

Productivity Increase by Optimum Utilization of Resources

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ABSTRACT

Productivity has often been cited as a key factor in industrial performance, and actions to increase it are said to improve profitability and the wage earning capacity of employees. Improving productivity is seen as a key issue for survival and success in the long term. This project focuses on examining key factors of productivity enhancement, and investigating the causal relationships among those key factors to better understand and plan for productivity improvement. The results prove 5 key productivity factors, including “leadership”, “strategic quality planning”, “people”, “data and information”, and “process management”, leading to a conceptual model.

Keywords :- Man Power, Optimum Utilization, Production Capacity, Process Management, Strategy Quality Planning.

I. INTRODUCTION

Productivity improvement is to do the right things better and make it a part of continuous process. Therefore it is important to adopt efficient productivity improvement technique so as to ensure individuals and organization's growth in productivity. The aim of my project is to introduce and understand productivity improvement, various techniques of productivity improvement, work study and its relation with productivity improvement.

Productivity and Productivity Improvement:

Concept Productivity is the ratio between output and input. It is quantitative relationship between what we produce and what we have spent to produce. Productivity is nothing but reduction in wastage of resources like men, material, machine, time, space, capital etc. It can be expressed as human efforts to produce more and more with less and less inputs of resources so that there will be maximum distribution of benefits among maximum number of people. Productivity denotes relationship between output and one or all associated inputs. European Productivity Council states that „ Productivity is an attitude of mind. It is a mentality of progress of the constant improvement of that which exists. It is certainty of being able to do

better than yesterday and continuously. It is constant adoption of economic and social life to changing conditions. It is continual effort to apply new techniques and methods. It is faith in human progress“. In the words of Peter Drucker productivity means a balance between all factors of production that will give the maximum output with the smallest effort. On the other hand, according to International Labour Organisation productivity is the ratio between the volume of output as measured by production indicates and the corresponding volume of labour input' as measured by production indices and the corresponding volume of labour input as measured by employment indices. This definition applies to an enterprise, industry or an economy as a whole.

The productivity of a certain set of resources (input) is therefore the amount of goods or services (output) which is produced by them. Land and building materials, machines, manpower (labour), technology etc. are the resources at the disposal of a manufacturing company. Therefore higher(improved) productivity means that more is produced with the same expenditure of resource i.e. at the same cost in terms of land, materials, machine, time or labour, alternatively, it means same amount is produced at less cost in terms of land, materials, machine time or labour that is utilized.

Improved productivity of materials:

A skilled tailor is able to cut 12 suits from a bale of cloth where an unskilled labour is able to cut only 10 suits from a bale of cloth, then the productivity of the bale used by skilled worker is 16.6 percent greater than unskilled labour.

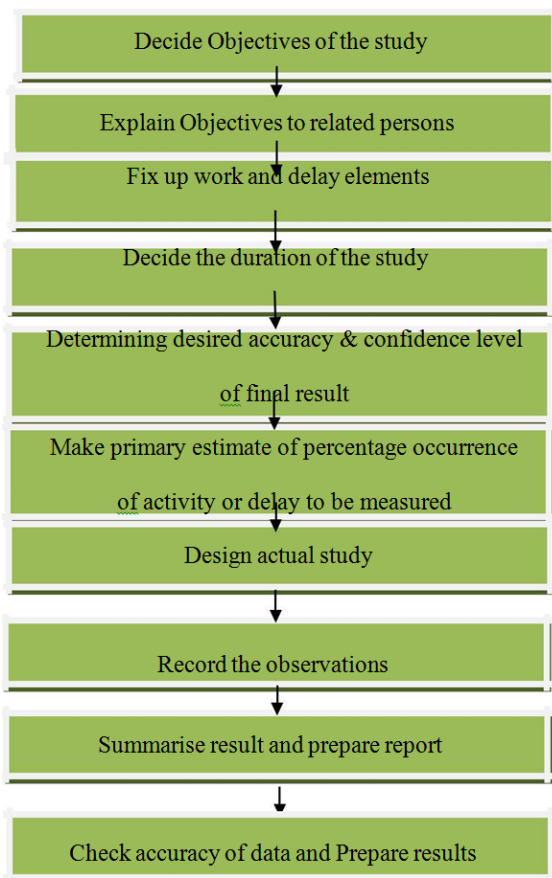
Improved productivity of machines:

A machine tool is producing 90 pieces per working day (i.e. 8 hours). Considering that through the use of improved cutting tools, the output is increased to 120 pieces, then the productivity of that machine will be increased by 33.33 percent.

