International Journal of Innovative Research and Advanced Studies (IJIRAS)
Volume 3 Issue 13, December 2016

ISSN: 2394-4404

The Effect Of Maintenance Management Policy On Productivity

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Abstract: ***The study investigates the effect maintenance management policy has on the productivity of manufacturing companies in Nigeria. The focus was on foreign manufacturing companies in Nigeria. The study was prompted by the continued perception of maintenance as a cost center and not a profit center by company executives and stakeholders in indigenous manufacturing companies in Nigeria. Thus, the productivity relationship with maintenance is blurred to the stakeholder and this has caused many indigenous companies to function below designed capacities. The specific objectives of the study were to: examine maintenance policy adopted by foreign manufacturing companies in Nigeria; investigate the influence maintenance management policy has on productivity of foreign manufacturing companies in Nigeria; and establish the relationship between maintenance policy and productivity of foreign manufacturing companies. Two sets of data, Likert scale response and productivity data obtained from the study were analyzed by descriptive statistics. The Likert scale data was obtained from structured questionnaire response using a sample size of 130 respondents drawn from 13 stratified randomly selected manufacturing companies in the Food & Beverages and Drug & Chemical manufacturing industries. The productivity data was obtained from real-time productivity chart in the Finance/Account department of Food & Beverages and Drug & Chemical manufacturing companies. The statistical analysis from the parameters established shows that maintenance policy has a positive influence on productivity. The linear regression coefficient of determination between maintenance policy and productivity had*** R^2 ***value 0.91 which established that 91% of the variability in productivity can be explained by the maintenance policy being practiced. The results of the test of hypotheses between maintenance policy and productivity revealed that the different p-values (0.00 & 0.003) were all less than 0.05*** $(P < 0.05)$***.The findings show that maintenance management policy has a positive influence and significant relationship with the productivity of manufacturing companies in Nigeria.***

I. INTRODUCTION

MAINTENANCE IN NIGERIA

Maintenance is seen as an unwanted cost that generate activity rather than one resulting in greater profitability, improved reliability and higher productivity. In Nigeria, maintenance is still neglected often and thus results into high operational costs (Obamwonyi, 2014). Eti (2004) investigation showed that, maintenance cost in Nigeria add up to approximately 22 - 37 percent of the total production cost. According to Eti (2004), the misguided opinion about maintenance in Nigeria is that management of indigenous companies regards maintenance as a cost that can be reduced in relation to overall business cost. It is however assumed that machine shouldn't be checked or inspected for future breakdown while it is still working, instead remain inactive until emergency occurs. Thus, company executives and stakeholders in indigenous manufacturing companies in Nigeria are often face with the inability to identify and quantify the effect of maintenance on company productivity because of the perception that maintenance is an unnecessary activity that only cost money with little or no return on the company's investment (Obamwonyi, 2014). Thus, the productivity relationship with maintenance is blurred to the executive/stakeholders of most indigenous manufacturing companies in Nigeria. This has caused many indigenous companies to function below designed capacities leading to a deficit in return on investment and an eventually untimely death. But the reverse is the case with foreign manufacturing companies in Nigeria with a clear evidence of high return on investment and high stability growth in the sector (Nigeria

manufacturing summary report 2010- 2013). Studies have been carried out on various aspects of plant maintenance in isolation in Nigeria manufacturing industries, However, there is no evidence that a research has been done on the effect of maintenance management policy on productivity of Foreign manufacturing companies in Nigeria; it is evident that the previous studies carried out on Nigeria manufacturing firms concentrated on impacts of reactive maintenance strategies on industrial facility performance. No research has been carried out on the effect of maintenance policy by assessing all four types of maintenance strategies, namely: preventive, predictive, breakdown and proactive maintenance strategies on productivity of foreign manufacturing companies in Nigeria. This study will attempt to fill this gap.

The aim of this study is to determine the effect of maintenance management policy on productivity in the manufacturing sector of Nigeria.

The Specific objectives of this study are:

- ✓ To examine maintenance policy adopted by foreign manufacturing companies in Nigeria.
- ✓ To investigate the influence maintenance management policy has on productivity of foreign manufacturing companies in Nigeria.
- ✓ To establish the relationship between maintenance policy and productivity of foreign manufacturing companies.

