

PLANT MAINTENANCE AND ORGANIZATIONAL PRODUCTIVITY OF FIRST ALUMINIUM PLC, PORT HARCOURT**David Onwuchekwa, Ph.D****Department of Management, Faculty of Management Sciences
Ignatius Ajuru University of Education, Port Harcourt, Rivers State, Nigeria****ABSTRACT**

This study examined the impact of Plant maintenance on Organizational Productivity of First Aluminium Plc, Port Harcourt. The research design used was the survey research, with questionnaire as the major instrument for data collection. The research population was 301, from which a sample size of 172 respondents was drawn. The method of data analysis employed was the histogram used to present the responses to the research questions and chi-square (i), to test the hypothesis which is a significant test technique that uses data from observed frequencies. It was concluded that Plant maintenance has great impact on the smooth operations of manufacturing firms and productivity in general. Based on the conclusion of the study, it was recommended among others that plant maintenance should be a routine exercise to enhance the safety of both man and machine, which will result in increased productivity and that plant maintenance should be part of the organizational policy.

INTRODUCTION

Over recent years, the role of maintenance and therefore maintenance management has grown rapidly. Managers of organizations are particularly interested in the smooth functioning of their assets especially, in manufacturing firms, where machines and equipments are used in the workstations in the conversion of inputs to product outputs. The regular use of these machines and equipments results in wear and tear, diminishing the value of the asset. Thus, regular maintenance of the assets will improve their functionality and enhance the efficiency of the production process. These efforts commonly include an examination of the maintenance function (Gustav and Hanna, 2012). Furthermore, the installation and layout of machines and equipments in a plant or factory and even the human resources are to be kept productive and reliable by having a maintenance performed by way of repair, rest, lubrication, and inspection. There are wears and tears of the components of the machine, by course of regular usage and even in a state of inertia as idle parts can rust, fixate and worn out.

High level of competition and extinction are regular features of the dynamic business environment as organizations try to maintain dominance in the industry as result of enhanced corporate performance. Every organization want a competitive edge over others in different areas such areas as; Human Resources, Production, Marketing, Equipment Maintenance, Research and Development Departments of the organizations. Production equipment is one of the most important critical success factors (CSF) in the manufacturing firms. Achieving the profitability, cost competitiveness, and growth in the long-term would be generated through productivity improvement (Neely, Adams, & Kennedy, 2002). Maintenance management has to become more productive, efficient and innovative in order to cope with the changing business environment (Nzewi et al., 2016). One approach to increase the performance of maintenance activities is to implement a total productivity maintenance system (Hermann, 2000). The productivity of organizations which is a yardstick used in measuring organizational performance depends on the effectiveness and efficiency of the equipment critical to meeting orders placed by customers, sales volume and revenue generation. The output of productive equipment depends to a large extent on the care and maintenance of the equipment. This was corroborated by Ahmed, Hassan, and Taha (2005) when they said "equipment maintenance is an indispensable function in a manufacturing enterprise". The recent competitive trends and ever

increasing business pressures have been putting maintenance function under the spotlight as never before (Garg & Deshmukh, 2006).

Gone are those days when new buildings were roofed with corrugated metal sheets, across Port Harcourt and elsewhere, homeowners and estate developers now prefer aluminium roofing sheets which are not only durable, but also aesthetically valuable. One company is credited for pioneering the aluminium roofing sheet movement in the country, and it is aptly named First Aluminium Nigeria Plc.

