Labour Output of Steel Fixers in Selected Building Construction Sites in Lagos State

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Abstract

This study investigates labour output of steel fixers in in-situ concrete storey building construction on some selected sites in Lagos state. The main aim of the study are to aid the estimation of labour cost of steel works in reinforced concrete construction and to provide information for planning and schedule of work. Data were collected from twenty (20) construction sites through work study and activity sampling. The investigation reveals that a proficient steel fixer, averagely motivated is capable of cutting and bending one tonne of steel using simple hand tools for beams, columns, stairs and floor slabs for 27.05hrs, 24.10hrs, 26.06hrs. and 41.58 hours respectively. He is also capable of tying one tonne of steel rods into the same structural elements aforementioned for 45.06hrs, 35.20hrs, 25.10hrs, and 67.70hours respectively. Furthermore, steel fixers use 75.1% of their working time effectively while 24.9% of same is used ineffectively. It was recommended that labour output obtained be adapted as local substitute for the British Standard labour rate currently in use.

Key words: Labour output, Steel fixers, Indigenous contracting organization.

Introduction

Labour productivity plays an important role in the successful delivery of engineering, procurement and construction projects. The indigenous contractors came into limelight with the introduction of the Nigerian Enterprises Promotion Decree in February, 1972 and have since been playing important roles in the construction industry. Before the emergence of the Nigerian Indigenous contractors, most construction activities were carried out by the Public Works Department (PWD) and the Royal Army Engineers (RAW) which later metamorphosed into Nigerian Army Engineers. The construction industry like any other industry such as Agriculture, Oil and Gas etc have been a major contributor to the growth and development of the Nigeria economy. The output of the construction industry alone constitutes 40 – 70% of the gross fixed capital formation and is 3 - 8% of the Gross Domestic Product (GDP), about 5% of labour force and 12% of industrial sector production (Omole, 1999 and Arditi and Mochtar, 2000).

In spite of the prominent role the construction industry is playing in the national economy, its productivity over the years have continue to declined. This is a source of concern to the academics and other stakeholders. Over the years, labour cost estimate of building works in Nigeria has been based on British Standards. This assumes that the labour output of construction workers in the U.K and Nigeria is the same. This is not only misleading but a contentious issue in view of the fact that productivity influence factors such as weather, education, construction methodology just to mention a few, differs between the two countries. According to Ashworth and Skitmore (1983), such data were rarely amended or revised and hence subject to considerable uncertainty.

Studies conducted by Edmond (1974), Wahab (1977), and Olomolaiye (1984) cited in (Ayandele, 1997) revealed that outputs of labour in Nigeria construction industry are much lower than those of their counterparts in the United States of America and United Kingdom. In specific terms Edmond (1974) reported an output of 2.93 and 4.18 square metre per man-day for formwork to soffits and walls respectively in Nigeria as against output of 10.87 and 13.38 square metre respectively for the same activity in United Kingdom. In Wahab's study, it was shown that the man-days per square metre in Nigeria varied from 6.44 to 16.78 as against 2.33 for U.K, 3.28 for Ireland and 1.53 for USA.

In the UK, the working party report on Building Productivity in 1950 for Ministry of Works by His Majesty's Stationary Office (HMSO), London gave productivity as having fallen in 1947 below the pre-war years by 31% in England and Wales and by 33% in Scotland (Ogbona, 1989). Ogbona (1989) also quoted a Canadian report published in 1963 where it was stated that construction worker was occupied for only 55% of his workday productively. Obowu (1985) noted that the average percentage productive work done by construction worker at a staff Housing site in Kano was about 45% daily and in Warri, Ogbona (1989) found that the production efficiency of a construction worker on a direct labour project was on the average 30% per workday. Thomas and Daily(1983) in a study of five-men iron worker crew placing reinforcement, discovered that 47% of the time in the work cycle was devoted to travel, waiting and delays which constitute ineffective work. Odeyinka and Yusif (1997) noted that construction planning and organisational structure of building firms has significant impact on site productivity. Ndu (1987) sited three factors on which the level of production of any organization depends. These according to him are performance and technical factors like quality of equipment used in the production process, quality of raw materials, and method/technique adopted. According to Tucker (1986), failure to improve productivity to match increase labour wages has pushed construction cost 50% over the inflation rate. Improved productivity, therefore is a necessity to limit to a bearing minimum cost overrun, delayed schedule and plant cancellation as well as increasing the country's Gross Domestic Product (GDP).