There are different types of maintenance approach depending on the condition and application. Alsyouf (2014) describes maintenance concept as the general structure that governs the types of maintenance actions (corrective, preventive, condition based etc) to be performed. For example, maintenance operations are basically divided in two categories of maintenance; Corrective maintenance and Preventive maintenance (which include condition-based and scheduled maintenance).

This study will assess maintenance management policies in foreign manufacturing companies in Nigeria as a tool which either enhances competence and productivity or reduces value among manufacturing companies. The findings from the study will enable indigenous manufacturing companies executives and maintenance managers to have a better understanding of the type of maintenance management policy being implemented in the industry, the effect maintenance management policy have on productivity and to know the relationship that exists between maintenance management policy and productivity in the industry so as to be able to formulate maintenance management policies to model their operations from strategy to operational excellence. This study appraised maintenance management policies in foreign manufacturing companies in Nigeria with a view to determining their impact on the productivity of manufacturing industries. The research work is limited to foreign manufacturing companies in Lagos State since it has the highest concentration of manufacturing companies in Nigeria. Thirteen (13) foreign manufacturing companies in the Food, Beverages, Tobacco, Chemicals and Pharmaceuticals sectors were sampled for this research.

II. MATERIALS AND METHOD

The population of interest in this research are foreign manufacturing companies in the Food/Beverages/Tobacco and Chemical/Pharmaceuticals sectoral groups of Nigeria manufacturing industries. In Lagos State, a total of three hundred and twenty two (322) companies were identified from the directory of manufacturing companies prepared by Lagos State Ministry of Commerce, Industry and Tourism. Only Food, Beverages/ Tobacco and Chemical/Pharmaceuticals foreign manufacturing companies were purposively selected. There are fifteen (15) foreign (9 & 6 Food, Beverage/Tobacco and Chemical/Pharmaceuticals companies respectively) of such companies on the register. The statistically required sample size was calculated from the formula given in equation 1 as follows:

$$n = n_1/[1 + \frac{n_1}{N}] \quad 3.1$$

$$n_1 = S_1/V^2 \quad 3.2$$

$$S_1 = Pq \quad 3.3$$

$q = (1 - p)$ with a total error = 0.1 at a confidence level of 95%. 3.4

Where:

n =the sample size.

N = the total estimated population.

V = the standard error of the sampling distribution = 0.05

S_1 = the maximum standard deviation in population.

P = the proportion of population element that belong to a defined class.

(Assumed to be 0.5).

q = the population proportion without the required class with a total error = 0.1 at a confidence level of 95%. (Sediary, 1994).

From Equations 3.3 and 3.4, S_1 = 0.25, then the sample size for the companies will be (Equation 3.1): n = $(0.25/0.05^2)/ (1+ (0.25/0.05^2)/15 = 13$. Using the sample size equation, 8 & 5 Food, Beverage/Tobacco and Chemical/Pharmaceuticals companies respectively firms were calculated as the sample size which were selected using stratified random sampling.

HYPOTHESES

HYPOTHESIS 1

H_0: Maintenance management policy has no influence on manufacturing company productivity.

H_1: Maintenance management policy has influence on manufacturing company productivity.

HYPOTHESIS 2

H_0: There is no significant relationship between maintenance management policy and productivity in manufacturing company.

H_1: There is significant relationship between maintenance management policy and productivity in manufacturing company.

A total number of thirteen (13) companies were used for this sample, for uniformity and convenience 10 questionnaires

were administered to the managerial, production and maintenance staff in each of the thirteen (13) foreign industrial firms selected giving a total of one hundred and thirty (130) questionnaires. Data (Likert scale data and productivity data) collected for this study were primary data quantitative in nature. The primary data collected was through questionnaires administered to the managerial, production and maintenance staff department and the productive data was obtained from real-time productivity chart in the Finance/Account department of Food, Beverages, Tobacco and Drugs and Chemicals manufacturing companies. Due to the various combination of questions' type in the research instrument, Microsoft excel software (Frequency table/Likert weighted average) and SPSS software were used to evaluate the data. Chi-square and linear regression were used to confirm the hypotheses. Out of 130 questionnaires that were administered a response rate of 92.3% and decline rate of 7.7% was achieved (that is 120 responses with 10 declines).

III. RESULTS AND DISCUSSION

From Table 1, 78.34% of the respondent have above 5years engagement with their companies which shows that the respondent sampled have the relevant experience in their respective companies to respond to the questionnaire.