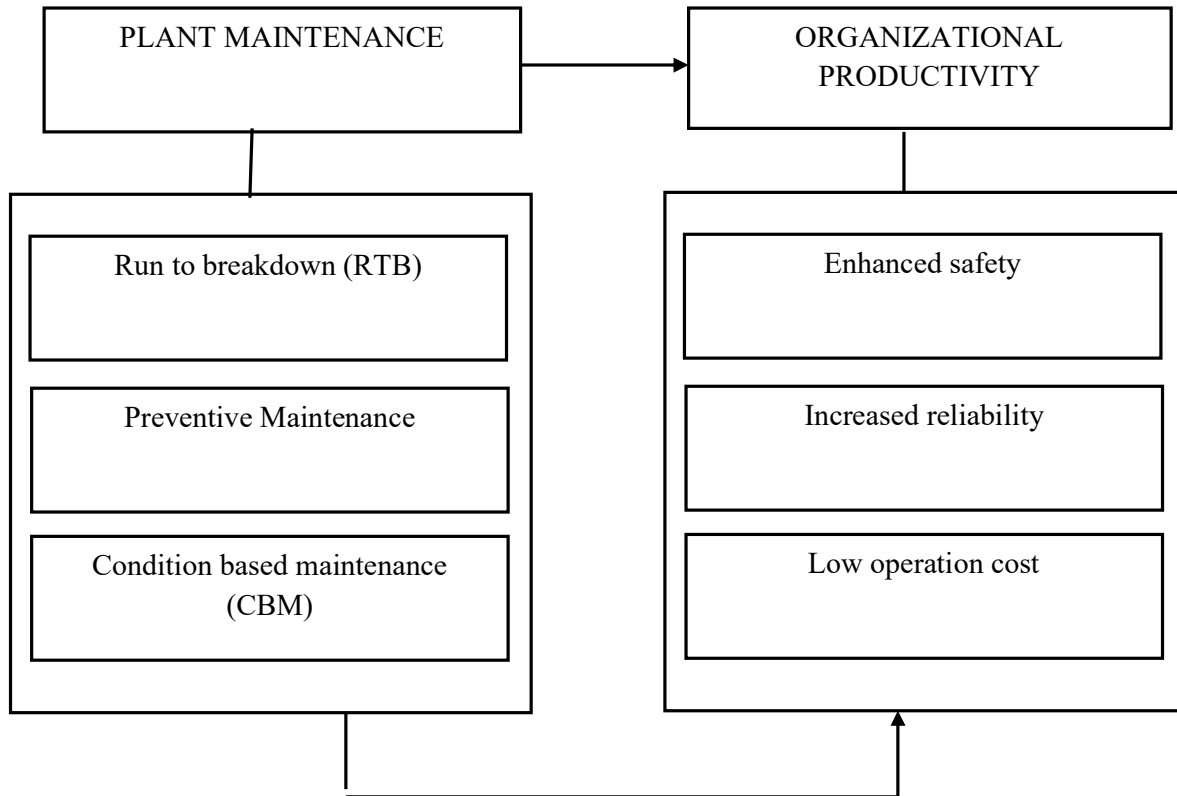
First Aluminium was incorporated on August 20th, 1960, and listed on the Nigerian Stock Exchange in May, 1992. The company specializes in the manufacturing and marketing of various kinds of aluminium products such as roofing sheets, coils, and laminates. It also produces packaging materials for the healthcare, cosmetics and engineering industries.

The company's entry into the Nigerian market began with the construction of its rolling mills located at Plot 19/21 Trans-Amadi Industrial Layout in Port Harcourt, Rivers State. Being one of the foremost companies to delve into the production of aluminium in Nigeria, First Aluminium Nigeria Plc has been able to master the industry over the years, even as it continues to diversify its business in a bid to maintain market dominance.