FACTORS AFFECTING LABOUR PRODUCTIVITY

On any construction site the contractor's financial gains is dependent on completion of the work in good time, at the least cost and absence or reduction of accident on site. Therefore, productivity of labour has a direct bearing on these being achieved.

Price et al (1985) identified the primary factors determining labour output rate to be;

(a) Work rate

(b) Delays and waiting caused by poor management

(c) Excessive breaks and poor motivation

He further stressed that the latter two items accounted for more than 50% of the available working time on many sites whereas work rate varied only slightly. However, Oloko (1978) viewed the factors affecting labour productivity to be in two set. The first set of factor which touches on indirect labour, materials and equipment are;

(a) the level of the organization of the work.

(b) The degree of mechanization and automation of the production process.

(c) The quality and quantity of supplies of raw materials.

The second set of factors have to do with the direct labour (i.e. the worker).

They are:

(a) The technical and attitudinal skills of the worker.

(b) His innate ability

(c) The integrity of the application of his skills to the production process.

Rapportuer (1988) highlighted the factors affecting labour productivity as;

(a) Management policy

(b) Incentives

(c) Weather

(d) Mechanisation and equipment policy.

Furthermore, Heap (1987), stated in his own work, three major factors affecting the performance and productivity of labour on construction site.

These are:

(a) The human factor

(b) The competence of site management

(c) The motivation of the workers.

THE HUMAN FACTOR

Heap (1987), further explained that there are certain factors affecting human capacity for work and this eventually affect their productivity and performance on site. The Table 1 below shows this human factor and how it affects human capacity for work.

Table1: FACTORS AFFECTING THE HUMAN CAPACITY FOR WORK

Factors	**Explanation**	**Comments and suggestion for improving the capacity**
Age	Peak capacity for physical work is generally reached between the ages of 20 – 35.	In older persons, especially in skilled jobs, experience and efficiency compensate for lower work capacity.
Nutrition	Affect the rate at which heat can be dissipated from the human body by radiation, convection and evaporation of sweat. Heat and humidity increase dangers of heat stroke and reduce work capacity.	Start work at first light and avoid working during the heat of the day.
Health	Resistance to disease is affected by diet. Good hygiene and sanitation is essential to avoid occurrence of debilitating internal parasites	Enforce strict site hygiene. Arrange talks on hygiene and sanitation.
Acclimatization, adaptation, learning	New workers, or workers given new tasks, need time for their bodies and muscle to adapt to the work.	Unpracticed workers, would initially have a lower productivity, which would improve as they become acclimatized to the work and are instructed in the best methods of working.

Source: Heap (1987)

STEEL BARS FOR CONCRETE REINFORCEMENT

Reinforcement in concrete may be steel bars or mesh fabric. The steel bars are usually classified or manufactured on account of their strength as:

* Mild steel, which is usually round in section and plain, but could be deformed.
* High yield which is usually deformed.

