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Productivity Increase by Optimum Utilization of Machines and Manpower Energy

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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

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. The debate about the sources and sustainability of the recent productivity, difference between " labor productivity" and "total factor" productivity, and the relative importance of the factors like "capital deepening" " spillover" productivity of machine output and productivity of machine use etc. Many of these terms are not only similar wording, but intellectual differences between them and can also be quite suitable.

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 will be 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 Organogram of (Niger Mills} is also included in the section three of this work so as to have a clearer picture of the study

II. STOCK-AND-FLOW STRUCTURE FOR PROJECT WORKFLOW

(Fig .1) 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.

Fig .1 Stock and flow structure of project workflow

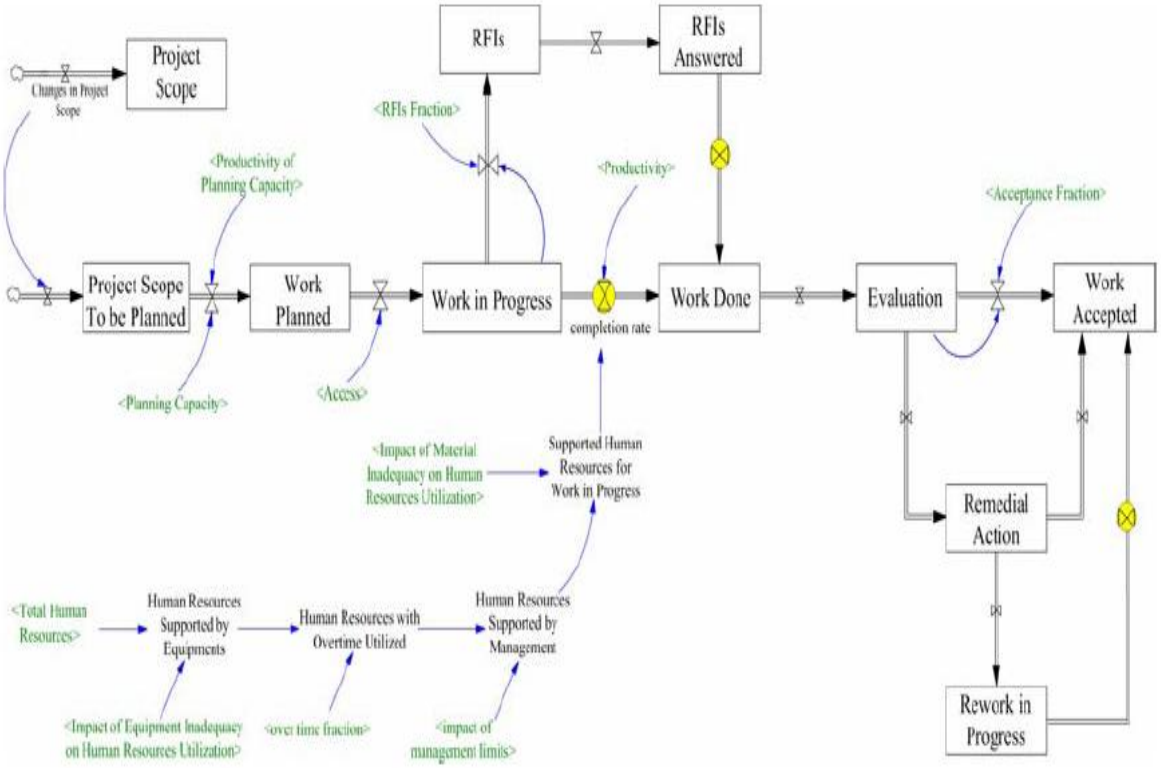
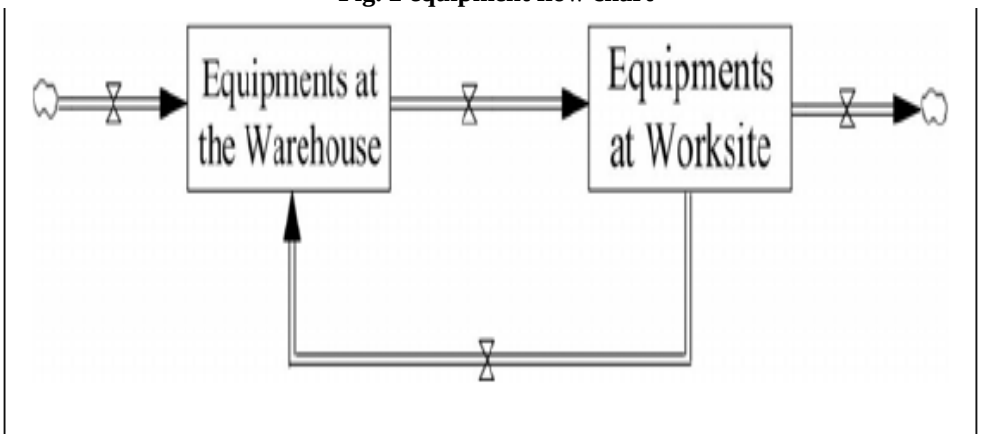


