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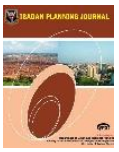

Impact of Construction Productivity Factors on Wall Tiling Labour Output in Abuja and Kaduna, Nigeria

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Abstract

Productivity is one of the important elements in construction planning and scheduling. However, construction industries in Nigeria are currently lacking in data with regard to productivity of the building's construction activities especially in tiling works. The focus of the study was to use work study approach to empirically establish relationship between the influential factors and productivity in wall tiles labour output in Nigeria Construction Company. A total of 46 gang sizes of tillers for wall tiles 400mm x 300mm x 5mm, width > 300mm long side horizontal, 32 gang sizes of tillers for wall skirting 400mm x 50mm high and Riser 400mm x 150mm high were observed within Kaduna state and Abuja. Physical observations and measurement of work outputs were conducted through work study approach. The difference in mean labour outputs of two groups and multiple groups was tested using independent t-test and analysis of variance (ANOVA) respectively. The mode of employment of tradesmen observed had a significant effect on the output for wall tiling 400mm X 300mm X 5mm, plain width >300mm, tiles with long side horizontal with backing. Those on daily paid term produced more on site in their outputs. Regarding the labour output for Wall Skirting, 400mm X 50mm High, Ceramic Tile 5mm Thick, the weather condition significantly affected the output. The study recommends that stakeholders in the construction industry should consider the use of daily paid workers for wall tilting on building sites to enhance project performance.

Keywords
Construction, Productivity, Labour output, Ceramic tiles

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1. Introduction

Globally, construction industry stands as the main indicator of the economic growth of a country (Al Refaie 2020). In developed countries, construction industry incorporates the Gross Domestic Product (GDP) growth of 7-10% whereas in under developed countries the percentage is only 3-6% (Muqeem, 2011). Dixit and Saurabh (2019) identified the construction industry as an engine of growth, as it contributes an average of 8-13% to the global GDP. Regrettably, most construction projects in developing countries experience low productivity either in simple or complex form (Agrawal & Halder, 2020). It is of note that for clients and the contractors to get value for money and huge return on investment, construction labour productivity needs to improve consequently contributing meaningfully to the country economy (Adebowale & Agumba, 2021; Adebowale & Agumba, 2022).

Productivity remains an intriguing subject and a dominant issue in the construction sector, promising cost savings and efficient usage of resources. Studies have shown that construction labour productivity is always associated directly with delays in project delivery which are most times used interchangeably with project time overruns or cost overruns (Odetola, 2015 & Murray et al 2013). Others studies associated labour productivity indirectly with cost and time overruns through factors affecting productivity under different headings (Odetola, 2015 & Ramanathan et al. 2012). Furthermore, Haseeb et al. (2011) remarked that for the client, construction delay refers to the loss of revenue. Kasimu (2012) in a study of significant factors that causes cost overruns in building construction projects in Nigeria ranked lack of labour productivity fifth, out of eight other factors identified under the group of factors related to construction item. Project overruns comprise of delays and cost overrun occurs at construction phase at the critical stage the impact of labour productivity is eminent. Developing countries facing unemployment problems, inflation and resource scarcity needs to utilize productivity resources in such a way to achieve economic growth and improve citizens' lives (Adnan et al., 2007) as buttressed by Oluseyi (2022) that construction stake-holders desire productivity growth, but there is little agreement on how the desired productivity can be achieved.

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This study intended to contribute to bridging this identified gap by examining factors that perceived to affect construction labor productivity in Abuja and Kaduna construction sites.

Construction industry lagged due to insufficient research in the area of productivity and methods for improving construction productivity to assist managers in identifying productivity barriers and offer solutions were limited.

In reality, increasing productivity benefits the stakeholders in several ways: Projects are completed more quickly; Project cost is lowered; the contractor can submit more competitive bids; and the project can be more profitable, because utilization of labour force in the construction industry accounts for a significant proportion of the cost of buildings (Udegbe, 2007; Mohammed *et al.*, 2011). A sustainable improvement in productivity, when associated with economic growth and development generates non-inflationary increases in wages and salaries as low productivity causes cost and time overruns in construction projects. Construction output is important especially in a developing country like Nigeria where most of the building construction work is still on manual basis (Faki *et al*, 2010).

