

# **RESEARCH ARTICLE**

### COMPARATIVE ANALYSIS OF THE MAINTENANCE PRACTICE ON PROCESS PLANTS IN CEMENT, PAPERAND BREWERY INDUSTRIES IN LAGOS AND OGUN STATES INDUSTRIAL AXES OF NIGERIA.

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#### Abstract

..... The aim of this study is to present a comparative analysis of the maintenance practice in process plants in cement, paper and brewery industries from the perception of practising estate surveyors and valuers in Lagos and Ogun States industrial axes of Nigeria because of their currency in economic activities and significant contributions towards the notable success of the manufacturing industry in this country. The objectives to achieve this shall be as underlisted to: identify the factors affecting the useful life of process plants in brewery, cement and paper industries; obtain and rank the views of practising estate surveyors and valuers on the factors affecting the useful life of process plants in these three industries in Lagos and Ogun States; obtain and rank the views of these practitioners on the periods for implementing maintenance schedules in these industries; obtain and rank the views of practising estate surveyors and valuers on the periods for retaining maintenance Engineers in the industries under analysis, establish which of the brewery, cement and paper industries mostly keep maintenance history of their plants and present a statement of the findings to practising estate surveyors and valuers in Lagos and Ogun States Nigeria. Questionnaire was the main instrument for soliciting data supported by scanty literature that were very difficult to find. A census of 337 practising estate surveying firms in the two states were administered with questionnaires and 172 returned representing 51% success rate which was considered fairly okay for this purpose. Statistical package for Social Sciences (SPSS) 20 was used to analyse these responses. It was found out that; frequency of usage of plant was ranked most significant (first) in cement and paper industries and was ranked second in brewery with Mean Item Score (MIS) of 4.38, 3.92 and 4.07 respectively. It was also found out that monthly maintenance schedule was mostly adopted in similar industries. The authors recommend among others that monthly maintenance of plants should be practised in these three industries since it was mostly suited for them from the perspective of practising estate surveyors and valuers.

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## Introduction:-

Whether engineering works, building structures, manufacturing plants or infrastructural facilities, organizations need not only build or provide but also need to maintain these facilities. The need to keep facilities running uninterrupted, sustain productivity, continue to provide service, repair and/or increase value as well as enhance life longevity of the plants remain some of the importance of maintenance.

According to Erkoyuncu, Fernan-del Arno, Mura, Raykuma and Gino (2017) industrial maintenance target is to maximize plant operational continuity and safety at least cost. Miet and Odoom (2016) have stated earlier that maintenance management is one of the strategies for improving the performance of production and manufacturing firms. Researchers Oladokun and Ojo (2012) and others have established the lack of maintenance culture in infrastructural facilities, stadia (or stadiums), national art theatre in the built environment in Nigeria. Similar lack also exist in our public plants for example in our petroleum refineries at Port-Harcourt, Kaduna and Warri, in our fertilizer plants etc. This is one of the motivations for investigating if similar situation present itself in process plants in Lagos and Ogun States industrial axes of Nigeria.

The purpose of this research is to analyse the maintenance practice in process plants in cement, paper and brewery industries in Lagos and Ogun States industrial axes of Nigeria from the perception of practising Estate Surveyors and Valuers, because of the importance of maintenance in the sustainability of plants especially in the third world countries where all the plants are imported from developed countries. The objectives set out to achieve this aim were to: identify the factors affecting the useful life of process plants; obtain and rank the views of practising Estate Surveyors and Valuers on the most significant factors influencing the useful life of process plants in these industries in Lagos and Ogun States, Nigeria, obtain and rank the views of practising Estate Surveyors and Valuers on the periods for implementing maintenance schedules in these industries under research; obtain and rank the views of practicing Estate Surveyors and Valuers on the periods of retainership of maintenance Engineers in the industries being compared; establish which of cement, paper and brewery industries mostly keep maintenance history of their plants and present a statement of importance of the findings to practising Estate Surveyors and Valuers and Engineers in Lagos and Ogun States of Nigeria.

The significance of this research is to stimulate further works in this area of industrial maintenance practice research among scholars as well as increase the momentum of investigations which is currently suffering from dearth of information due to insignificant research efforts.

#### **Review Of Literature:-**

Miet and Odoom (2016) are of the opinion that the main purposes of maintenance practice are minimizing cost and maximizing through put and plant efficiency. Mwanza and Mbohwa (2015) have found out that most organizations are using proper maintenance of operation facilities and plants to achieve world – class service delivery.

Miet and Odoom (2016) researching on development of an effective industrial maintenance practice for plant optimum performance defined maintenance as the act of restoring plant into its functioning state or operational mode. Maintenance practice is concerned with organizational and managerial tasks connected with establishing objectives, strategies and realizing maintenance activities through action plans to monitor and control maintenance programmes. There is no imperial study in literature in this important endeavour of maintenance practice in process plants despite the fact that almost one hundred percent of plant and machinery are not made in African or to say the least, in Nigeria.