Fig. 2 equipment flow chart



Stock-flow structure for labor

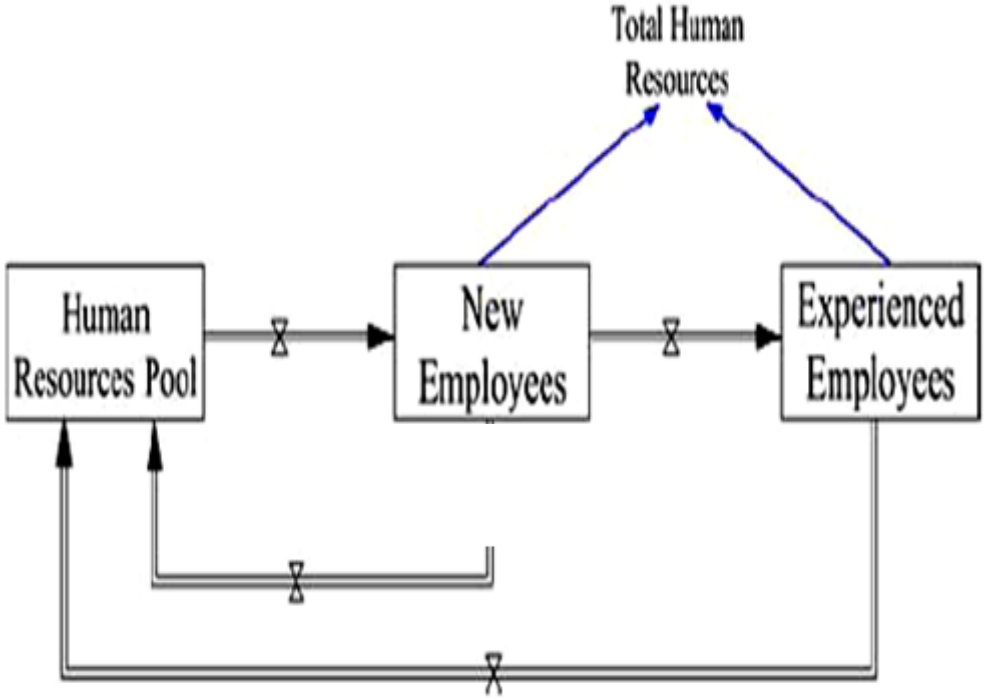
Total human resources are disaggregated into new employees, New employees and experienced employees. New employees are hired from the human resource pool and moved to experience working on the project. Experienced employees are more productive than new employees. Both new employees and experienced employees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