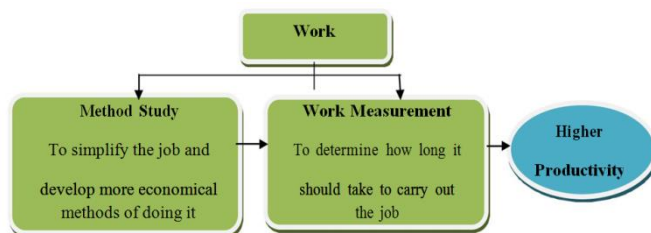
Improved productivity of Men (Labour):

The worker is producing 32 plates per hour. Considering that with the improved methods of work, he will be able to produce 42 plates per hour, then productivity of worker will be improved by 31.25 percent.

Work Sampling Steps



Relationship between Method Study And Work Study



Productivity Improvement Techniques And It's Relationship With Work Study

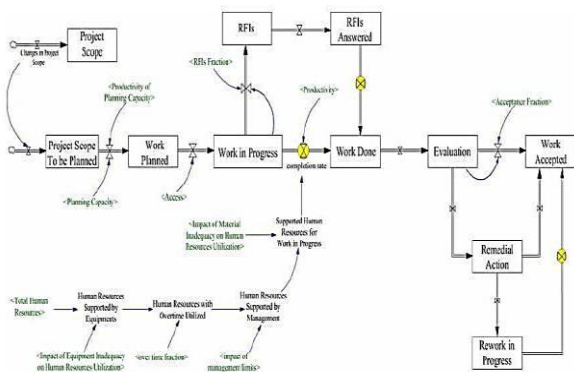
In as much as productivity is concerned in the development of any society, place or industry. We are all towing towards that direction of effective and efficient productivity. Productivity as the case may be is the effective use of all factors of production; or each factors of production which is defined as output to input (Oraee1998). Recent years have seen widespread discussion of productivity, and for good reason. It appears that labour productivity growth has improved sharply, perhaps approaching the pace of the “golden age” of the new millennium. To put the importance of this recent change in perspective, consider the direct impact of productivity in machine and human effort. If labour productivity were to grow at 2.5% (the average rate from 2006-2011) be output per hour will rise by 35% after 5 years. Clearly, the rate of productivity growth or the rate of productivity increase can have an enormous effect on real output and standard of living.

This work aims to elucidate the key ideas and concept in the economic analysis of productivity and apply them to recent trends. We begin by describing the most commonly used measurement of the productivity, discussed the importance of productivity for several major economic variables, and also sketch some of the factors believe to determine productivity, and finally note several open research question, as it concern machine, manpower, and optimum utilization of the factors of productivity. Also some tables used in various sections to determine the production and productivity of each of the variable like machine and manpower energy as the case may be. The Organization of Niger Mills is also included in the section.

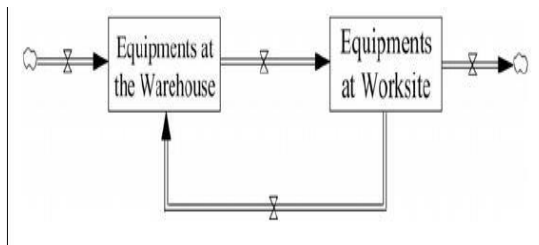
Stock-And-Flow Structure For Project Workflow

As shown below depicts the stock and flow structure contained in the workflow sector of the capital project management model (CPMM). This model constrains neither the type of construction project nor the type of project delivery method. Developed with generic parameters, this model characterizes the specific construction project and it is associated level of project management at either level milestone management or low level process management.

