

## Productivity Improvement Through Work Study Techniques: A Case of a Modern Rice Mill in Ikwo, Ebonyi State

### ABSTRACT

**Aim:** To explore the use of the work-study techniques in the efficiency improvement in the productivity of a firm or industry. A firm's profit can be increased through productivity improvement by reducing non-value-added operations and adopting a new process for a particular activity.

**Study design:** Currently, productivity improvement is a crucial factor in industries. Therefore, one of the primary goals of this firm is to improve productivity which enhances its long-run profit. The most critical tool for enhancing the firm's productivity is work study. Hence, this study noted the bottleneck and provided an appropriate technique for productivity improvement.

**Place and Duration of Study:** A modern rice mill in Ikwo Ebonyi State Nigeria, between March 2021 and October 2022.

**Methodology:** A method study was carried out using well-designed questionnaire techniques with interconnected critical analysis of a particular production line. A reasonable work content reduction was obtained when the proposed improvement method was applied. A stopwatch was used to obtain the time study with much emphasis on the standard time for the operation sequences. As a result, each workstation capacity per day was calculated.

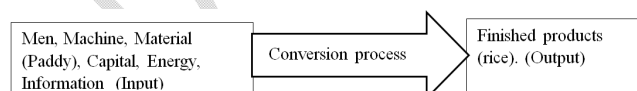
**Results:** The result shows that the firm productivity index improved by 12.71% when method study and work measurement were applied in the production line. Implementation of the proposed production line improved productivity from the old production line by 12.71%. Previously, the amount of work per ton was 26.97mins. Production line balancing and analysis of work method took 25.58mins to complete, this leads to a reduction of work method by 1.39mins.

**Conclusion:** In the Ikwo modern rice mill, productivity improvement is considered a critical factor for increasing the profit margin. Therefore, an increase in the profitable index of the firm is the function of productivity improvement, as a result of proper planning and control of the available input variables.

**Keywords:** Production; Productivity improvement; Work study; Method study; Work measurement

### 1. INTRODUCTION

Production is any method or technique established to transform a certain set of input into a unique set of output in the right quantities and quality while achieving an industry's goals. Through the transformation of raw materials, production facilities the development of finished goods [1]. The systematic diagram of a typical rice mill production system is shown in Fig. 1.



**Fig. 1. Production system [1].**

Productivity is defined as the ratio of the value produced to the resources needed for the production [2]. A productivity index is typically calculated as a component of productivity measurement used to compare output quantities with input resources [2, 3]. Thus,

$$Productivity = \frac{Output}{Input} \quad (1)$$

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Productivity is used to determine the quantities of output products produced from a given quantity of input materials [4]. Currently, productivity measurement is a critical factor in industries. It is important to note that, the profit enhancement of any firm is a function of its productivity improvement with respect to the input variables. The reduction of non-value-added processes and other bottlenecks in a production cycle helps to improve productivity and facilitates customer satisfaction [5]. [6] Noted the correlation between the productivity and output and material utilization techniques, output prices, inventory management, and distribution time. Profit increase is a result of productivity improvement [7].

Elimination of wastes, process repair, techniques modification, process simulation, minimization of input variables, and increase in output quality and decrease in set-up-time are other ways to increase a firm's productivity. An increase in the quantity of value-added processes brings about an increase in productivity [8].

[3, 9, 10] Noted that productivity could be improved if production cost per unit and labour cost are reduced with proper balancing of the production line. [3, 11] Defined productivity as the method of improving production at a constant production rate. This study x-ray the application of the work-study technique in a production line of Ikwo modern rice mill to enhance the firm productivity. Increased profit and effective labour utilization in a firm can be obtained when improved productivity is achieved via work study [6].

The main focus of this study is to determine how Ikwo modern rice mill can improve its productivity by applying the work-study technique. A critical management model for increasing productivity is work study. It deals with men, work methods, and performance efficiency of a firm. For a firm to survive in a competitive environment depends on the use of modern technology and economic manufacturing processes [12]. Effective utilization of the machine, man, capital, and energy, helps to improve production efficiency. Proper implementation of work-study, with much emphasis on method analysis and performance evaluation, aids in improving production efficiency. To achieve the same or greater efficiency at a reduced cost, work is divided into smaller units, studied, and redesigned. [13] Classified Work study is a methodology that integrates method study and works measurement techniques to ensure the proper allocation of men and material resources while producing a specific product.

It is a managerial function with a focus on method study and work measurement that is used to determine labour efficiency and to investigate all the available resources that have a direct impact on the economy and increase production efficiency.

