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Original Article

Evaluation of Standard Times for Some Local Blacksmith's Products

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ABSTRACT

The practice of menial farming in the southwestern part of Nigeria have necessitated the need for the blacksmith industry to produce farm implements for the need of their immediate environment (farmers). With increased cost and time of production, coupled with demand size, reduced productivity and in order to meet the customer's schedule, the study was conceived to evaluate the standard time to start and finish a product to manage production time and to estimate the optimum production capacity of the blacksmith workstation. After a careful survey of the local blacksmiths and with the aid of a stopwatch and study time chart, standard time was evaluated for harvester, digger and axe. These implements are the most commonly used items by the locals. The standard time for the local blacksmith's axe, digger and harvester production was estimated to be 1458.35, 1931.44 and 936.66 Seconds respectively. It can therefore be concluded that the blacksmiths working for 8 hours a day will produce either (i) about 20 units of axe per day, (ii) 15 units of digger per day, or (iii) 31 units of harvester per day, or (iv) 7 units each, of the products per day.

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INTRODUCTION

Blacksmithing is an indigenous technology which is the origin of many modern metal forging operations and is present in almost every major global culture (Bukar Ngawaitu et al., 2022). It is a flourishing profession in Nigeria before the advent of colonial administration that provides

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services for the growth of the economy (Oloidi, 2021; Aro et al., 2021; Chidiebere, 2017; Ezenagu, 2014; Agu & Ali, 2012). According to Raji et al. (2013), the products of blacksmithing are usually dictated by the needs of the people in their immediate environment and they themselves produce their own tools first and foremost. For example, they make use of such articles as hoes, cutlasses, hammers, anvils and chisels which are further employed in making other articles. They also produce farm tools, knives, axe, guns, bows and arrows, spears and javelins, earring and metallic bracelet (Chidiebere, 2017; Roberts & Berns, 2018). Like any other business, productivity must be encouraged to keep the business alive since some people depend on it to make ends meet.

Productivity is the balance between all factors of production that will give the maximum output with the smallest effort (Sreekumar et al., 2018). It is enhanced by work standardization; setup reduction; reduction of cycle time; and wastage of resources like men, material, machine, capital (Taifa & Vhora, 2019; Kulkarni et al., 2014; Sanjay & NandKumar, 2007). Measuring productivity in terms of quality and quantity has become more important and has been regarded as a necessity for continuous evolution and improvement (Kaydos, 1991). Work productivity measurement can therefore be used to improve productivity (Tapasco-Alzate et al.,2020), and this is concerned with reducing and eliminating ineffective time from the production time and this process cannot be done without the scientific study and analyzing the methods called work study (Taifa & Vhora, 2019).

Work Study is the systematic methodology of carrying out different, yet related activities so as to improve the efficient use of resources and to set up standards of performance and quality for the activities to be carried out (Kulkarni et al., 2014). The application of a work-study approach can be applied to a diversity of conditions. It can be considered an all-embracing template that encompasses a broad scope of applications ranging from the design of a new plant to the design of a new product, new process, improvement of an existing process and even the improvement of an existing workplace. Wherever work is being done, the work study approach ensures that work is being done in the easiest, safest, and most productive way with the view to improving productivity (Nur et al., 2016; Hassanali, 2011). Work productivity is typically associated with production standard times (Nur et al., 2015).

Standard times is a unit time value for the completion of a work task as determined by the proper application of the appropriate work-measurement techniques (Nur et al., 2016; Li et al., 2015). It is the technique of establishing an allowed time standard for an average trained operator to perform a given task, based upon measurement of work content of the prescribed task, with due allowance for fatigue, personal and unavoidable delays under usual working conditions and working at a normal pace (Hartanti, 2016; Kulkarni et al., 2014; Wiyaratn and A. Watanapa, 2010). Study has shown that time study and motion study are the two main approaches for developing standard times (Elnekave & Gilad, 2006).

Apoorva and Ram (2016) describe time study as a tried and tested method of work measurement for setting basic times and hence standard times for carrying out specified work. It further clarified time study as a direct and continuous observation of a task, using a timekeeping device such as a decimal minute stopwatch, computer-assisted electronic stopwatch, and videotape camera to record the time taken to accomplish a task and it is often used when there are (i) repetitive work cycles of short to long duration, (ii) wide variety of dissimilar work is performed or (iii) process control elements constitute a part of the cycle. Whereas motion study is rarely used in the industry today, it consists of a wide variety of procedures for the description, systematic analysis, and improvement of work methods considering the raw materials, the design of the outputs, the process or order work, the tolls, workplace and equipment for each step in the

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process and the human activity used to perform each step (Bon & Daim, 2010).

