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Analysis of Labour Outputs of Selected Substructural Blockwork in Abuja

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This paper aims to determine empirically the labour outputs for selected masonry works at substructural level in ongoing construction sites in Abuja, the north central zone of Nigeria. The absence of empirical standard of masons' outputs on construction sites which usually generates conflicts when preparing unit rate for labour item necessitates the study. 70 gang size of masons were purposively sampled in randomly sampled ongoing construction sites in Abuja. The site influencing factors on labour outputs (geographical and physical location, wages, and years of experience and site weather) were taken into consideration during observations of gang of masons on sites. The observations were taken with the aid of stop clock, visual recording and measurement of work done per day. The output of masons was determined based on the quantity of work done vis a vis the actual time taken to perform the task with due consideration of above- mentioned site factors. This study concludes that gang size (number of mason and unskilled labourer) plays a major role in determining the daily labour output in substructural operations on Nigerian construction sites provided all influencing factors remain constant.

Keywords: Blockwork, construction, empirical, output, substructure,

Introduction

Manpower is one of the cardinal determinants of project success in the construction industry all over the world. At project inception stage, a quick and reliable method of estimating labour resource requirement and cost is desirable. Garret (2006) opined that the sustainability and success of the construction industry depends greatly on the level of accuracy in project estimates. This is strongly supported by the fact that the construction industry statistics indicates that more than 50% of the construction projects exceed their initial cost and time estimates. The consequences of adopting inaccurate estimates are quite enormous and overwhelming. If the price for the project is wrong then financial pressures, hardship, supply chain, conflict and quality problems will result. In addition the client's vulnerability as the ultimate risk holder of the finished building can be horribly exposed and no one may possibly gain (Morledge, 2006).

According to Proverbs *et al.* (1997), knowledge of productivity rates is an essential part of the construction management process, such knowledge being necessary for any study of construction productivity. One of the most important applications of productivity rates is in the area of construction planning and scheduling. Other uses include estimating, accounting and cost control. Perhaps the most important application of accurate productivity rate is in the area of resource management where rates are being adjusted for each project taking into consideration specific site factors and conditions that may impact the productivity of construction operations.

The construction industry is confronted with the problems of determining the unit rate for labour which had been traced to the absence of empirical determination of labour outputs on construction sites. In addition, the inaccurate determination of activity duration has in most cases led to the

incorrect estimation of contract periods. Delays in completion of projects in the construction industry are indicators of productivity problems and it has been a big challenge.

Based on this premise, the study aims at determining empirically the output of labour working on selected blockwork operation in substructural level of residential buildings in order to arrive at outputs acceptable to Nigerian building professionals.

Labour Productivity and National Economy

Construction is a key sector of the national economy for countries all around the world, as traditionally it took up a big portion in nation's total employment and its significant contribution to a nation's revenue as a whole. Construction sector influences and is being influenced by a nation's Gross Domestic Product (G.D.P) (Madi, 2003). The sector's output contributes one-half of the Gross Capital and is about 3-8% of the (GDP) in most countries (Ardit & Moditar, 2000; Ameh & Odusami, 2002). However, until today, construction industry is still faced with a number of problems regarding the low productivity, poor safety and insufficient quality. The construction projects are mostly labour based with basic hand tools and equipment.

Therefore, to achieve higher construction activity in an economy, human resource plays a strategic role in improving productivity level of any organisation and this makes human resource superior in the industrial competition. Labour productivity measure the overall effectiveness of an organisational system in utilising labour, equipment and capital to labour efforts into useful output. Poor labour productivity of craftsmen causes cost overrun on building projects and an increase in labour output causes real income and standard of living for an economy (Sarri, 2006). The timely execution of construction projects in Nigeria rely heavily on the human resource as most construction projects are labour intensive. Higher productivity is necessary for the survival of any Nation and any profit-oriented organisation as it represent effective and efficient conversion of resources into marketable product and determines business profitability (Wilcox et al., 2000).

Labour productivity in generally speaking is the same as the "average product of labour" (average output per worker or per worker-hour, an output which could be measured in physical terms or in price terms). It is the ratio of a volume measure of output to a volume measure of input. The three most commonly used measures of input are: hours worked; workforce jobs; and number of people in employment. Measured labour productivity will vary as a function of both other input factors and the efficiency with which the factors of production are used (total factor productivity).

