A Comparative Evaluation of Labour Productivity of Wall Plastering Activity Using Work study

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ABSTRACT

Accurate estimation of manpower requirements is germane to successful project completion in terms of time, cost and quality performance. This study determines productivity of building craftsmen in wall plastering activity and explores the possibility of establishing productivity norm for accurate estimation of manpower requirements for projects executed in South-South Geo-Political Zone of Nigeria. A descriptive survey research design approach was adopted using a continuous observation method of work study. Project work study manual served as the research instrument to collect data on selected building sites for 30 working days across six states in the zone. Data collected were analysed using descriptive statistics and ANOVA. The results show that there is no significant variation in construction labour productivity of wall plastering activity across the states in the zone. This study concludes that a common productivity norm for wall plastering activity in South-South Geo-Political Zone of Nigeria is feasible using work study approach. Hence, the average construction labour productivity of wall plastering activity in the zone based on a gang comprising of a plasterer and mate is 2.69m²/hr. The study therefore concludes that a common productivity norm for wall plastering activity could be adopted for use in South-South Geo-Political Zone of Nigeria and that labour cost estimation of construction projects in the zone should be based on productivity values emanating from work study rather than from project records which may be influenced by inaccurate documentation and differences in contractual claims.

Key Words: Wall plastering, Construction, labour, productivity, work study, Nigeria

INTRODUCTION

Productivity is considered as one of the most important factors that affect the success and overall performance of every organization, whether large or small, in today’s competitive market (Attar et al., 2012). However, Park et al. (2005) identified construction productivity as a cause of great concern. Veiseth et al. (2013) and Hewage and Ruwanpura (2006) observed that for decades, many researchers have reported the decline in construction productivity. Lawal (2008) reported that in Nigeria, construction workers in the public service have almost zero productivity while Kaming et al. (1997) identified poor productivity of craftsmen as one of the most daunting problems confronting the construction industry especially in developing countries. In view of this, there is a growing and continuous interest in productivity studies all over the world because of its contribution to successful project delivery. Hendrickson and Au (2003, p.80) stated that “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 constructed facilities”.

Understanding the productivity of building craftsmen is complex because several factors influence it and therefore cause differences from place to place and from individual to
individual. Previous studies identified and assessed factors affecting construction labour productivity (Durdyev and Mbachu, 2011; Odesola et al., 2013; Odesola and Idoro, 2014). The results of these studies have indicated that while some factors have significant effects, others may not be significant but their relative effects generally could differ from place to place. Apart from understanding the factors that influence the productivity of craftsmen, another major issue is the measurement of productivity.

Measures of productivity can be examined in terms of the full range of production factors – capital, labour, intermediate goods, and services (including natural resources) or a single factor such as labour. In as much as productivity describes the output potential of a production process in relation to its inputs, it can be measured based on two broad categories of Single Factor Productivity such as Average Labour Productivity (ALP) and Multi-Factor Productivity or Total Factor Productivity (TFP). While Single Factor Productivity measures the impact of one input (labour), Multi-Factor or Total Factor Productivity measures the impact of all inputs on output (Crawford and Vogl, 2006). Tasks refer to specific construction activities such as block/brickwork, wall plastering, concrete placement or structural steel erection and so on. Huang et al. (2009) opined that task-level productivity metrics are widely used in the construction industry.

Most task-level productivity metrics are single factor measures and focus on labour productivity. Attar et al. (2012) maintained that at project sites, contractors are often interested in labour productivity which can be defined in one of the following two ways:

\[
\text{Labour Productivity} = \frac{\text{Output}}{\text{Labour Cost}} \tag{1}
\]

\[
\text{Labour Productivity} = \frac{\text{Output}}{\text{Work-hour}} \tag{2}
\]

The study also observed that there is neither a consensus as to the meaning nor a universally accepted measure of productivity and that the inverse of labour productivity, man-hours per unit (unit rate) is also commonly used.

