S. (1997). Neural network model for estimating construction productivity; *Journal of Construction Engineering and Management.*123, 399-410.

Price, A.D. and Harris, F.C. (1985).*Methods and rates for concrete and bituminous road paving operations; SERC report.*Department Of Civil Engineering,Loughborough University. U.K

Pilcher, R. (1997).*Principles of construction management.*Third Edition, McGraw Hill London.

Proverbs, D.G., Holt, G.D., &Olomolaiye, P.O. (1999).A comparative evaluation of concrete placing productivity ratios amongst French, German and UK construction contractors.*Journal of Engineering Construction and Architectural Management*, 5(2), 174-181

Rojas, M. E. and Aramvareekul, P. (2003).Labor productivity drivers and opportunities in the construction industry.*Journal of management in engineering,* 19(2),78-82.

Russell,S.J and Skinniewski,J.M.(1990). An Ergonomic Analysis Framework for Construction Tasks; *Construction Management and Economic*s, l8, 329-338

Sisalem, E., Aboubad, K. and Hamad, M. (2000).Engineering management -value added assessment of construction. Graduation project, Islamic university - Gaza (unpublished).

Sweis, J.R., Sweis, J.G. Hammad, A.A.andMalek,A. R. (2009). Modelling thevariability of labor productivity in masonry construction; *Jordan Journal of Civil Engineering* , 3(3), 197-212

Talhouni,T.K.B. (1990).Measurement and analysis of construction labour productivity. A Thesis for PhD, Department of Civil Engineering of the University of Dundee (http://www.google.com)

Teicholz, P. (2001). United Stateconstruction labor productivity trends, 1970-1998. *Journal of Construction Management and Engineering*, 127,(5), 427-429.

Thomas, HR. and Mannering, F.l. (1986).Development of the framework for a labour-intensive construction site forecasting model. Grant proposal forNational Science Foundation, U.S.A

Thomas, H. R. (1990). Labour productivity and work sampling: the bottom line. *Journal of Construction Engineering and Management*,116(3),309-320.

Thomas, H. R. (1991). Factors affecting masonry productivity.Journal of Construction Engineering and Management, 117(4),626-644.

Thomas, H.R.(1992): Effects of scheduled overtime on labor productivity. *Journal of Construction Engineeringand Management*,118 (1), 60–76

Thomas, H.R and Napolitan, C.L. (1995): Quantitative effects of construction changes on labor productivity. *Journal Construction Engineering and Management*, 121(3), 290–296.

Thomas, H.R, Horman, M.J, Lemes De Souza, U.E, and Zavrski, I. (2002). Benchmarking oflabour – Intensive construction activities: Lean construction and fundament principles of workforce management.Technical Report. Pennsylvania TransportationInstitute, University Park, PA.

Udegbe, I. M. (2007).Labour output on painting activity in the construction industry in Edo, Nigeria. *Journal of Social Science*, 14(2),179-184

United Nations, (1965).*The Effect of repetition on building operation sand processes on site.* New York.

Wachira, I. N. (2001).Labour management in Kenya.Department of Building Economics and Management, university of Nairobi, Nairobi.

Wahab, K.A. (1991). Satisfying the training needs of management and staff in the construction industry.*Proceedings of the National Seminar on Effective Contract Management in the Construction Industry: Pp* 80 -107

Wainwright, W.H and Wood, A. A.B.(1977). *Practical estimating and final accounts (3rd* ed.). Anchor Press Limited, London.

Whitehead, R.C.(1986). *Record the data*. Building Technology and Management

Wilcox,S.Stringfellow, B. Harris, R. and Martin, B. (2000).Management and productivity.Transportation Research Board, Committee on Management and Productivity.

Yates,J. K. andGuhathakurta .S. (1993): International labour productivity in cost engineering. *Journal of cost estimation, cost/schedule control, and project management, 35(1*),15-25.

Zayed, T. and Haplin, D. (2004).Quantitative assessment for piles productivity factors. *Journal of Construction Engineering and Management.130*(3), 405-414.

APPENDIX 1

An Extract of Block Work Items

Reference	Description of work items	Unit	Construction definition of key descriptive features
1.1.1	Wall; thickness stated, type stated laid in stated bond	M²	Laying in a predetermined pattern
1.1.1.1	Wall; thickness stated, type stated laid in stated bond against other work	M²	Laying in a predetermined pattern on existing work
1.1.1.2	Wall; thickness stated, type stated laid in stated bond against other bonding	M²	Laying in a predetermined pattern on existing different materials
1.1.1.3	Wall; thickness stated, type stated laid in stated bond used as formwork	M²	Laying in a predetermined pattern used as formwork
1.1.2	Wall; thickness stated, type stated laid in stated bond; battering	M²	Sloping walls with parallel sides
1.1.3	Wall; thickness stated, type stated laid in stated bond; tapering, one side	M²	Walls of diminished width or thickness of one side

1.1.4	Wall; thickness stated, type stated laid in stated bond ; tapering, both sides	M²	Walls of diminished width or thickness.
M4	Wall; thickness stated, type stated laid in stated bond curved with stated radius	M²	Laying a predetermined circular wall
1.2.1	Wall; thickness stated, type stated laid in stated bond,face work one side**,** thickness stated	M²	Better type of material and finish masking an interior of one side of wall. It is generally applied in a thin layer, such as ashlar
1.2.2	Wall; ditto, battering	M²	Ditto on battering wall
1.2.3	Wall; ditto, tapering one side	M²	Ditto on wall, tapering one side
1.2.4	Wall; ditto, tapering both side	M²	Ditto on wall, tapering both side
1.3.1	Wall; thickness stated, type stated laid in stated bond, face work both sides, thickness stated	M²	Better type of material and finish masking an interior of both sides of wall. It is generally applied in a thin layer, such as ashlar
1.3.2	Wall; ditto, battering	M²	Ditto on battering wall
1.3.3	Wall; ditto, tapering one side	M²	Ditto on wall, tapering one side
1.3.4	Wall; ditto, tapering both side	M²	Ditto on wall, tapering both side
2.1.1	Isolated piers; thickness stated	M²	A detached mass of construction generally acting as a support, such as the solid part of a wall between two opening

Continued

2.1.2	Isolated piers; thickness stated, battering	M²	Ditto, sloping
2.1.3	Isolated piers; thickness stated, tapering one side	M²	Ditto, thickness or width diminished
2.1.4	Isolated piers; thickness stated, tapering both sides	M²	Ditto, both wall width diminished
2.1.5	Face work to walls	M²	Better type of material and finish masking an interior one. It is generally applied in a thin layer, such as ashlar
2.2.1.	Isolated piers; face work one side thickness stated	M²	A detached finish masking an interior mass of construction generally acting as a support, such as the solid part of a wall between two openings or a massive element from which arches spring as in a bridge
4.1.2	Chimney stacks; thickness stated, battering	M²	Ditto, sloping

