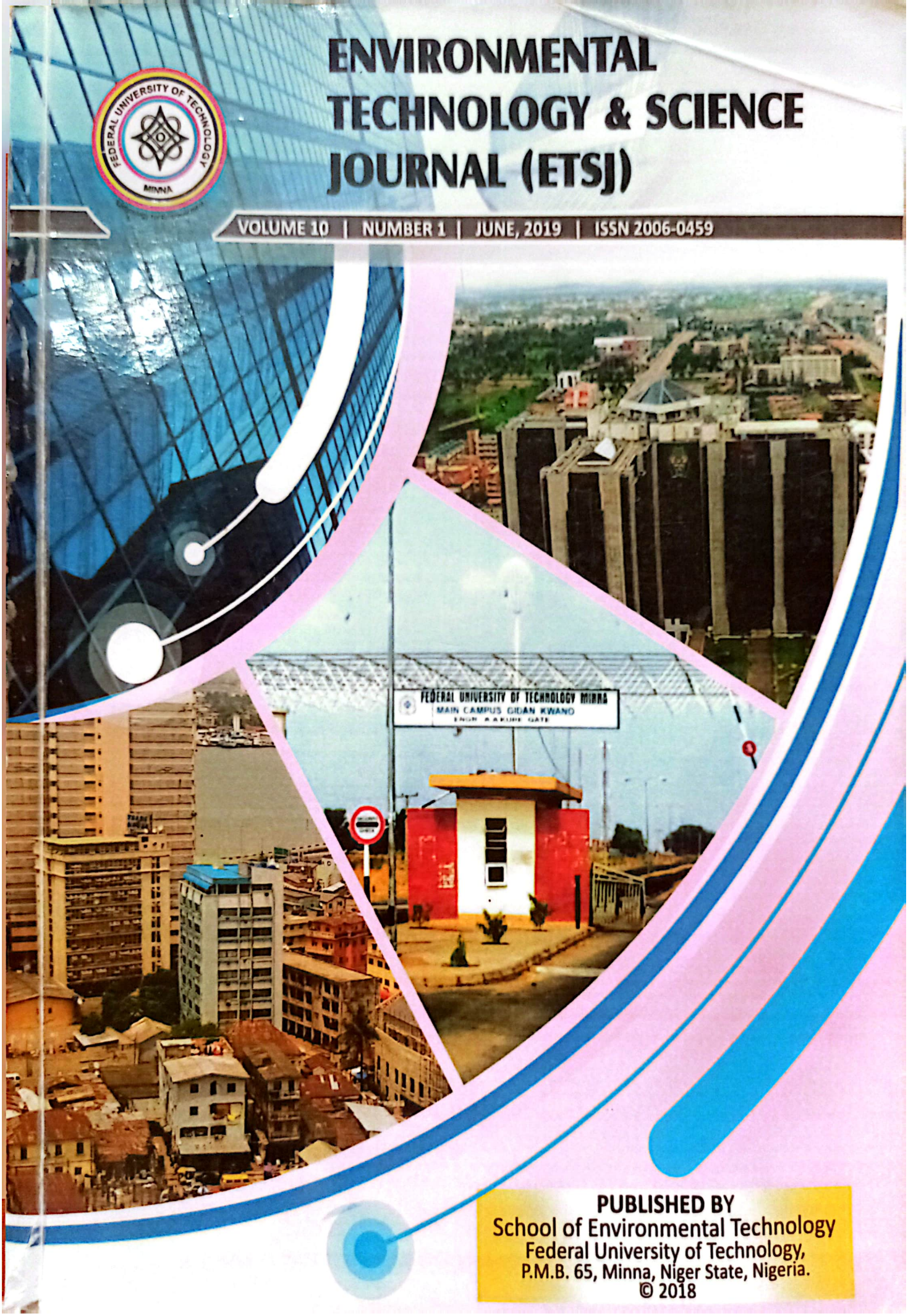
ENVIRONMENTAL TECHNOLOGY & SCIENCE JOURNAL (ETSJ)

VOLUME 10 | NUMBER 1 | JUNE, 2019 | ISSN 2006-0459



PUBLISHED BY
School of Environmental Technology
Federal University of Technology,
P.M.B. 65, Minna, Niger State, Nigeria.