Fig. 3 Human Resources Flow



III. 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.

Fig. 4 Fish-bone Model

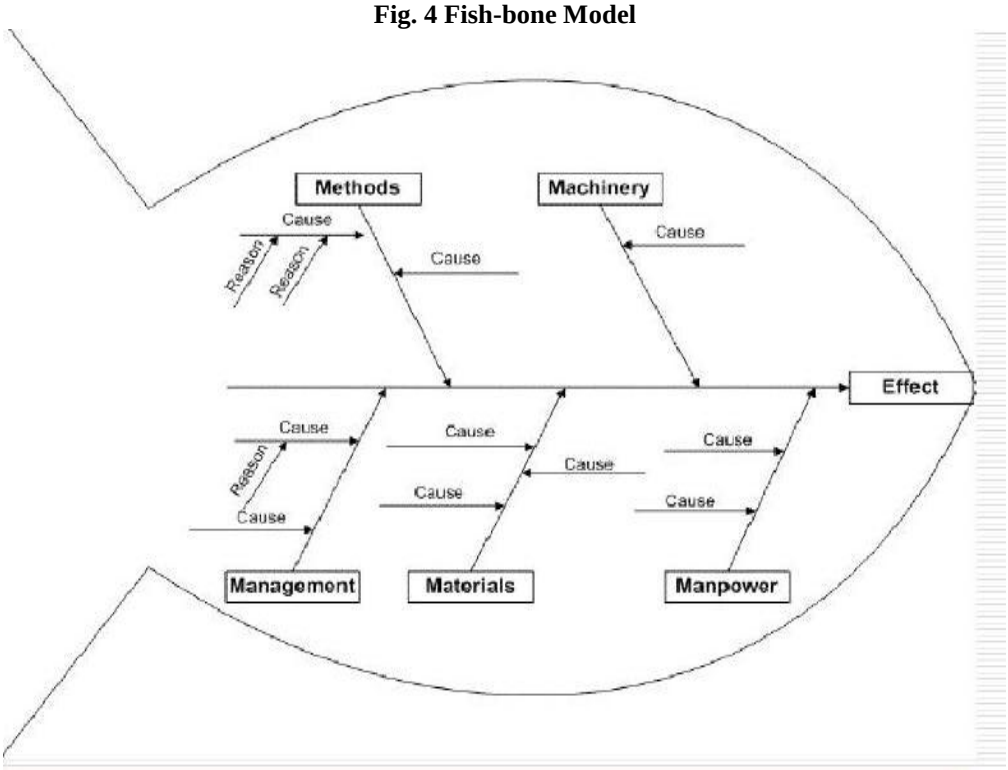
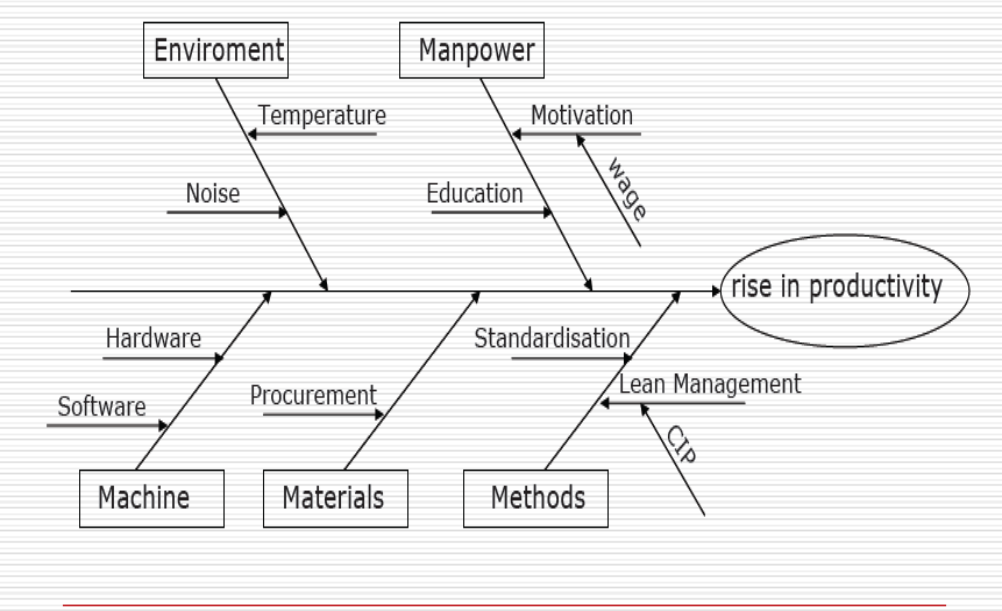


Fig .5 Practical example of productivity flow with factor of productivity



Factory production capacity, factory production capacity is derived from the resources available at the manufacturing plant. It is calculated simply by the amount of machine s 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 machines x 480 x 80/ 100 = 38400 mins/day
38400mins x 26days = 99400mins/month or 16640 hours/month.
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 machine x 480 mins x80 / 100 = 3840 mins/day.
3840mins x 26days = 99840mins/month or 1664hours/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.
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