Limited studies on the productivity of building craftsmen for wall plastering activity in Nigeria were carried out in specific location at a time without recourse to the likelihood of variation existing in productivity from different states. Olomolaiye and Ogunlana (1989) investigated the productivity of building craftsmen in wall plastering activity in Lagos state and found that average productivity is 9.31m² per day involving 8 working hours. Odesola (2015) attempted a comparative study among six states in South-South of Nigeria and reported average productivity to be 2.68m²/hr and that significant variation exist in labour productivity across the states. The comparison was based on productivity determined from project’s records of cost incurred on the activity and the quantity of work involved as indicated in the Bill of Quantities. In addition, the study was based on the assumption that the same normal eight working hours were observed during the construction stage of the building projects and that provided the labour costs were adjusted to ensure that the same amount of wage for artisans and labourers applies, a higher value indicated by the productivity measure will imply higher labour productivity and vice versa. Relying on productivity values obtained through this procedure will be subjected to the fulfilment of these assumptions which therefore, underscores the importance of using work study approach.
Basically, the concept of productivity measurement is rooted in what is called work study or time-and-motion study. Work study is a category of operations management but it is fundamentally different from operations research (Uher, 2003). Thomas et al. (1990) considered work study as the systematic study of work systems for the purposes of finding and standardizing the least-cost method, determining standard times, and assisting in training in the preferred method. The concept aims at improving productivity by examining in detail specific parts of a system rather than the system as a whole. A work study consists of two main parts: a methods study and a work-measurement study. Thomas et al. (1990) stated that work-methods study (sometimes called a motion study) involves finding the preferred method of doing the work while work-measurement or time study is used to determine the standard time to perform a given task.

The principal aim of time study according to Harris and McCaffrey (2006) is to seek the standard time of work, which can assist in: determining appropriate quantities of human and physical resources - once standard time of activities in a construction schedule are known, it is then possible to allocate appropriate resources to such activities; measuring the utilization of committed resources; providing the basis for sound financial incentive schemes and evaluating the economic viability of alternative methods of work. According to Mojahed (2005) some of the common work-measurement techniques for productivity measurement and obtaining information about the time spent on productive and non-productive activities by workers are: work samplings, five minute ratings, craftsmen questionnaires, foreman delay surveys, time-lapse photography or video recordings, and group timing techniques.

Although there are published production norms by the Nigerian Institute of Quantity Surveyors, their accuracy have often times been challenged because they are based on experience which may not be applicable in all cases. Therefore, work-studying the actual work process to establish accurate production norms for estimating manpower requirements is pertinent for the Nigerian building industry. Arising from this, the problem of this study therefore, is concerned with determining productivity of building craftsmen in wall plastering activity and exploring the possibility of establishing productivity norm for accurate estimation of manpower requirements for projects executed in South-South Geo-political Zone of Nigeria. Consequently, the objectives of the study are to assess the productivity of craftsmen in wall plastering activity, compare their productivities across the states in South-South Geo-political Zone, and to establish productivity norms for wall plastering activity in the Zone.

RESEARCH METHODS

This study adopts a descriptive research survey design approach using a project work study manual as the research instrument. The productivity data collection manual used in this study was adopted from project’s work study manual developed by Pennsylvania State University and Dundee University (Thomas et al., 1989). It comprised of three parts namely; form 1, 2 and 3. Form 1 contained questions to collect information on the project being monitored. Form 2 contained questions designed to collect information on the work processes and work contents of the block work activity in the study. Form 3 contained questions used to obtain data on the non-working time of construction labour and the quantity of work done for the day.

Research assistants were engaged in monitoring building sites for the selected activities. A total of 34 field assistants were employed and trained for the exercise. The project’s work study manual was used by the trained field assistants to collect data on on-going construction projects.
for wall plastering activity in each of the six states of the South-South Geo-Political zone namely: Akwa Ibom, Bayelsa, Cross River, Delta, Edo and Rivers states. Direct continuous observations were made for 30 working days being the benchmark for small and large sample sizes (Lucey, 2002) to ensure that the number of observations were adequate for generalisation. On-going public building projects involving wall plastering activity with the same specification of cement-sand (1:4) 13mm thick plastering finishing according to Building and Engineering Standard Method of Measurement 3 (2008) were surveyed. The research assistants were to observe and record the non-working time and quantity of work done by a gang comprising of a plasterer and mate noted to be the predominant gang composition for wall plastering activity in the study area (Odesola, 2012). Descriptive statistics and Analysis of Variance were used for data analysis. A hypothesis was postulated to test variation in construction labour productivities of wall plastering activity across the six states that constitute the study area. The hypothesis states as follows:

\[ H_0: \text{Construction labour productivities do not vary significantly across the states in south-south of Nigeria} \]