Statement of the Problem

The effectiveness of machines is a function of maintenance culture adopted by the organization. In the focused organizations, it is believed that the duty of maintaining productive equipment and machinery is that of engineers, technicians and the engineering department as a whole. Oil check, cleaning and greasing machines, changing of worn-out parts, replacement of machineries, checking the operating parameters and general inspection seem to be left to the engineering department to carry out during specific periods. This implies that the organizations maintenance culture is scheduled maintenance and breakdown maintenance. Workers that use productive machines on daily basis needs to be trained and empowered with the basic knowledge to undertake some maintenance routine like; cleaning of equipment, fault detection and changing of oil. In Total Productive Maintenance is a basis requirement for operators is to have ability to detect abnormalities in the working of the equipment with respect to operation and quality of output, based on a sense that there is something wrong (Sharma Kumar and Kumar, 2012; Shiroze, 1996). The maintenance culture in the organizations is possibly the reason why the organizations encounter frequent machine breakdown which makes the organizations unable to meet with the order placed by customers and reduction in the revenue of the firms. There is a plethora of reasons of research work with respect to plant maintenance and organizational performance. However, there is dearth of literature with respect to plant maintenance and organizational productivity, especially in First Aluminium Plc. Hence, this work was aimed at filling that lacuna.

Conceptual Framework



Conceptualized by the researcher, 2022

Objective of the study

The general purpose of this study is to examine the contributory effect of plant maintenance on organizational performance of First Aluminium Plc, Port Harcourt. Specifically, the study seeks to:

1. Examine the effect of Run to breakdown (RTB) on enhanced safety of First Aluminium Plc, Port Harcourt.
2. Ascertain the impact of preventive maintenance on increased reliability of First Aluminium Plc Port Harcourt.
3. To examine the impact of condition based maintenance (CBM) strategy on low operation cost of First Aluminium Plc, Port Harcourt.

Research Questions

In line with the specific objectives, the following research questions were posed.

1. To what extent does run to breakdown (RTB) as a plant maintenance strategy affects enhanced safety of First Aluminium Plc Port Harcourt?
2. To what extent does preventive maintenance as a plant maintenance strategy impacts on increased reliability of First Alumunium Plc Port Harcourt?
3. To what extent does condition based maintenance (CBM) strategy as a plant maintenance impacts on low operation cost of First Aluminium Plc Port Harcourt?

Research Hypotheses

The following null hypotheses were tested at 0.05 level of significance.

Ho₁: There is no significant effect of between run to breakdown (RTB) as a plant maintenance strategy on enhanced safety of First Aluminium Plc, Port Harcourt.

Ho₂: There is no significant impact of preventive maintenance as a plant maintenance strategy on increased reliability of First Aluminium Plc, Port Harcourt.

Ho₃: There is no significant impact of condition based maintenance (CBM) strategy as a plant maintenance strategy on low operation cost of First Aluminium Plc, Port Harcourt.

Review of related literature

Conceptual Review

Maintenance

Maintenance means to hold, keep, sustain or preserve facilities to an acceptable standard (Abdul-Moshen, 2008). Also, maintenance is a combination of technical and administrative activities to keep a machine or equipment in its functional state. Machines or equipment with poor maintenance will result in dysfunction that might likely result to production of defective products which affect the quality of the product in a production process. It involves reliability of the machines and equipments to perform to a standard level of quality assurance (Shohet, 2009). Again, poor maintenance of production facilities can result in poor end-product quality and customer dissatisfaction, lost production runs, cost inefficiencies, and sometimes, unavailability of the facility for future use (Lavy, Garcia and Dixit, 2010). Unfortunately, most organization's facilities in Nigeria, lack good maintenance due to relatively high cost of maintenance, and this results in frequent breakdown and stoppages (Usman et al., 2012).

Objectives of Maintenance

According to Banjoko (2009), the objectives of maintenance are:

1. To maximize the amount of time the machine, tools, equipment, building etc will be available for use and for the purpose for which they are required.
2. To enhance toe operational reliability of the machine, tools and equipment.
3. To minimize overall operational cost of production through reduction of scraps and wastages that may be due to the malfunctioning of the machines.
4. To preserve the value of the assets by reducing the rate by which they deteriorate. These objectives reveal the "infant mortality" and "wear and tear" period of an equipment or machine.

Benefits of Maintenance

Slack et al. (1995) had identified the following benefits of maintenance.