Meanwhile, a thorough assessment of a blacksmith workstation located in Ile-Ife, Osun State, Nigeria revealed that there is too much idle time in the manufacturing of products. It was observed that while a particular worker is busy working and getting tired others within the same workstation are idle. This, among others, has been recognized as the basis for low productivity and output (Kulkarni et al., 2014; Turner et al., 1993). Incidentally, many researchers have explained that the best way to improve productivity is to eliminate or reduce time-consuming actions which generally do not contribute to actual production (Wiyaratn and Watanapa, 2010). It is believed that reducing production time will result in reduced manufacturing cost, thereby increasing productivity (Kulkarni et al., 2014). Consequently, this study is conceived to determine the job completion time ignoring the idle time; to determine the current operator's utilization; and to establish the standard time required to perform a particular task. This is with a view to managing production time and estimating the optimum production capacity of the blacksmith workstation.

METHODOLOGY

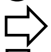
Task Selected

A thorough assessment of the local blacksmithing industry in Ile-Ife was carried out in order to identify the operational activities involved in the industry. During the survey, it was discovered that the industry is involved in the production of articles such as hoe, knife, cutlass, traps, harvester, digger and axe using crude method or processes as shown in the Appendix. Only the harvester, digger and axe was analyzed for the purpose of this study because these products are the most commonly produced items.

Task Division

The various steps involved in the production of harvester, digger and axe were examined and divided into different basic operations explained by Turner *et al*. (1993). The operations are defined by the various steps (Table 1) involved in the production.

Table 1: Symbol used for Process Chart

SYMBOL	NAME	ACTIVITY REPRESENTED
	Operation	Material selection, shaping and sharpening.
	Transportation	Change in location of materials/product.
	Inspection	Examination of materials/product for quality.
	Delay	Retention of materials/product in a location awaiting next activity.
	Storage	Eluting of object in location in which it is protected against unauthorized removal.

Time Study

Time study of each task (operation, transportation, inspection, delay and storage) involved in the process of production of axe, digger and harvester was determined with the help of stopwatch and study time chart. The standard time was evaluated using Eq. (1), as presented in the work of Apoorva and Ram (2016); an average of five replicate of time study was recorded in the study time chart. The study was carried out under a normal working condition with an experienced blacksmith in operation and following the same study, an allowance given is 12% was used to calculate the standard time.

$$\text{Standard time} = \text{Normal time} + \text{Allowance} \quad (1)$$

RESULT AND DISCUSSION

Task Normal Time for Axe, Digger and Harvester Production

The results of the time study for the local blacksmith production of axe, digger and harvester are recorded in Figures 1, 2 and 3 respectively. The results show the various

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operational steps involved in the production as well as the time taken for each operation. The time taken recorded was an average of 5 replicate of time for each step.

The normal time for the local blacksmith production of axe, digger and harvester evaluated from Eq. (1) are 1302.1 seconds (Figure 1); 1783.5 seconds (Figure 2); and 856.2 seconds (Figure 3) respectively.

Figure 1. Flow diagram and process chart for making an axe

Present method ■
Proposed method □

TIME STUDY CHART

SUBJECT CHARTED: Standard time for making an axe in a local blacksmith workshop
DEPARTMENT: Mechanical Engineering — CHART BY: OKE A.O.
SHEET NO. 1 — DATE: 18TH of May, 2021

DISTANCE (METERS)	AVE. NORMAL TIME (S)	CHART SYMBOLS	PROCESS DESCRIPTION
	15.4		Selection of the raw material
10	17.4		Transportation of raw material to the furnace
	264.6		Heating of the raw material
2	4.1		Transportation of work to the anvil
	53.3		Cutting off rough edges
2	4.7		Transportation of work back to the furnace
	188.0		Heating of the work
2	4.2		Transportation of the work to the anvil
	62.0		Cutting out the excess part of the work to make the v-shaped handle
2	4.6		Transportation of work back to the furnace
	5.5		Refilling of the furnace's fuel (coal)
	102.9		Heating of the unfinished handle of the work
2	4.5		Transportation of the work to the anvil
	30.2		Cutting and smoothening of the handles edge
2	4.2		Transportation of the work to the furnace
	7.7		Adjusting and refilling of coal
	226.5		Heating of the other edge to form the handle
2	4.5		Transportation of the work to the anvil
	69.9		Hitting the edge to form a sharp edge
2	4.3		Transportation of the work to the furnace
	146.6		Heating of the edge of the work
2	4.2		Transportation of the work to the anvil
	72.8		Reshaping and sharpening of the edge
28	1302.1	11 10 - 2 -	Total