RESULTS

Results of the analysis of the data collected are presented as follows:

Construction Labour Productivity of Wall Plastering Activity in Selected Public Building Projects in South-South Geo-political Zone on Nigeria

Descriptive results of the measures of variation in the daily labour productivity of wall plastering activity across the six states in South-South zone of Nigeria are shown in Table 1. The result in Table 1 indicates that Akwa Ibom state has the highest average construction labour productivity of 2.78m\(^2\)/hr while Edo state has the least. The minimum and maximum construction labour productivities across the six states are 1.88m\(^2\)/hr and 3.52m\(^2\)/hr respectively and were recorded in Bayelsa state. Minimum, maximum and average construction labour productivities of wall plastering activity across the states in the zone are depicted in Table 1.

Bayelsa state also recorded the highest range of construction labour productivity within the period of the work study and is equal to 1.64m\(^2\)/hr. This depicts the magnitude of the influence of situations or factors affecting construction labour productivity of wall plastering activity in Bayelsa state. In the same vein, the variability of construction labour productivity for wall plastering activity in the state is indicated by sample standard deviation and variance values of 0.475 and 0.226 respectively.

Similarly, the range, standard deviation and variances indicating variability of construction labour productivities in wall plastering activity across other states in the zone are shown in Table 1.
Table 1: Descriptive results of measures of variation in the daily labour productivity of wall plastering activity for the six states in South-South zone of Nigeria

<table>
<thead>
<tr>
<th>Parameters Tested</th>
<th>N</th>
<th>Range (m²/hr)</th>
<th>Min (m²/hr)</th>
<th>Max (m²/hr)</th>
<th>Mean (m²/hr)</th>
<th>Std. Dev.</th>
<th>Variance</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Labour Productivity of Wall Plastering Activity in Akwa Ibom State</td>
<td>30</td>
<td>1.20</td>
<td>2.18</td>
<td>3.38</td>
<td>2.78</td>
<td>.382</td>
<td>.146</td>
<td>1</td>
</tr>
<tr>
<td>Daily Labour Productivity of Wall Plastering Activity in Rivers State</td>
<td>30</td>
<td>1.16</td>
<td>2.24</td>
<td>3.40</td>
<td>2.76</td>
<td>.331</td>
<td>.109</td>
<td>2</td>
</tr>
<tr>
<td>Daily Labour Productivity of Wall Plastering Activity in Bayelsa State</td>
<td>30</td>
<td>1.64</td>
<td>1.88</td>
<td>3.52</td>
<td>2.73</td>
<td>.475</td>
<td>.226</td>
<td>3</td>
</tr>
<tr>
<td>Daily Labour Productivity of Wall Plastering Activity in Cross River State</td>
<td>30</td>
<td>.80</td>
<td>2.36</td>
<td>3.16</td>
<td>2.65</td>
<td>.222</td>
<td>.049</td>
<td>4</td>
</tr>
<tr>
<td>Daily Labour Productivity of Wall Plastering Activity in Delta State</td>
<td>30</td>
<td>.98</td>
<td>2.20</td>
<td>3.18</td>
<td>2.64</td>
<td>.270</td>
<td>.073</td>
<td>5</td>
</tr>
<tr>
<td>Daily Labour Productivity of Wall Plastering Activity in Edo State</td>
<td>30</td>
<td>1.08</td>
<td>2.12</td>
<td>3.20</td>
<td>2.59</td>
<td>.323</td>
<td>.105</td>
<td>6</td>
</tr>
</tbody>
</table>

*N = Number, Min = Minimum, Max = Maximum, Std. Dev. = Standard Deviation
Source: Excerpts from SPSS output of Researcher’s data analysis.

