Establishing Appropriate Labour Output Rate for Increased Site Work Productivity of Building Projects in Owerri Metropolis, Imo State, Nigeria

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ABSTRACT

This study examines the standards of tradesmen in the building industry as spring boards to assessing and utilizing labour forces for increased site work productivity. The standards usually given as labour constants in form of standard time and standard output are determined, and they serve as benchmark for productivity. Since productivity is being affected by some environmental factors, the standards are termed appropriate when determined under the reality of these environmental factors. Hence, for effective measurement and monitoring of workforce performance, work sampling and work force group stage discussion approach were adopted to study work forces on masonry and carpentry trades in Owerri Metropolis. It is established that there are strong relationships between the activity sampling results of the work trades and their respective rates of productivity. It is concluded, therefore, that the average of 64.8min/m^2 and 0.925m^2/hr are standard time and standard output respectively for Masonry trade at ground floor level of a building, while 39mins/m^2 and 1.54m^2/hr for standard time and standard output respectively for Carpentry trade at ground floor to deck works level in Owerri Metropolis. The work also has successfully shown that relationship exists between the labour constants, and labour supply in the study of labour output, as well as convincingly provided a framework for establishing the constant in another unique environment or guide for establishing labour constants for other trades in the industry.

Keywords: *Appropriate labour Constants, Owerri Metropolis, Work Sampling, Productivity Rate and Increased Site Work Productivity.*

INTRODUCTION

Study on construction tradesmen is very significant in assessment of production cost and productivity rates in the building projects. The financial implication of using any of the trades and their respective outputs contribute to cost and delivery condition of the project. Thus, the assessment of performance and utilization of the labour forces in the industry account significantly for a successful delivery of the project. The Nigeria building industry is strongly characterized with the desire for cheap labour ignoring the proper use of a realistic basic wage rates for tradesmen in a given construction environment. The wage rates are appropriate if at their levels, people are willing and able to supply labour to

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execute the tasks. According to Okoye, Ngwu and Ugochukwu (2015), most of the construction workers are casual workers' who have not properly learnt or stayed on the trade and/or do not belong to the unions. The level of their productivity is not known, and determining the wage rate by using the labour rate becomes difficult. Hence, instead of labour output to be determined by the level of productivity of the workers, they are done by mere agreement between the employers and the workers (Udegbe, 2007). This development is therefore taking to be a crude measure which can have a financial implication on the project. Udegbe (2007) also concludes that financial implication or utilization of labour force in the construction industry accounts for a significant proportion of cost of construction, which buttresses the fact that construction materials account for about 70% of the average construction cost of building project (Ikechukwu, 2014). Thus, production cost would always be reduced by either increasing labour productivity or reducing material waste in order to improve on construction efficiency (Dasgupta and Varghese, 2014). Labour is one of the basic requirements in construction industry; and labour productivity usually relates manpower in terms of labour cost to the quantity of output produced.

Appropriate Labour output with suitable wage rate leads to effective building production performance through efficient labour production and stable supply of competent labour. Since labour rate need be estimated base on the productivity of workers, the constants of labour for establishing the cost of labour in the item of work in the bill of quantities therefore, need not be guessed, imagined or thought. It is then, difficult to draw reliable conclusion or accurate cost estimation without any available baseline standards. The standards are guided by standard supply of labour, effective labour production and activities sampling. These standards are mainly standard time (S_t) and standard output (Sop) for a specified work period in a given construction environment. In construction project, the builder, site engineer or supervisor should have a sound knowledge of the necessary skills involved as well as being able to determine the optimum composition of each skill, in order to accomplish a given task within specified duration and at reduced cost. It is possible with the use of the technological standards for labour. The standards are usually constants in the form of time necessary for the manual or mechanical completion of a defined quantity of work effectively. They are:

i. Standard time (S_t), or in the form of unit output
ii. Standard Output (Sop) for a specified working period.