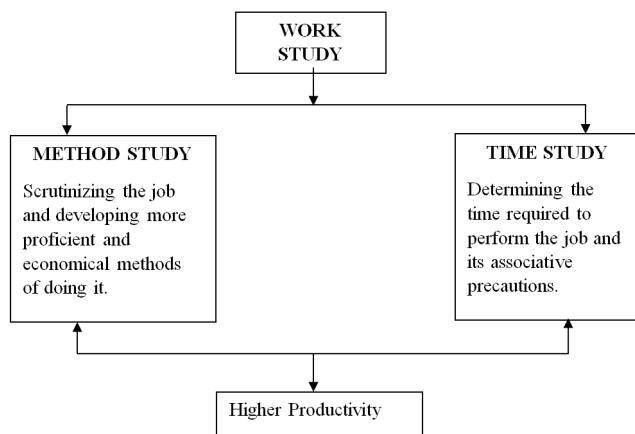
According to [13], the goal of work-study is to reduce costs by either planning the work for maximum productivity or increasing the productivity of the current work by making changes in existing processes through the elimination of non-value-added processes. As a result, it leads to a direct method of increasing productivity.

Consequently, it can be considered to be a practical method of increasing productivity. Work study has a close connection to productivity advancement since it is widely used to enhance the production capacity from a given set of resources with little to no additional capital investment [13].

[14] Stated that work-study is a practical methodology, specifically method study and work measurement used to determine the labour efficiency and to evaluate all the input variables that affect the effectiveness and economy of the existing problems under review in order to improve productivity. This shows that work-study is a direct method of increasing or enhancing productivity as a result of its capability to analyze human labor, which influences efficiency, as well as production improvement.

[15] Suggest that productivity and work-study are correlated as a tool to increase profitability. It is widely utilized to increase output while requiring little to no more input from a given set of resources. Several factors, including labor, material, land, machines, capital, technology, product, and management, have a direct impact on a firm's productivity and profitability. Innovative processes and the installation of modern machinery are two effective long-term productivity drivers. But a significant amount of funds is needed for this operation. Additionally, attempts to increase productivity through the use of modern technology may have an impact on initiative to increase job opportunities.

The goal of work study, on the other hand, is to increase productivity by objectively analyzing the current operations, processes, and work practices in order to increase their efficiency with little to no additional capital expenditure. It is necessary to use work study effectively and throughout the production processes in order to achieve productivity improvement. As a result, the International Labour Organization has demonstrated the correlation between work study and increased productivity.



**Fig. 2. Work Study Methods [13].**

This conceptual diagram is used to analyze the production line using a specific set of products. We chose the Ikw modern rice mill for this study to analytical evaluate its existing methods and time study with a stopwatch. We compute the standard time from the observed time for each operation, while the performance rate of the workers was computed using a rating system and two forms of allowance. The goal of this study is to increase productivity by analyzing the firm's manufacturing process using the work study approach. Identifying current production problems and devising new approaches via technical evaluation.

## 2. MATERIAL AND METHODS

In order to reduce the work content of the selected product, we adopted step by step procedure to achieve productivity improvement through work study method. To achieve the stated goal we developed a conceptual framework for the study, we first selected Ikw rice mill to the study its production line. All the operations in the production line were observed with the help of stopwatch. At the point of observing the operation the existing problem was identified through questioning technique. After that a new method or process for the product was developed. The practical application of the new proposed method in a particular production line showed that the productivity has been improved.

The following tools were employed to enable us collect and analyzed the data collected for the study. These include:

### 2.1 Time observed

[16] Defined it as the time taken to carry out a single operation or series of operations, which can be determined through direct measurement

### 2.2 Time considered

The time chosen as being representative of a group of times for an operations or group of work by calculating mean, median or mode.

### 2.3 Rating

This is used to evaluate the worker's productivity in relation to the researcher's perception based on the method employed. [17] Presented the widely accepted rating system as presented in table 1.

**Table 1. Rating system [17].**

Rating (%)	Explanation
≤ 0	Zero Activity
Up to 50	Operations too slow, loss of interest to perform jobs
Up to 75	No compromised performance while on job, No waste of time, effective supervision of the workers
Up to 100	Serious business orientation, use of skilled labourers, standard quality and right production rate
Up to 125	Operators show interest, fast moving operations, under well-coordinated materials flow
≥ 150	Little or no supervision, exceptional performance by outstanding workers

### 2.4 Basic time

This is the minimum time needed to produce a unit output from available input resources. According to [17] it is the time required to perform some activity at a given specification or standard.

$$Basic\ Time = \frac{Observed\ Time \times Observed\ Rating}{Standard\ Rating} \quad (2)$$

### 2.5 Standard time

This is a job cycle time at a standard performance (Time needed to complete on operation) [17].

$$\text{Standard Time} = \text{Basic time} + \text{Allowances} \quad (3)$$

In this study, 15% and 3% relaxation and contingency allowances respectively were considered.