	Frequency	Percentage (%)
Less than 2 years	10	8.33
2 to 4 years	16	13.33
5 to 7 years	20	16.67
8 to 10 years	33	27.50
Above 10 years	41	34.17

Table 1: Respondents Years of engagement in the company

RESULTS OF ASSESSMENT OF MAINTENANCE POLICY

The first objective of the study was to examine the maintenance policy adopted by the manufacturing industries as summarized in Table 2. From the result, it was observed that the frequently carried out maintenance task was monitoring equipment with a weighted Likert score of 4.28, while the less frequently carried out maintenance task was the deferring of planned maintenance activities to attend to emergency cases with a weighted Likert score of 2.12. Monitoring production equipment status and equipment failure trends represent the predictive maintenance. Preventive maintenance strategy is represented by managing scheduled maintenance activities, maintaining equipment in operation and carrying out equipment overhauls at intervals. Involvement in selection of original equipment manufacturers (OEM), designing better production processes and improving the production processes are all consistent with an approach to a proactive maintenance strategy.

Maintenance Tasks	Σ fi	Σ wifi	Σwifi / Σ fi
Monitoring equipment	120	513	4.28
Restoring equipment to operations	120	310	2.58
Involvement in the selection of OEM for your equipment	120	356	2.97
Enlarging the scope of predictive maintenance techniques	120	423	3.53
Managing scheduled maintenance activities	120	487	4.06
Designing better production processes	120	311	2.59
Maintaining equipment in operation	120	450	3.75
Replacing the broken down equipment	120	295	2.46
Improving the production processes	120	312	2.60
Deferring planned maintenance activities to attend to emergency cases.	120	254	2.12
Monitoring of equipment failure trend with a few to taking corrective action before failure occurs	120	486	4.05
Carrying out equipment overhauls at intervals.	120	427	3.56

Table 2: Frequency/Weighted average of Maintenance Tasks carried out

Restoring equipment to operations, replacing the broken down equipment and deferring planned maintenance activities to attend to emergency cases represent the traditional, reactive/breakdown maintenance strategy. The maintenance tasks in Table 2 representing each of the four maintenance strategies are summarized in Table 3.

Maintenance Policy	Maintenance Tasks	Weighted likert scores	Aggregated means
Predictive	Monitoring production equipment status	4.28	3.95
	Monitoring of equipment failure trend with a view to taking corrective action before failure occurs	4.05	
	Enlarging the scope of predictive techniques	3.53	

Preventive	Managing scheduled maintenance activities	4.06	3.79
	Maintaining equipment in operation	3.75	
	Carrying out equipment overhauls at intervals.	3.56	
Proactive	Involvement in the selection of OEM for your equipment	2.97	2.72
	Designing better production processes	2.59	
	Improving the production processes	2.60	
Breakdown	Restoring equipment to operations	2.58	2.38
	Replacing the broken down equipment	2.46	
	Deferring planned maintenance activities to attend to emergency cases.	2.12	

Table 3: Frequency of Carrying out Maintenance Tasks in Reference to Maintenance Policy

From Table 3 it can be established that the most practiced maintenance policy by foreign manufacturing companies in Nigeria is Predictive maintenance having an aggregated mean of 3.95 and the least practiced is breakdown maintenance with aggregated mean of 2.38. See Figure 1 below for mean value for the various maintenance strategy.

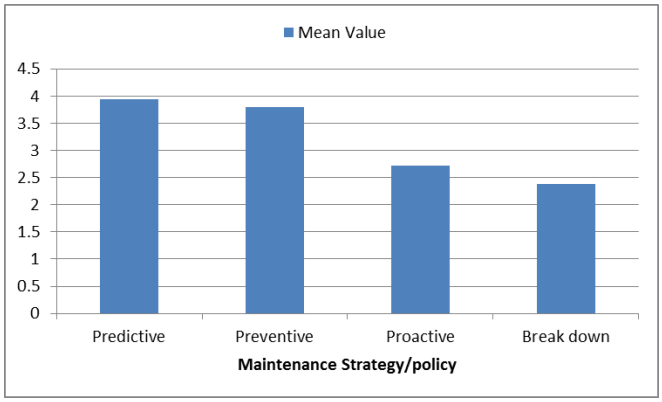

Figure 1: Mean statistics for Maintenance Strategy/Policy

RESULTS OF ASSESSMENT OF MAINTENANCE POLICY ON PRODUCTIVITY

The second objective of the study was to examine the influence maintenance policy adopted by the manufacturing industries have on productivity. In this section, Frequency tables were used to construct a table of response (in percentages) and statistical test was also performed to confirm the hypothesis for this study. Using frequency distributions, Table 4 was constructed. Cumulative frequencies for Strongly Agree and Agree options are shown in the third column. The Neither Agree nor Disagree option has been taken as is from the frequency tables and this is indicated in the fourth column. The cumulative percentages for Disagree and Strongly Disagree options are shown in the fifth column.