4.2.1	Chimney stacks; face work one side thickness stated	M²	Finish masking an interior of external side of chimney stack.
4.2.2	Chimney stacks; face work one side thickness stated, battering	M²	Ditto,
5.1.1	Projections; width and depth of projection stated	M	Representation of design in perspective. The attached piers whose length on plan is ≤ four times than thickness
5.1.2	Projections; width and depth of projection stated, raking	M	Ditto but inclined
5.1.3	Projections; width and depth of projection stated, horizontal	M	Ditto but horizontal
6.1.0	Arches; height on face, thickness and width of exposed soffit and shape of arch stated	M	Construction , known as an arching-ring, made of truncated wedged shaped blocks that by mutual pressure stay in place, set out in curved form span an opening and carry a superimposed load as an alternative to lintel
7.1.1	Isolated chimney shafts and the like; thickness stated, size on plan, shape and overall height stated.	M²	As stalk, but more often a chimney stack containing only one flue
8.1.0	Boiler seating; thickness stated	M²	Boiler seating

Continued

9.0.0	Flue linings	M	A passage for the discharge of the product of construction to the outside air and can be formed by means of chimney, special flue block
10.1.0	Boiler seating kerbs; shape and size stated	M	A constructed base for reservoir or cistern
11.1.0	Items extra over the work in which they occur, special dimensioned description, reveal, angle, horizontal	M	An allowance for additional measurement due related special case
12.1.1	Closing cavity; width of cavity of method of closing stated	M	Closing of vertical wall constructed of two leaves or skins, with a cavity between them
12.1.2	Closing cavity; width of cavity of method of closing stated, raking	M	Closing of inclined wall constructed of two leaves or skins, with a cavity between them
12.1.3	Closing cavity; width of cavity of method of closing stated, horizontal	M	Closing of horizontal wall constructed of two leaves or skins, with a cavity between them

13	Face work ornamental bands and the like, type stated	M	Decorative devices not essential to structure but often necessary to emphasize or diminish the impact of structural element
14	Face work quoins	M	Any external angle or corner of a structure, angular courses of stone etc at corner of a building, one of the dressed stones used to dress and strengthen the corner of a building
14	Face work quoins	M	Any external angle or corner of a structure, angular courses of stone etc at corner of a building, one of the dressed stones used to dress and strengthen the corner of a building
15.1.0	Face work sills; dimensioned description	M	Sill or cill, sole, lower horizontal member of a door or window frame
16.1	Face work thresholds; dimensioned description	M	Cill of house door, so the entrance to a house or building
17.1	Face work copings; dimensioned description	M	Top course of masonry, brick etc, usually slopping of a chimney gable, parapet or wall formed of cap stone, cop stone or copping stone to throw off water
18.1.1	Face work steps; dimensioned description,	M	Tread and riser of a stair or a single flat topped structure, e.g. doorstep, to enable progression from one level to another
18.1.2	Ditto, raking	M	Ditto, inclined
18.1.3	Ditto, horizontal	M	Ditto, horizontal
19	Face work tumbling to buttress; dimensioned description	Nr	Courses of brick work laid at 90 degree to the slope of a buttress. Chimney, gable or other feature and tapering into the horizontal course
20	Face work by key blocks; dimensioned description	Nr	Better type of material and finish masking an interior key blocks
21	Face work corbols; dimensioned description	Nr	Ditto, corbols
22	Face work bases to plaster; dimensioned description	Nr	Ditto, bases to plaster
23	Face work capping to plasters; dimensioned description	Nr	Ditto, capping to plasters
24	Face work capping to isolated piers; dimensioned description	Nr	Ditto, capping to isolated piers

25	Bonding to existing thickness of new work stated	Nr	The bonding of prevailing thickness is paramount.
261.1	Surface treatment; type and purpose stated, on stated wall	M²	This item does not include application of materials to wall

Source: Author's Compilation

APPENDIX 2

Labour Productivity Influencing Factors Arrange In Chronological Order

S/No	Author/Reference	Factor Influencing Labour Productivity
1	Herbsman and Ellis, (1990)	Deterministic factors(Specification factors, design factors, location factors, material factors) and stochastic factors (production factors, labour factor, social factor)
2	Thomas *et al.*, (1990)	Work to be done, work environment and indirect causes categories
3	Thomas *et at.*, (1993)	Work environment (congestion, sequencing, supervising , weather, plant status, information, equipment, tools, materials, rework) and work to be done (size of components, specification and quality, work content, design features, work scope)
4	Guhathakurta and Yates (1993)	Lack of material, lack of proper tools, report work and inspection days
5	Lim and Alum (1995)	Difficulty in the recruitments of supervisor and workers, high rate of labour

		turnover, absenteeism and work site and communication problems with foreign workers
6	Lema (1995)	Financial incentives, wages, other non-financial incentives and level skill, lack of mechanization and quality of leadership
7	Anderson *et al.*, (1996)	Supervisor looking after many, low pay, waiting for materials, tools, machine breakdown, poor site layout, too many labourer to one mason, working in a confirmed.
8	Heizer and Render, (1996)	Labour characteristics, project condition and non-productivity activities.
9	Olomolaiye, Kaming, Holt and Harris, (1996)	Lack of tools, equipment break down, change crew members, supervision delay, overcrowding, change foreman and working time.
10	Olomolaiye*etal.*, (1998)	External (nature of industry, client knowledge, construction procedure, weather and level of economic development) and internal factor (management, technology, labour and labour union).
11	Teicholz, (2001)	Inadequate training of workers, few young workers entering the work force, increase complexity of projects, more safety procedure, greater time pressure on project completion and greater fragmentation of the work process.
12	Waachira,2001	Unfair wages, recruitment of unskilled personnel; poor communication, late deliveries of materials and equipment, poor welfare facilities, lack of motivation, lack of training and lack of investment in research and development.

Continued

13	Thomas, (2002)	Overstaffing, interference with other crews and alternative work assigned.
14	Rojas and Aramvareekul, (2003)	Management system (such as management skills, work scheduling, and material and equipment) and manpower issues (such as labour experience, activity training, education and motivation)
15	Dunlop and Smith, (2004)	Adequate tools should be provided such as effective and efficient planning and scheduling operation.
16	Aiyetan and Olotuah (2006)	Improvement welfare of the workers and their family; increase salary; promotion, overtime and holiday with pay
17	Enshassi*et al*., (2007)	Materials/tools factor, supervision factors, leadership, quality factors
18	Udegbe (2007)	Management of workforce, quality of supervision, unfriendly with the workers, occasional training, morale boosting incentives.
19	Sweis, Sweis, Hammad and	Work environment; such as adverse weather, unavailability of materials, lack of equipment and tools, out of sequence work, congestion, dilution of supervision,

	Malek (2009)	rework and fatigue due to schedule overtime.
20	Muhammed*et al.,* (2010)	Significantly affected are pattern of payment, age of operatives, and experience of the workers
21	Abdulsalam*et al.,* (2010)	Motivation by the implementation of non- financial incentive scheme
22	Adamu, Dzasu, Haruna and Bello (2011)	Low wages, lack of material, unfriendly working atmosphere, incompetence supervisors
23	Ameh and Osegbo (2011)	Use of wrong construction method, inadequate construction materials and inaccurate drawings
24	Olatunde, Okunlola and Abiodun (2012)	Pour Size

Source: Author's Compilation

APPENDIX 3

PILOT SURVEY OF POSSIBLE HOLLOW SAND CRETE BLOCK LAYING OPERATIONS FREQUENTLY OCCURS IN CONSTRUCTION SITES AS RELATE TO BESMM.