## 2.6 Relaxation allowance

This is the important aspect of the time that can be added to the basic time to determine the standard time to produce a particular product. Allowances given to a worker depend upon the type of job performed. 15% of the basic time was generally accepted as a relaxation allowance added to determine standard time [18].

## 2.7 Contingency allowance

This is the minimum time estimated while planning for unexpected production activities. This time should be added to the basic time to determine the standard time for time studies [18]. 3% contingency was chosen for our study.

$$\text{Efficiency} = \frac{\text{Minutes Output}}{\text{Minutes Input}} \quad (4)$$

$$\text{Increasing Efficiency} = \left[ \frac{(\text{The efficiency of proposed line} - \text{Present efficiency})}{\text{Present efficiency}} \right] \times 100 \quad (5)$$

$$\% \text{ of work content reduction per ton} = \left[ \frac{(\text{Present work content/ton} - \text{Proposed content/ton})}{\text{Present work content/bag}} \right] \times 100 \quad (6)$$

$$\text{Increasing productivity at (100\% capacity)} = \left[ \frac{(\text{Proposed Standard output} - \text{Existing output})}{\text{Existing output}} \right] \times 100 \quad (7)$$

## 3. COLLECTED DATA AND ANALYSIS

In order to achieve our research objective practically, a modern rice mill Ikwo was selected for real-life implementation. On milled rice, observation was done on each production line with respect to time study. We observed that 17 operations were involved in a complete production cycle. Based on this, we observed and computed time for the 17 operations with the aid of a stopwatch. In each operation, five observed times were taken to determine the time for an operation to be completed. From the data obtained, the basic times were calculated using a specific rating point for a worker as stated in equation (2). Equation (3) was used to calculate the standard time including relaxation and contingency allowances. Based on this, standard time of 8 hours working time were considered for each worker.

**Table 2. Existing operations in Ikwo rice mill in minutes**

S/ No	Name of the operations	Observed times in minutes					Selected Time	Rating	Basic Time	Standard Time	Manual or m/c	Man power	Capacity/Daily @100% efficiency
		1	2	3	4	5							
1	Loading & off load of paddy	566	56	49	545	550	542	80	434	513	Manual	6	94
2	Steam heating of paddy	273	26	27	269	275	271	80	217	256	Manual	5	563
3	Drenching	108	11	12	111	115	114	80	91	107	Manual	4	897
4	Soaking	33	37	34	29	35	34	80	27	32	Manual	6	1500
5	Clearing	240	25	23	246	238	242	85	206	243	Manual	8	592
6	Drying	40	37	32	42	35	37	80	30	35	Sun	10	1371
7	Inspection	105	11	10	120	118	111	85	94	110	Manual	3	873
8	Polishing	22	23	27	19	25	23	80	18	21	M/c	6	2286
9	Milling	230	22	22	235	218	225	80	180	212	M/c	7	453
10	Destoning	208	23	22	227	223	223	80	178	210	M/c	4	457
11	Whitening	188	19	18	178	185	185	85	157	185	M/c	2	519
12	Length Grading	45	40	42	44	39	42	80	34	40	Manual	2	1200
13	Inspection	112	10	99	114	108	107	85	91	107	Manual	2	449
14	Shifting	129	12	12	139	138	131	85	111	131	Manual	6	733
15	Blending	259	27	25	265	269	263	85	224	264	Manual	4	727
16	Final Inspection	58	65	60	67	60	62	85	53	63	Manual	2	1524
17	Weighing & Bagging	177	17	16	188	185	177	80	142	168	Manual	12	857
			0	7					2287	2697		89	

### 3.1 Analysis of data

#### 3.1.1 Proposed production line for the firm

We observed a significant improvement on some of the identified problem while implanting the proposed techniques on the existing operations. We did some important operations to improve the productivity of the selected product. In table 3 the vital activities carried out while implementing our research approach were presented