High yield bars are almost twice as strong as mild steel for the same diameter. This factor enables designers to achieve reduction in the overall sectional area of steel reinforcement in concrete by using high yield rod. Reinforce bars are rolled in eleven standard diameters as shown in the Table 2 below:

Table 2: ASTM Standard Reinforcing Bars

	U.S. CUSTOMARY			METRIC		
	Nominal diameter (inc)	Nominal area (sq.inc)	Nominal weight (U/ft)	Nominal diameter (mm)	Nominal area (mm^2)	Nominal weight (kb/m)
1	0.375	0.11	0.376	9.52	71	0.560
2	0.500	0.20	0.668	12.70	129	0.994
3	0.625	0.31	1.043	15.88	200	1.552
4	0.750	0.44	1.502	19.05	284	2.235
5	0.875	0.60	2.044	22.22	387	3.042
6	1.000	0.79	2.670	25.40	510	3.973
7	1.128	1.00	3.400	28.65	645	5.060
8	1.270	1.27	4.303	32.26	819	6.404
9	1.410	1.56	5.313	35.81	1006	7.904
10	1.693	2.25	7.650	43.00	1452	11.38
11	2.257	4.00	13.600	57.33	2581	20.24

Source: Illingworth (1993), Pg. 443.

However, in the Nigerian context, there are ten major standard sizes of reinforcing bars found in the market. This is shown in Table 3 below.

Table 3: Standard reinforcing Bars in Nigeria Market

SIZES		WEIGHT
mm	**inches**	**weight**
6	¼	0.222
8	$^{5}/_{16}$	0.375
10	$^{5}/_{8}$	0.616
12	½	0.888
16	$^{5}/_{8}$	1.579
20	$^{3}/_{4}$	2.466
25	1	3.854
32	1¼	6.313
40	1½	9.864
50	2	15.413

THE STEEL FIXERS AND THEIR WORKING TOOLS

The steel fixer is one who specializes in the cutting, bending and fixing of steel reinforcement into forms and in accordance to specification. The common tools used by steel fixers in Nigeria are:

(a) Pincers: This is a tool consisting of two hinged arms, for gripping and for cutting binding wire.

(b) Bender: This is another important tool used by the steel fixer, formed and welded into F-shape using high yield steel bar, mainly used in bending reinforcement into the required shape so as to fit into the forms easily.

(c) Hacksaw: It is a hand saw used for cutting metal.

(d) Measuring Tape: Used for measuring steel bar, size of forms etc.

WORK MEASUREMENT TECHNIQUES

Heap (1987) defines work measurement as the application of techniques designed to establish the time for a qualified worker to carry out a specified job at a defined level of performance. It is used to develop time standard for:

(a) Planning and scheduling of construction operations

(b) Estimates for tenders, quotations and completion dates

(c) Setting out standards for workers and machinery.

(d) Balancing the work of workers or machine to form a composite team.

Figure 1 below is the outline procedure of work measurement.