SECTION A: NO SPECIFIC REFERENCE IN BESMM

S/No	Description of work items Site Occurrence	Unit	No of Site Occurrences
1	**Wall;** 150mm thick, hollow sand crete block laid with cement and sand (stated mix) in stretcher bond, **in foundation**	M²	57
2	**Wall;** 225mm thick, ditto	M²	80
3	**Wall;** 150mm thick, ditto curved with stated radius	M²	46
4	**Wall;** 225mm thick, ditto	M²	56
5	**Wall;** 150mm thick ditto **in pit**, area of bottom not exceeding 4m²	M²	33
6	**Wall;** 225mm thick, ditto	M²	55

7	**Wall;** 150mm thick, ditto, **buildingoverhand** in substructure	M²	9
8	**Wall;** 225mm thick, ditto	M²	29
9	**Wall;** 150mm thick ditto **in pit**, area of bottom pit exceeding 4m²	M²	26
10	**Wall;** 225mm thick, ditto	M²	54
11	**Wall;** 150mm thick, ditto, **buildingoverhand** in substructure	M²	23
12	**Wall;** 225mm thick, ditto	M²	49
13	**Wall;** 150mm thick ditto **in basement**	M²	9
14	**Wall;** 225mm thick, ditto	M²	26
15	**Wall;** 150mm thickditto**, building overhand**	M²	9
16	**Wall;** 225mm thick, ditto	M²	26
17	**Wall;** 150mm thick, hollow sand crete block laid with cement and sand (stated mix) spaces left in between blocks in stretcher bond **in pit**, area of bottom pit exceeding 4m².	M²	32
18	**Wall;** 225mm thick, ditto	M²	52
19	**Wall;** 150mm thick ditto, **buildingoverhand** in substructure	M²	3
20	**Wall;** 225mm thick, ditto	M²	7
21	**Wall;** 150mm thick, hollow sand crete block laid in honey comb with cement and sand (stated mix) in stretcher bond in superstructure	M²	20
22	**Wall;** 225mm thick, ditto	M²	36
23	**Wall;** 150mm thickditto b**uilding overhand**	M²	4

Continued

24	**Wall;** 225mm thick, ditto	M²	6
25	**Wall;** 150mm thick, hollow sand crete block laid on their headers with cement and sand (stated mix) in an alternating half overlapping bedding facing bond (basket weave bond)	M²	3
26	**Wall;** 225mm thick, ditto	M²	4
27	**Wall;** 150mm thickditto **buildingoverhand**	M²	3
28	**Wall;** 225mm thick, ditto	M²	4
29	**Wall;** 150mm thick pierced and screen walling, unit facing dimension ≤ 225 x 112 laid with cement and sand (stated mix) in **regular stack bond**	M²	19
30	**Wall;** 225mm thick, ditto	M²	16
31	**Wall;** 150mm thickditto **buildingoverhand**	M²	19
32	**Wall;** 225mm thick, ditto	M²	16
33	**Wall;** 150mm thick pierced and screen walling, unit facing dimension ≥ 225 x 112 laid with cement and sand (stated mix) in **regular stack**	M²	22

	bond		
34	**Wall;** 225mm thick, ditto	M²	11
35	**Wall;** 150mm thickditto **buildingoverhand**	M²	22
36	**Wall;** 225mm thick, ditto	M²	8
37	**Wall;** 150mm thick pierced and screen walling, unit facing dimension ≤ 225 x 112 laid with cement and sand (stated mix) in **regular stack bond**	M²	16
38	**Wall;** 225mm thick, ditto	M²	22
39	**Wall;** 150mm thick,ditto **building overhand**	M²	16
40	**Wall;** 225mm thick, ditto	M²	22
41	**Wall;** 150mm thick pierced and screen walling, unit facing dimension ≥ 225 x 112 laid with cement and sand (stated mix) in **irregular stack bond**	M²	16
42	**Wall;** 225mm thick, ditto	M²	20
43	**Wall;** 150mm thick,ditto **buildingoverhand**	M²	16
44	**Wall;** 225mm thick, ditto	M²	20

SECTION B: SPECIFIC REFERENCE IN BESMM

S/No	Description of work items	Unit	No of Site Occurrences
1	**Wall;** 150mm thick, hollow sand crete block laid with cement and sand (stated mix) in stretcher bond.	M²	83
2	**Wall;** 225mm thick, ditto.	M²	96
3	**Wall;** 150mm thick, hollow sand crete block laid with cement and sand (stated mix) in stretcher bond against other work	M²	16
4	**Wall;** 225mm thick, ditto.	M²	19
5	**Wall;** 150 thick, hollows and crete block laid with cement and sand (stated mix) in stretcher bond against other bonding	M²	7
6	**Wall;** 225mm thick, ditto.	M²	10
7	**Wall;** 150mm thick, hollow sand crete block laid with cement and sand	M²	0

	(stated mix) in stretcher bond used as formwork		
8	**Wall;** 225mm thick, ditto.	M²	0
9	**Wall;** 150mm thick, hollow sand crete block laid with cement and sand (stated mix) in stretcher bond; **building overhand**	M²	83
10	**Wall;** 225mm thick, ditto.	M²	96
11	**Wall;** 150mm thick, hollow sand crete block laid with cement and sand (stated mix) in stretcher bond; **battering**	M²	22
12	**Wall;** 225mm thick, ditto.	M²	27
13	**Wall;** 150mm thick, hollow sand crete block laid with cement and sand (stated mix) in stretcher bond; **tapering, one side**	M²	26
14	**Wall;** 225mm thick, ditto	M²	30
15	**Wall;** 150mm thick ditto **building overhand**	M²	26
16	**Wall;** 225mm thick, ditto	M²	30
17	**Wall;** 150mm thick, hollow sand crete block laid with cement and sand (stated mix) in stretcher bond; **tapering, both sides**	M²	19
18	**Wall;** 225mm thick, ditto.	M²	24
19	**Wall;** 150mm thick; ditto **building overhand**	M²	19
20	**Wall;** 225mm thick, ditto	M²	24
21	**Wall;** 150mm thick, hollow sand crete block laid with cement and sand (stated mix) in stretcher bond; **curved with stated radius**	M²	26
22	**Wall;** 225mm thick, ditto.	M²	33
23	**Wall;** 150mm thick; ditto **building overhand**	M²	26