1. Enhanced safety.
2. Increased reliability, that is, less disruption of normal activities of operations, results in increased production outputs.
3. Higher product quality.
4. Lower operating cost.
5. Longer life span through regular care, cleaning and lubrication of facilities.
6. Well maintained facilities will earn higher scrap values.

Maintenance Strategies

Maintenance strategies Slack et al (1995) classified the maintenance activities into three approaches. These are:

1. Run to Breakdown (RTB) which is typical to breakdown maintenance where maintenance work is performed only after a breakdown has occurred. Examples are televisions, telephones in a hotel's guest room.
2. Preventive maintenance which is a procedure of eliminating or reducing the likelihood of failure of an asset or machine through inspection (checking potential areas of failure); and servicing (cleaning, lubricating, replacing) the facilities at preplanned intervals. Example, the

engine of an aircraft are checked, cleaned and calibrated by regular, routine check after a number of flight hours.

3. Condition Based Maintenance (CBM). This is in the class of preventive maintenance, allowing maintenance of the facility only when the opportunity is created to do so. The prompting factors that call for maintenance action are the measured values (condition data indicating a developing failure) which indicate that the asset or machine will require maintenance action (Holmberg et al., 2010). This leads to higher probability of preventing failures. As long as the failure is a gradual process with a detectable deterioration, the condition can be monitored; CBM can be a useful tool in ensuring smooth operations (Gopalakrishnan and Banerji, 2004).

Preventive Maintenance

Preventive maintenance involves identifying potential areas of failure as to avoid breakdown which might be costlier. This is followed through by inspection, service and replacement of parts before they fail. Banjoko (2009) stated that preventive maintenance "involves the regular or periodic check and servicing of the machines, tools and other facilities used in the production process so as to delay or prevent the breakdown or the total failure of the facilities."

Total Productive Maintenance

Total productive maintenance (TPM) is the maintenance that is carried out by all employees through small group activities (Slack et al., 1995). The concept of total production maintenance started in Japan.

Reactive Maintenance:

It is a concept in which a highly skilled maintenance team is kept ready to step in whenever maintenance problem faced in production and the repairs are made by working overnights and on weekends (Dowlatshahi, 2008). However, the required spare and replacement parts held in heavy stock in anticipation of breakdowns. It is also undesirable strategy, now-a-days and almost no industry can adopt its principles

Organizational Productivity

Organizational Productivity: Is the capacity of an organization, institution or business to produce desired results with minimum expenditure of energy, time, money, personnel, materials etc. Organizational productivity gives rise to innovativeness, competitiveness, creativeness, effectiveness, productiveness, efficiency, enhanced safety. Increased reliability, low operation cost and profitability (www.nigentaconnect.com)

Theoretical Framework

The study was anchored on the Theory of Structural Empowerment credited to the work of Kanter (1977). According to this theory, the behavior of employees and their performance in the organization depend on how empowered they are. Empowerment in this theory means the level of opportunity given to the employees for growth and mobility, the amount of power possessed by employees to access resources and information to carry out their duties. This theory states that when employees are provided with access to information, resources, support and the opportunity to learn and develop, then it can be said that such an organization promotes empowerment (Larkin, Ciepiak, Stack, Morrison & Griffith, 2008). The rationale for anchoring this study on the theory of Structural Empowerment is because part of the problem that contributed to frequent machine breakdown is probably lack of empowerment. The operatives seemed not empowered to carry out simple maintenance activities and to exercise maintenance autonomy.

Empirical Review

Seng and Jantan (2012) assessed the implementation of TPM in selected Manufacturing companies in Malaysia. A structured survey approach was used in the study and data were collected using questionnaire. Three hypotheses were formulated and tested with the use of multiple regression analysis. Their findings showed that there is a positive relationship between human-oriented strategy and the extent of TPM implementation.