Environmental Technology & Science Journal
Vol. 10 No.1 June 2019

Impact of work environment factors on labour productivity of masons in Abuja-Nigeria

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Determine the impact of the various factors affecting craftsmen productivity on construction site is paramount to productivity improvement. This study determines labour productivity output in block work activity and quantify impact of work environment factors on labour productivity in block work activity in Abuja Federal Capital of Nigeria. Mix method approach was adopted, using continuous observation on site and structured questionnaire as research instrument for data collection. Data were analysed using ANOVA, Regression model, productivity and variation formula. Results of the analysis show that impact of work environment on labour productivity on block work activity in Abuja was negative and is statistically significance. The result equally shows that the average daily productivity ranges from 0.925 to 1.822whr/m2 and baseline productivity from 0.734 to 1.055whr/m2. The value of R2 was o.98, demonstrating a good model fit. The study concluded that the impact of work environment factors on labour productivity on block work activity is statistically significance at 0.05 level. Equally that the average daily productivity of the block laying mason was lower than the standard average daily productivity in Abuja. It is therefore recommended that construction managers on construction sites should constantly evaluate factors affecting labour productivity with a view to eliminate negative impact and enhance positive impact in order to improve workers' productivity.

Keywords: Work environment factors, Labour productivity, Block work activity, Block laying mason

Introduction

It has been well established that, productivity stands as one of the most important factors affecting the general performance of a nation's economy and is a crucial source of growth in the living standard of a Nation (Sarri, 2006). As pointed out by Bergen and Langenberg (2009), productivity is a fundamentally controllable factor in wealth production, since other economic variables depend on it. When the productivity of a nation is high, it raises people's ability to purchase goods and services, enjoy leisure, and contribute to social and environmental programmes (Mersi, 2005; Moselhi *et al.*, 2005).

One major problem of the construction industry is its perceived low-level productivity (Shehata & El-Gohary, 2012; Chavan & Salunkhe). In Nigeria and other developing nations of the world, construction operatives have over the years been subjected to a work environment that has not encouraged higher level of productivity, consequent upon which loss of moral, productivity and "exodus" of traditional craftsmen, from the industry to another sector have frequently been reported (Agbo, 2014).

Zakeri *et al.* (1997); Makulsawatudom and Emsley (2004) and Moselhi, *et al.* (2005) in specific terms stated that the factors affecting labour productivity on a typical construction site environment varies from task to task, project to project and trade to trade. Some of these factors could have similar influence on productivity of a number of tasks, but their rate of impact on productivity may differ (Talhouni, 1990, Iyagba & Ayandele, 1999). These differences can only be understood through information relating to numerical

assessment of productivity and the site environment in which the productivity is being measured (Ovararin, 2001).

Limited studies on labour productivity of craftsmen on construction site have been carried out in different parts of Nigeria without taken into consideration, measurement of influence of work environment factors on labour productivity of the craftsmen. Odesola, Okolie and Nnametu (2015) evaluate and compared labour productivity of wall plastering activity in the South-South geo-political in Nigeria and concluded that a common standard output per day for a gang of 2 in wall plastering is possible as a norm. Ameh and Odusami (2002) investigated factors affecting labour productivity in construction industry in Lagos and observed that low wage level has the highest influence on productivity of construction workers. Idiake (2014) investigated the relationship between performance and variability in blockwork flow and labour productivity in North-Central Nigeria and discovered that there is a significant correlation between labour productivity and performance in blockwork. The study suggested that in measuring the impact of variability on performance emphasis should be laid on variability instead of work flow.

Although some attempt has been made in studying the various aspect of factors affecting labour productivity of craftsmen on Nigerian construction site in blockwork activity, but measuring the effect of individual factors or group of factors on productivity of craftsmen on site is lacking. Consequently, the major objectives of this study are to determine daily productivity, baseline productivity and coefficient of variation in daily productivity in blockwork activity in Abuja, and to measure the influence of works environment factors on the productivity of blocklaying mason in Abuja.

Research Methodology

In order to achieve the stated objectives of this study, the study adopted a mixed method of data collection. Three major approaches were used in data collection for this study. The first two sets of data were obtained through structured questionnaire and oral interview for those mason that could not understand how to fill questionnaire and it relates to the characteristics of the respondents. The third set of the data was a numerical data obtained through continuous observation on site (Time Study).