Continued

24	**Wall;** 225mm thick, ditto	M²	33
25	**Wall;** 150mm thick, hollow sand crete block laid with cement and sand (stated mix) and **pointing with a struck flush joint** as work proceeds	M²	0
26	**Wall;** 225mm thick, ditto	M²	0
27	**Wall;** 150mm thick ditto **building overhand**	M²	0
28	**Wall;** 225mm thick, ditto	M²	0
29	**Wall;** 150mm thick, hollow sand crete block laid with cement and sand (stated mix) **pointing with over hung struck joint** as work proceeds	M²	0
30	**Wall;** 225mm thick, ditto	M²	0
31	**Wall;** 150mm thick ditto **building overhand**	M²	0
32	**Wall;** 225mm thick, ditto	M²	0
33	**Wall;** 150mm thick ditto and pointing with a curved recessed joints as work proceeds	M²	2
34	**Wall;** 225mm thick, ditto	M²	4

35	**Wall;** 150mm thick ditto and ditto; **building overhand**	M²	2
36	**Wall;** 225mm thick, ditto	M²	4
37	**Wall;** 150mm thick ditto and pointing with a struck or weathered joint as work proceeds	M²	0
38	**Wall;** 225mm thick, ditto	M²	4
39	**Wall;** 150mm thick ditto and ditto; **building overhand**	M²	0
40	**Wall;** 225mm thick, ditto	M²	4
41	**Wall;** 150mm thick ditto and pointing with square recessed joint as work proceeds	M²	2
42	**Wall;** 225mm thick, ditto	M²	5
43	**Wall;** 150mm thick ditto and ditto; **building overhand**	M²	2
44	**Wall;** 225mm thick, ditto	M²	5
45	**Isolated piers;** 150mm thick, hollow sand crete block laid with cement and sand (stated mix) in stretcher bond	M²	48
46	**Isolated piers;** 225mm thick, ditto.	M²	79
47	**Isolated piers;** 150mm thick ditto **building overhand**	M²	48
48	**Wall;** 225mm thick, ditto	M²	79
49	**Isolated piers;** 150mm thick hollow sand crete block laid with cement and sand (stated mix) in English bond	M²	2
50	**Wall;** 225mm thick, ditto	M²	3
51	**Isolated piers;** 150mm thick ditto **building overhand**	M²	2
52	**Wall;** 225mm thick, ditto	M²	3

Continued

53	**Isolated piers;** 150mm thick, hollow sand crete block laid with cement and sand (stated mix) in stretcher bond; **battering,**	M²	24
54	**Isolated piers;** 225mm thick, ditto.	M²	37
55	**Isolated piers;** 150mm thick ditto ; battering, **building overhand**	M²	24
56	**Wall;** 225mm thick, ditto	M²	37
57	**Isolated piers;** 150mm thick, hollow sand crete block laid with cement and sand (stated mix) in stretcher bond; **tapering one side.**	M²	22
58	**Isolated piers;** 225mm thick, ditto.	M²	44
59	**Isolated piers;** 150mm thick ditto; tapering one side **building overhand**	M²	22
60	**Wall;** 225mm thick, ditto	M²	44
61	**Isolated piers;** 150mm thick, hollow sand crete block laid with cement and sand (stated mix) in stretcher bond; **tapering both sides**	M²	19
62	**Isolated piers;** 225mm thick, ditto.	M²	16
63	**Isolated piers;** 150mm thick ditto; tapering two side **building overhand**	M²	19

64	**Wall;** 225mm thick, ditto	M²	36
65	**Chimney stack**; 150mm thick, hollow sand crete block laid with cement and sand (stated mix) in stretcher bond;	M²	1
66	**Chimney stacks;** 225mm thick, ditto.	M²	0
67	**Chimney stacks;** 150mm thick ditto **building overhand**	M²	1
68	**Wall;** 225mm thick, ditto	M²	0
69	**Chimney stacks;** 150mm thick, hollow sand crete block laid with cement and sand (stated mix) in stretcher bond; **battering**	M²	0
70	**Chimney stacks;** 225mm thick, ditto.	M²	0
71	**Chimney stacks;** 150mm thick ditto **building overhand**	M²	0
72	**Wall;** 225mm thick, ditto	M²	0
73	**Projections;** 150mm thick, hollow sand crete block laid with cement and sand (stated mix) in stretcher bond; width and depth of projection stated	M	22
74	**Projections;** 225mm thick, ditto.	M	33
75	**Projections;** 150mm thick ditto **building overhand**	M	22
76	**Wall;** 225mm thick, ditto	M	33
77	**Projections**; 150mm thick, hollow sand crete block laid with cement and sand (stated mix) in stretcher bond; width and depth of projection stated, raking	M	3
78	**Projections;** 225mm thick, ditto.	M	4
79	**Projections;** 150mm thick, hollow sand crete block laid with cement and sand (stated mix) in stretcher bond; width and depth of projection stated, horizontal.	M	0
80	**Projections;** 225mm thick, ditto.	M	2
81	**Surface treatment;** type and purpose stated, on stated wall	M²	64

MAJOR HOLLOW SAND CRETE BLOCKS ACTIVITIES OCCURRENCE IN 100 CONSTRUCTION SITES

Reference	Site occurrence	Ranking	Remark
S/No. 2 and 10 of Section B	96	1	Studied
S/No. 1 and 9 of Section B	83	2	“ “
S/No. 2 of Section A	80	3	“ “
S/No. 46 and 48 of Section B	79	4	“ “
S/No. 81 of Section B	64	5	“ “

S/No. 1 of Section A	57	6	" "
S/No. 4 of Section A	56	7	" "
S/No. 6 of Section A	55	8	" "
S/No. 10 of Section A	54	9	" "
S/No. 18 of Section A	52	10	" "
S/No. 12 of Section A	49	11	" "
S/No. 45 and 47 of Section B	48	12	" "
S/No. 3 of Section A	46	13	" "
S/No. 58 and 60 of Section B	44	14	" "

The following reference No's of Section B listed below are not found as relate to hollow sand crete work in the 100 construction sites surveyed; 7,8,25,26, 27,28,29,30,31,32,37,39,49,51,65,66, 67,68,69,70,71, 72 and79.

Source: Field Survey

APPENDIX 4

School of Postgraduate
Studies,
Ahmadu Bello University,
Zaria, Kaduna,
Kaduna State.

Dear Sir/Madam,

REQUESTTO CONDUCT TIME STUDY OF BLOCK LAYING OPERATIVES IN YOUR CONSTRUCTION SITE.

I am a postgraduate student conducting a time study on output of block laying operatives on construction sites to enable me determine the labour output constant to be used for preparation of construction estimates in Nigeria.

It is for this purpose, permission is sought from you to carry out time study to observe the time it takes block laying operatives to accomplish a given output of operation in your site. Please note that these observations may take a period of two weeks without the operatives necessarily knowing that they are being observed. Also, be assured that the data obtained from this exercise will be strictly used for academic purpose.

Yours faithfully,

Onyeagam O. Peter.

Hollow Sand Crete Block laying Time Study Report Sheet

SECTION A: BACKGROUND INFORMATION

Date: …………………………………. Sheet No: ……………………………………….