**Table 3. Critical analysis of operation**

Operation	Existing Line Existing method	Standard Time/ton	Proposed Line Suggested method	Standard Time/ton
Cleaning of paddy	Removing all impurities and unfilled grains from the paddy is generally done using a single screen bed oscillating. This usual need more time.	212	Due to large quantity of the paddy required, it is could done with double screen bed oscillating with an aspiration. This type of method makes cleaning quicker than existing method	170
Husking	Removing the husk from the paddy is generally done using Steel husker. The using Steel husker for husking need more time. It has low milling efficiency and produces high amount of cracked and broken rice.	210	We could use rubber rollers operating at different speeds. It has high milling efficiencies of 80% to 90% with minimum broken or cracked grain. Due to speed variation a quicker technique could be used to save time.	179
De-stoning	Separating small stones from the brown rice is done manually. The using of manual method to separate stones from rice need more time.	264	Apply mechanized tools to save time.	211
Inspection	Inspection is done in de-stoning.	107	Should be avoided it in de-stoning section,	0
Polishing	Improving the appearance of milled rice by removing remaining bran particles and by polishing the exterior of the milled kernel. This is done using friction – friction – polishing. This method need more time than a mist method.	168	We could use a mist method to brush off remaining dust and to create a characteristics gloss on the milled rice. This method save time.	123
Weighing and bagging	Preparing milled rice for transport to the customer. This is done using bags, filled manually and closed by the bag stitchers. Due to the nature of the top, it need more skilled worker and more time.	187	If we could use mechanized bagging with closing –sawing machine. This method save time and also improve productivity.	44

Table 4 showed the operations and time analysis of the proposed production line balancing.

**Table 4. Production line balancing as proposed for Ikwo rice mill**

S/No	Operation	Time observed (mins)	Rating (%)	Basic Time (mins)	Standard Time (mins)	Machine or Manual	Labour capacity	Production capacity per day @ 100% efficiency	Production capacity per day @ 85% efficiency
1	Loading & off load of paddy	542	80	434	513	Machine	6	281	239
2	Steam heating of paddy	271	80	217	256	Machine	5	563	479
3	Drenching	276	85	253	275	Machine	4	698	593
4	Soaking	111	85	94	110	Manual	6	873	742
5	Clearing	60	80	48	56	Machine	8	857	728
6	Drying	180	80	144	170	Machine	10	564	480
7	Inspection	190	80	152	179	Manual	3	536	456
8	Polishing	120	85	102	120	Machine	6	800	680
9	Milling	42	80	34	40	Machine	7	1200	1020
10	Destoning	107	85	91	107	Machine	4	449	382

11	Whitening	67	85	57	67	Machine	2	716	609
12	Length Grading	210	85	179	211	Machine	2	910	774
13	Inspection	129	85	110	130	Manual	2	738	627
14	Shifting	130	80	104	123	Machine	6	1171	935
15	Blending	60	85	51	60	Machine	4	1600	1882
16	Final Inspection	22	85	19	22	Manual	2	2182	1855
17	Weighing & Bagging	119	85	101	119	Machine	12	1210	1029
				2190	2558			89	

#### 4. RESULTS AND DISCUSSION

The firm documents showed that the existing production line has a production capacity of 240bags per day. The firm has 8 hours working days. It also showed that the total number of workers on the same production line is 89 persons, therefore, following equation (1), the production line has mean productivity of about 2.5tons per day. The total operating time on the production line was 48000mins as recorded, then the labour capacity per ton was 26.97mins.

The standard production under 100% efficiency was 582tons per day. When equation (3) is applied 41.23% efficiency was obtained. This efficiency value showed that the existing production line operates low production capacity, with a direct impact on the productivity of the firm.

In this study, implementation of the proposed production line improved productivity from the old production line by 12.71%. Previously, the amount of work per ton was 26.97mins. Production line balancing and analysis of work method took 25.58mins to complete, this leads to a reduction of work method by 1.39mins.

The proposed production line under the standard production efficiency of 100% produced 656tons per day. The daily input for the proposed production line was 582tons. When equation [6] was applied, 12.71% increase in productivity was obtained.

Our new approach, which includes balancing of production line and reduction in job content improved productivity by 12.71%. Our proposed method helps to increase productivity to 12.71% with reduction of work content and line balancing.

#### 5. CONCLUSION

The study has shown that in lkwo modern rice mill, productivity improvement is considered a critical factor for increasing the profit margin. Therefore, an increase in the profitable index of the firm is the function of productivity improvement, as a result of proper planning and control of the available input variables.

The study identified the differences between processes and operations while producing an output. The study also identified how to determine the limitations of production operations and processes of producing a particular product.

Productivity improvement can be achieved by putting time and method studies into practice, as well as adopting method methodology for specific operations. Productivity improvement of a product also depends upon a proper balancing of the production line. We were unable to use this method for other products due to the time factor. For effective reduction of activities and tasks for productivity improvement, the best technique to be employed for such a goal is lean manufacturing. The study demonstrates how reducing work content and balancing the production line affect the productivity of the firm.

Finally, I recommend that further research could be on the integration of lean manufacturing and work-study technique.

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