Thus, these elements of standardization are sometimes referred to as technological standards or constants (Okereke, 2006). In the contemporary challenges facing the building industry, time and cost overruns are among the pressing issues that are yearning for immediate attention. This arises as a result of pitfalls in cost construction management and poor work scheduling programme of the construction project. There are no guides for proper assessment of baseline for labour rate, labour supply and wage rate in a specified period of time in a given project within a certain environment. Appropriateness of labour rate and standardization of labour supply are paramount to ensure labour availability and known levels of productivity for a concerned trade. However, unrealistic bases are used for assessment in most cases which involves mere agreement between association of employers

and the labour union. The work forces in the labour union are the minority who will never become the true representative of the general active labour in the society. Again are two different geographical, regional or socio-economic environments having different characteristics of labour and environmental management. That implies difference in labour and wage rates in the industry. On the aforementioned ugly situation, determination of labour productivity should be on the basis of appropriate knowledge of the concerned locality from time to time. Hence, the determination of labour constants for establishing cost of labour which are usually guessed, imagined or thought out unempirical should not be so but, instead deploy work study and activities sampling to form the technological standards, as guide to generating labour productivity rates. Consequent upon this, this study is therefore aimed at providing basis for establishing technological standards in Nigeria, as well as determination of labour productivity rate in Owerri Metropolis in the building industry.

METHOD

The study location is Owerri Metropolis, Imo State of Nigeria. It is the hub nub of the State business, industrial and civil service activities. Owerri Metropolis' Central point of location is Ama-JK station at the post office building along Douglas Road, Owerri. The Metropolis extends as far as 18km radius from the post office. Within this boom (extension) it covers Owerri Municipal (OM), Parts of Owerri North (ON), and Owerri West (OW) respectively. In this area, many construction activities are going on currently especially in Owerri Municipal and Owerri North. The climatic condition of the area is warming humid in nature with rich vegetation coverage on the earth surface. Contextually, the study covers standard time and standard output of some trades in nine major construction sites in the study area. These construction sites run building projects, and the trades targeted are masonry and carpentry trades at ground floor levels. At these levels, labour productivity for the respective work trades rates were determined.

The study adopts the field survey approach. In the field work, the survey covers activity sampling, measurement and recording of information. Interview and group stage discussion were also conducted. The information are in quantitative nature, sourced from primary and secondary sources. The ones sourced in the field were through observation, measurement, interview and discussion. The population of the study represents the building production professionals, masonry and carpentry tradesmen in the building industry in the study area. They are the major stake holders in this study who are directly concerned with labour rates of the trades. Three building project were systematically sampled in each of the three parts of the study area respectively. In the sampling procedure, one person from each of the profession present in the respective projects in all parts of Owerri Metropolis was sampled. Three tradesmen for each trade in each of the three projects sampled in every part of the study area were also interviewed and their work operations studied. To supplement the information from interview, group stage discussions involving workers other than those directly interviewed were organized. Each set of group stage discussion

representatives contain at least 7 workmen picked at random within each of the respective sites. This brings the total number of people sampled in the field survey to one hundred and twenty six persons. Arithmetic mean and percentage frequency were used to determine average values obtained from the study of work sampling and field survey. At this stage, the numerous amounts of data are reduced into a more compact form which reveals and represent the general trends of state of affairs of the subject matter. Data obtained in the study are presented in a tabular form to enable a clearer understanding of the data in their categories to form basis for analysis. Data obtained through interview and group stage discussion formed basis for planning of work sampling exercise. Besides, data obtained by way of activity sampling were used to establish standard time and labour rate of the respective trades of defined condition. In order to ensure that reliable facts about masonry and carpentry trades were obtained for the study, the following steps were taken:

i) Definition of the manufacturing tasks for which the standard time was determined
ii) Definition of task element
iii) Designing plan for the activity sampling
iv) Choosing cautiously and contacting the concerned tradesmen
v) Starting the study by observing the work as they progress at site
vi) Sourcing, measuring and recording of the complementary information
vii) At the end of the study, analyze and present results for calculation of standard time and output respectively.

Thus, the duration of direct observation for the sampling sequentially lasted 2 weeks, in the respective work trades. The standards eight working hours in a day were maintained. Recreation, odd period and tradesman work efficiency rate in each of the days were estimated with percentage on a daily basis. Finally, standard outputs, were analyzed on hourly basis in order to arrive at the daily output of an average trade man in the study area, which serve as controlling rates of productivity and wage assessment for masonry and carpentry trades respectively.