Stock and Flow Structure of Project Workflow



Equipment flow chart



Stock-flow structure for labor

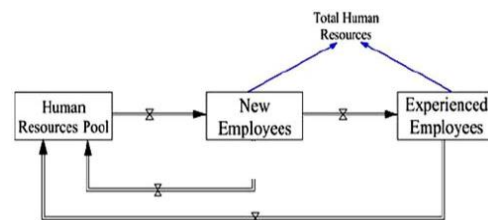
Total human resources are disaggregated into new employees, New employees and experienced employees. New employees are hired from the human resource pool and moved to experience working on the project. Experienced employees are more productive than new employees. Both new employees and experienced employees are laid off when the project of task is completed.

Stock-and-flow structure for machine or equipment

The structure for equipment is similar to that of labor. However, equipment is utilized and can wear out, but it is not consumed in the same manner as of labor.

Equipment is ordered and delivered to the warehouse and is then sent to the worksite as needed. Change in project scope may require ordering new equipment. If equipment at the worksite is under-utilized it is returned to the warehouse. Lack of equipment at the worksite leads to the under-utilization of human resource, and therefore slows down the completion rate of the project.

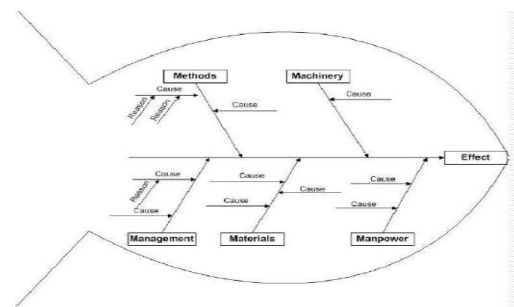
Human Resources Flow



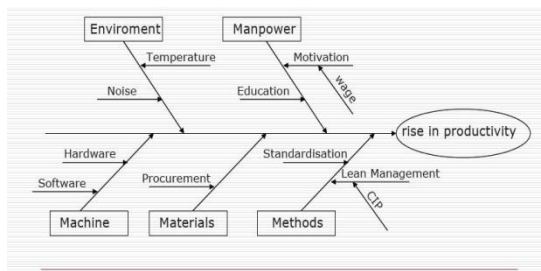
II. METHODOLOGY

This work is focused on how to improve productivity by optimum utilization of machines and manpower energy of a manufacturing company in Nigeria. Below is a Fish-bone Model to show productivity variables and processes, to achieve optimum productivity.

Fish-bone Model



Practical example of productivity flow with factor of productivity



Factory production capacity, factory production capacity is derived from the resources available at the manufacturing plant. It is calculated simply by the amount of machines available and hours per day determined to work to be realistic, one has to determine the efficiency level of the operators and incorporate the percentage % to derive actual capacity. Example, if a factory has 100 machines and working hours is 8 hours per day and 26 days per month. The efficiency level of the operator is observed to be 80%. The production capacity available time per month would be as follows

Available monthly production time capacity

$$100 \text{ machines} \times 480 \times 80 / 100 = 38400 \text{ mins/day}$$

$$38400 \text{ mins} \times 26 \text{ days} = 998400 \text{ mins/month or } 16640 \text{ hours/month.}$$

3.2.2 Special machine production capacity

Once planning production, it has to be known that if any special operation is required within the production of flour which requires machine or machines, in the transformation of millet into finished product. If so the output capacity for the flour has to be based upon special machine production. The management can then decide if those machines be worked overtime or if require to meet shipman date, additional machine be purchased.

To calculate special machine capacity per month, the available machines are 10, work hours/day are 8hours

efficiency level is 80% and working days per month is 26 days, break for one hour per day. Special production capacity in time/month = $10 \text{ machine} \times 480 \text{ mins} \times 80 / 100 = 3840 \text{ mins/day}$.

$$3840 \text{ mins} \times 26 \text{ days} = 99840 \text{ mins/month or } 1664 \text{ hours/month.}$$

Maximum capacity, this is the total hours available under normal conditions in a given period of time.

Potential capacity, maximum capacity adjusted for efficiency.

Committed capacity, this is the total hours previously allocated for production during a certain period of time.