These two authors above further found out that effective maintenance record keeping is very important and all forms of report should be organized to provide ready accessibility to data when needed and to flag down problem areas.

### Methodology:-

Methodology used for this article is descriptive in which questionnaire was administered to practising estate surveyors and valuers in Lagos and Ogun States of Nigeria. The number of practising estate surveyors and valuers in Lagos and Ogun States was obtained membership and firm directory (2014) of the Estate Surveyors and Valuers Registration Board of Nigeria (ESVARBON) and showed a total of 337 (317 from Lagos State and 20 from Ogun State). This number was administered with questionnaires. 172 of them completed and returned successfully. The

retrieved questionnaires were coded and entries made into Statistical Package for Social Sciences (SPSS) 20. This was used to analyse data in form of Mean Item Score (MIS) and ANOVA which was used to test the statistical significance in variations of factors affecting useful life of process plants in the three industries being compared. Findings are presented in the following tables:

	Cement Ind	lustry	Paper Industry		Brewery Industry	
Plant and Machinery	MIS	Rank	MIS	Rank	MIS	Rank
How often it was used	4.38	1	3.92	1	4.07	2
How old it was when acquired	4.10	2	3.88	2	3.90	3
How often it was repaired or renewed or	3.79	3	3.83	3	3.71	4
part replaced						
Technological improvements	3.56	4	3.49	4	4.52	1
The climate in which it was used	3.49	5	3.28	5	3.22	5
Prohibitory laws	3.49	6	3.10	8	3.17	7
Progress in the arts	3.48	7	3.24	6	3.18	6
Reasonably foreseeable economic	3.47	8	3.22	7	3.09	8
changes						
Shifting of business centres	3.40	9	3.09	9	3.01	9
Others	3.09	10	2.77	10	2.41	10

Table 1. Danking of Factors	Affecting Useful	Life of Plant and	Machinary in th	o Industrios
Table 1Kaliking of Factors	Anecing Oseiui		wachinery in u	le mausures

Source:field survey, 2018

Table 1 above shows ranking of factors affecting useful life of plant and machinery. For cement industry, frequency of use was ranked as first with mean of 4.38. Age of machinery when acquired, frequency of repairs/part replacement, technological improvements and climate of location of use were ranked second, third, fourth and fifth with mean of 4.10, 3.79, 3.56 and 3.49 respectively. Prohibitory laws, progress in arts, reasonably foreseeable economic changes, shifting of business centres and others were ranked sixth, seventh, eighth, ninth and tenth with mean of 3.49, 3.48, 3.47, 3.40, and 3.09 respectively.

For paper industry, frequency of use, age of machinery when acquired, frequency of repairs/change of parts, technological improvement and climate at the location of use were ranked first, second, third, fourth and fifth with mean of 3.92, 3.88, 3.83, 3.49 and 3.28 respectively. Progress in arts, reasonable foreseeable economic changes, prohibitory laws, shifting of business centres and others were ranked sixth, seventh, eighth, ninth and tenth with mean of 3.24, 3.22, 3.10, 3.09 and 2.77 respectively.

For brewery industry, technological improvement, frequency of use, age of machinery when acquired, frequency of repairs/renewal of parts and climate at place of use were ranked first, second, third, fourth and fifth with mean of 4.52, 4.07, 3.90, 3.71 and 3.22 respectively. Progress of arts, prohibitory laws, reasonable foreseeable economic changes, shifting of business centres and others were ranked sixth, seventh, eighth, ninth and tenth with mean of 3.18, 3.17, 3.09, 3.01 and 2.41 respectively.

Table 2Airo VA Significant Differences in Drewery, Cement and Faper in Oseral Ene of Flant and Machinery						
	Sum of Square	F	Mean Square	F	Sig.	
Between Groups	0.333	2	0.167	0.750	0.482	
Within Groups	5.995	27	0.222			
Total	6.328	29				

Table 2:-ANOVA – Significant Differences in Brewery, Cement and Paper in Useful Life of Plant and Machinery

p > 0.05 = Not significant.

Table 2 shows ANOVA to determine whether there is statistically significant difference between our group means. Table shows that f(cal) 0.750 is greater f(tab) 0.021 at 0.05 level. Significant level of 0.482 (i.e. p = 0.021) is more than the adopted 0.05. There is therefore, no statistically significant variation in the factors affecting useful life of plant and machinery in cement, paper and brewery industries.