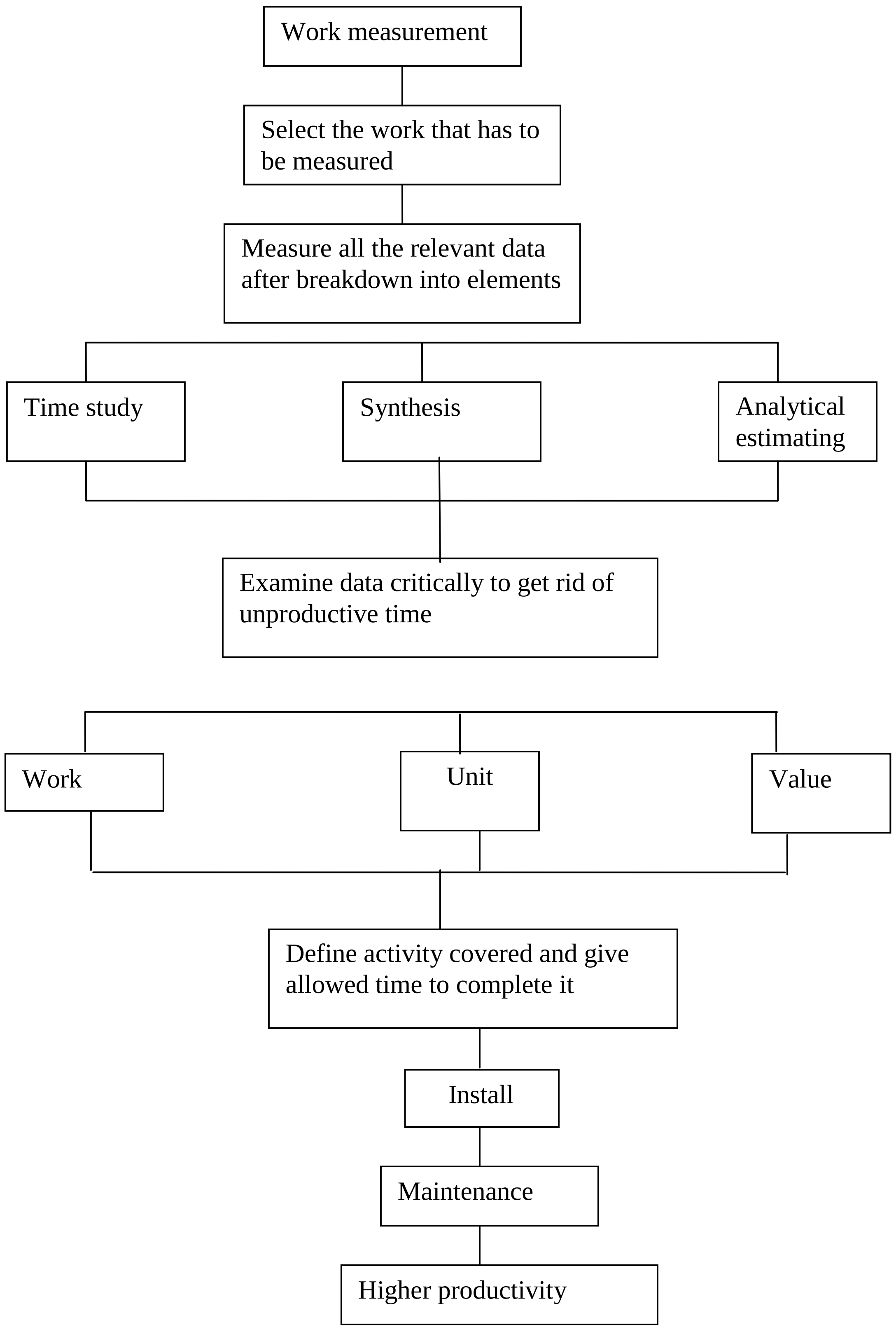

Fig. 1: Outline procedure of work measurement.
Source: Butler (1965)

WORK SAMPLING

Heap (1987) define activity sampling as that in which large number of instantaneous observations are made over a period of time on a group of machines or workers. It can also be defined as a method of finding percentage of occurrence of a certain activity by statistical sampling at random observations.

The result of the sample can be used to estimate within definable limits the proportion of job, time being occupied by each type of activity and delay recorded. It can also be used to access the degree of activity on the various sections of construction site, to check the amount of time wasted and reasons.

OBJECTIVES OF THE STUDY

The primary aim of this study are:

1. To determine the output of steel fixers in reinforced concreting operation in tones per hours.
2. To provide data base for planning and schedule of work and
3. To lessen the burden of preparing labour estimate and cost control.

SIGNIFICANCE OF THE STUDY

The data from this study will be used for preliminary advice to the client and in preparing labour estimate for steel fixers based on Nigerian standard by the estimator. It will also be useful to the contractors when decision regarding the award of bonus incentives scheme, to deserving workers, who put in work in excess of the set standard has to be taken. The findings will also enable the planning engineer to maintain basic productivity rate and likewise enhance the assessment of sub-contractors like the steel fixers nationally.

SAMPLE SIZE

The sample was made up of twenty indigenous construction sites. Three questionnaire were self administered in each of the site selected meaning that the questionnaires were administered randomly.