ANOVA Test of Difference in Construction Labour Productivities across the States in South-South Geo-Political Zone of Nigeria

The objective of the study sought to compare the daily construction labour productivity of wall plastering activity among the six states of the south-south geo-political zone of Nigeria. The purpose of this comparison was to know if significant variation exists in construction labour productivities that will necessitate the use of separate productivity norms in each of the states. To achieve the objective, the research hypothesis was tested using Analysis of Variance test.

Table 2 shows the result of the Analysis of Variance test of difference in the daily construction labour productivities of wall plastering activity across the states in the zone.
Table 2: ANOVA test of difference in daily construction labour productivities of wall plastering activity across the states in South-South of Nigeria

<table>
<thead>
<tr>
<th>Parameter Tested</th>
<th>N</th>
<th>Mean (m²/hr)</th>
<th>Min.</th>
<th>Max.</th>
<th>Std. Dev.</th>
<th>F-value</th>
<th>df</th>
<th>p-value</th>
<th>Levene’s (p-value)</th>
<th>Welch (p-value)</th>
<th>BF Test (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily construction labour productivities of blockwork activity</td>
<td>180</td>
<td>2.69</td>
<td>1.88</td>
<td>3.52</td>
<td>0.346</td>
<td>1.485</td>
<td>5</td>
<td>0.197</td>
<td>0.000</td>
<td>0.199</td>
<td>0.198</td>
</tr>
</tbody>
</table>

*N = Number, Std Dev = Standard deviation, BF = Brown-Forsythe

The result indicates that the p-value (0.000) for Levene’s test is greater than the critical p-value (0.05) indicating a violation of the assumption of homogeneity of variance. However, since the sizes of the groups were reasonably similar (i.e. largest/smallest = 1 which is less than 1.5) analysis of variance could be considered robust enough to accommodate this violation. Alternatively, to be assured that the result of the analysis of variance was reliable, the robust tests of equality of means were considered. In this case, the p-values (0.199 and 0.198) for both Welch and Brown-Forsythe tests were greater than the critical p-value (0.05) which indicates that there is no significant variation and confirms that the ANOVA results was reliable.

Consequent upon this the results of the test of difference in the daily productivities of construction labour engaged in wall plastering in Table 2 shows that p-value (0.197) is greater than the critical p-value (0.05) therefore; the test fails to reject the hypothesis. This result indicates that construction labour productivity of wall plastering does not vary significantly among the six states that constituted the study area. Average construction labour productivity of wall plastering activity in the zone was 2.69m²/hr which represents approximately 21.52m² per day (i.e. 2.69 x 8 working hours). Variability in the daily labour productivity of wall plastering in the zone during the period of the study is indicated by the sample standard deviation of 0.346. The average construction labour productivity obtained using work study compares well with that obtained from projects’ records in the study carried out by Odesola (2015).

However, there is disagreement in the variation of labour productivities across the states in the zone. While the result from work study indicates that there is no significant variation that from projects’ records shows that there is significant variation. Differences in contractual claims across the states may have accounted for this difference since the evaluation of labour productivity from projects’ records was based on labour cost rather than the time spent on the activity. Nevertheless, since the work study approach involved actual measurement of both the output in terms of quantity of work done and the input in terms of the time spent on the activity, the result is considered to be more reliable compared to that from projects’ records.

CONCLUSION

This study concludes that a common productivity norm for wall plastering activity in South-South Geo-Political Zone of Nigeria is feasible using work study approach. Hence, the average construction labour productivity of wall plastering activity in the zone based on a gang comprising of an artisan and mate is 2.69m²/hr. Furthermore, differences in contractual claims...
may influence assessments of construction labour productivity using projects’ records. The study therefore, recommends that labour cost estimation of construction projects in the zone should be based on productivity values emanating from work study rather than from project records which may be influenced by inaccurate documentation and differences in contractual claims. Productivity norms for other building activities should be established based on work study to enhance labour cost estimation of construction projects.

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