With the optimum uses of human resources, all the advantages supplied by the productivity growth can be obtained. In their view, Agbo and Ayegba (2014) stated that the Nigerian construction operatives have over the years being subjected to a work environment that have not encouraged higher level of productivity. The building industry in Nigeria, like any other sub-Saharan Africa, is highly labour intensive as it is largely in situ construction. Lawal (2008) reported that construction workers in the Nigerian public service have almost zero productivity. Therefore, poor productivity of craftsmen has been identified as one of the most difficult problems that construction industries especially those in developing countries face. In view of this, there is a growing and continuous interest in productivity studies all over the world because of its importance in the management and control of project cost.

A good project management in construction must vigorously pursue the efficient utilization of labour, material and equipment and that improvement of labour

productivity should be a major and continuous concern of those who are responsible for cost control of construction project. Adamu *et al.* (2011) asserted that the Nigerian construction craftsmen are exposed to extremes of hot and cold weather conditions, poor wages, hazardous working environment etc. This greatly affects the output of the craftsmen. Productivity is the one of the most important factor that affects overall performance of any small or medium or large construction industry.

According to Olomolaiye & Ogunlana (1989), there is a dearth of information on the output levels of building operatives in Nigeria, and sometimes estimators base their labour constants for estimating on experience which at best are educated guesses. Without adequate knowledge of standards, it is impossible to draw reliable construction programmes or make accurate cost estimates for tendering purposes. Unrealistic cost estimates and inadequate job programming soon result in cash flow problems and subsequently delays; cost overrun and project abandonment. The aspect of labour pricing is usually done on the basis of the output constants collected on each trade (Ayeni, 1999). The high degree of inaccuracy found in Bill of Quantities (BOQ) estimates especially in Nigeria is mostly attributed to the uncertainty of the accuracy of the labour constants used in pricing labour costs. According to Ajia (2002), most of the outputs used by estimators in West Africa are the British originated constants, since these outputs do not reflect the reality of works on site, some contractors therefore adopt outputs obtained from their realm and wealth of experience and hence non-uniform outputs are widely in use.

The measured quantities in the BOQ are obtained from drawings and specifications for the works using rules specified by the Building and Engineering Standard Method of Measurement (BESMM3), though applied, especially in terms of the item descriptions, the calculation of the unit rates for the individual measured items will require the collation of current cost information for labour, plant and materials, as well as overhead and profit (Ayeni, 1999). However, the source, accuracy and application of these labour outputs for the preparation of cost estimates for construction projects in Nigeria have been challenged by researchers (Ajia, 2002; Udegbe, 2005).

In addition, results of a study by Ajia (2002) revealed a very sharp variation between output constants established for block work and concrete work as compared with British-based outputs that are still being used for teaching in institutions offering Quantity Surveying in Nigeria.

Research Methodology

Data on output of the gang of masons were recorded for 225mm hollow sandcrete blockwork in the foundation trenches operation. The data collected were quantitative records of observed time per day. These observations were done at two different periods; in the morning and in the afternoon. It should be noted that workers engaged in the selected trades resume work at 8.00am and close at 4.00 pm. This strengthened the validity of the research results, since researchers have observed obvious deviations between outputs at different time period. 70 gang of masons were purposively sampled at different depths of foundation trenches through direct observation and the use of stop clock to record the time taken for a given task.

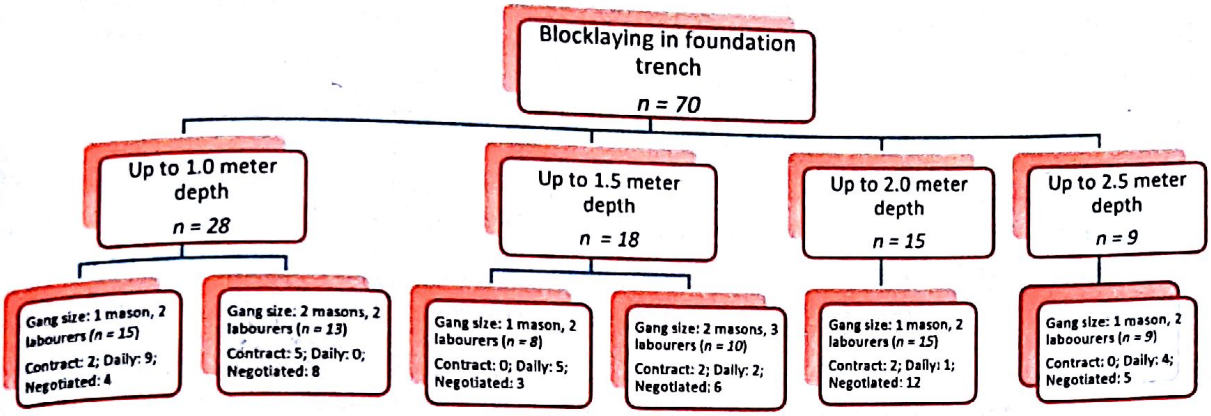

Figure 1: presents the number of artisans sampled in selected trade and the location of work during gathering of data.