Questionnaire and evaluation

The study could not access the current list of registered Building Contractors in Abuja who were supposed to be the population of study as the Federal Ministry of works has stopped registration of contractors in line with Public Procurement Act 2007. However, a list of 405 Building Contractors that registered with Real Estate Developers Association of Nigeria (REDAN) Abuja branch was used as the population of this study. For any of these contractors to be included in sampling, such must have ongoing project on site. This made the study to use purposeful sampling as the best option. Twenty-five (25) contractors were sampled from the population using purposeful sampling technique. Two hundred and ten structured questionnaires were distributed directly through personal contact across the twenty-five (25) construction sites sampled. The questionnaire was targeted at obtaining complementary data on work environment factors influencing productivity in blockwork activity on site. One hundred and fifty (150) questionnaires were duly completed and returned to the researcher. The results were collated and analyzed using Relative importance index (RII).

$$RII = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + n_1}{5(n_1 + n_2 + n_3 + n_4 + n_5)} \quad \text{..... equation (1)}$$

Continuous observation on site

Accordingly, the procedure for continuous observation on site was adopted from Talhouri (1990). The first step taken in the continuous observation approach was the identification of 25 on-going public building projects in Abuja, the study area which use standard sandcrete blocks of 225mm x 225mm x 450mm. This was followed by getting official permission from the client and the contractors by the researcher and his

observers to have free access to the site. Before the commencement of the study, the workers to be observed were assembled on site and the purpose of the observation was explained to them. Research assistants were engaged on site to make observation on site. On each site 16 observations were made, and the whole exercise lasted for two weeks and three days.

The research assistants arrived on site 20 minutes before the commencement of work each day and stayed some distance away from the gangs being observed to avoid instance of distraction and to observe instance of late start and errors in the time. All observations made were as directly as possible. This include short notes were necessary on rough paper which were later transcribed on the appropriate data collection sheets. To reduce the tediousness of the method, observers were asked to record only unproductive time (Time not spent on direct work or contributory work by labourers). Each time a record of unproductive time is taken, the factors causing the disruption or the interruption is noted with the length of time it takes to stay. Total time for each work day was obtained by asking the foreman their working hours per day. At the end of each work day, the daily productivity and daily variation is determined.

Work content scale of 1 for masonry was adopted from Sweis *et al.* (2009) and used for the study. A standard output for craftsmen on construction site was obtained from Nigerian Institute of Quantity Surveying Information handbook in corroboration with information from craftsmen and foremen on site on their daily output. This information was compiled and used as standard condition for block layers output for this study. Table 1 gives details of standard condition.

Results and Discussion

Characteristics of the respondents

This section discussed the characteristics of the respondents for this study.

All the respondents investigated were males. The possible reason given by respondents was that blocklaying is not a woman's job because of the rigour of activities involved. Table 2 shows that 71% of block laying masons investigated were within the age of 31 – 45 years, 185 were between 20 and 30 years while 11% were 46 years and above. This age distribution indicates that the larger population of the respondents are young men and middle age men full of energy. This implies that there is an expected high productivity because age is a strong factor in rating of output.

Approximately 43% of the respondents have 1 – 15 years of working experience, 36% have 16 – 30 years of working experience and 21% have 31 years and above of working experience. There is a popular saying that experience is the best teacher. The more experience a craftsman is the better is his performance. From the survey, 70% of the respondents investigated were holders of WAEC/GCE, 15% were National Diploma holders, 20% primary school certificate holders, HND and BSc have 0%. The result indicated that all the respondents can read and write. This will help them in quick and better understanding of instructions given by Engineer or foreman thus enhance better productivity.

Identification and Ranking of work environment factors affecting productivity in blockwork activity in Abuja

Table.3 shows the result of the factors identified and the ranking of their effects in descending order.

DETERMINATION OF PRODUCTIVITIES, OUTPUT QUANTITIES AND COEFFICIENT OF VARIATION IN BLOCKWORK ACTIVITY

Shehata and El-Gohary (2012); Swapnil and Biswas (2015), individually defined daily productivity, overall productivity, baseline productivity and coefficient of variation as follows:

Equations 1 to 5 was used for the computation of the values for productivities and coefficient of variation in this study. Equation1 was an inverse of productivity formula output input. According to Shehata and El-Gohary (2012), many contractors prefer using the inverse of productivity formula since it measure unit rate and labour is a unit rate. When the inverse of the formula is used as in equation 1, higher value of productivity means poor productivity and poor performance while low value indicates better productivity and better performance. In this study the inverse formula was used. Table 4 shows the results of average daily productivity, cumulative productivity, baseline productivity, and coefficient of variations in daily productivity from 25 project sites in Abuja Nigeria

$$\text{Daily productivity} = \frac{\text{Daily input hours}}{\text{Daily output quantities}} \quad \text{_____1}$$

$$\text{Cumulative productivity} = \frac{\text{Total work hours}}{\text{Total output}} \quad \text{_____2}$$

$$\text{Baseline productivity} = \frac{\text{Work hours}}{\text{Output quantities in 'n' workdays}} \quad \text{_3}$$