Contract / Project: ………………………………………………………………………

Project Location: ………………………………………………………………………

Operation Location: foundation/pit/superstructure/superstructure building overhand

Please indicate the **operation location** applied to study No.1………………………………

No.2 …………………………………………..No.3………………………………………

Work item description for operative/study No.1 …………………………………………………

No.2…………………………………………………………………………………………….

No.3……………………………………………………………………………………………

SECTION B: WORK MEASUREMENT

Study No.	Gang Size	Block Thickness	Morning			Afternoon			Total observed time	Basic time	Output		Total Output
			Start	Stop	observed time	Start	Stop	observed time			morning	afternoon	
1													
2													
3													

Possible Work item description to be covered by the operatives:

1. Block Work in foundation
2. Block work in superstructure
3. Block work in pit area of bottom exceeding 4m²
4. Block work in pit, space between blocks.
5. Block isolated piers in superstructure overhand
6. Block work in pit area of bottom not exceeding 4m²

7Block Work in superstructure over hand

8. Block work in curved foundation
9. Block isolated piers in superstructure

Note; Building over hand is work beyond the comfortable reach of the operative

SECTION C: OPERATIVE'S PERSONAL INFORMATION

(1) **Gender**	St. No	Tick
Male	1	
	2	
	3	
Female	1	
	2	
	3	

(3) **Mode of Employment**	St. No	Tick
Contract employment worker	1	
	2	
	3	
Negotiated worker	1	
	2	
	3	
Daily paid worker	1	
	2	
	3	

(2) **Age**	St. No	Tick
Below 20yrs age	1	
	2	
	3	
20-35yrs	1	
	2	
	3	
Above 36yrs	1	
	2	
	3	

(4) **Weather Condition**	St. No	Tick
Sunny	1	
	2	
	3	
Windy	1	
	2	
	3	

Rainy	1	
	2	
	3	

(5) **Qualification of Worker**	St. No	Tick
Primary sch. certificate	1	
	2	
	3	
S.S.C.E	1	
	2	
	3	
C&G/ NABTED	1	
	2	
	3	
NAPTEB	1	
	2	
	3	
ND	1	
	2	
	3	
Others	1	
	2	
	3	

(6)**Experience of Worker**	St. No	Tick
Below 1yr	1	
	2	
	3	
2-5yrs	1	
	2	
	3	
6-10yrs	1	
	2	
	3	
Above 11yrs	1	
	2	
	3	

(7)**Operation Design Shape**	St. No	Tick
Straight	1	
	2	
	3	
Irregular	1	
	2	
	3	

(8) **Quality of Block Used**	St. No	Tick
Poor	1	
	2	
	3	
Fair	1	
	2	
	3	
Good	1	
	2	
	3	

NOTE: St. No means operative under studied

APPENDIX 5

Table 3.3:Output for 150mm Thick Hollow Sand Crete Block in Foundation Not Greater Than 1.00m Deep; (Gang Size: 1 Mason, 1 Labourer).

Gang No	Total observed time (hr)	Output		Total output (m^2)/Day
		Morning (m^2)	Afternoon (m^2)	
1	7.00	6.45	4.47	10.92
2	7.00	7.05	4.95	12.00
3	7.00	6.85	4.85	11.70
4	7.00	7.15	5.25	12.40
5	7.00	6.85	5.05	11.90
6	7.00	6.80	4.75	11.55
7	7.00	6.65	4.85	11.50
8	7.00	6.75	4.45	11.20
9	7.00	6.95	4.90	11.85

10	7.00	10.28	7.88	18.16
11	7.00	9.40	7.34	16.74
12	7.00	9.72	8.10	17.82
13	7.00	7.14	5.30	12.44
14	7.00	7.00	5.56	12.56
15	7.00	6.60	5.44	12.54
16	7.00	8.85	7.30	16.15
17	7.00	9.25	7.50	16.75
18	7.00	6.95	6.25	13.20
19	7.00	6.70	5.30	12.20
20	7.00	6.50	5.62	12.02
21	7.00	7.24	5.90	13.14
22	7.00	6.37	5.30	11.67.
23	7.00	6.60	5.50	12.10
24	7.00	6.80	5.05	11.85
25	7.00	9.20	7.34	16.54
26	7.00	8.60	7.56	16.16
27	7.00	8.45	7.45	15.90
28	7.00	6.95	5.62	12.57
29	7.00	6.70	5.75	12.45
30	7.00	7.30	5.50	12.80
31	7.00	7.00	5.90	12.90
32	7.00	7.40	4.10	11.50
33	7.00	7.95	6.30	14.25
34	7.00	8.15	6.10	14.25
35	7.00	7.50	4.55	12.05
36	7.00	7.15	5.15	12.30
37	7.00	7.05	5.10	12.15
38	7.00	6.95	5.20	12.15
39	7.00	7.02	5.62	12.64
40	7.00	6.48	5.40	11.88
41	7.00	6.80	5.29	12.09
42	7.00	6.58	4.90	11.48
		Continued		
43	7.00	7.55	5.85	13.40
44	7.00	7.65	5.40	13.05
45	7.00	8.15	6.10	14.25
46	7.00	7.20	5.45	12.70
47	7.00	7.25	5.35	12.60
48	7.00	7.15	5.33	12.48
49	7.00	7.40	5.50	12.90
50	7.00	6.58	4.85	11.43
51	7.00	6.80	5.05	11.85
52	7.00	6.45	4.75	11.20
53	7.00	6.70	4.96	11.66
54	7.00	7.45	5.45	12.90
55	7.00	6.95	5.15	12.10
56	7.00	7.25	5.45	12.70
57	7.00	8.15	5.98	14.13
58	7.00	6.75	5.05	11.80
59	7.00	7.20	5.25	12.45
60	7.00	7.85	5.90	13.75

61	7.00	8.25	6.15	14.40
62	7.00	6.65	5.46	12.11
63	7.00	6.35	4.55	10.90
64	7.00	6.55	4.68	11.33
65	7.00	7.10	5.45	12.55
66	7.00	6.85	5.86	12.71
67	7.00	6.65	5.65	12.30
68	7.00	7.80	5.98	13.78
TOTAL OUTPUT		**497.11**	**380.69**	**877.65**
AVERAGE OUTPUT		**7.31**	**5.60**	**12.91**

APPENDIX 6

Table 4.4: Output for150mm Thick Hollow Sand Crete Block in Superstructure Not Greater Than 1.5m High above Over Site Concrete; (Gang Size: 1 mason, 1 labourer).