III. RESULTS OF DATA COLLECTED

Flour Mills Limited located in Calabar Municipality is used as our case study. In this company, we collected data based on the following:

- The rate production (in tones) for five years (2007-2011)
- The total number of staffs employed for five years (2007-2011)
- The number of machines used in the production of flour
- The Organogram of the case study

Table 1. Total Production (tones) for 2007

MONTHS	TOTAL PRODUCTION (TONES)
JANUARY	16987.42
FEBRUARY	14438.12
MARCH	14927.48
APRIL	15247.25
MAY	14229.28
JUNE	14161.66
JULY	13275.38
AUGUST	13884.39
SEPTEMBER	14024.98
OCTOBER	13975.84
NOVEMBER	13812.05
DECEMBER	16034.94
TOTAL	174,998.79
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But we know that one ton is equal to 1000kg. To get the value in kilograms, we have to multiply by 1000, and this yields:

Table 2 Total Production (kilograms) for 2007

MONTHS	TOTAL PRODUCTION (KILOGRAMS)
JANUARY	16987420
FEBRUARY	14438120
MARCH	14927480
APRIL	15247250
MAY	14229280
JUNE	14161660
JULY	13275380
AUGUST	13884390
SEPTEMBER	14024980
OCTOBER	13975840
NOVEMBER	13812050
DECEMBER	16034940
TOTAL	174,998,790

Table 3 Total Production (tonnes) for 2008

MONTHS	TOTAL PRODUCTION (TONES)
JANUARY	16895.34
FEBRUARY	16024.32
MARCH	148014.21
APRIL	13154.14
MAY	14001.21
JUNE	15361.40
JULY	14695.24
AUGUST	14376.64
SEPTEMBER	13021.41
OCTOBER	14826.87
NOVEMBER	13015.35
DECEMBER	16342.22
TOTAL	175,727.95

Table 4 Total Production (kilograms) for 2008

MONTHS	TOTAL PRODUCTION (KILOGRAM)
JANUARY	16895340
FEBRUARY	16024320
MARCH	148014210
APRIL	13154140
MAY	14001210
JUNE	15361400
JULY	14695240
AUGUST	14376640
SEPTEMBER	13021410
OCTOBER	14826870
NOVEMBER	13015350
DECEMBER	16342220
TOTAL	175,727,950

Table 5 Total Production (tonnes) for 2009

MONTHS	TOTAL PRODUCTION (TONES)
JANUARY	16321.30
FEBRUARY	16873.24
MARCH	14542.16
APRIL	14480.75
MAY	14245.11
JUNE	13987.20
JULY	13678.27
AUGUST	14735.16
SEPTEMBER	14813.48
OCTOBER	13124.19
NOVEMBER	14432.23
DECEMBER	14786.53
TOTAL	176,019.62

Table 6 Total Production (kilograms) for 2009

MONTHS	TOTAL PRODUCTION (KILOGRAM)
JANUARY	16321300
FEBRUARY	16873240
MARCH	14542160
APRIL	14480750
MAY	14245110
JUNE	13987200
JULY	13678270
AUGUST	14735160
SEPTEMBER	14813480
OCTOBER	13124190
NOVEMBER	14432230
DECEMBER	14786530
TOTAL	176,019,620

Table 7 Total Production (tones) for 2010

MONTHS	TOTAL PRODUCTION (TONES)
JANUARY	16887.21
FEBRUARY	14885.38
MARCH	13978.66
APRIL	13725.62
MAY	13789.76
JUNE	13544.11
JULY	13335.26
AUGUST	15878.54
SEPTEMBER	13872.43
OCTOBER	14895.26
NOVEMBER	15375.24
DECEMBER	16435.48
TOTAL	176,602.95

Table 8 Total Production (kilograms) for 2010

MONTHS	TOTAL PRODUCTION (KILOGRAMS)
JANUARY	16887210
FEBRUARY	14885380
MARCH	13978660
APRIL	13725620
MAY	13789760
JUNE	13544110
JULY	13335260
AUGUST	15878540
SEPTEMBER	13872430
OCTOBER	14895260
NOVEMBER	15375240
DECEMBER	16435480
TOTAL	176,602,950