Furthermore, ten of these sites were sub-selected among the twenty formerly selected, five from group A projects comprising Lagos State Ministry of Works and Housing projects in Ajah and five from group B comprising projects in Victoria Garden City also in Ajah for thorough observation which enable the activity sampling to be carried out.

THE STUDY

Activity Sampling

In the activity sampling, a large number of instantaneous observations were made over a period of time so as to determine the effectiveness of the time spent on site by the steel fixers. The equipment used were mainly stop watch, pencil, calculator and activity sampling sheet. These studies were observed on different days but starting at the same time and stopped at the same time in all the sites visited for observation. An observation interval of ten minutes was used between 9.30am – 3.20pm making a total of 25 observation per steel fixers in a day. Table 4. shows the result of activity sampling of steel fixers on different sites. The result indicate a mean effective time of 75.1% and a mean ineffective time of 24.5%. This shows that the steel fixer has more effective use of his time with less time denoted to unproductive ventures.

Table 4: ANALYSIS OF THE EFFECTIVENESS OF STEEL FIXERS' WORKING TIME ON SITE

Site	No. of effective time observed	Number of ineffective time observed	Total Number of Time observed	Effective time (%)	Ineffective time (%)
A	92	33	125	73.6	26.4
B	75	25	100	75	25
C	41	9	50	82	18
D	56	19	75	74.7	25.3
E	37	19	75	74.7	25.3
F	59	13	50	64	36
G	74	16	75	78.7	21.3
H	55	26	100	74	26
I	37	20	75	73.3	26.3
J	37	13	50	64	36

Mean effective time = 75.1%

Mean ineffective time = 24.9%.

Table 5: Demographic Characteristic of Steel Fixers

1.	**Level of Education** (N=60)	Frequency	Cumulative Frequency	%	Cumulative
i.	Primary School	28	28	46.7	46.7
ii.	O' Level	14	42	23.3	70
iii.	No basic education	6	48	10	80
iv.	Trade test	12	60	20	100
2.0	**Year of experience** (N=60)				
i.	Below 5 years	9	9	15	15
ii.	5 – 10 years	17	26	28.3	43.3
iii.	11 – 15 years	19	45	31.7	75
iv.	16 – 20 years	7	52	11.7	86.7
v.	Over 20 years	8	60	13.3	100
3.0	**Age** (N= 60)				
i.	Below 20 years	6	6	10	10
ii.	20 – 30 years	14	20	23.3	33.3
iii.	31 – 40 years	20	40	33.3	66.6
iv.	41 – 50 years	16	56	26.7	93.3
v.	Over 50 years	4	60	6.7	100
4.0	**Weekly wages in Naira** (N=60)				
i.	1000 – 2000	2	2	3.3	3.3
ii.	2000 – 3000	10	12	16.7	20
iii.	3000 – 4000	43	12	16.7	20
iv.	Over 4000	5	60	8.3	100

Analysis/ Discussion

Level of Education

Four stages of level of education were identified and used for the study. The response indicate that ten percent of the steel fixers had no basic education, 20% have trade test, 23.3% have ordinary level school certificate while 46.7% have primary school leaving certificate. It can be observed that the steel fixers were not will educated academically. The implication of this on the steel workers ability for critical reasoning and ability to make independent judgment is grievous.

Year of Experience

This variable represents the total number of years which each steel fixer have spent on the Job. Only 25% of the respondent have over 16 years work experience 15% have below 5 years on the job experiences, 28.3% have between 5 and 10 years experience and 31.7%

have between 11 and 15 years experience. The model class for the years of experience is between 11 – 15 years.

Age

The study sought to find out the age of the steel fixers as at their last birthday. Very few (six percent) of the steel fixers were below 20 years. This category were in the minority. They are mostly apprentices who are working for their masters. 23.3% were between 20 and 30 years, 33.3% were between 31 – 40 years and 33.4% were ever 40 years. From the analysis, it can be inferred that majority of the steel fixers are within the active work group, although this again depend on the physiological makeup of the individual.