RESULTS AND DISCUSSION

Active and Non-Active States of the Respective Tradesmen in the Study: Based on the observations carried out on masons and carpenters working at the various sites of the study, it is shown that there are active (productive) and non-active production stages in the construction processes.

Activity Sampling on the Basis of Active and Non-Active States: In each of the activities sampled in the study in every given time, note were taken on the cumulative time involved in the active and non active state of the respective workmen in the job. At the maximum of every 30 minutes interval, this observation is always carried out for average assessment (tables 3 and 4). In each of the three different project sites in each part, 3 workers each were listed including their helpers. They were observed, and measurement

for observed time taken and noted. From the presentation, it means that observations were taken at random intervals for 2 weeks in every ½ hour of the 8 working hours per day. It also shows that 576 observations were taken at random intervals over the period in every ½ hour out of 8 hours per day. Every ½ hour (half hour), observation is made in 8 hours in a day at each of the respective project site with average workers of 3 tradesmen and 3 helpers, for the respective trades.

Masonry: Out of 576 observations made, 504, 468 and 468 average observations were made as productive observations for each site of Owerri Municipal (OM), Owerri North (ON), and Owerri West (OW) respectively, while 72, 108 and 108 observations were observed to be idle time in the average working conditions of masons in the three respective parts of Owerri Metropolis.

Carpentry: For the carpentry work trade, the average working conditions of the tradesmen sampled in the respective project sites within the study area show that out of 576 observations in each of the respective parts of the study, the average productive observations made are 540, 540 and 468 observations for each site of Owerri Municipal (OM), Owerri North (ON) and Owerri West (OW) respectively, while the non productive observations made are 36, 36 and 108 observations in the three respective parts of Owerri Metropolis.

The highlights of the key findings in this study provide basis for recommending some measures that would help boost up average productivity of labour as well as reducing waste for improved building production management. In this study, it is seen that the application of group stage discussion in the fieldwork helped to groom up basis for good and on point work sampling. As it concerns research, it moderate the information obtained through interview. The active working period discovered from the work sampling study rates above 80% to 94%. It is seen that carpentry trade utilizes effectively much of their working hours than the masonry tradesmen. With these situations, decision making during analysis would be reliable. Thus, a good methodical approach in developing labour productivity rate was found to be possible by identifying the basic characteristics of work sampling study as well as defining the basic step taken in the process of the sampling exercise. This serves as the framework with which information from the field were used.

Consequently, the labour constants established have average of 64.8min/m^2 and 0.96m^2/hr for standard time and standard labour output respectively for masonry trade, while the average of 39mins/m^2 and 1.54m^2/hr for standard time and standard output respectively are for carpentry trade. Proportion of time spent by workers in various defined categories of activity is determined against the crude approach of unrealistic mere agreement about labour rates. Contractors are usually pushed into cash flow problem and uncertainty due to non existence of reliable and realistic labour standard. The near absence of unrealistic cost and rate of labour in the industry sensitized this current study. Thus, the study therefore developed the appropriate labour constants directly from the field in Owerri Metropolis.

Table 1: Masonry Work (Block Laying), at Ground Floor Level - 2 Weeks Duration

Working (Active) State	Non-Working (Non-Active) State
Setting of the scaffold	Changing of clothes
Plumbing the walls i.e. blocks to be laid	Assembling of working tools such as; shovel, trowel, head pan etc
Laying of the blocks	Relaxation at work location
Bringing of the blocks to the mason man by his helpers	Loitering about and talking
Choking of the block with mortar after alignment	Eating / drinking of water
Covering of the laid blocks with water-proofs or cement bags in case it rains.	Gathering and clearing of those apparatus/ equipment/tools used.