Table 9 Total Production (tones) for 2011

MONTHS	TOTAL PRODUCTION (TONES)
JANUARY	16985.30
FEBRUARY	14987.65
MARCH	13324.32
APRIL	13515.74
MAY	12415.63
JUNE	15895.48
JULY	14885.22
AUGUST	13431.22
SEPTEMBER	15975.64
OCTOBER	14448.56
NOVEMBER	13773.67
DECEMBER	16672.85
TOTAL	176,311.28

Table 10 Total Production (kilograms) for 2011

MONTHS	TOTAL PRODUCTION (KILOGRAMS)
JANUARY	16985300
FEBRUARY	14987650
MARCH	13324320
APRIL	13515740
MAY	12415630
JUNE	15895480
JULY	14885220
AUGUST	13431220
SEPTEMBER	15975640
OCTOBER	14448560
NOVEMBER	13773670
DECEMBER	16672850
TOTAL	176,311,280

Table 11 NUMBERS OF STAFFS WORKING DURING 2007

MONTH	NO. OF STAFFS
JANUARY	220
FEBRUARY	220
MARCH	218
APRIL	218
MAY	218
JUNE	215
JULY	219
AUGUST	220
SEPTEMBER	220
OCTOBER	220
NOVEMBER	219
DECEMBER	216
TOTAL	2623

Table 12 NUMBERS OF STAFFS WORKING DURING 2008

MONTH	NO. OF STAFFS
JANUARY	218
FEBRUARY	218
MARCH	219
APRIL	219
MAY	219
JUNE	215
JULY	215
AUGUST	215
SEPTEMBER	215
OCTOBER	220
NOVEMBER	220
DECEMBER	220
TOTAL	2613

Table 13 NUMBERS OF STAFFS WORKING DURING 2009

MONTH	NO. OF STAFFS
JANUARY	220
FEBRUARY	220
MARCH	218
APRIL	218
MAY	218
JUNE	218
JULY	218
AUGUST	220
SEPTEMBER	220
OCTOBER	220
NOVEMBER	220
DECEMBER	222
TOTAL	2632

Table 14 NUMBERS OF STAFFS WORKING DURING 2010

MONTH	NO. OF STAFFS
JANUARY	222
FEBRUARY	222
MARCH	222
APRIL	222
MAY	222
JUNE	220
JULY	220
AUGUST	220
SEPTEMBER	218
OCTOBER	220
NOVEMBER	224
DECEMBER	224
TOTAL	2656

Table 15 NUMBERS OF STAFFS WORKING DURING 2011

MONTH	NO. OF STAFFS
JANUARY	219
FEBRUARY	219
MARCH	219
APRIL	219
MAY	219
JUNE	220
JULY	225
AUGUST	225
SEPTEMBER	225
OCTOBER	226
NOVEMBER	228
DECEMBER	228
TOTAL	2672

3.3 Improving productivity: The major five ways of improving productivity are as follows:

- Increase inputs but get a greater increase in output
- Maintain inputs but increase output
- Decrease inputs with a smaller decrease in output
- Decrease inputs but increase output.
- Decrease input but increase output

System	Output	Reject	%	Net output	Man hour	Productivity
Old	60	10	16	50	24	2.1/hour
New	48	2	6	45	16	2.8/hour

One of the fundamental principle of productivity improvement is that the productivity of the existing process should be measure in as much details as possible before any attempt to improve it is made.

Single Resource Productivity (SRP)

OUTPUT		
300 bags Input	20 manhour	SRP
Man power		
		15 bags/manhour

The same method is used to measure all the other inputs of resources into the process .

Output	300 bags
Input	20 manhours 10 machine hours 450 metres flour 2 litres glue
Manpower	
Machinery	
Materials	

SRP Ratio
15 bags/manhour
30 bags/machine hour
0.6 bags/tons 150bags/kilo

But we said that we should break the various resource into as much details as possible for example, what type of labour are employed

Output	300 bags
Input	Labour - 8manhours Assistant - 8manhours Stacker - 4 hours
Manpower	

SRP Ratio
37.5 bags/manhour
37.5 bags/machine hour
75 bags/manpower

Productivity Index

Normal company reporting system are a mixture of positive and negative figures; some indicate good results, some bad. For example when costs go down, that's good but if production goes down, that's bad. Interpreting positive and negative variances in such reports is tricky and time-consuming. Many managers don't even attempt it, relying on their accountant to tell them when things have gone wrong- by which time, of course, it's too late to do much about it. Since measuring productivity would be waste of time and effort unless results were constantly reviewed and correctly interpreted, productivity results are always expressed as a percentage of a standard – results above 100% are positive and results below clearly negative. This measures is known as the productivity Index (PI).