Gang. No	Total observed time (hr)	Output		Total output (m^2)/Day
		Morning (m^2)	Afternoon (m^2)	
1	7.00	6.95	5.17	12.12
2	7.00	7.65	6.15	13.80
3	7.00	7.85	5.95	14.02
4	7.00	8.15	6.17	14.32
5	7.00	7.24	5.40	12.64
6	7.00	7.75	5.80	13.55
7	7.00	6.98	5.35	12.33
8	7.00	8.10	6.00	14.10
9	7.00	8.64	6.48	15.12

10	7.00	7.56	5.67	13.23
11	7.00	7.02	5.15	12.17
12	7.00	7.56	5.65	13.21
13	7.00	6.48	4.80	11.28
14	7.00	6.91	5.62	12.53
15	7.00	7.34	5.08	12.42
16	7.00	7.24	5.29	12.53
17	7.00	6.80	5.08	11.88
18	7.00	7.45	4.97	12.42
19	7.00	7.13	5.62	12.75
20	7.00	7.02	5.08	12.10
21	7.00	7.13	5.18	12.31
22	7.00	6.91	4.97	11.88
23	7.00	6.48	5.08	11.56
24	7.00	6.91	5.29	12.20
25	7.00	6.70	4.75	11.45
26	7.00	6.70	4.97	11.67
27	7.00	7.02	5.08	12.10
28	7.00	6.80	4.64	11.44
29	7.00	7.25	5.40	12.65
30	7.00	7.15	5.40	12.55
31	7.00	6.95	5.10	12.05
32	7.00	8.17	6.15	14.32
33	7.00	8.75	6.50	15.25
34	7.00	8.55	6.40	14.95
35	7.00	7.35	5.95	13.30
36	7.00	7.75	6.15	13.90
37	7.00	7.45	5.85	13.30
38	7.00	7.95	5.95	13.90
39	7.00	8.15	6.15	14.30
40	7.00	8.00	5.90	13.90
41	7.00	7.15	5.25	12.40
42	7.00	7.30	5.18	12.48

Continued

43	7.00	6,95	5.20	12.15
44	7.00	9.85	6.80	16.65
45	7.00	7.30	5.45	12.75
46	7.00	8.25	6.15	14.44
47	7.00	8.45	6.40	14.85
48	7.00	7.08	5.20	12.28
49	7.00	6.58	4.96	11.49
50	7.00	7.05	5.35	12.40
51	7.00	7.76	5.75	13.51
52	7.00	7.28	5.40	12.68
53	7.00	7.85	5.65	13.40
54	7.00	8.15	6.10	14.25
55	7.00	7.25	5.36	12.61
56	7.00	8.05	5.97	14.02
57	7.00	8.13	6.05	14.18
58	7.00	7,65	5.50	12.15
59	7.00	7.05	5.24	12.29
60	7.00	8.25	6.25	14.50

61	7.00	7.75	5.55	13.30
62	7.00	8.56	6.45	15.01
Total		**473.63**	**351.34**	**824.87**
Average		**7.64**	**5.67**	**13.30**

APPENDIX 7

Table 4.5: Output for 150mm Thick Hollow Sand Crete Block in Superstructure Overhand 1.5m Above Over Site Concrete Upto Roof Level. (Gang Size: 1 mason, 2 Labourers.)

Gang/No	Total observed time (hr)	Output		Total output (m^2)/Day
		Morning (m^2)	Afternoon (m^2)	
1	7.00	7.65	5.70	13.35
2	7.00	7.05	5.15	12.20
3	7.00	6.95	5.20	12.15
4	7.00	6.95	5.25	11.90
5	7.00	6.45	4.45	11.40
6	7.00	6.50	4.85	11.35
7	7.00	6.85	5.40	12.25

8	7.00	6.45	4.80	11.25
9	7.00	7.45	5.50	12.95
10	7.00	7.15	5.30	12.45
11	7.00	7.65	5.70	13.35
12	7.00	7.02	4.95	11.97
13	7.00	7.78	5.72	13.50
14	7.00	6.95	5.15	13.20
15	7.00	9.94	5.74	15.68
16	7.00	10.28	7.25	17.53
17	7.00	9.60	6.69	16.29
18	7.00	6.25	5.30	11.53
20	7.00	6.59	4.75	11.34
21	7.00	6.16	4.54	10.70
22	7.00	6.26	4.64	10.90
23	7.00	6.45	4.64	11.12
24	7.00	5.94	4.75	10.69
25	7.00	6.16	4.64	10.80
26	7.00	6.37	5.18	11.55
27	7.00	6.16	4.86	11.02
28	7.00	6.59	4.64	11.23
29	7.00	7.15	5.30	12.45
30	7.00	6.85	5.10	11.95
31	7.00	6.65	5.05	11.70
32	7.00	6.95	5.50	12.45
33	7.00	7.00	5.90	12.90
34	7.00	7.35	5.85	13.20
35	7.00	7.45	5.55	13.00
36	7.00	8.15	6.10	14.25
37	7.00	7.85	5.65	13.70
38	7.00	7.15	5.30	12.45
39	7.00	7.75	5.78	13.53
40	7.00	7.35	5.45	12.80
41	7.00	7.50	5.53	13.03
42	7.00	6.87	4.90	11.77
43	7.00	6.45	4.80	11.25
		Continued		
44	7.00	6.65	4.95	11.60
45	7.00	7.45	5.50	12.95
46	7.00	7.25	5.40	12.65
47	7.00	7.85	5.90	13.75
48	7.00	6.97	5.15	12.12
49	7.00	6.75	4.85	11.60
50	7.00	7.05	5.20	12.25
51	7.00	7.90	5.68	13.58
52	7.00	6.55	4.75	11.30
53	7.00	7.05	4.90	11.95
54	7.00	7.65	5.60	13.25
55	7.00	7.95	5.85	13.80
56	7.00	6.45	5.16	11.61
57	7.00	7.00	5.15	12.20
58	7.00	7.05	5.05	12.10
59	7.00	6.85	4.93	11.78

60	7.00	7.20	5.20	12.40
61	7.00	6.38	4.55	10.93
62	7.00	6.50	4.85	11.35
Total		**442.57**	**327.88**	**770.45**
Average		**7.14**	**5.29**	**12.45**

APPENDIX 8

Table 4.6: Output for225mm Thick Hollow Sand Crete Block in Foundation Not Greater Than 1.00m Deep. (Gang Size: 1 Mason,1 Labourer).

Gang. No	Total observed time (hr)	Output		Total output (m^2)/Day
		Morning (m^2)	Afternoon (m^2)	
1	7.00	4.20	3.35	7.55
2	7.00	4.40	3.05	7.45
3	7.00	3.85	3.10	6.95
4	7.00	4.05	2.95	7.00
5	7.00	5.40	3.95	9.35
6	7.00	6.25	4.55	10.80
7	7.00	6.15	4.25	10.40