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Figure 2. Flow diagram and process chart for making a digger

TIME STUDY CHART

Present method ■
Proposed method ☐
SUBJECT CHARTED: Standard time for making a digger in a local blacksmith workshop
DEPARTMENT: Mechanical Engineering — CHART BY: OKE A.O.
SHEET NO. 1 — DATE: 18TH of May, 2021

DISTANCE IN METERS	AVE. NORMAL TIME (S)	CHART SYMBOLS	PROCESS DESCRIPTION
	294.3	● ⇨ ☐ D △	Heating of the raw material
12	17.9	○ ➡ ☐ D △	Moving the heated material to the anvil
	71.2	● ⇨ ☐ D △	Cutting out the rough edges and material to size
12	20.2	○ ➡ ☐ D △	Transporting of material to the furnace
	8.8	○ ⇨ ☐ ◗ △	Arranging and refilling of the coal
	223.1	● ⇨ ☐ D △	Heating the cut raw material
12	16.8	○ ➡ ☐ D △	Moving the heated erial to the anvil
	44.3	● ⇨ ☐ D △	Bending and rolling to form the round handle
12	19.9	○ ➡ ☐ D △	Transporting of material to the furnace
	209.0	● ⇨ ☐ D △	Heating the rolled end
2	4.8	○ ➡ ☐ D △	Moving the heated material to the anvil
	87.7	● ⇨ ☐ D △	Smoothening of the rolled end
2	7.6	○ ➡ ☐ D △	Transporting of material to the furnace
	8.5	○ ⇨ ☐ ◗ △	Arranging and refilling of the coal
	198.5	● ⇨ ☐ D △	Heating the rolled end
2	4.7	○ ➡ ☐ D △	Moving the rolled part to the anvil
	40.4	● ⇨ ☐ D △	Slanting the rolled part at an angle
2	9.8	○ ➡ ☐ D △	Transporting of the other end to the furnace
	198.1	● ⇨ ☐ D △	Heating the other end
2	4.5	○ ➡ ☐ D △	Moving the other end to the anvil
	54.5	● ⇨ ☐ D △	Shaping of the blade
2	10.1	○ ➡ ☐ D △	Transporting of the blade to the furnace
	140.6	● ⇨ ☐ D △	Heating the blade
2	4.4	○ ➡ ☐ D △	Moving the blade to the anvil
	83.8	● ⇨ ☐ D △	Smoothening and sharpening of edge
60	1783.5	12 11 - 2 -	Total

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Figure 3. Flow diagram and process chart for making a harvester

Present method ■
Proposed method □

TIME STUDY CHART

SUBJECT CHARTED: Standard time for making a harvester in a local blacksmith workshop
DEPARTMENT: Mechanical Engineering CHART BY: OKE A.O.
SHEET NO. 1 DATE: 18^{TH} of May, 2021

DISTANCE IN METERS	AVE. NORMAL TIME (S)	CHART SYMBOLS	PROCESS DESCRIPTION
	102.7	● ⇨ □ D △	Slicing of the raw material
9	16.8	○ ➡ □ D △	Transporting of the sliced material to the work area
	95.4	● ⇨ □ D △	Heating of the end to be used for the handle
2	5.3	○ ➡ □ D △	Transporting the material from furnace to anvil
	40.8	● ⇨ □ D △	Folding the edge of the middle of the harvester
2	4.8	○ ➡ □ D △	Transporting the material from anvil to furnace
	68.5	● ⇨ □ D △	Heating of the handle
2	4.3	○ ➡ □ D △	Transporting of the material from furnace to anvil
	79.7	● ⇨ □ D △	Shaping of the handle
	48.8	● ⇨ □ D △	Smoothening of the handle
	28.5	● ⇨ □ D △	Marking out the blade from the edge
2	4.4	○ ➡ □ D △	Transporting the material from anvil to furnace
	40.7	● ⇨ □ D △	Heating the uncompleted harvester
2	3.9	○ ➡ □ D △	Transporting of the material from furnace to anvil
	108.6	● ⇨ □ D △	Shaping out of edge from the marked-out edge and reshaping curving of the main blade
2	4.2	○ ➡ □ D △	Transporting of the material from furnace to anvil
	34.9	● ⇨ □ D △	Heating of the uncompleted harvester
2	4.1	○ ➡ □ D △	Transfer of the harvester from furnace to anvil
	159.8	● ⇨ □ D △	Reshaping edge, sharpening of edge and filing of edge
28	856.2	129 - 2 -	Total

