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Implications Of Poor Energy Supply On The Productivity Of Nigerian Manufacturing Industries: A Case Study of Delta Steel Company, Delta State Nigeria

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ABSTRACT- *A comprehensive evaluation of the effectiveness and delay contribution due to power outages and fluctuations is presented. The purpose of this study is to reveal the implications of poor energy supply on the effective utilization of the input resources in a typical Nigerian manufacturing industry. Delta Steel Company, Delta State, Nigeria, was used as a case study. Data on power outages were collected from the energy distribution unit, steel melting shop and the rolling mill. Additionally, the total delays, standard or planned production and actual production were determined from the records, from which the power delay contributions and effectiveness were evaluated. Results from this study revealed that power delay contributed more than 6% and monthly effectiveness was less than unity throughout year 2017. Analysis of data collected for 2017 production period showed that the energy distribution unit experienced 54 outages with a total duration of 11472mins, while a total of 44937mins was lost in the steel melting shop due to power outages and under-voltage. More so, 25 billets worth 34tonnes were scrapped and 20811mins were lost as a result of power failure and fluctuations. The implications clearly showed that poor power supply lowers the productivity of the company.*

KEYWORDS: *Energy, Manufacturing, Productivity, Power delay*

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I. INTRODUCTION

Every manufacturing industry requires energy to power their machines, computers, and lighting the establishment for various purposes. However, in Nigeria, power requirement of the manufacturing sector far outweighs the available power being generated, transmitted and distributed by power Holding Company of Nigeria (PHCN) to both manufacturing and non-manufacturing sectors.

This energy deficiency has resulted in the emigration of some companies to other countries as exemplified by Mitchelin, which relocated their production facility to Ghana, some industries lying moribund as experienced by most textile industries in Northern Nigeria, and some industries resorting to diesel engines as prime movers for industrial alternators, which supplied inadequate power and cannot run continuously for many days.

Also, the running cost of these diesel engines are on the high sides, thereby increasing the cost of production and in many cases, lowers productivity.

Political instability has also hindered any possibility of progression in the energy sector, with the sacking of numerous high profile figures that have the interest of the Nigerian masses at heart. This selfish act was seen by Nigerian masses as a way the political leaders in this country manipulate the citizens to press on their own self-interested agenda, while the society infrastructure remained in bad conditions and the people in abject poverty. Fundamentally, the power sector, a component of which is the electricity sector of the economy has a great importance to our lives and takes central role in the economic transformation process (Uzorh and Nnanna, 2014).

Enterprises produce goods and services for sale with the aim of making returnson their investments. The goods and services are the output of the enterprises. In theprocess of production, an enterprise makes use of scarce resources which are calledfactors of production, namely land, labour and capital. These factors of production aregenerally referred to as inputs in the production process and their owners are rewardedfrom the returns generated by the enterprise. How to combine the inputs to have amaximum result - greatest output with a given input - is the problem of productivity.

Unfortunately, there is no universal definition of the term, productivity. It has beendefined by Economists as the ratio of output to input in a given period of time. In other words, it is the amount of output produced by each unit of input. Business Managers,on the other hand, see productivity not only as a measure of efficiency, but alsoconnotes effectiveness and performance of individual organisations. For them,productivity would incorporate quality of output, workmanship, adherence to standards,absence of complaints, customer satisfaction, etc (Udo-Aka, 1983).

The administrator is more concerned with organisational effectiveness, while theindustrial engineer focusses more on those factors which are more operational andquantifiable, work measurement and performance standards (Adekoya, 1989).

Productivity can be computed for a firm, industrial group, the entire industrial sector orthe economy as a whole. It measures the level of efficiency at which scarce resourcesare being utilised. Higher or increasing productivity will, therefore, mean either gettingmore output with the same level of input or the same level of output with less input. Letus look at the sub-concepts.

Total-Factor Productivity: This is the ratio of output to the aggregate measure ofthe inputs of all the factors of production. Theoretically, this is the true measure ofproductivity as it incorporates the contribution of all the factor inputs.

Pertinent to this study is the understanding of the keywords “Manufacturing” and

1.1Fundamental Concepts “Productivity”.

The word “Manufacturing” is derived from Latin word “manus” and “factus” meaning hand and made respectively,that is the literal meaning is “made by hand”. However, in the modern sense, “manufacturing” means making of goods or articles from raw materials by hand or machinery by following a well defined plan for each activity required.

Productivity has now become an everyday watch word that is crucial to the welfare of the industries as well as for the economic progress of the country.

Productivity is the measure of how well the resources brought together in an organization and utilized accomplishing a set objectives (Telsang, 2008). Productivity is the ratio of outputs of goods or services from the conversion process to inputs consumed in the generation of these outputs (Buffa and Sarin, 2010).