Productivity index
Result being measured (actual) x 100
Standard
= PI

The result being measured is multiplied by 100 so that the PI will be expressed as a percentage of the standard (100).

Total Resource Productivity (TRP)

So far we have been concentrating on the productivity of the individual inputs into a process and we have seen how changes in inputs and output can affect productivity.

However, sometimes an improvement in the productivity of one resource input will cause a deterioration in another (as in last example). In these cases you need to be able to check and compare the overall productivity of the process. For this purpose we use Table Resource Productivity (TRP).

Old method
Input
40 manhours @ N 1.5
8 machine hours N 15
120 material units N 6
Total Resource Productivity

In other to find the TRP all inputs are converted into monetary values, added together and divided into the output to establish the output per N of input. Let's apply if first to the old method of making flour.

Using the same input values you can calculate the TRP of the new method.

New method
Input
24 manhours @ N 1.5
8 machine hours N 15
80 material units N 6
Total Resource Productivity

IV. PRODUCTIVITY MEASUREMENT

4.1 Productivity Index

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4.2 Total Resource Productivity (TRP)

So far we have been concentrating on the productivity of the individual inputs into a process and we have seen how changes in inputs and output can affect productivity.

However, sometimes an improvement in the productivity of one resource input will cause a deterioration in another (as in last example). In these cases you need to be able to check and compare the overall productivity of the process. For this purpose we use Table Resource Productivity (TRP).

Old method				
Input			Output	
40 manhours @ N 1.5	N60			24m³ tones
8 machine hours N 15	N120			
120 material units N 6	N720			
		N900	=	
Total Resource Productivity		= 24/900 0.026 m³ input per Nt		

In order to find the TRP all inputs are converted into monetary values, added together and divided into the output to establish the output per N of input. Let's apply it first to the old method of making flour.

Using the same input values you can calculate the TRP of the new method.

Input			Output		
24 manhours	@ N 1.5	N36			20m³ tones
8 machine hours	N 15	N120			
80 material units	N 6	N480			
		N636	=		
Total Resource Productivity		= 20/636 = 0.031 m³ input per Nt			

Checking the productivity indices of old and new methods you can see whether or not the changes made by the foreman have in fact increased overall productivity.

$$\frac{(\text{actual} \times 100)}{\text{standard}} = \frac{(0.03 \times 100)}{0.026} = 115\%$$

So you have improved by 15% which seems very good but is it the best you can get? Using the previous standard as a guide the standard TRP for the process works out at 0.03m³ per N input. You can now measure your new performance against the standard.

$$\frac{(\text{actual} \times 100)}{\text{standard}} = \frac{(0.03 \times 100)}{0.032} = 94\%$$

MAN POWER

Manpower: these are set of individuals who make up the workforce of an organization, business sector or an economy. Human capital is sometimes used synonymously with manpower, although human capital typically refers to a more narrow view, i.e., the knowledge the individual and embody can contribute to an organization. Likewise, other terms sometimes used include "human resources", "talent" or simple "people" manpower also refers to the manual labor or workers found in a firm or any company. Manpower can actually affect the productivity of any industry and Niger Mills is no exception. After analyzing the number of workers employed for the period given, we want to look at Labor Productivity for these periods. And these types of productivity are:

Labor productivity Machine productivity and Total productivity

We know that Labor productivity is expressed as: After analyzing the number of workers employed for the period given, we want to look at Labor Productivity for these periods. Labor Productivity is given by:

Labor productivity = **Total Output / Total Labor**

For 2007, Labor Productivity is given by:

$$\text{Labor Productivity} = 174998790 / 2623 = 66.71$$

For 2008,

$$\text{Labor Productivity} = 175727950 / 2613 = 67.25$$

For 2009,

$$\text{Labor Productivity} = 175727950 / 2632 = 66.87$$

For 2010,

$$\text{Labor Productivity} = 176602590 / 2656 = 66.49$$

For 2011,

$$\text{Labor Productivity} = 176311280 / 2672 = 65.98$$

There are different types of machines used in Niger Mills Limited, and six of these distinct machines found in their factory are:

- Splitting Machine
- Distillation/ Purification
- Mixing Machine
- Cooling Machine
- Milling Machine

- Packaging Machine

In order to ascertain the productivity increase by optimum utilization of machines, we want to calculate the machine productivity for the period given: Machine Productivity is expressed as:

$$\text{Machine Productivity} = \frac{\text{Total Productivity}}{\text{No. of Machines}}$$

However, there are other machines found in their workshops which includes; Lathes, drilling machines, milling machines, welding machines etc. The total number of machines counted in Niger Mills Limited was found to be 37. So that Machine Productivity for the period from 2007 to 2011 will be:

For 2007,

$$\text{Machine Productivity} = 174998790 / 36 = 4861077.5$$

For 2008,

$$\text{Machine Productivity} = 175727950 / 36 = 4881331.9$$

For 2009,

$$\text{Machine Productivity} = 176019620 / 36 = 4889433.9$$

For 2010,

$$\text{Machine Productivity} = 176602950 / 36 = 4905637.5$$

For 2011,

$$\text{Machine Productivity} = 176311280 / 36 = 4897535.6$$

From the above analysis, Total Productivity can be expressed as:

4.3.3 Total Productivity= Labor Productivity + Machine Productivity

Total Productivity for 2007 will be:

$$\text{Total Productivity} = 66.71 + 4861077.5 = 4861144.20$$

For 2008,

$$\text{Total Productivity} = 67.25 + 4881331.9 = 4881399.15$$

For 2009,

$$\text{Total Productivity} = 66.87 + 4889433.9 = 4889500.77$$

For 2010,

$$\text{Total Productivity} = 66.49 + 4905637.5 = 4905703.99$$

For 2011,

$$\text{Total Productivity} = 65.98 + 4897535.6 = 4897601.58$$

POTENTIAL CAPACITY OF NIGAR MILLS LIMITED

This is expressed as

$$\text{No. of machines} \times \text{No. of hours per day} \times \text{percentage of efficiency}$$

Where efficiency is given as:

$$\text{Efficiency} = \frac{\text{work input}}{\text{work output}} \times 100\%$$

Where;

$$\text{Work Output (Ave. for the five years)} = 175932118$$

$$\text{Work Input (Ave. for the five years)} = 161857549$$

Efficiency of machines then becomes:

$$\text{Machine Efficiency } (\eta) = \frac{161857549}{175932118} \times 100 = 0.92 \times 100 = 92\%$$

So that **Potential capacity of Niger Mill Limited will be:**

$$36 \times 8 \text{ hours/day} = 288 \text{ hours/day} \times 92\% \text{ efficiency} = 26496 \text{ potential production hours/day for all machines/day.}$$

Potential capacity for 26 working days (one month) is:

$$26 \times 26496 \text{ hours} = 688896 \text{ hours Potential capacity for one month}$$

Potential capacity for one year will be:

$$12 \times 688896 = 8266752 \text{ hours}$$

V. CONCLUSION

Productivity growth is clearly a fundamental measure of economic health and all of the major measures of aggregate labour and total factor productivity have recently shown improvements after long spells of sluggishness. If this improved performance continues, strong overall performance of real growth and low inflation may be sustained, although the short-run linkage of productivity to real income (and to output, after the very shortest period) is not as tight as some might expect. Examination of the sources of productivity growth suggests that a major source of the better aggregate performance has been the remarkable surge of the high-technology sector. The productivity increase in

Niger Mills in two major areas, namely ; Manpower and Machines. From the above analysis, the rate of production when machine is used (optimum use of machine or as calculated, machine productivity) far exceeds the rate of labor productivity. The analysis also shows that increase in manpower can also give rise to increase in productivity, although it has been observed that increase in production may or may not affect increase in productivity ratio.

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