Standard Time

The standard time for the local blacksmith production of axe, digger and harvester was estimated as follows:

$$\text{standard time (axe)} = 1302.1 + (0.12 \times 1302.1) = 1458.35 \text{ s}$$

$$\text{standard time (digger)} = 1724.5 + (0.12 \times 1724.5) = 1931.44 \text{ s}$$

$$\text{standard time (harvester)} = 836.3 + (0.12 \times 836.3) = 936.66 \text{ s}$$

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Operator's/Tool Utilization

The result of the operators and tool utilization time for the local blacksmith production of axe, digger and harvester are shown in the worker-tool utilization chart shown in (Figures 2, 3 and 4). The operator's working time consists of the time spent by the operators to heat the material and then shape it to form the desired product. The result show that 76.4% of the normal axe production time was spent firing the material while the remaining 23.6 % was spent shaping the material to form the desired axe. 77.5% of the normal time spent on manufacturing the digger was spent firing the materials while shaping consumed the remaining the 22.5%. Meanwhile, the material for harvester production was fired for only 34.0% of the normal production time while shaping of the material to form the harvester consumed 66.0%.

Table 2: Operator/Tool Utilization Chart for Making an Axe by Local Blacksmith

	OPERATOR	TOOLS	FIRE
Idle time (S)	0	926	286
Operating time (S)	1212	286	926
Cycle time (S)	1212	1212	1212
% utilization	$=\frac{1212}{1212} = 100\%$	$=\frac{286}{1212} = 23.6\%$	$=\frac{926}{1212} = 76.4\%$

Table 3: Operator/Tool Utilization Chart for Making a Digger by Local Blacksmith

	OPERATOR	TOOLS	FIRE
Idle time (S)	0	1219	354
Operating time (S)	1573	354	1219
Cycle time (S)	1573	1573	1573
% utilization	$=\frac{1573}{1573} = 100\%$	$=\frac{354}{1573} = 22.5\%$	$=\frac{1219}{1573} =77.5\%$

Table 4: Operator/Tool Utilization Chart for Making a Harvester by Local Blacksmith

	OPERATOR	TOOLS	FIRE
Idle time (S)	0	280	544
Operating time (S)	824	544	280
Cycle time (S)	824	824	824
% utilization	Time $=\frac{824}{824} = 100\%$	$=\frac{544}{824} = 66.0\%$	$=\frac{280}{824} = 34.0\%$

The proportion of normal time spent firing the material when manufacturing the harvester is shorter (34.0%) when compared to the other products considered. This is due to the blank thickness and the required sharpness for the axe and digger compared to the harvester produced. The need to produce sharp axes and diggers necessitates the need to keep the material longer in fire knowing that the longer it stays in the furnace, the hotter it becomes and the easier to shape as explained by Arkundato et al. (2019).

CONCLUSION

Axe, digger and harvester are essential tools, used by the farmers. To make the tools available at affordable price and without disappointing the customers, local blacksmiths have to invest their time, ingenuity and material resources into their production.

Production time for each tool differ from one another as the research proved that it takes longer time to produce a digger when compared to axe; while harvester is manufactured in lesser time than the two. It is believed that the standard time established for these production processes will help to schedule production in order to meet farmers demands without overstressing the workforce.

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It can therefore be concluded that production crew (blacksmiths) working for 8 hours a day will produce either of (i) about 20 units of axe per day, or (ii) 15 units of digger per day, or (iii) 31 units of harvester per day, or (iv) 7 units each, of the products per day.

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APPENDIX

a) Local blacksmith operator beating a harvester to shape

b) Material undergoing heating process

(c) Local blacksmith anvil

(d) Local blacksmith furnace

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Samples of local blacksmith products on display