Variation (Xi)

$$V(x) = \sqrt{\frac{\sum (Ur_{ij} - Baselineproductivity_j)^2}{n}} \quad \text{.....4}$$

Where Ur_{ij} = Daily productivity for work day i project j

n = number of work days on project j

Then coeficient of productivity variation (CPV)

for each project can be calculated thus

$$CPV_t = \frac{PV_j \times 100}{(Base\ line\ productivity)} \quad \text{..... ....5}$$

Where CPV_t = Coefficient of productivity for project j

PV_j = Productivity variation for project

Table 4: Values of productivities and coefficient of variation

Project Number	Work content	Average daily productivity whr/M²	Cumulative productivity whr/M²	Baseline productivity whr/M²	Coefficient of variation (%)
001	1	1.140	1.021	0.750	36.13
002	1	1.325	1.275	1.032	23.52
003	1	1.256	1.160	0.923	25.68
004	1	1.195	1.084	0.857	26.49
005	1	1.356	1.253	0.923	35.75
006	1	1.367	1.245	0.887	40.36
007	1	1.174	1.079	0.842	28.14
008	1	1.155	1.078	1.032	4.46
009	1	1.298	1.183	0.950	24.53
010	1	1.334	1.225	0.980	25.00
011	1	1.480	1.300	0.900	44.44
012	1	1.315	1.210	0.915	32.24
013	1	1.675	1.411	0.920	48.78
014	1	1.260	1.405	0.880	59.66
015	1	1.590	1.385	0.900	56.32
016	1	1.411	1.245	0.890	39.88
017	1	0.925	0.895	0.865	3.47
018	1	1.650	1.410	0.915	54.10
019	1	1.275	1.005	0.734	36.92
020	1	1.361	1.124	0.923	21.78
021	1	1.822	1.685	1.055	59.72
022	1	1.635	1.332	0.895	48.83
023	1	1.470	1.343	0.920	45.98
024	1	1.526	1.345	0.930	44.62
025	1	1.133	1.020	0.885	15.25

Note: A gang Ratio of 1mason to 1 labourer was used throughout.

From the result project 021 has the highest value of cumulative productivity of 1.685 whr/m², average daily productivity of 1.822whr/m², baseline productivity of 1.055 whr/m² and coefficient of variation of 59.72%. These values indicated that project 021 has poor productivity and poor performance as the higher the value of productivity the poorer the productivity and visa viz. On the contrary, project 017 has the lowest cumulative productivity of 0.895whr/m², average daily productivity of 0.92whr/m², baseline productivity of 0.865whr/M² and coefficient of variation of 3.47%. These values show that project 017 has the best productivity value and best performance among the projects investigated. On the whole, the average daily productivity of all the projects investigated ranges from 0.925whr/m² – 1.822whr/m², cumulative productivity 0.895 - 1.685whr/m², baseline, 0.75whr/m² and coefficient of variation 3.477 – 59.72%.

QUANTIFICATION OF IMPACT OF WORK ENVIROMENT FACTORS IN BLOCK WORK ACTIVITY IN ABUJA.

In order to quantify the impact of work environment factors in block work activity on construction sites, multiple regression was employed. The regression model of work environment factors with parameters Y= loss productivity, X1= waiting for materials, X2= Unexplained movement, X3= Supervision, X4 = Weather, X5= waiting for tools,X6= Work redone, X7= Waiting for other crew, X8= interference, X9= Waiting for information, X10= Congestion, X11= Accident, X12=gang composition, X13=Plant status, X14=Waiting for instruction and X15= Being on the job but not working.