Badli (2012) studied Automotive Small and Medium Enterprises in Malaysia to explore the TPM implementation level and Critical Success Factor (CSF). The surveys covered 550 companies with 94 responses considered valid. Questionnaire was used in data collection and analysis was done using a combination of ANOVA test statistics and paired comparison test. He found out that TPM was a part of overall maintenance management evolution and important for keeping the assets in good condition and enhancement of the manufacturing performance.

Awolabi (2012) carried out a study in Ibadan, Nigeria to determine the type of relationship between equipment maintenance and performance of breweries. Information was sort through the use of questionnaire and data analyzed with the Pearson's Product Moment Correlation Coefficient. Hypotheses were tested with Z-test statistics. The study concluded that maintenance is a veritable tool for enhanced performance and advocated more frequent equipment maintenance.

METHODOLOGY

The design for the study was the descriptive survey method. The population of the study consisted of three hundred and one (301) employees of First Aluminium Plc, Port Harcourt with a sample size of 172 derived by the Taro Yamene formula. The primary source of data collection was the questionnaire which was structured in a modified four point likert scale format. The reliability coefficient using of 0.82 was obtained using the Pearson Product Moment Correlation (PPMC) and the hypotheses were tested using the Chi Square statistics.

Questionnaire Distribution and Retrieval

S/n	Respondent Institution	No. of questionnaire administered	No. of questionnaire retrieved	% questionnaire retrieved
1	First Aluminium Plc, Port Harcourt	172	160	93%
	Total	172	160	93%

Research Question 1:

To what extent does Run to Breakdown as a plant maintenance strategy affects enhanced safety of First Aluminium Plc, Port Harcourt?

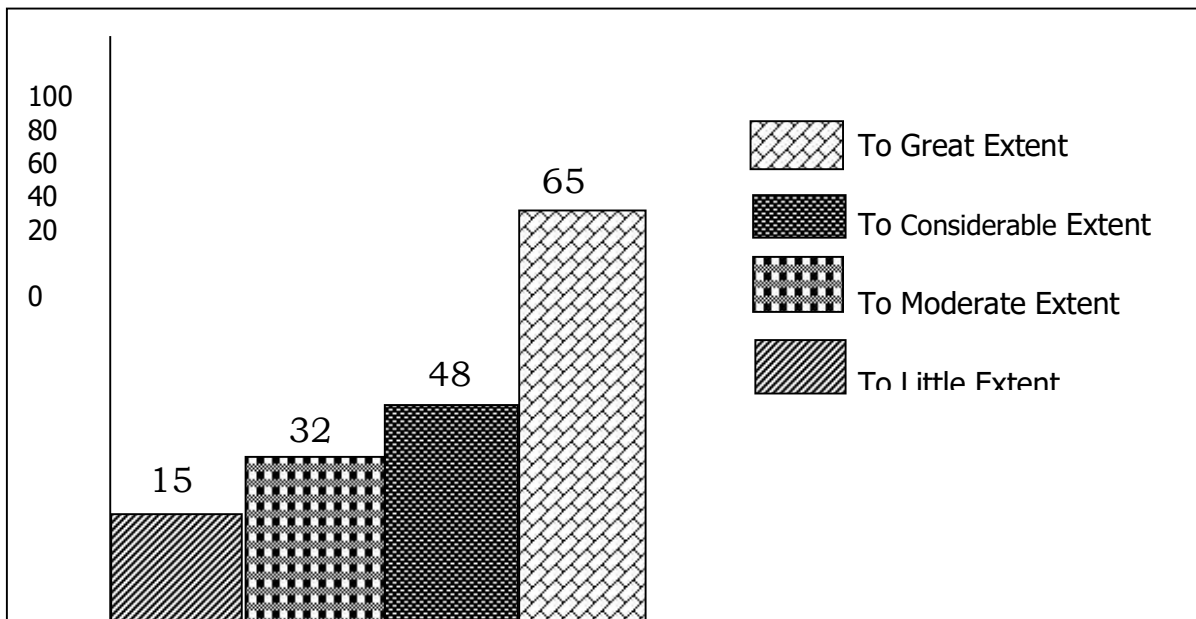


Figure 4.1: Run to Breakdown and enhanced safety of First Aluminium Plc, Port Harcourt.

