Analysis of Production Line Quality Using Time Study

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Abstract- **Every industry must devise a technique for evaluating the process output with measurable standard and take remedial action if there exist variation in both results; it is called quality control and it enhances productivity. This research focuses on the analysis of an industry's service quality using time study to identify the non-value adding task such as motion that increases the service delivery time thereby reducing the overall productivity. A flow chart was drawn to show the flow operation processes and five members of staff were examined to evaluate the observed time each task was performed relative to the standard time for efficiency computation. The results from the efficiency chart as depicted by the bar chart showed that task F, G, H and G (which required minimum motion) had the highest efficiencies in decreasing order compared to the other tasks. The location model was used to analyze the assembly line to determine suitable possible locations for both facility; storage site and workshop floor that will enhance staff efficiency and improve productivity. The effect of staff age and number of work experience relative to working hour was also evaluated and the result as shown by MS-Excel line plot is that, experience increases performance for technical tasks and is also a function of age while for task requiring human labour (in terms of effort) the younger the staff the higher the level of performance.**

Keywords: **Time Study, Service Quality, Statistical Process Control, Flow Chart.**

I. INTRODUCTION

Service quality is a broad term that is viewed from various perspective encompassing consistency, promptness in resolving customers complaints as well as delivery time etc. Service quality has five major definition approach-product based approach which focuses on the measurable attributes of the service; process-based approach which means compliance to set standards; opposite-demand that is, customer's satisfaction; Value-approach which is the ratio of provided benefits to acquired cost and finally the philosophical service delivery. The location model was also applied to restructure the assembly line for increased productivity at minimal cost.

II. MATERIALS AND METHODS

A Description of Study Area: The study was conducted in Artificial Lift Solution (ALS) segment of Schlumberger Nigeria Limited (SLB) in Trans-Amadi Industrial area of Port Harcourt, Rivers State Nigeria. ALS employs down hole lift mechanism including Electric Submersible Pump (ESP) and gas lift mandrels and valves in monitoring systems and optimizing oil production. The gas

definition that refers to the perfection of service delivery [2]. Owing to the recent competition in all business aspects, service delivery time has become an important factor to consider for continuous business patronage of any firm because time is one of the most important tools in determining a company's performance [1]. Time can be defined as a component used in measuring systems to arrange and compare events duration and also measure the motion of work element [3]. This parameter can be measured using time study-the time required to perform a specific task at a defined level of performance. Time study is a useful tool for employee's assessment during appraisal and for computing machine and man-hour for proper job allocation and for conducting quality control and Quality assurance (QC/QA). One of the seven wastes in any industry as identified by lean manufacturing which is 'waiting' can be handled by applying this principle. Several researchers have employed time study in solving the problem of productivity in both service and manufacturing industries. [1] in his research to determine the standard time for a man power process was able to maximize production and optimize cost through the application of pro-model to simulate production time, layout and the number of processes. [5] was able to insert five minutes break every production hour maintaining productivity without changing demand or increasing operator's workload by applying time and motion study techniques to a manufacturing industry. [6] in their work used time and motion study with assembly line balancing to improve the productivity of a firm. The efficiency of a firm in terms of productivity was increased by 53% through the application of time and motion study techniques in the work of [7]. In this research, the productivity of a petroleum servicing company was enhanced by using time study to evaluate and identify the non-value adding operations and bottleneck in the processes resulting in delay in

lift (GL) as an ALS technique is a process of lifting fluids from redundant wells by the continuous injection of a high-pressure gas to supplement the reservoir energy. The major components of the GL equipment are the gas lift mandrels, valve and pup joints which are all prepared in the blue-base before they are carried out for down-hole operations. Fig 1 gives a flow chart of the basic service operations necessary for successful service delivery.

B Method of Data Collection and Analysis: The time used by each employee in carrying out the individual task was recorded with a stop watch and used to generate values for the observed time which was later used to compute both the

normal and standard time. The time study formula is presented in Eq (1) - Eq (3).

$$Normal\ time = Observed\ ime \times \frac{Rating\ \%}{100} \qquad (1)$$

$$Stadard\ time = Observed\ time + Allowance \qquad (2)$$

$$Efficiency = \frac{Standard\ time\ \times 100}{Actual\ time} \qquad (3)$$

The performance rating is gotten by assessing the operators effective speed in carrying out a specific task relative to the observer's concept of normal speed while the allowance is the sum of all the allowances which covers but not limited to: relaxation, interference, contingency and policy time as shown in Table 1. The staff efficiency was computed using Eq (3).