The general regression model $Y_i = \beta_{0i} + \beta_{1i}X_1 + \beta_{2i}X_2 + ----+\beta_{15i}X_{15} + \varepsilon_i$.
Where: Y = loss productivity
β_{0i} = baseline productivity
$\beta_{1i}\beta_{2i} ----+ \beta_{15i}$ = average daily productivity

$$X_1X_2 \text{ - - - - } + X_{15} = \text{work enviromnt factors.}$$

The regression model for the Block work activities for Table 5 is

$$Y_{1(Block)} = 0.011 + 0.003X_1 + 0.004X_2 + 0.005X_3 + 0.004X_4 + 0.003X_5 + 0.002X_6 + 0.003X_7 + 0.001X_8 + 0.011X_9 - 0.002X_{10} + 0.002X_{11} + 0.002X_{12} + 0.007X_{13} + 0.004X_{14} + 0.003X_{15}$$

Table 5: Regression coefficient

Model		Unstandardized Coefficients		Standardized Coefficients			REMARK
		B	Std. Error	Beta	T	Sig.	
1	(Constant)	.011	.062		.184	.855	
	x1	.003	.001	.440	3.041	.004	Signif.
	x2	.004	.002	.281	2.840	.044	Signif.
	x3	.005	.002	.484	2.988	.005	Signif.
	x4	.004	.002	.301	3.153	.038	Signif.
	x5	.003	.002	.262	2. 978	.009	Signif.
	x6	.002	.002	.170	2.925	.015	Signif.
	x7	.003	.003	.131		.388	Not. Signif.
	x8	.001	.003	.048	2.312	.025	Not. Signif.
	x9	.011	.003	.521	3.300	.002	Signif.
	x10	-.002	.003	-.100	-.686	.497	Not. Signif.
	x11	.002	.003	.104	.691	.009	Not. signif.
	x12	.002	.002	.201	3.289	.006	Signif.
	2.925	.007	.003	.315	1.953	.059	Not. Signif.
	.874	.004	.002	.337	2.852	.007	Signif.
	x15	.003	.004	.253	2.888	.038	Signifi.

a. Dependent Variable:Y

Table 6 Analysis of variance (ANOVA) for Block work activities

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	.057	15	.004	2.520	.012[a]
	Residual	.054	360	.001		
	Total	.110	51			

a. Predictors: (Constant), x15, x11, x3, x8, x4, x7, x2, x1, x9, x13, x10, x12, x6, x5, x14

Table 7: One-way Analysis of variance (ANOVA) for Block work Activities and Work environment factors affecting productivity

Source of variation	DF	SS	MS	F	P
Factor		6	4539669 756612	3061.65	0.000
Error			357	88224 247	
Total				363.4627893	

S = 15.72 R-Sq = 98.09% R-Sq(adj) = 98.06%

Tables 5, 6 and 7 show the analysis of variance and coefficient of regression results. The work environment factors was the predictor variable. From the analysis in Table 5, X1, X5, X7, and X15 contributed about 0.003, while X6, X11, and X12 contributed about 0.002. Similarly, X2, X4 and X14 contributed about 0.004. X3, X9, X10, andX13 contributed 0.005, 0.011, -0.002 and 0.007 respectively. The variables X1 toX6, X6, X12 and X14, X15 are statistically significance at 5% level of significance because the p-values were less than 0.05, while others were not significance. The adjusted R-square value of the regression was 98.06% demonstrating a good model fit. The test for the residual indicate normality and homoscedasticity which satisfy the assumption of regression analysis. The result of the regression model indicated negative impact of the work environment factors on block work activity in Abuja the study area. However, X1, X6, and X4 have more negative impact on block work activity than other factors. The ANOVA result shows significance variation in productivity of the block laying mason because p-value of 0. 000 is less than 0.05 ($p< 0.05$).

Conclusion and Recommendation

Impact of work environment factors on productivity in block work was studied in Abuja, Federal Capital of Nigeria. Variability in ranking the impact of each work environment factors on productivity in block work activity exist in analysis of data from questionnaire and direct observation on site. It was observed that the average daily productivity achieved by block laying masons in all but one project investigated was lower than the standard daily productivity.

Regression model was developed to quantify the impact of various work environment factors on construction productivity and it demonstrated a good fit. It was also evidenced that there was significance variation in daily productivity of the block laying masons within and among projects. The impact of the work environment factors on labour productivity of the block laying mason in the selected projects was negative. IT was noticed that the test for the predictors' variables was significance at ($p< 0.012$) demonstrating that the predictors' variables are not equal to zero. The study has illustrated the application of Regression model to quantify impact of work environment factors on labour productivity on construction site. Based on these, it is recommended that construction managers on construction sites should constantly evaluate factors affecting labour productivity with a view to eliminate negative impact and enhance positive impact in order to improve workers productivity.

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