8	7.00	5.22	4.65	9.87
9	7.00	4.95	3.85	8.80
10	7.00	4.70	3.95	8.65
11	7.00	6.10	4.76	10.86
12	7.00	6.25	4.12	10.37
13	7.00	5.50	3.95	9.45
14	7.00	4.15	3.05	7.20
15	7.00	6.48	4.76	11.21
16	7.00	6.25	4.30	10.55
17	7.00	6.85	5.15	12.00
18	7.00	5.48	4.25	9.73
19	7.00	4.65	4.23	7.88
20	7.00	4.35	3.05	7.40
21	7.00	4.50	3.15	7.65
22	7.00	4.82	3.95	8.77
23	7.00	6.48	4.80	11.28
24	7.00	6.05	4.90	10.95
25	7.00	6.00	4.50	10.50
26	7.00	5.22	4.56	9.78
27	7.00	6.25	4.15	10.40
28	7.00	5.65	4.50	10.15
29	7.00	5.85	4.65	10.50
30	7.00	6.35	4.55	10.90
31	7.00	5.35	4.40	9.75
32	7.00	5.80	4.44	10.74
33	7.00	5.70	4.75	10.45
34	7.00	5.75	4.65	10.40
35	7.00	4.95	3.95	8.90
36	7.00	5.05	4.10	9.15
37	7.00	4.65	3.40	8.05
38	7.00	4.32	3.15	7.47
39	7.00	4.70	3.45	8.15
40	7.00	4.56	3.85	8.41
41	7.00	5.05	3.90	8.95
42	7.00	4.95	3.65	8.60

Continued

43	7.00	5.35	4.25	9.60
44	7.00	5.25	4.05	9.30
45	7.00	5.50	4.15	9.65
46	7.00	5.15	4.05	9.20
47	7.00	5.05	4.15	9.20
48	7.00	4.85	3.35	8.20
49	7.00	4.55	3.30	7.85
50	7.00	4.30	3.28	7.58
51	7.00	4.87	3.75	8.62
52	7.00	3.75	3.15	6.90
53	7.00	5.80	3.65	8.45
54	7.00	4.05	3.80	8.45
55	7.00	4.25	3.09	7.34
56	7.00	3.95	2.94	6.89
57	7.00	5.12	3.65	8.77
58	7.00	4.55	3.30	7.85

59	7.00	3.85	2.95	6.80
60	7.00	4.95	3.73	8.68
61	7.00	4.34	3.15	7.49
62	7.00	4.50	3.30	7.80
Total		**388.50**	**286.69**	**661.84**
Average		**6.25**	**4.78**	**11.03**

APPENDIX 9

Table 4.7: Output for225mm Thick Hollow Sand Crete Block in Superstructure Not Greater Than 1.5m High above Over Site Concrete; (Gang Size: 1mason,1 labourer).

Gang .No	Total observed time (hr)	Output		Total output (m^2)/Day
		Morning (m^2)	Afternoon (m^2)	
1	7.00	5.15	4.25	9.40
2	7.00	5.17	4.05	9.22
3	7.00	6.00	3.90	9.90
4	7.00	6.20	4.20	10.40
5	7.00	5.94	4.45	10.39
6	7.00	7.02	5.95	12.97

7	7.00	4.86	3.80	8.76
8	7.00	4.95	3.90	8.85
9	7.00	8.48	6.41	14.89
10	7.00	8.17	6.28	14.45
11	7.00	7.00	5.10	12.10
12	7.00	6.75	4.80	11.55
13	7.00	6.94	4.65	11.59
14	7.00	4.84	3.74	8.58
15	7.00	4.82	3.66	8.48
16	7.00	4.64	3.98	8.92
17	7.00	4.94	3.86	8.80
18	7.00	5.43	4.46	9.89
19	7.00	4.67	3.72	8.39
20	7.00	4.68	3.65	8.33
21	7.00	4.82	3.82	8.64
22	7.00	5.25	3.86	9.11
23	7.00	4.84	3.64	8.48
24	7.00	4.80	3.52	8.32
25	7.00	4.93	3.93	8.86
26	7.00	4.82	3.96	8.78
27	7.00	4.84	3.74	8.58
28	7.00	4.95	3.98	8.93
29	7.00	4.80	3.94	8.74
30	7.00	4.75	3.93	8.68
31	7.00	6.25	4.55	10.80
32	7.00	8.42	7.10	15.42
33	7.00	8.86	7.24	16.10
34	7.00	8.65	7.00	15.65
35	7.00	8.50	7.25	15.75
36	7.00	8.86	7.00	15.86
37	7.00	8.30	6.40	14.70
38	7.00	8.50	6.90	15.40
39	7.00	8.75	6.35	15.10
40	7.00	6.80	4.90	11.70
41	7.00	8.98	4.97	11.95
42	7.00	6.37	4.75	11.12

Continued

43	7.00	4.86	3.42	8.28
44	7.00	4.71	3.56	8.27
45	7.00	6.80	4.80	11.60
46	7.00	6.48	4.99	11.47
47	7.00	6.40	4.75	11.15
48	7.00	6.48	*5.10*	*11.58*
49	7.00	6.80	*5.30*	*12.10*
50	7.00	6.50	4.95	11.45
51	7.00	5.75	4.25	10.00
52	7.00	6.20	4.54	10.74
53	7.00	4.90	3.75	8.65
54	7.00	7.25	5.34	12.59
55	7.00	6.85	5.05	11.90
56	7.00	7.80	5.65	13.45

57	7.00	8.05	5.90	13.95
58	7.00	8.25	6.10	14.35
59	7.00	6.35	4.50	10.85
60	7.00	4.98	3.65	8.63
61	7.00	5.65	4.20	9.85
62	7.00	6.55	5.07	11.62
Total		**388.5**	**286.69**	**661.84**
Average		**6.25**	**4.78**	**11.03**

APPENDIX 10

Table 4.8: Output of225mm Thick Hollow Sand Crete Block in Superstructure Overhand 1.5m Above Over Site Concrete Upto Roof Level. (Gang Size: 1 mason, 2 labourers).

ang. No	Total observed time (hr)	Output		Total output (m^2)/Day
		Morning (m^2)	Afternoon (m^2)	
1	7.00	4.55	3.47	8.02
2	7.00	6.15	4.25	10.40
3	7.00	4.70	3.45	8.15
4	7.00	4.56	3.65	8.21
5	7.00	4.65	3.25	7.90

6	7.00	4.50	3.66	8.16
7	7.00	4.45	3.25	7.70
8	7.00	4.60	3.45	8.05
9	7.00	6.26	4.70	10.96
10	7.00	4.54	3.45	7.99
11	7.00	4.85	3.75	8.60
12	7.00	4.85	3.50	7.85
13	7.00	6.05	5.00	11.05
14	7.00	5.85	5.15	11.00
15	7.00	5.30	4.85	10.15
16	7.00	6.36	4.95	11.31
17	7.00	4.85	3.45	8.30
18	7.00	5.75	4.00	9.75
19	7.00	4.85	4.10	8.95
20	7.00	4.65	3.80	8.45
21	7.00	5.10	4.00	9.10
22	7.00	5.18	3.90	9.08
23	7.00	5.15	4.05	9.20
24	7.00	5.20	4.20	9.40
25	7.00	5.40	4.35	9.75
26	7.00	5.65	4.65	10.30
27	7.00	5.30	4.85	10.15
28	7.00	5.05	4.70	9.75
29	7.00	4.85	4.20	9.05
30	7.00	4.65	3.95	8.69
31	7.00	6.70	4.45	11.15
32	7.00	4.65	4.10	8.75
33	7.00	4.85	3.85	8.70
34	7.00	5.95	5.40	11.35
35	7.00	6.40	5.60	12.00
36	7.00	6.15	5.30	11.45
37	7.00	6.16	4.25	10.41
38	7.00	5.94	4.43	10.37
39	7.00	5.24	4.80	10.52
40	7.00	6.25	4.35	10.60
41	7.00	5.75	4.45	10.20