Source: Survey Data, 2022

Figure 4.1 showed 65%) of respondents said that there is a great extent, (48%) of respondents said there is considerable extent of adoption, (32%) of respondents said there is moderate extent of adoption while (15%) respondents said there is a little extent to which Run to Breakdown affect enhanced safety of First Aluminium Plc in Port Harcourt.

Research Question 2:

To what extent does Preventive Maintenance impacts on Increased Reliability of First Aluminium Plc, Port Harcourt?

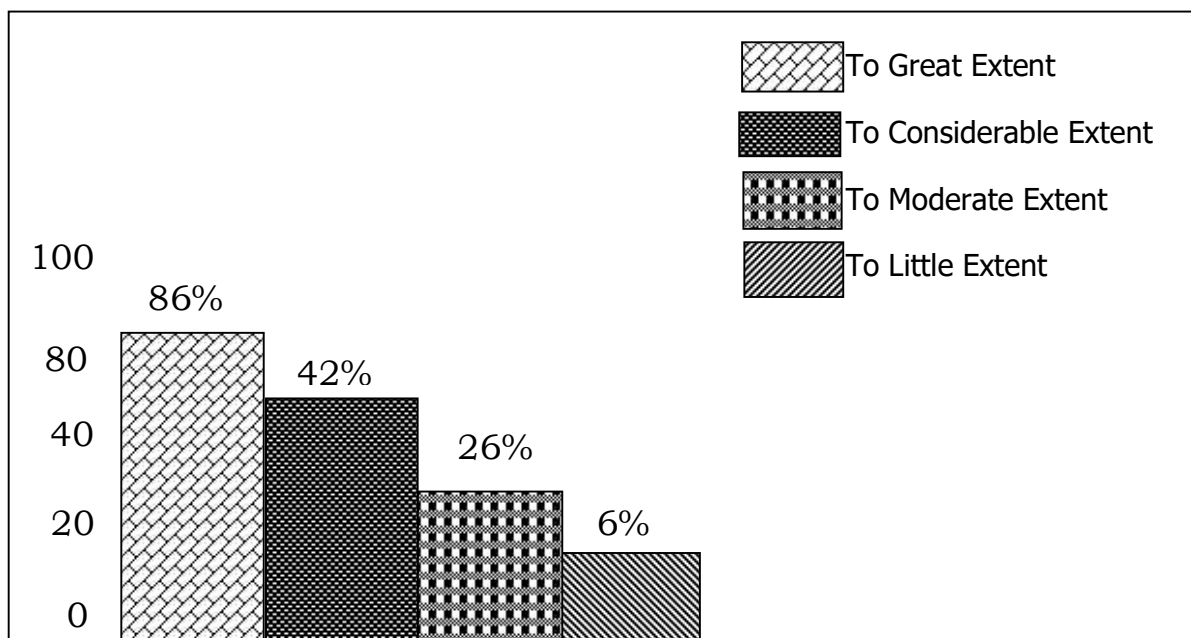


Figure 4.2: Preventive Maintenance and Increased Reliability of First Aluminium Plc,

Figure 4.2 above shows that 86% indicated that Preventive Maintenance impact on Increased Reliability of First Aluminium Plc in Port Harcourt. to a great extent, 42% of the respondents say it is to a considerable extent, 26% of the respondents say it is to a moderate extent; while 6% of respondents are of the opinion that it is to a little extent.

Research question 3

To what extent does Condition Based maintenance impacts on Low Operation Cost of First Aluminium Plc, Port Harcourt?