But we know that one ton is equal to 1000kg (www.wilkepadia.com, 2012). 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 (tones) 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 (tones) 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	1698530O
FEBRUARY	1498765O
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 DURING2008

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 DURING2011

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

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

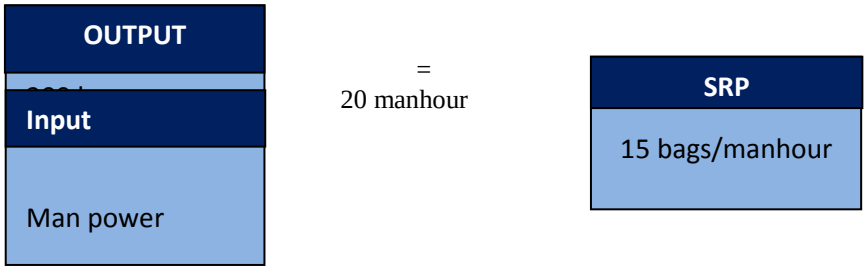
- Increase inputs but get a greater increase in output
- Maintain inputs but increase output
- Decrease inputs with a smaller decrease in output
- Decrease inputs but increase output.
- Decrease input but increase output

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**

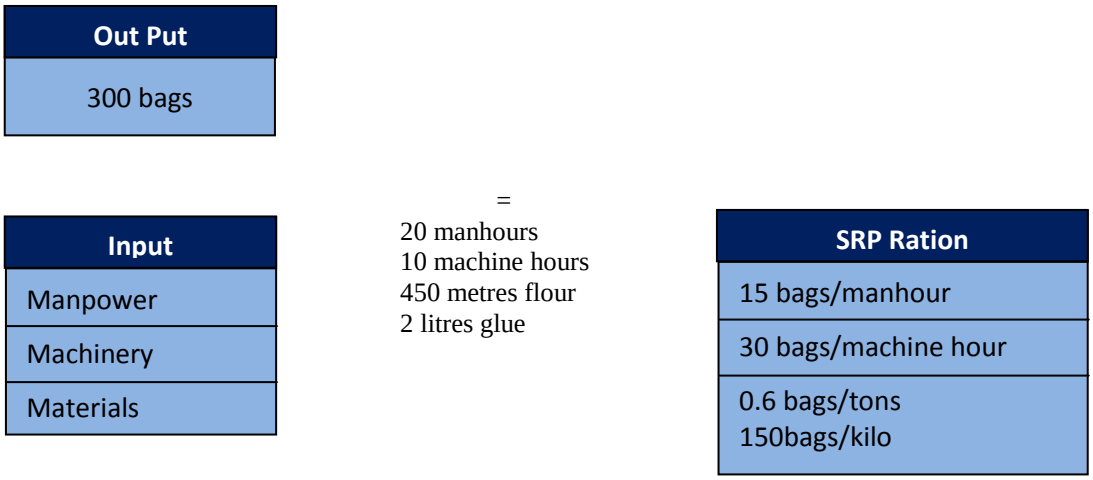
This shows that by decreasing the man power by 33% and decreasing output by only 10% productivity increased by 33%. A similar decrease resulted in the cost labour and materials per item thus making the product more profitable and or more competitive. The spare work could either be used full time or part time to increase production (if the lower price increase demand) or could be employed in some other productive capacity.

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.

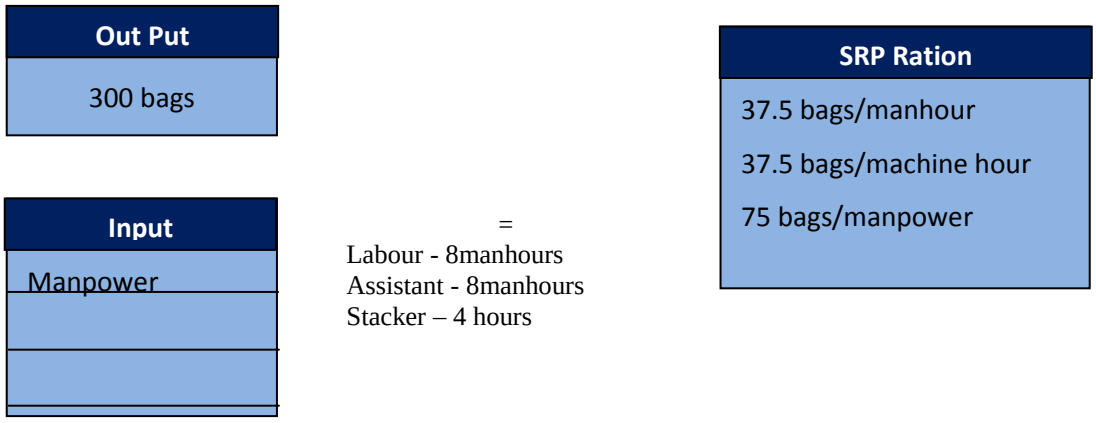
Single Resource Productivity (SRP)