Question Number	Aspect	Strongly Agree (SA) /Agree (A) (%)	Neither Agree (NA) / Disagree (%)	Disagree / Strongly Disagree (SD) (%)	Total Percentage (%)
Q 19	Customer Satisfaction	93.33	0.00	6.67	100
Q20	Production	99.17	0.00	0.83	100
Q21	Equipment downtime	100.00	0.00	0.00	100
Q22	Competitors	94.17	5.00	0.83	100
Q23	Product quality	100.00	0.00	0.00	100
Q24	Profitability	98.33	1.67	0.00	100
Q25	Availability	100.00	0.00	0.00	100
Q26	Safety	95.83	1.67	2.50	100
Q27	Reliability	100.00	0.00	0.00	100
Q28	Process downtime	97.50	1.67	0.83	100
Q29	Cost	86.67	4.17	9.17	100
Q30	Motivation	86.67	6.67	6.67	100

Table 4: Maintenance Policy influence on Productivity

By comparing column three, four and five in Table 4, the majority of the respondents agree that maintenance management policy adopted has a positive influence on all the relevant aspects of productivity as seen in the table above. For instance 86.67% of the respondents agreed that Maintenance management policy adopted reduces production costs. However 9.17% of the respondents feel that the maintenance management policy adopted does not reduce production cost. In the same vein, only 4.17% of the sampled population indicated their neutral stance with regards to maintenance management policy adopted reducing production costs. 100% of the respondents submitted that the maintenance management policy adopted reduces equipment down time which is also confirmed by the fact that 100% of the respondents agreed that the maintenance management policy adopted improve equipment availability. 99.17% of the respondents indicated that maintenance management policy increase production. In other words, a total average of 95.96% of all the respondents indicated that maintenance management policy has a positive influence on productivity and it can be said that these results fully agree with the results illustrated in Table 6.

RESULTS OF ESTABLISHMENT OF RELATIONSHIP BETWEEN MAINTENANCE POLICY AND PRODUCTIVITY

The third objective of the study was to establish the relationship between maintenance policy *and* productivity of foreign manufacturing companies in Nigeria. The real time Maintenance / Production data collected from the

Finance/Account department of Food & Beverages and Drug & chemical manufacturing companies were analyzed by linear regression and curve fitting to ascertain the relationship between maintenance policy and productivity. From the regression analysis results in Table 5, which shows the linear relationship between the dependent (Productivity) and independent (Maintenance) variables with a correlation coefficient (r) of 0.892, 0.969, 0.971, 0.927, 0.934, 0.987, 0.962, 0.942, 0.969, 0.952, 0.978, 0.974, 0.952 respectively which also is an indication that the strength of relationship between the variables are high. In other words about 79.6%, 93.9%, 94.3%, 86%, 87.3%, 97.4%, 92.5%, 88.8%, 93.9%, 90.7%, 95.7%, 94.8% & 90.7% respectively of the variability in productivity of the sampled manufacturing companies can be explained by maintenance costs.