Table 1: Male and Female staff allowances

Allowance	Male	Female
Personal Needs	5	7
Basic Fatigue	4	4
Contingency	5	5
Variable	0	0
Policy	0	0

III. RESULTS AND DISCUSSION

Five different members of staff were observed and Eq (1) – Eq (3) were used to compute their efficiencies for various task. The results of the staff efficiency presented in Fig 2 shows that, task A, B, D, E and I had the lowest efficiency in decreasing order compared to task C, H, G, and F (arranged in increasing order). The afore listed tasks were those requiring high technical skill with minimal motion hence, the observed reduction in efficiency. The efficiency of all observed staff A-E was highest for operation F, that is the QA/QC operation followed by the latch redressing (H), valve retrieval (G) and pre-test operation (C). The mandrel pre-test and valve retrieval are task that involve motion (that is, movement of the mandrel from the storage site to the workshop floor). The mandrel storage site is not close to the workshop; hence they are carried into the workshop by conveyors (that is, forklift or trolley) and as such a long distance is usually covered during these circles leading to long waiting and eventually increase in the service delivery time (especially in situation were conveyors are unavailable). Close examination of the facility design in terms of material storage and shop floor location shows that, there is a possible mishap in the original facility design which did not take into account non- value adding task like unnecessary motion within the location which may lead to increased motion and finally cause delay in service delivery time.

Transportation, motion and waiting are three of the seven waste in industries as identified by lean manufacturing and they can be addressed by applying models like transportation, assignment and facility location model. In light of this, the location theories, postulated by Alfred Weber (1909) which accounts for several spatial factors for finding the optimal location and minimal cost for a manufacturing plant was used to identify the best location for both mandrels and pup joint storage as well as workshop floor to reduce the carrying cost, excessive motion and waiting time.
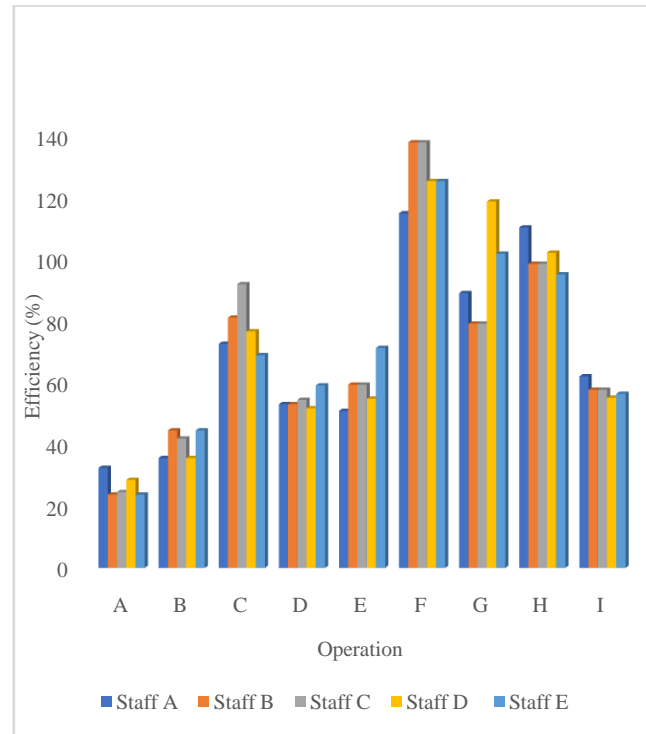

Fig 2: A chart showing staff efficiency on various operations.

Table 3: location model for the mandrels and Pop

S/N	Location Factor	Fact or Rating	Location 1		Location 2		Location 3	
			Rating	Tot al	Rating	Tot al	Rating	Tot al
1	Facility Utilization	5	3	15	4	20	4	20
2	Ease of access	6	2	12	5	30	6	36
3	Distance travelled (m)	8	5	40	4	32	7	56
4	Average Time Spent per trip (min)	7	4	28	3	21	6	42
5	Cost of Transporta tion (₦ x 1000)	8	1	8	3	24	2	16
6	Employee's preference	3	2	6	2	6	3	9
			Total	104	Total	133	Total	179

Location 1, 2 and 3 are Western Geco, Completions storage site and ALS storage sites respectively, all located in the blue

base area. The rating factor utilization was computed based on the fraction of space occupied by the mandrel relative to the available space. A stop watch was used to calculate the average time spent per trip, cost of transportation was estimated based on fork lift charges per trip in Naira, distance travelled was computed based on readings from surveyor's chart while employee's preference is based on individual's opinion. The location factor considered were the facility utilization, ease of access, distance travelled, average time spent per trip, cost of transportation and employee's preference. employee's preference and facility utilization have rating factor of 3 and 5 respectively which is low compared to the other factors because both have the lowest impact on motion. The result of the location model showed that location 1 had a total load value of 109, location 2 had a total load of 133 while location 3 had a total load of 179. Since location 3 had the highest load value it is considered as the best storage site for minimal motion and reduced cost. Furthermore, the effect of age and experience on employee's efficiency was evaluated and the result is presented in Fig 3 and Fig 4.