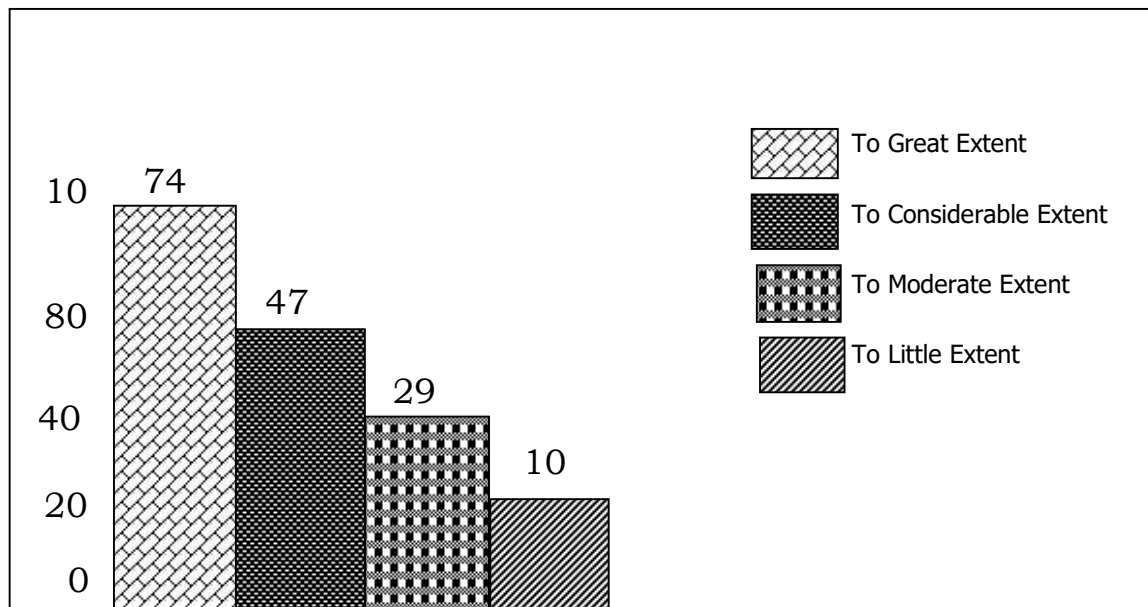


Figure 4.3 Condition Based Maintenance and Low Operation Cost of First Aluminium Plc, Port Harcourt.

Source: Survey Data, 2022

Figure 4.3 showed that 74 of the respondents are of the opinion that Condition Based Maintenance impact Low Operation Cost of First Aluminium Plc in Port Harcourt to a great extent, 47% of respondents say it is to a considerable extent, 29% say it is to moderate extent, while 10% of respondents are of the opinion that it is to a little extent.

Test of Hypotheses

Hypothesis One

Ho₁: There is no significant effect of Run to Breakdown on enhanced safety of First Aluminium Plc, Port Harcourt.

Calculation of chi-square for hypothesis one

Fo	Fe	Fo-fe	(fo-fe) ²	$\frac{(fo-fe)^2}{Fe}$
20	15.4	4.6	21.16	1.37
7	11.4	- 4.4	19.36	1.70
3	7.6	4.6	21.16	2.78
8	3.6	4.4	19.36	5.38
45	49.6	4.6	21.16	0.43
41	36.6	- 4.4	19.36	0.53
29	24.4	- 4.6	21.16	0.87
7	11.4	4.4	19.36	1.70
				14.79

Source: Survey Data, 2022

Since the calculated chi-square value which is $\chi^2 = 14.79$ is greater than ($>$) the critical value which is 7.82, the null hypothesis is rejected and the alternative hypothesis accepted.

Hypothesis Two

Ho₂: There is no significant impact of Preventive Maintenance on Increased Reliability of First Aluminium Plc, Port Harcourt.