Food and beverages Manufacturing Companies							
Company		*Coeff.*	*Stand Error*	*R*	*R Square*	*T Statistics*	*Sig. (P-value)*
A	Intercept	9.873	5.239				
	X Variable	3.682	0.929	**0.892**	**0.796**	**3.961**	**0.016**
B	Intercept	55.426	8.084				
	X Variable	1.099	0.139	**0.969**	**0.939**	**7.882**	**0.001**
C	Intercept	25.428	9.047				
	X Variable	1.554	0.189	**0.971**	**0.943**	**8.186**	**0.001**
D	Intercept	21.438	15.487				
	X Variable	1.027	0.207	**0.927**	**0.860**	**4.959**	**0.007**
E	Intercept	15.443	10.245				
	X Variable	7.963	1.512	**0.934**	**0.873**	**5.263**	**0.006**
F	Intercept	14.270	8.009				
	X Variable	11.639	0.940	**0.987**	**0.974**	**12.372**	**0.000**
G	Intercept	2.285	1.120				
	X Variable	0.205	0.029	**0.962**	**0.925**	**7.060**	**0.002**
H	Intercept	-13.686	105.143				
	X Variable	59.893	10.603	**0.942**	**0.888**	**5.648**	**0.004**
Drug and Chemical Manufacturing Companies							
A2	Intercept	-6.952	6.365				
	X Variable	7.847	0.993	**0.969**	**0.939**	**7.898**	**0.001**
B2	Intercept	43.151	78.076				
	X Variable	7.025	1.118	**0.952**	**0.907**	**6.279**	**0.003**
C2	Intercept	2.955	1.548				
	X Variable	0.1858	0.019	**0.978**	**0.957**	**9.438**	**0.000**
D2	Intercept	16.842	2.905				
	X Variable	0.584	0.067	**0.974**	**0.948**	**8.608**	**0.001**
E2	Intercept	6.6079	11.792				
	X Variable	4.360	0.696	**0.952**	**0.907**	**6.258**	**0.003**
AVERAGE					**0.912**		**0.003**

Table 5: Linear Regression Coefficients Summary Table for hypothesis two

TEST OF HYPOTHESES

To verify the validity of the data obtained from the field study from Tables 3 & 4 the use of Chi-Square and linear regression technique were then applied to test the hypothesis one and two respectively.

TEST OF HYPOTHESIS ONE

Chi-Square Analysis from SPSS software was used to test hypothesis one which states that:

Null: *Maintenance management policy has no influence on manufacturing company productivity.*

Alternative*: Maintenance management policy has influence on manufacturing company productivity*.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square (X^2)	163.541a	44	.000
Likelihood Ratio	141.383	44	.000
Linear-by-Linear Association	13.716	1	.000
N of Valid Cases	1440		

Table 6: Chi-Square Test Results

The theoretical value of X^2 obtained at the degree of freedom 44, and at the level of confidence of 95% was 60.481. Since the calculated value of X^2 =163.541 from Table 6 which is more than the theoretical value (60.481), it therefore, follows that the null hypothesis as stated above is not valid thus is rejected and the alternative hypothesis which state that: *Maintenance management policy has influence on manufacturing company productivity is accepted.*

TEST OF HYPOTHESIS TWO

Linear regression technique was used to test the hypothesis two which states that:

Null: *There is no relationship between maintenance management policy and productivity in manufacturing company*.

Alternative*: There is significant relationship between maintenance management policy and productivity in manufacturing company*.

From the Table 5, the strength of association between the variables in Food & beverages and Drug & chemical companies are very high (r = 0.892, 0.969, 0.971, 0.927, 0.934, 0.987, 0.962, 0.942, 0.969, 0.952, 0.978, 0.974, 0.952) respectively while the coefficient of determination (R^2= 0.796, 0.939, 0.943, 0.860, 0.873, 0.974, 0.925, 0.888, 0.939, 0.907, 0.957, 0.948, 0.907) respectively. The calculated t-value (3.961, 7.882, 8.186, 4.959, 5.263, 12.372, 7.060, 5.648, 7.898, 6.279, 9.438, 8.608 & 6.258) respectively are higher than the critical value (2.015) with degree of freedom of five thus, the null hypothesis is rejected and the alternative hypothesis is accepted. Rejection of the null hypothesis above further confirmed the logical empirical analysis results obtained from the survey as shown in Table 4 and also the results of the analysis on the real time maintenance / productivity data in Table 5.

IV. CONCLUSIONS

The study established that robust maintenance management policies/strategies play a key role in a company performance and productivity. Predictive Maintenance was identified as the most practiced form of maintenance management policy/strategy of manufacturing companies studied which can be said contributed to their long term profitability, sustainability and optimum performance.

Also the findings from the study has also established that maintenance management policy has a positive influence on the productivity of a company and in addition has positive and strong relationship with company productivity. Furthermore, the study has also been able to discover the productivity aspect of maintenance as it relate to a company performance in the area of equipment availability, equipment reliability, increase production etc. Finally, the study shows that maintenance management policy has a positive effect on foreign manufacturing company productivity. Thus, it can be submitted that maintenance is a profit center and not a cost center.

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