Source: Field Survey, 2014

Table 2: Carpentry Work to Deck Forming Level - 2 Weeks Duration

Working (Active) State	Non-Working (Non-Active) State
Arrangements of the scaffold	Changing of clothes
Clearing of the working platform to position scaffold	Arrangement of tools such as saw, hammer, line, rope etc
Bringing/collections of the boards, bamboo tree for framework and propping	Relaxation at work location
Taking measurements on the area	Loitering about and talking
Placement/mounting of the boards	Eating/drinking of water
Cutting and nailing of the boards	Gathering and cleaning of tools, as well as self cleansing
Bracing and Propping with bamboo sticks to hold the mounted boards at the soffits	
Aligning the boards, measuring out and girthing the deck with bracing	

Source: Field Survey, 2014

Table 3: Activity Sampling Observation Sheet Study of Masonry Work (Block-Laying) at Ground Floor Level

Sites in Parts of the Study Area	Duration of Sampling Observations in 8 hrs	Working State	Non-Working State (idle time)	Number of workers Observed
OM Sites	8hours	14	2	3 masons and 3 helpers per day, for 2 weeks
ON Sites	8hours	13	3	3 masons and 3 helpers per day, for 2 weeks
OW Sites	8hours	13	3	3 masons and 3 helpers per day, for 2 weeks

Total Observations = [(16 x 6) x 3] x 2 weeks = 576 Average Observations

Source: Field Survey, 2014

Table 4: Work Sampling Observation Sheet Study - Carpentry Work on Deck Formation

Sites in Parts of the Study Area	Duration of Sampling Observations in 8 hrs	Working State	Non-Working State (idle time)	Number of workers Observed
OM Sites	8hours	15	1	3 carpenters and 3 helpers per day, for 2 weeks
ON Sites	8hours	15	1	3 carpenters and 3 helpers per day, for 2 weeks
OW Sites	8hours	13	3	3 carpenters and 3 helpers per day, for 2 weeks

Total Observations = [(16 x 6) x 3] x 2 weeks = 576 Average Observations
Source: Field Survey, 2014

i. **Owerri Municipal (OM) Sites:**

$$Percentage\,of\ ideal\,time = \frac{72}{576} \times \frac{100}{1} = 13\%$$

$$Percentage\,of\ productive\,time = \frac{504}{576} \times \frac{100}{1} = 87\%$$

ii. **Owerri North (ON) Sites and Owerri West (OW) Sites Respectively:**

$$Percentage\,of\ ideal\,time = \frac{108}{576} \times \frac{100}{1} = 19\%$$

$$Percentage\,of\ productive\,time = \frac{468}{576} \times \frac{100}{1} = 81\%$$

i. **Owerri Municipal (OM) Sites and Owerri North (ON) Sites Respectively:**

$$Percentage\,of\ ideal\,time = \frac{36}{576} \times \frac{100}{1} = 6\%$$

$$Percentage\,of\ productive\,time = \frac{540}{576} \times \frac{100}{1} = 94\%$$

ii. **Owerri West (OW) Sites:**

$$Percentage\,of\ ideal\,time = \frac{108}{576} \times \frac{100}{1} = 19\%$$

$$Percentage\,of\ productive\,time = \frac{468}{576} \times \frac{100}{1} = 81\%$$

Masonry Work (Computation of Standard Time and Output)

Owerri Municipal (OM) Sites:
First Mason and Helper
Average observed time (OT): 8 hours
Average output: 9.6m²/day

Therefore, $output\ per\ hour = \frac{9.6}{8hours} = 1.2m^2\ /\ hr$

Basic time = OT + Recreation + Allowance for odds
Basic time: = OT + 15%
Basic time: = 8 + 1.2 = 9.2 hours (for 9.6m²)
Standard quality work has rating of 100%
Therefore, based on the labour efficiency, estimated rate = 87%

$$= \frac{87}{100} \times \frac{9.6}{1} = 8.35m^2/day$$

Taking standard work hour/day = 8hours
Since 8.64m² = 8.4 hours (labour rate)

$$\text{In 8 hours} = \frac{8}{9.2} \times \frac{8.35}{1} = 7.26m^2/day$$

Standard time
For 1m² = 8/7.26m² = 1.10hrs

Standard output

$$\text{For 1 hour} = \frac{7.26m^2}{8hours} = 0.91m^2/hr.$$

Owerri North (ON) Sites:
Average set of a mason and helper
Average observed time (OT): 8 hours
Output: 10.02m²/day

$$\text{Therefore, output per hour} = \frac{10.02m^2}{8hours} = 1.25m^2/hr$$

Basic time = OT + Recreation + Allowance for odds
Basic time = OT + 18%
Basic time = 8 hours+ 1.44 = 9.44 hours (for 10.2m²)
Standard quality work has rating of 100%
Therefore, based on the labour efficiency, estimated rate = 81%

$$= \frac{81}{100} \times \frac{10.02}{1} = 8.1m^2/day$$

Taking standard work hour/day = 8hours
Since 8.1m^2 = 9.44 hours (labour rate)

$$\text{In 8 hours} = \frac{8}{9.44} \times \frac{8.1}{1} = 6.9\text{m}^2\text{/day}$$