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



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



Standards of productivity

In productivity improvement programme the norm usually used is a productivity standards. This standard can be determined in several ways

Setting productivity standards
• **Use the results of a previous period – last 6 months, last 12 months etc**
• **Use an outstanding result from a previous period**
• **Use an industry standard-most industries have developed performance norms**
• **Establish a standard by working measurement and/or work sampling**

The standard gives you something to aim for and something to measure against but it is not static. In fact, it must be changed whenever you change the inputs or the process otherwise its power to motivate will be lost and the results it throws out will be meaningless.

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 god 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				Output
40 manhours @ ₦1.5	₦60			
8 machine hours ₦15	₦120			
120 material units ₦ 6	₦720	₦900	=	$24m^3$ tones
Total Resource Productivity	= 24/900		$0.026\ m^3$ per ₦input	

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 ₦ 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				Output
24 manhours @ ₦1.5	₦36			
8 machine hours ₦15	₦120			
80 material units ₦ 6	₦480	₦636	=	$20m^3$ tones
Total Resource Productivity	= 20/636		$0.031\ m^3$ per ₦input	

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.

(actual x 100) / standard = (0.03 x 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 ₦ input. You can now measure your new performance against the standard.

(actual x 100) / standard = (0.03 x 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 capita typically refers to a more narrow view, i.e., the knowledge the individual and embody can contribute to an organization. Likewise, other terms sometimes uses 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:

$$\text{Labor Productivity} = \frac{\text{Total Output}}{\text{Total Labor}}$$

For 2007, Labor Productivity is given by:

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

For 2008,

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

For 2009,

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

For 2010,

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

For 2011,

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

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:

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

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 36. So that Machine Productivity for the period from 2007 to 2011 will be:

For 2007,

Machine Productivity = $\frac{174998790}{36}$ = 4861077.5

For 2008,

Machine Productivity = $\frac{175727950}{36}$ = 4881331.9

For 2009,

Machine Productivity = $\frac{176019620}{36}$ = 4889433.9

For 2010,

Machine Productivity = $\frac{176602950}{36}$ = 4905637.5

For 2011,

Machine Productivity = $\frac{176311280}{36}$ = 4897535.6

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

Total Productivity =Labor Productivity + Machine Productivity4.3

Total Productivity for **2007** will be:

Total Productivity = 66.71 + 4861077.5 = 4861144.20

For 2008,

Total Productivity = 67.25 + 4881331.9 = 4881399.15

For 2009,

Total Productivity = 66.87 + 4889433.9 = 4889500.77

For 2010,

Total Productivity = 66.49 + 4905637.5 = 4905703.99

For 2011,

Total Productivity = 65.98 + 4897535.6 = 4897601.58

POTENTIAL CAPACITY OF NIGER MILLS LIMITED

This is expressed as

No. of machines x No. of hours per day x percentage of efficiency4.4

Where efficiency is given as:

Efficiency = work input / work output x 100%4.5

Where;

Work Output (Ave. for the five years) = 175932118

Work Input (Ave. for the five years) = 161857549

Efficiency of machines then becomes:

Machine Efficiency (ŋ) = $\frac{161857549}{175932118}$ x 100 = 0.92 x 100 =92%

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

36 x 8 hours/day = 288 hours/day x 92% efficiency = 26496 potential production hours/day for all machines/day.

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

26 x 26496 hours = 688896 hours Potential capacity for one month

Potential capacity for one year will be:

12 x 688896 = 8266752 hours

IV. CONCLUSION

Productivity growth is clearly a fundamental measure of economic health and all of the major measures of aggregate labor 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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