Productivity is a summary measure of the quantity and quality of work performance with resource utilization considered (Schermerhorn, 1986)

Productivity can be defined as the optimum utilization of all the resources of organization: Men, money, materials, machinery, energy, space, technology, etc (Sharma, 2006).

1.2Measurement of Productivity

Productivity is the arithmetic ratio of amount produced (output) to the amount of resources (input).

$$\text{Productivity} = \frac{Output}{Input}$$

Productivity refers to the efficiency of the production (Telsang, 2008).A basic component of productivity measurement is a means of comparing output forecasts with actual output at selected intervals.

In general systems theory, effectiveness is defined as the degree to which the actual outputs of the system corresponds to its desired or planned outputs. Productivity is a function of effectiveness and efficiency (www. authorsden.com).

$$\text{Effectiveness} = \frac{Actual\ \ Outputs}{Desired\ \ Output}$$

$$\text{Productivity} = \frac{Actual\ \ Production}{Standard\ \ Production}$$

II. RESEARCH METHOD

Power outages in Delta Steel Company (DSC) were collected for one year (January-December 2017) from the energy distribution unit. Therecord which showed the specific date, time out, time in, duration and feeders has been summarized as shown in table 3.1.

The delay due to power outages, insufficient power to run the furnaces and preheat ladles, power fluctuation and power failure that resulted in the abortion of heats were determined from one year record and percentage contribution of the power failure to the total delay was determined and compared to the productivity of the steel melting shop. See table 3.2.

More so, delay due to power outages, cobbles due to power outages, percentages contribution of the one year data, and the contribution of power failure compared to the total delay was determined and compared to the productivity of the rolling mill (see table 3.3).

2.1Description of the study area

Delta Steel Company (DSC) is an integrated steel plant with iron making, steel making and rolling mill facilities. These three important plants consume a lot of power during production and adversely lower the productivity of the company when there is power fluctuations or failure. However, the steel melting shop and rolling mill were functional during the period under study.

2.2 Power Utilization in the Steel Melting Shop

Melting in this plant is achieved with Electric Arc Furnaces (EAF), which cannot do without electricity. They melting point of steel is about 1539°c, its superheat temperature before tapping into the preheated ladle is 1700°c and the casting temperature in the continuous casting platform is 1600°c.

When there is power failure and the temperature of the liquid steel is below 1600°c (say), the usual option is toabort the heat by quickly tapping into the ladles and pouring the liquid steel on the ground floor before it solidifies. More so, when the power failure is experienced at a temperature of about 1200°c, the metal is left in the furnace, while heating and melting continue when the power is re-instated.

2.3 Power Utilization in the Steel Rolling Mill

Both power fluctuations and failures are very dangerous and highly undesirable in the rolling mill. This is as a result of the formation of cobble which can occur when a billet undergoing deformation derails due to the stoppage or malfunctioning of the mill stands, shears, approach roller table and loppers along the mill train.

Power fluctuation or failure causes cobble formation in this mill, thereby grounding the rolling operation. Also, the temperature (1200°c) of the heated billets drops when there is power failure. When cobble forms, the mill is shut down, and cobble removal crew cut and remove the cobble, while the maintenance/production crew re-instates the plant before production continues.

III. RESULTS AND DISCUSSION

3.1 Results

The results from the data collected are summarized in tables 3.1, 3.2 and 3.3.

Table 3.1 Power outages for 2017. Source: Energy Distribution Unit

Month	Feeders	Duration (mins)	Number of Power failure
February	GIW, S4W	790	4
March	GIW, S4W	1319	5
April	GIW	68	4
May	GIW	520	6
June	GIW	238	3
July	GIW	642	10
August	GIW	2201	6
September	GIW, S4W	325	4
October	GIW, S4W	232	3
November	GIW, S4W	2946	3
December	GIW, S4W	2191	6
Total		**11472**	**54**

Table 3.2: Evaluation of Productivity and Power Delay Contribution in Steel Melting Shop

Month	All EAF Power Delay (mins)	All EAF Delays (mins)	Power Delay Contribution (%)	No. of Delay periods	Quantity of Heat recharged per Ton (Joules)	Standard production or planned production (Tonnes)	Actual production (tonnes)	Productivity or Effectiveness
February	11578	52615	22.01	15	80	21000	12708.40	0.61
March	851	55690	1.53	7	70	25725	14675.35	0.57
April	507	52001	0.97	8	60	25200	13896.31	0.55
May	369	68998	0.54	5	Nil	23520	7899.22	0.34
June	444	59623	0.75	3	30	30660	11902.23	0.39
July	1091	59962	1.82	9	290	23940	13456.50	0.56
August	5058	62439	8.10	6	Nil	16200	12270.82	0.76
September	537	48297	1.11	5	55	20000	17080.00	0.85
October	780	45502	1.71	7	48	21800	20956.00	0.96
November	12445	52771	23.58	19	55	27000	16143.00	0.60
December	11277	51902	21.73	12	419	25500	16518.30	0.65
Total	**44937**	**609800**	**7.37**	**96**	**1107**			