Standard time

For 1m^2 = 8/6.9m^2 = 1.2hrs = 72mins

Standard output

$$\text{For 1 hour} = \frac{6.9m^2}{8hours} = 0.86\text{m}^2$$

Owerri West (OW) Sites:

Average set of a meson and helper

Average observed time (OT): 8 hours
Average Output: 12.34m^2/day

$$\text{Therefore, output per hour} = \frac{12.34m^2}{8hours} = 1.54\text{m}^2\text{/hr}$$

Basic time = OT + Recreation + Allowance for odds
Basic time = OT + 16%
Basic time = 8 hours + 1.28 = 9.28 hours (for 12.34m^2)
Standard quality work has rating of 100%
Therefore, based on the labour efficiency, estimated rate = 81%

$$= \frac{81}{100} \times \frac{12.34}{1} = 10\text{m}^2\text{/day}$$

Taking standard work hour/day = 8hours
Since 10m^2 = 9.3 hours (labour rate)

$$\text{In 8 hours} = \frac{8}{9.3} \times \frac{10m^2}{1} = 8.6\text{m}^2\text{/day}$$

Standard time

For 1/m^2 = 8/8.6m^2 = 0.93hrs x 60mins = 55.8 mins

Standard output

$$\text{For 1hr} = \frac{8.6m^2}{8hours} = 1.08 = 1.1\text{m}^2\text{/hr}$$

Finally on the Masonry trade in the study area, the net standard time and output of building projects are calculated as follows:

i) Net standard time of masonry work are therefore taken as the arithmetic mean of the results obtained from the respective building sites sampled.

$$\text{Thus, Net St} = \frac{1.10 + 1.20 + 0.93hrs}{3} = 1.08\text{ hrs/m}^2 = 64.8\text{ mins/m}^2$$

ii) In the same way net standard output (Sop) in the study area is thus, calculated as follows:

Net Sop = = $0.96m^2/hr.$

Carpentry Work (Computation of Standard Time and Output)

Owerri Municipal (OW) Sites:

Average observed time (OT): 8 hours

Output: $15.2m^2$

Therefore, output per hour $\frac{15.2m^2}{8hours}$ = $1.9m^2/hr$

Basic time = OT + Recreation + Allowance for odds

Basic time = OT + 18% (OT)

Basic time = 8 hours + 1.44 = 9.44 hours (for $15.2m^2$)

Standard quality work has rating of 100%.

Therefore, based on the labour efficiency, estimated rate = 94%

$$= \frac{94}{100} \times \frac{15.20}{1} = 14.29m^2/day$$

Taking standard work hour/day = 8hours

Since $14.29m^2$ = 9.44 hours (labour rate)

In 8 hours = $\frac{8}{9.44} \times \frac{14.29}{1} = 12.11m^2/day$

Standard time

For $1m^2$ = $8/12.11m^2$ = 0.66hr = $40mins/m^2$

Standard output

For 1 hour = $\frac{12.11m^2}{8hrs} = 1.51m^2/hr$

Owerri North (ON) Sites:

Average observed time (OT): 8 hours

Average Output for 8 hours = $16.0m^2$

Therefore, output per hour = $\frac{16.0m^2}{8hrs} = 2m^2/hr$

Basic time = OT + Recreation + Allowance for odds

Basic time = OT + 15.75%

Basic time = 8 hours + 1.34 = 9.34 hours (for $16.0m^2$)

Standard quality work has rating of 100%

Therefore, based on the labour efficiency, estimated rate = 81%

$$= \frac{94}{100} \times \frac{16}{1} = 15.04m^2/day$$

Taking standard work hour/day = 8hours

Since 15.04m² = 9.34 hours (labour rate)