The operations involving mandrels which are: mandrel loading (B), mandrel Pre-test (C), and mandrel flushing (A) were analyzed against member of staff work experience and age to examine the effect of each factor on the level of performance relative to the delivery time
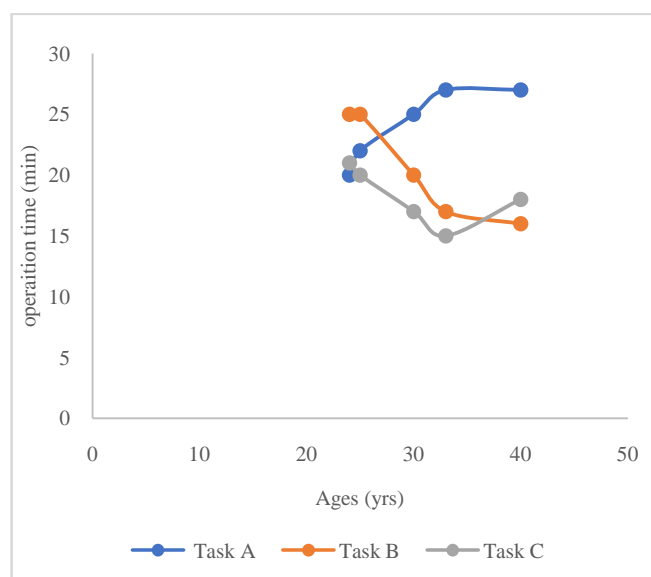

Fig 3: A graph of operation time against staff age

From the result shown in Fig 3, the first two observed staff completed task A at almost the same time because the age difference is small which implies that they probably have the same work experience or strength. More also, the older observed staff performed the same task at a longer time. For task B, the older members of staff performed the task at a shorter time compared to the younger ones. This is because it requires more of experience than strength while for task C, the middle-aged members of staff performed the task at a lower time compared to the younger and older ones who did it at almost equal operation time.
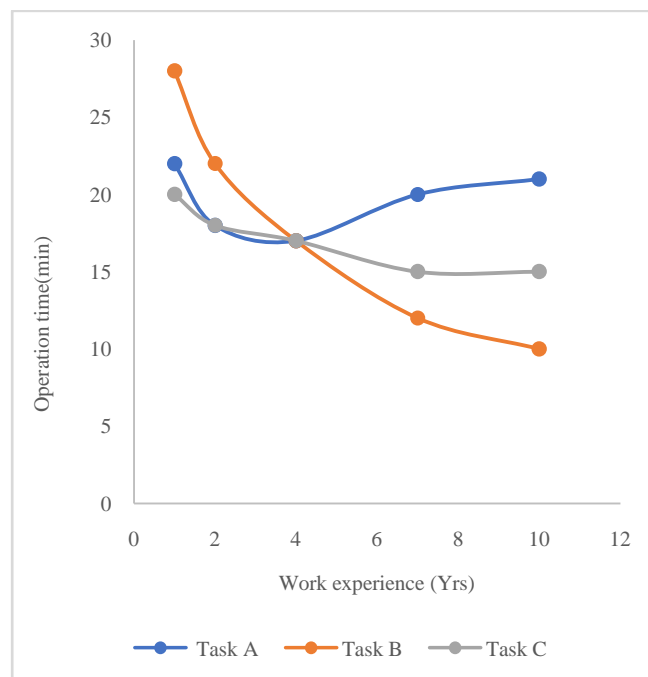

Fig 4: A graph of operation time against staff work experience

From the result shown in Fig 4 the higher the number of working experiences the lower the operation time for task B which is mandrel loading and this can be attributed to the fact that experience is a key factor to load a retrievable valve into the port of the mandrel. Hence, it would take a shorter time for an experienced staff to complete the task compared to a newly employed staff. This is also the case with task C but for task A, as the years of experience increased, the operation time decreased and later began to increase gradually which can be attributed to the fact that increased work experience means increase in age and the task requires more of human strength than experience.