Table 3.3: Evaluation of Productivity and Power Delay Contribution in Steel Rolling Mill

Month	Power Delay (mins)	Total Delays (mins)	Power Delay Contribution (%)	No. of Cobbles due to Power Failure	Standard production (tonnes)	Actual production (tonnes)	Productivity or Effectiveness
January	146	39338	0.37	Nil	25250	3547	0.14
February	1648	24997	6.59	3	18180	11295	0.62
March	1455	21043	6.91	5	20200	12450	0.65
April	651	25746	2.53	1	22220	6701	0.56
May	1327	35264	3.76	1	21715	11500	0.31
June	428	27094	1.58	1	22725	12012	0.51
July	2172	26827	8.10	6	22220	11037	0.54
August	4217	30311	13.91	Nil	15150	14826	0.73
September	737	25389	2.90	3	18180	17186	0.82
October	785	22258	3.53	1	25250	17186	0.68
November	4058	23429	17.32	2	30300	15043	0.50
December	3187	30181	10.56	2	22725	12233	0.54
Total	**20811**	**331877**	**6.27**	**25**			

IV. DISCUSSION

Table 3.1 showed thatthe cause of the outages includes system collapse, system disturbance, high frequency, undervoltage, over — voltage or poor generation. The number of power failure times was found to be 54 and the outage duration totaling 11472mins in 2017.

GIW ⟶ Ughelli supply, S4W ⟶ Sapele supply

Table 3.2: A total of 44937mins delay due to power outages and inadequacy was recorded in 2017 in the steel melting shop which contributed 7.37% to the total delay and resulted in the abortion or return of heat worth 1107tonnes of liquid steel. No monthly target was achieved throughout 2017, as revealed by the effectiveness.
EAF II and EAF IV delays due to power are presented in second column.

Table 4.3 showed thatwhen the effectiveness is 0.82, the power delay contribution is 2.90%, while the effectiveness of 0.50 resulted when the power delay contribution is 17.32%. These clearly show that power delay affect the productivity adversely. Also, the total number of billets devalued due to power failure throughout 2017 was 25. Total delay due to power failure was calculated to be 20811mins with a contribution of 6.27% to the total delay. The effectiveness from January to December, 2017, was found to be less than unit. Tables 3.2 and 3.3 also showed the implications of poor power supply.

4.1 Implications of Poor Power Supply in the Steel Melting Shop

The implication of power fluctuation and failure are listed as follows:

i. Loss of consumables and ferroalloys used in the treatment of the aborted heat
ii. Loss of money accruable from 110 tons (furnace capacity) of steel had it been successfully casted
iii. Devaluation of already treated steel to scrap
iv. Increased expenditure on the cutting of the aborted steel to sizeable form for easy loading into the EAF
v. Consumption of more energy in re-melting or continued melting because of temperature drop.
vi. Loss of money paid to PHCN for power expended on return or aborted heat
vii. Increased idle times of workers because the entire plant gets heated up and polluted when there is heat abortion
viii. Loss of man-hours especially when a heat is aborted
ix. Inability to make the planned or standard production
x. Productivity ratio or effectiveness is always less than one with respect to the production quantity.

4.2 Implications of Poor Power Supply in the Steel Rolling Mill

The implications of power fluctuations and outages in thesteel mill includes:

i. Devaluation of the billet to scrap
ii. Loss of a would be income if a billet was successfully rolled
iii. Extra expense on the oxygen and acetylene used in cutting the cobbles
iv. Maintenance and repair of damage parts due to cobble
v. Expenditure on the treatment of injured personnel or compensation of the family when a worker is entangled by cobble (Death situation)
vi. Increased downtime
vii. Increased idle time of some workers
viii. Increased energy consumption when the furnace temperature drops

ix. Loss of man-hours and expenditure on power when cobble forms
x. Productivity is always less than unity because actual production was always less than the planned production.
xi. Loss of machine hours as some machines takes up to thirty minutes before assuming normal operating condition.

V. CONCLUSION

Obviously, poor energy supply lowers the productivity of manufacturing industries in Nigeria as shown by the two functional plants in Delta Steel Company. This is due to its associated unwanted events such as increased idle time, delivery time delay, increased cycle time, reduced machine output, increased expenditure on material recovery and recycle, increased maintenance and repair expenses, semi-finished product devaluation, compensation to injured personnel or family of dead personnel, increased downtime, loss of consumables, alloys and extra expenses on raw materials or semi-finished product protection. All these implications arise due to power fluctuation and outages and in some cases the use of diesel engines as an alternative source of power supply.

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