Calculation of chi-square for hypothesis two

Fo	Fe	Fo-fe	(fo-fe) ²	<u>(fo-fe)²/fe</u>
10	20.425	- 10.425	108.681	5.321
19	9.975	9.025	81.451	8.166
8	6.175	1.825	3.331	0.539
1	1.425	- 0.425	0.181	0.128
76	65.575	10.425	88.831	1.334
23	32.025	9.025	81.451	2.543
18	19.825	- 1.825	3.331	0.168
5	4.575	0.425	0.181	0.04
			$\chi^2 =$	18.239

Source: Survey Data, 2022

Since the calculated chi-square value which is $\chi^2 = 18.24$ is greater than ($>$) the critical value which is 7.82, the null hypothesis is rejected and the alternative hypothesis accepted.

Hypothesis Three

Ho₃: There is no significant impact of condition based maintenance on Low Operation Cost of First Aluminium Plc, Port Harcourt.

Calculation of chi-square for hypothesis Two

Fo	Fe	Fo-fe	(fo-fe) ²	<u>(fo-fe)²/fe</u>
26	17.575	8.425	70.981	4.039
9	11.162	- 2.162	4.674	0.419
2	6.887	- 4.887	23.883	3.468
1	2.375	- 1.375	1.891	0.796
48	56.425	- 8.425	70.981	1.258
38	35.837	2.163	4.679	0.131
27	22.112	4.887	23.893	1.081
9	7.625	1.375	1.891	0.248
			$\chi^2 =$	11.446

Source: Survey Data, 2022

Since the calculated chi-square value which is $\chi^2 = 11.45$ is greater than ($>$) the critical value which is 7.82, the null hypothesis is rejected and the alternative hypothesis accepted.

Discussion of Findings

This research investigated Plant Maintenance and Organizational Productivity of First Aluminium, Port Harcourt, Rivers State. From the various analyses of this research, these were the findings; In line with the findings of hypothesis one, it has been observed that Run to Breakdown enhances safety and organizational productivity in general. The second hypothesis showed that Preventive Maintenance significantly impacts on Increased Reliability of First Aluminium Plc Port

Harcourt. Experts and leaders in direct contact with the responsibility of modelling a project, should be more committed in order to facilitate dissemination of results into the organization (Case B). It is in line with the requirements on good client participation and high client ownership, identified truly crucial by Akkermans and Bertrand (1997). The third hypothesis revealed that Condition Based Maintenance significantly impacts on low operation cost of First Aluminium Plc, Port Harcourt... As long as the failure is a gradual process with a detectable deterioration, the condition can be monitored; CBM can be a useful tool in ensuring smooth operations (Gopalakrishnan and Banerji, 2004). However, a mixed maintenance strategy is advised to be used. The run-to-breakdown strategic option will be preferable where repair of machines or equipments are simple and easier, and where preventive maintenance carried out in stopping or disrupting normal production runs is very costly. Also, in situations where failure of the machines do not have prevalent random occurrence of failure or breakdown, preventive maintenance of such machines or equipments can be carried under a predetermined timeframe.

CONCLUSIONS

Generally it was concluded that Plant maintenance is necessary for optimum operation of any manufacturing firm. Besides, Plant maintenance can be a strong contributor to the strength of the organization and has the ability to improve manufacturing performance. It was also concluded that with competition in manufacturing industries rising relentlessly, Plant Maintenance can be the maintenance philosophy that prevents the failure of an organization. Moreso, efficient and effective maintenance of equipment play a dominant role in modern manufacturing industry to determine the performance of the organizational production function as well as the level of success achieved in the organization.

RECOMMENDATIONS

The made the following recommendations.

- i. Plant maintenance should be a routine exercise to enhance safety of both man and machine, will results in higher productivity.
- ii. Plant maintenance should be part of the organizational policy, which rise to increased reliability, that is, less disruption of normal activities of operations, results in increased production outputs.
- iii. Plant maintenance should be encouraged to achieve higher product quality.
- iv. Plant should be carried out regularly reduce operating cost.
- v. Plant maintenance should also be carried out regularly for longer life span of machines through regular care, cleaning and lubrication of facilities.
- vi. Well maintained facilities will earn higher scrap values.

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