Continued

42	7.00	5.40	4.65	10.05
43	7.00	4.95	3.35	8.30
44	7.00	4.55	3.50	8.05
45	7.00	4.85	3.45	8.32
46	7.00	4.35	3.30	7.65
47	7.00	4.54	3.22	7.76
48	7.00	4.06	3.15	7.21
49	7.00	4.65	3.40	8.05
50	7.00	4.80	3.35	8.15
51	7.00	4.45	3.15	7.60
52	7.00	5.25	4.20	9.45
53	7.00	6.50	4.25	10.75
54	7.00	6.05	4.44	10.49
55	7.00	4.25	3.15	7.40

56	7.00	3.90	2.94	6.84
57	7.00	5.12	3.60	8.72
58	7.00	4.65	3.35	10.00
59	7.00	3.95	2.90	6.85
60	7.00	4.95	3.75	8.70
61	7.00	4.44	3.15	7.59
62	7.00	4.55	3.35	7.90
Total		**319.19**	**247.56**	**556.75**
Average		**5.15**	**3.99**	**9.14**

APPENDIX 11

Table 4.9:Output for225mm Thick Isolated Block Piers in Superstructure

Gang No.	Total observed time (hr)	Output		Total output (m²)/Day
		Morning (m²)	Afternoon (m²)	
1	7.00	2.30	1.70	4.00
2	7.00	2.05	1.65	3.70
3	7.00	2.30	1.60	3.90
4	7.00	2.49	1.85	4.34
5	7.00	2.95	2.38	5.33
6	7.00	2.85	2.53	5.38
7	7.00	2.60	2.45	5.05
8	7.00	2.95	2.05	5.00
9	7.00	2.90	2.20	5.10
10	7.00	3.16	2.45	5.61
11	7.00	2.30	1.95	4.25

12	7.00	2.50	1.80	4.30
13	7.00	3.42	1.75	4.17
14	7.00	2.35	1.73	4.13
15	7.00	2.75	1.98	4.73
16	7.00	2.35	1.75	4.20
17	7.00	2.30	1.80	4.10
18	7.00	3.40	1.80	5.20
19	7.00	2.70	2.05	4.75
20	7.00	2.75	2.15	4.90
21	7.00	3.00	2.05	5.05
22	7.00	2.30	1.70	4.00
23	7.00	3.45	2.00	5.45
24	7.00	2.95	2.10	5.15
25	7.00	2.30	1.95	4.25
26	7.00	2.38	1.69	4.07
27	7.00	3.12	2.30	5.42
28	7.00	3.06	2.45	5.51
29	7.00	3.49	2.50	5.99
30	7.00	3.65	2.15	5.80
31	7.00	3.00	2.25	5.25
32	7.00	3.35	2.35	5.70
33	7.00	3.20	2.45	5.65
34	7.00	3.15	2.35	5.50
35	7.00	3.50	2.35	5.85
36	7.00	3.40	2.30	5.70
37	7.00	2.45	2.05	4.50
38	7.00	3.75	2.60	6.35
39	7.00	3.55	2.58	6.13
40	7.00	3.45	2.87	6.32
41	7.00	3.26	2.80	6.08
42	7.00	3.65	2.20	5.85
43	7.00	3.75	2.20	6.95
44	7.00	3.14	2.50	5.64
45	7.00	3.35	2.60	5.95
46	7.00	3.20	2.45	5.65
47	7.00	2.95	2.15	5.10
48	7.00	3.15	2.30	5.45
49	7.00	3.00	2.23	5.23
50	7.00	2.85	2.05	4.90
51	7.00	3.60	2.60	6.20
52	7.00	3.15	2.25	5.40
53	7.00	3.25	2.35	5.60
54	7.00	3.50	2.45	5.95
55	7.00	3.05	2.10	5.15
Total	**7.00**	**164.99**	**119.89**	**284.88**
Average		**3.00**	**2.18**	**5.18**

APPENDIX 12

Table 4.10: Output for 225mm Thick Isolated Block Piers in Superstructure Overhand.

Gang .No	Total observed time (hr.)	Output		Total output (m²)/Day
		Morning(m²)	Afternoon(m²)	
1	7.00	2.05	1.55	3.60
2	7.00	2.07	1.57	3.64
3	7.00	2.10	1.60	3.70
4	7.00	2.65	2.15	4.80
5	7.00	2.75	2.30	5.05
6	7.00	2.60	2.35	4.95
7	7.00	2.05	1.55	3.60
8	7.00	2.23	1.69	3.92
9	7.00	2.38	1.60	3.98
10	7.00	2.13	1.72	3.85
11	7.00	2.55	1.90	4.45
12	7.00	2.70	2.00	4.70

13	7.00	2.64	1.94	4.58
14	7.00	2.25	1.65	3.90
15	7.00	2.08	1.60	3.68
16	7.00	2.32	1.70	4.02
17	7.00	2.27	1.60	3.87
18	7.00	2.23	1.70	3.93
19	7.00	2.30	1.67	3.95
20	7.00	2.10	1.52	3.62
21	7.00	2.30	1.85	4.15
22	7.00	2.50	1.96	4.46
23	7.00	2.55	1.90	4.45
24	7.00	2.56	2.00	4.56
25	7.00	2.40	2.05	4.45
26	7.00	2.80	1.95	4.75
27	7.00	3.05	2.10	5.15
28	7.00	3.06	2.40	5.46
29	7.00	2.85	2.20	5.05
30	7.00	3.05	2.15	5.20
31	7.00	3.20	2.20	5.40
32	7.00	3.12	2.05	5.17
33	7.00	3.95	2.55	6.5
34	7.00	3.55	2.65	6.2
35	7.00	2.95	2.10	5.05
36	7.00	3.05	2.10	5.15
37	7.00	3.17	2.90	6.07
38	7.00	2.80	2.35	5.15
39	7.00	2.65	2.30	4.95
40	7.00	2.95	2.65	5.00
41	7.00	3.05	2.60	5.65
42	7.00	2.95	2.25	5.20
43	7.00	2.57	1.95	4.52
44	7.00	2.75	2.00	4.75
45	7.00	3.25	2.15	5.40
46	7.00	3.15	1.95	5.10
47	7.00	2.85	2.25	5.10
48	7.00	2.30	1.90	4.20
49	7.00	2.70	1.95.	4.65
50	7.00	3.10	2.25	5.35
51	7.00	3.35	2.30	5.65
52	7.00	2.95	2.34	5.29
53	7.00	2.45	1.85	4.30
54	7.00	2.65	2.05	4.70
55	7.00	3.26	2.25	5.51
Total		**146.29**	**111.21**	**259.48**
Average		**2.70**	**2.02**	**4.72**