A study on productivity growth in Nigeria is important for a number of reasons. First, there is a direct linkage between productivity growth and sustained economic growth. Secondly, Nigeria's development experience shows that past growth strategy based on factor accumulation is both infeasible and sub-optimal. The economic reality facing the country today requires a shift in emphasis to factor efficiency to higher productivity efficiency which is a key to poverty reduction (Adenikinju, 2005). Most of the previous studies in Nigeria indicated that workers on a construction project are unproductive for 50 percent of their time on site. Waiting eats up more than half of an employees' unproductive time and about one third of total project time. This wrecks a schedule and reduces the contractor's profits. Moreover, different workers have different variables affecting their level of productivity. The most prevalent includes; lack of training and retraining, poor communication, inclement weather, unfair wages, lack of motivation, negative influencing factors, design changes, poor specification, late information, out of sequence work, recruitment of unskilled labour, lack of investment in research and development, etc.

Jan C. van & Lenny (2010) stated that the relationship between selected variables and productivity requires data at the level of the firm because productivity is a firm-level phenomenon. Productivity of individual workers is hardly ever observed, nevertheless, there are not many empirical studies based on this type of data and seems no recent related study in Nigeria. This study contributes to the literature by studying empirically to what extent selected variables influence labor productivity and aggregate fluctuations with view to alleviate the impact and complementing existing survey. The outcomes can be used to guides projects and construction managers for efficient application of the labor force, thus assist in achieving a reasonable level of competitiveness and money-making operation.

2. Related literature

Productivity is the measure of how well resources are brought together in organizations and utilized for accomplishing a set of results. It involves reaching the highest level of performance with the least expenditure of resources. Many definitions have been given to productivity as cited in Mohammed (2009) believes that every good definition of productivity should contain three major elements, output, resources commitment and time. It is referred to as the effective use of factors of production to produce goods and services.

Productivity is a ratio of production output to what is required to produce it. John (2006) defines productivity as a total output per one unit of a total input. Productivity is the average direct labour hours to install a unit of material. Adnan *et al.,* (2007) productivity generally is defined as the ratio of outputs to inputs and is given by any of the followings shown below:

$$\text{Productivity} = \text{Output/Input} = \frac{\text{Units}}{\text{Work hours}} = \frac{\text{Total output}}{\text{Total work hours}}$$

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

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

$$\text{Multifactor measures} = \frac{\text{Output}}{\text{Labour} + \text{Machine}} = \frac{\text{Output}}{\text{Labour} + \text{Capital} + \text{Energy}}$$

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

Thus, evolves the following productivity sources;

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

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

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

i. *Downsizing/Rightsizing*: This is a planned elimination of jobs, which is achieved by encouraging early retirement of employees through sweetened voluntary retirement. Workers give out their best before reaching their retirement ages.
ii. *Re-engineering*: This is about fundamental rethinking and radical re-designing of business process to achieve dramatic improvement in cost, quality, service and speed.
iii. *Total Quality Management (TQM)*: These are set of principles and practices whose core ideas includes the understanding of customer's needs, doing things right at the first time and striving for continuous improvement. Mohammed (2009) identified seven (7) steps to be taken in order to ensure the improvement of productivity as thus;
    i. Developing productivity measures for all operations
    ii. Analysing the system as a whole to decide which operations are most critical.
    iii. Develop methods for achieving productivity improvements, such as soliciting ideas from workers.
    iv. Establishing reasonable goals for improvement
    v. Making it clear that management supports and encourages productivity improvement.
    vi. Measuring improvement and publishing them.
    vii. Do not confuse productivity with efficiency.

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

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

Resources comprise labour, capital, energy, raw materials etc. The most common single factor of productivity measure is labour productivity.

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

Labour can be measured as:

- persons employed
- hours worked
- labour cost

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

3. Research Methods

3.1 Research Design/ Approach

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

This research work was carried out within Kaduna state and Abuja (FCT) in Nigeria. The choice of the area was influenced by the reported increase in the volume of construction activities occasioned by the agitation of the people for sustainable development. Data sets were collected only from on-going construction projects of the geographical location for the purpose of the study. Wall tilling activity was considered in the study because it is a common building activity associated with most buildings in the study area, therefore availability of data would not be a problem.

The population of interest considered in respect of this research study was the "*construction sites*" within the scope and area of study earlier described for the research. These construction sites constituted mostly of building projects such as residential, industrial, and commercial buildings for both public and private owners. The research captured the age of workers, mode of employment of workers, weather condition, educational background, experience of workers, and all other relevant information of the population of interest.