Result for blockwork in foundation trenches

In an attempt to determine the output of masons in the foundation trenches during morning and afternoon blockwork operations, the quantity of work done in the form of area covered by blockwork and the time taken to perform the task was taken into consideration alongside the site factors (weather, material distance and wages) to arrive at the output of masons. Table 1 was prepared to present the outputs according to work locations and gang size formations.

Table 1 presents the average output in the morning and afternoon with the optimum gang size operating in the laying of blocks in the substructural level. It can be seen that the summation of outputs of morning and afternoon gives the total output per day. For a gang size of one mason and two labourers working at 1.00m deep below the ground, the morning output gives 2.93m^2 per hour whereas the output in the afternoon gives 2.43m^2 per hr. In the same vein, the combination of two masons and two labourers gives output of 6.40m^2 per hour in the morning and afternoon output gives 4.49m^2 per hour. It should be noted however, that operations in the substructural level that is two meters deep by one mason and two labourers resulted in 1.81m^2 per hour and 1.84m^2 per hour in the morning and afternoon respectively. The upsurge in the output in the afternoon session could be attributed to motivation through wages. The minimum labour output per hour 1.42m^2/hour was recorded when one mason and two labourers worked in the foundation depth of 2.50 meters.

Findings

1) The mean daily output of a gang laying 225mm hollow sandcrete blockwork in substructure and operations reduces as depth/level of work in substructure and as height of wall in superstructure increases.
2) The blockwork operation in 1.0 meter deep foundation trench gives an average daily output of 2.66m^2/hr when a gang of 1 mason and 2 labourers was involved in blockwork operation.
3) Whereas when a gang of 2 masons and 2 labourers are involved, an average daily output of 5.41m^2/hr was achieved. The blockwork operation involving a gang of 2 masons and 2 labourers at 1.5 meters deep gives a mean output of 4.88m^2/hr. As depth increases to 2.5 meters, a gang of 1 mason and 2 labourers was able to produce a daily mean output of 1.42 m^2/hr.

Table 1: Summary of output of mason for blockwork in foundation trenches

S/Nr	Work location	Nr of mason	Nr of Labourers	Work Depth	Mornin Output per Hr	Afternoon Output per Hr	Mean Daily Output per l	Sample size (n)
1	Substructure	1	2	1.00	2.93	2.43	2.66	15
2	Substructure	2	2	1.00	6.40	4.49	5.41	13
3	Substructure	1	2	1.50	1.89	1.83	1.69	8
4	Substructure	2	3	1.50	5.27	4.60	4.88	10
5	Substructure	1	2	2.00	1.81	1.84	1.82	15
6	Substructure	1	2	2.50	1.51	1.34	1.42	9

Notes: Hr = hour; Nr = number

Conclusion

The study concludes that depth and height of work had great influence on the output of artisans in blockwork operations and as depth/height of operation location increases the output of gang reduces. The output reduces as height of work increases, the care that must be taken when working on the scaffolds and the proximity of the materials to the workmen. The optimum gang utilization is achieved in blockwork operation in pit when 2 masons and 3 unskilled labourers are engaged to work in the depth not exceeding 2.0 meters. Similarly, the mean daily output of the operatives working on wall in superstructure increases to 2.97 m2 per hour as gang formation changes to 2 masons and 2 labourers work on 2.5 meters height operations.

Recommendations

The labour output constants in this study are recommended as veritable tools for realistic pricing because it will reduce the level of variability in tender sum among contending bidders. The labour constants would assist in effective project planning and control through realistic determination of optimal labour force in the execution of building projects. The Building and Engineering Standard Method of Measurement (BESMM) should be localized to Nigerian content in such a way that it accommodates average daily output for each item of work and average daily output of artisans for item of works should be taken as minimum output by which the estimates for work done is based.

It is recommended that when carrying out construction operation in the substructure that is above 1.5 meters deep, incentives should be employed to motivate the operatives as it is found out from the study that living wages exerts improvement on the output of workers.

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