In 8 hours = $\frac{8}{9.34} \times \frac{15.04}{1}$ = 12.88m²/day

Standard time

For 1m² = 8/12.88m² = 0.62hrs = 37.3mins/m²

Standard output

For 1 hour = $\frac{12.88\ m^2}{8\ hrs}$ = 1.61m²/hr

Owerri West (OW) Sites:

Taking on the average value of the three sets of a carpenter and helper, the labour constant are calculated as: Average observed time (OT): 8 hours; Average Output: 17.30m²

Therefore, output per hour $\frac{17.30\ m^2}{8\ hrs}$ = 2.16m²/hr

Basic time = OT + Recreation + Allowance for odds

Basic time = OT + 16% (OT)

Basic time = 8 hours + 1.28 = 9.28 hours (for 17.30m²)

The estimated labour efficiency rate is 81% in the activity sampling

Therefore, the supposed output is

= $\frac{81}{100} \times \frac{17.3}{1}$ = 14.0m²/day

$\frac{1.51 + 1.61 + 1.51 m^2}{3}$

Standard work hour in a day is 8hours

Since 14.0m² is produced in 9.28 hours (labour rate)

In 8 hours = $\frac{8}{9.28} \times \frac{14.0}{1}$ = 12.07m² is produced

Standard time

For 1m² = 8/12.07m² = 0.66hr = 40mins/m²

Standard output

For 1 hour duration = $\frac{12.07\ m^2}{8\ hrs}$ = 1.51m²/hr

For Average Standard time and output of the carpentry work in the study area being represented by the three respective building project sites, the labour constants are obtained as Net Standard time (St) for the Carpentry trade work

St = $\frac{0.66 + 0.62 + 0.66 hrs}{3}$ = 0.65hrs = 39mins/m²

Net Standard output (Sop) for the carpentry trade work

Sop =

= 1.54m²/hr

CONCLUSION AND RECOMMENDATIONS

This work has successfully shown the relationship between the labour constants (standard time (St) and standard output (Sop)), and convincingly provided a framework for establishing the constant in another unique environment or guide for establishing labour constants for other trades in the industry. Stability in supply of labour is certain with work sampling because the establishment of the constants is a function of willingness and considerable supply of tradesmen at site. By this approach, instability in labour supply which may affect productivity, low labour productivity or high cost of labour would be always controlled for optimum building production in the study area and Nigeria in general. Based on the findings of this study, it should be emphasized that cost effectiveness of a building project increases as the work productivity increases. This implies a situation of making reasonable returns or impacts of every expense incurred in the project. It is therefore recommended that tendering and cost analysis of work tasks be related to the actual work sampling study in a given location. The sampling of the work being studied should be methodical, having considered the local and unique factors influencing productivity in the area. Thus, establishment of realistic labour constants should be encouraged for determination of labour output rather than a mere agreement of unrealistic labour rate between the association of employers and the labour union.

The stakeholders should as a matter of importance disseminate this information through workshop and seminars. Government on her own side should also form machineries at State levels to as a matter of urgency, carry out work sampling study for establishment of these labour constants from unique location to another according to the trend of significant economic change in Nigeria. This machinery would also extend their service to seeing that people are encouraged to make use of these constants. Training and cross training of workmen should be encourage to also improve productivity and stabilize supply of labour when demanded, in order to argument this work activity sampling efforts.

REFERENCES

Dasgupta, A. and **Varghese, K.** (2014) Investigation of Relationship between Results of Work Sampling and Productivity measurement. Indian Institute of Technology, Madras.

Ikechukwu, U. F. (2014). Improving on the properties of sandcrete block produced in the Warm Humid Climate (WHC) of Nigeria. A Ph.D Dissertation Proposal in Construction Technology, submitted to Imo State University, Owerri.

Okereke, P. A. (2006). Construction Technology and Management. A work book in Building Science. Owerri: Imo State University.

Okoye, P. U., Ngwu, C. and **Ugochukwu, S. C.** (2015). Methodical Approach of Determining Labour Constants Models for Building Construction Process in Nigeria. *International Journal of Engineering Research and General Sciences,* 3, 1

Udegbe, M. I. (2007) Labour Output on Painting Activity in the Construction Industry in Edo State. *Journal of Social Sciences,* 14 (2), 179 – 184

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