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

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

i. Walls
ii. Skirting
iii. Risers

The sampling was based on wall tiles 400mm x 300mm x 5mm, width > 300mm long side horizontal, wall skirting 400mm x 50mm high and Riser 400mm x 150mm high according to Building and Engineering Standard Method of Measurement (BESMM) and in which the observed working hours per day was 8 hours. The study assessed and examined the influence of the various labour productivity factors on the outputs of the workers observed,

3.2 Instrument for Data Gathering

A well-structured "*Time study sheet*" was prepared for data gathering. The time study sheet was divided into three different sections; A, B, C. Section A compiled data on the general information of the project and tradesmen under observation. Section B consisted of a structured closed ended questionnaire designed to capture all relevant background information relating to the operative and work in progress. This background information was designed to accommodate the factors that affect labour productivity on site into the study and to clearly see and determine how such factors influence the output of the respective tradesmen under observation. The five different influencing productivity factors observed were:

i. *Age of workers*: This was aimed at determining the impact of age group on the labour output. The three categories of age groups are:
   - Age group below 19 years
   - Age group range from 29 – 39 years
   - Age group, above 39 years

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

iii. *Qualification of workers*: The study meant to observe if educational qualification has significant impact on labour productivity. The six classes of educational qualification of workers observed are:
   - Primary certificate
   - S.S.C.E
   - NABTEB
   - Diploma (ND) (that related to building construction)
   - Others (other qualification apart from those mentioned above)

iv. *Mode of employment*: The study meant to observe the influence of categories of engagement on productivity of workers. The three categories of workers considered were:
   - Contract employed workers: those enjoyed certain incentives and job security such as annual leaves, medical allowance, transport and housing allowances, maternity leaves etc. as recommended by National Joints Industrial Council (NJIC), and this category of workers receives full wages even when there are disruptions such as inclement weather, force majeure, perils etc.
   - Negotiated workers: this category of workers has no time regulation. They start or stop operation at any time they desire.
   - Daily paid workers: This category of workers receives their wages according to the surface areas covered at the end of the day work as agree by their employer

v. *Experience of workers*: The study also aimed at observing the influence of experience on productivity of workers. Four categories of years of experience were observed.
   - Operatives, below 1 year.
   - Operatives, ranges from 2 to 5 years
   - Operatives, ranges from 6 to 10 years
   - Operatives, above 11 years.

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

3.3 Methods of Data Collection

Two different data sets were collected for the purpose of this research work through the following methods: literature search and Field survey

4. Data Analysis

From Table 1, there was no significant difference in the mean labour output based on age of workers, weather condition, qualification and experience of workers. The mean labour output values for contract-employed workers, daily-paid workers and negotiated workers were 27.94, 29.03 and 20.78 respectively with p value of 0.041. Mode of employment appeared to have a significant effect on the output of tradesmen observed with the daily paid workers having the highest mean labour output.

From Table 2, there was no significant difference in the labour output for wall skirting based on the age, experience, and qualifications of the workmen studied. Mode of employment did not significantly determine the labour output but weather conditions significantly did ($p = 0.031$).

From Table 3, the labour output for riser tiling work was not significantly affected by the age and experience of workers. The data on mode of employment, qualifications of workers and weather conditions had only one option each were not adequate for comparative analysis

Table 1: Productivity Factor Effect in Respect to Labour Output for Wall Tiling 400mm X 300mm X 5mm, Plain Width >300mm, Tiles with Long Side Horizontal with Backing

Variables	Frequency (N)	Mean Output	Standard Deviation	Test Statistic	P–Value
Age of workers				F= .869	.427
Below 19 years	3	21.30	04.88		
19 – 39 years	36	25.90	10.30		
Above 39 years	3	19.30	01.21		
Mode of Employment				F= 3.480	.041
Contract Employed Workers	15	27.94	11.51		
Negotiated Workers	18	20.78	05.10		
Daily Paid Workers	9	29.03	10.46		
Weather Condition				t=1.83	.078
Sunny	40	25.71	09.65		
Windy	2	13.10	00 .00		
Rainy	-	-	-		
Qualification of workers				F= .252	.859
Pry Cert	-	-	-		
SSCE	30	24.91	10.48		
NABTEB	1	17.50	-		
ND	3	25.80	05.07		
Others	8	26.54	09.42		
Experience of workers				F= .046	.987
Below 19 years	7	26.38	10.46		
2 – 5 years	13	25.00	10.46		
5 – 11 years	17	24.75	09.89		
11 years above	5	24.82	09.83		

F = ANOVA, t = Independent sample t-test

Table 2: The Effect of Productivity Factor in Respect to Labour Output for Wall Skirting, 400mm X 50mm High, Ceramic Tile 5mm Thick