Weekly wages

This variable represent the weekly (six days) wages in Naira of the steel fixers. Overwhelming majority 71.7% earn between 3000 and 4000 Naira a week, 16.7% earn between 2000 and 2999 Naira while only few (eight percent) earn over 4000 Naira. It is important to note that as at the time of this study, a U.S. dollar officially exchange for One hundred and Thirty Naira seventy kobo (₦130.70k). This means that an hourly wage rate of the highest paid steel fixer is about 0.63 US dollars ($0.63) a week. This is lower than the United Nation's recommendation of at least $1.25 dollar per hour or $10 (₦1307.00k).per day.

Table 6 shows the labour output in hours per items for cutting and bending steel bars into structural forms for floor, beams, columns, staircase and floor slabs base on one steel fixer. The result indicate a mean labour output of 27.05 hours, 24.10 hours, 25.06 hours and 41.58 hours per tonne for beams, columns, stairs and floor slabs respectively. Similarly, Table 7 shows the mean labour output per steel fixer of 45.6 hours, 35.20 hours, 25.10 hours and 67.70 hours per tonne for placing, trying into forms for Beams, columns, staircase and floor slabs respectively.

Conclusions

This study has shown that a proficient steel fixer is capable of cutting and bending one tonne of steel rods manually into beams, columns and stairs for 66.04 hours and also capable of doing the same for floor slabs for 41.58 hours.

Similarly, a proficient steel fixer is capable of placing and tying one tonne of steel rods into beams, columns and stairs for 105.5 hours and also capable of doing same into slab for 67.70hours.

Steel fixers manage their time more effectively on site when engaged as sub-contractors rather than when employed on a day work schedule. They study revealed that steel fixers use 75.1% of their working time effectively while 24.9% of same is used ineffectively

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TABLE 4: LABOUR OUTPUTS FOR CUTTING AND BENDING STEEL RODS BASED ON ONE STEEL FIXER IN HOUR PER TONNE

Location	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Sizes of reinforcement	Mean labour output per steel fixer (hr/tor)
Superstructure Beam.	32.4	28.5	26.4	25.4	22.5	28.3	28.4	25	29	27.5	25.1	26.2	29.5	22.4	29.2	32	24	30.5	28.3	21.4	16mm & 10mm	27.05
Columns	18.5	25	24	35.5	32	25.2	24.5	20.5	22	23.5	27.5	37.5	28	22.5	24	23.5	26.5	20.5	21.3	19.4	16mm & 10mm	24.10
Stairs	25.2	24	25.5	18	21.4	27.5	30	28.1	-	-	-	27	23.2	25.5	24	28	-	-	24.5	24	12mm	25.06
Floor slabs	-	41.2	37.5	44	42.4	40.2	-	-	39.5	42	41.5	51.2	44.3	35.1	37	44.3	-	-	38	40.5	12mm	41.58

TABLE 5: LABOUR OUTPUT FOR PLACING AND TYING OF STEEL RODS BASED ON ONE STEEL FIXER IN HOUR PER TONNE

Location	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Sizes of reinforcement	Mean labour output per steel fixer (hr/tor)
Superstructure Beam.	-	44	45.2	38.5	48.1	51.5	-	46.2	45	44.3	-	44.5	45.5	39.4	50.2	43.2	49.5	45	43.5	51.4	16mm& 10mm	45.6
Columns	-	-	31	40	44	32.2	31.4	-	45	32.4	29.2	31.5	30	39	-	-	31.4	35	-	-	16mm & 10mm	35.20
Stairs	18.5	31.5	-	27.4	24.2	32	19.2	-	25.1	27.4	-	24.2	31.4	19.2	19.5	-	25	25.5	20.4	-	12mm	25.10
Floor slabs	67.3	70.4	-	-	69.4	70.4	63.2	70.1	-	65.3	60.2	-	72.5	73	-	65	69.5	69.5	59.2	-	12mm	67.70