IV. CONCLUSION

Time study is a proven useful technique for estimating worker's efficiency relating to their level of performance. The staff efficiency as computed using the time study model in this study shows that, technical task requiring little or no movement from one work station to another within the facility had the highest efficiency compared to the other tasks. The low efficiency value for the tasks involving motion indicates that, there is possible mishap in the facility layout original design which was improved upon by the application of location model. The improved design increased the overall efficiency by 26% and 42% for location 1 and 2 respectively.
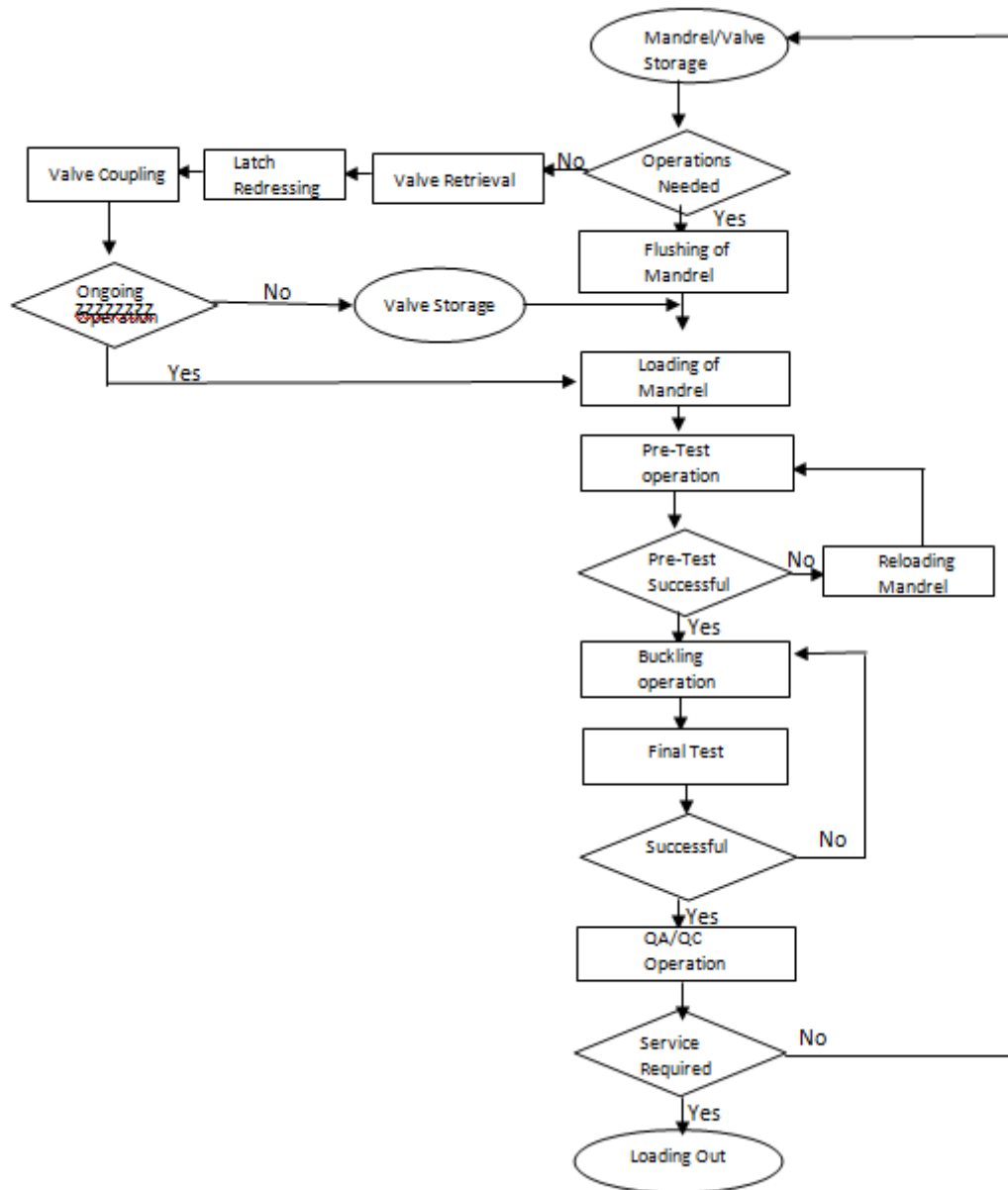
Fig 4: A Flow chart showing operation processes

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