Variable	Frequency (N)	Mean Output	Standard Deviation	Test Statistic	P - Value
Age of workers				t=1.331	.154
19 – 39 years	30	29.17	20.99		
Above 39 years	6	42.33	27.72		
Mode of Employment				F=2.697	.082
Contract Employed Workers	12	42.15	24.18		
Negotiated Workers	14	29.26	22.60		
Daily Paid Workers	10	21.37	14.76		
Weather Condition				t=1.05	.031
Sunny	34	32.30	22.65		
Rainy	-	-	-		
Windy	2	15.35	00.61		
Qualification of workers				F=412	.746
SSCE	26	32.57	23.05		
NABTEB	3	23.83	05.48		
ND	5	35.08	28.84		
Others	2	17.70	13.15		
Experience of workers				F=318	.812
Below 1 years	2	17.70	13.15		
2 – 5 years	12	34.23	22.77		
5 – 11 years	13	30.05	21.38		
11 years above	9	32.48	26.51		

F = ANOVA, t = Independent sample t-test

Table 3: Effect of Productivity Factor in Respect to Labour Output for Risers in tiling, 400mm x 150mm high, ceramic tiles 5mm thick

Variable	Frequency (N)	Mean Value	Standard Deviation	Test Statistic	P - Value
Age of workers				F=.050	.952
Below 19 years	3	21.73	5.93		
19 – 39 years	3	25.83	26.45		
Above 39 years	3	23.97	3.62		
Experience of workers				F=0.82	.783
Below 1 years	-	-	-		
2 – 5 years	6	22.85	4.56		
5 – 11 years	-	-	-		
11 years above	3	25.83	26.65		
Qualification of workers					
SSCE	-	-	-		
NABTEB	-	-	-		
OND	-	-	-		
Others	-	-	-		
Weather Condition					
Sunny	-	-	-		
Rainy	-	-	-		
Windy	-	-	-		
Mode of employment					
Contract workers	-	-	-		
Negotiated workers	-	-	-		
Daily paid workers	-	-	-		

F = ANOVA, t = Independent sample t-test

5. Discussion

The utilization of labour force in the construction industry accounts for a significant proportion of the cost of buildings, it was reported that workers on a construction project are unproductive for 50 percent of their time on site. This wrecks a schedule and reduces the contractor's profits. The study investigates a total of 46 gang sizes of tillers for wall tiles to assess the extent of influence of the various labour productivity factors considered over the resulting labour output for tiling works. The work output value collected for the two different period of observation (morning and afternoon) shows that the age of workers on site has no influence over labour output this is supported by the observation made by Hellerstein & Neumark (2004) and Jan & Lenny (2010) that Age alone is found to be a poor predictor of individual performance. Lallemand & Rycx (2009) found age structure effects on productivity to have substantially decreased over time. The result is attributed to the fact that, tilling works has a pattern-based to follow requiring little or no amount of skills no matter the age; it gives almost the same output.

Educational qualification did not determine labour output in this study. This may be due to the fact that tilling works requires no skill or qualification. This is in agreement with the findings of Odesola (2012) who affirmed educational background visa-vis the quality of labour has no effect on output levels. Also, the length of experience of workers does not dictate the level of output from the study. This is contrary to the findings of Kaming et al. (1997) & Haegeland and Klette (1999) reported significant variation in production output, experience and operative's productivity, experienced workers are more productive than inexperienced workers.

According to Onwusonye (2006) and Ayeni (1997) who stated that inclement weather influenced approximately 8% and 6% of the workers productivity respectively. The intended to study three variable working conditions including sunny, rainy and winding days. However, throughout the period of study it was sunny. Some of the tilling activities were carried out on internal wall surfaces which may control the effect of sunny or windy weather conditions on the labour output. Therefore, with the adoption of adequate labour productivity management strategies in tilling activity, the effect of weather is expected to be lower compared to other activities exposed to the uncontrollable effects of weather which may have contributed to the overall negative effect on workers' productivity. Non-significant differences reported in the study may be indicative of inaccurate project records as opposed to the determination of actual construction labour productivities through work study methods (Odesola, 2012).

We found a significant variation in construction labour productivity output and mode of employment in wall tilling activities in Abuja and Kaduna in Nigeria. it implies that mode of payment to workers positively affects productivity output, this is in consonance with the findings of Kaming et al. (1997), Hellerstein and Neumark (2004) and Rinz (2022), that there is significant variation with operative's productivity and their wages, it however, differs with the findings in Odesola (2012) that there is no significant variation in construction labour productivity in South-South zone of Nigeria.

6. Conclusion

The study investigated the influence of the productivity factor on the resulting labour output for tiling works in Abuja and Kaduna. The age, qualification and length of experience of workers on site did not dictate their output or productivity. However, mode and style of payment to workers positively affected their output. Daily paid workers performed better than other mode of payments.

The study recommended that contractors should employ daily payment mode for tilers so as to optimize the productivity of their workers and profitability.

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