14(7.4%)

26(13.9%)

6(12.8%)

1(0.5%)

0(0%)

21(44.7%)

		MeanDifference			95% Confidence Interval	
Industries (I)	Industries (J)	(I – J)	Std. Error	Sig.	Lower Bound	Upper Bound
Cement	Paper	0.24300	0.21073	0.523	-0.3028	0.7888
	Brewery	0.19700	0.21073	0.650	-0.3488	0.7428
Paper	Cement	-0.24300	0.21073	0.523	-0.7888	0.3028
	Brewery	-0.04600	0.21073	0.976	-0.5918	0.4998
Brewery	Cement	-0.19700	0.21073	0.650	-0.7428	0.3488
	Paper	0.04600	0.21073	0.976	-0.4998	0.5918

Table 3:-Dependent Variable – Useful Life of Plant and Machinery

Table 3 above shows multiple comparisons as groups differed from each other. From the table, there is statistically insignificant difference in cement to paper and cement to brewery on useful life of plant and machinery (as p =0.523, 0.650). There is also no statistically significant difference in paper to cement and paper to brewery on useful life of plant and machinery (as p = 0.523, 0.976). Furthermore, there is no statistically significant difference in brewery to cement and brewery to paper on useful life of plant and machinery (as p = 0.650, 0.976). There is therefore no statistically significant difference in the factors affecting useful life of plant and machinery in cement, paper and brewery industries.

		Weekly	Monthly	Half-yearly	Yearly	Others
Cement	Turnaround	58(23.2%)	74(29.6%)	55(22.0%)	60(24.0%)	3(1.2%)
Industry	Maintenance					
·	Routine Maintenance	56(22.3%)	122(48.6%)	47(18.7%)	18(7.2%)	8(3.2%)
	Preventive Maintenance	63(24.9%)	110(43.5%)	56(22.1%)	21(8.3%)	3(1.2%)
	Curative Maintenance	57(22.9%)	95(38.2%)	67(26.9%)	27(10.8%)	3(1.2%)
Other	Others (please specify)	10(19.6%)	8(15.7%)	11(21.6%)	4(7.8%)	18(35.3%)
PaperTurnarouIndustryMaintenaRoutineMaintenaPreventivMaintenaMaintenaPreventiv	Turnaround Maintenance	50(19.8%)	73(29.0%)	63(25.0%)	56(22.0%)	10(4.0%)
	Routine Maintenance	71(28.1%)	96(37.9%)	55(21.7%)	31(12.3%)	0(0%)
	Preventive Maintenance	65(25.9%)	98(39.0%)	55(21.9%)	20(11.4%)	4(1.6%)
	Curative Maintenance	69(27.6%)	91(36.4%)	51(20.4%)	39(15.6%)	0(0%)
	Others (please specify)	4(5.5%)	22(30.1%)	8(11.0%)	3(4.1%)	36(49.3%)
Brewery Industry	Turnaround Maintenance	43(22.4%)	59(31.1%)	47(24.7%)	38(20.0%)	3(1.6%)
·	Routine Maintenance	58(30.5%)	74(38.9%)	42(22.1%)	15(7.9%)	1(0.5%)

Table 4:-Maintenance Schedules in Cement, Paper and Brewery Industries N / . . . 41. 1 XX7 - - 1-1--

52(27.5%)

55(29.4%)

2(4.3%)

### Source:field survey, 2018

Preventive

Maintenance Curative

Maintenance Others

specify)

(please

Table 4 shows the frequency distribution of respondents to maintenance schedules in the cement, paper and brewery industries. In the cement industry, and on turnaround maintenance, 23.2%, 29.6% and 22% agree on weekly, monthly and half-yearly schedule respectively, while 24% and 1.2% agree on yearly and others schedule respectively. On routine maintenance, 22.3%, 48.6% and 18.7% agree on weekly, monthly and half-yearly

91(48.1%)

75(40.1%)

12(25.5%)

31(16.4%)

31(16.6%)

6(12.8%)

respectively, while 7.2% and 3.2% agree on yearly and others schedule respectively. On preventive maintenance, 24.9%, 43.5% and 22.1% agree on weekly, monthly and half-yearly schedule respectively, while 8.3% and 1.2% agree on yearly and others schedule respectively. On curative maintenance, 22.9%, 38.2%, 26.9%, 10.8% and 1.2% agree on weekly, monthly, half-yearly, yearly and others schedule respectively. On other maintenance schedule in cement industry, 19.6%, 15.7%, 21.6%, 7.8% and 35.3% agree on weekly, monthly, half-yearly, yearly and others schedule respectively.

On paper industry and on turnaround maintenance, 19.8%, 29%, 25%, 22% and 4% agree on weekly, monthly, half-yearly, yearly and other schedule respectively. On routine maintenance, 28.1%, 37.9%, 21.7% and 12.3% agree on weekly, monthly, half-yearly and yearly schedule respectively. On preventive maintenance, 25.9%, 39%, 21.9%, 11.4% and 1.6 agree on weekly, monthly, half-yearly, yearly and other schedule respectively. On curative maintenance, 27.6%, 36.4%, 20.4% and 15.6% agree on weekly, monthly, half-yearly and yearly schedule respectively. On other maintenance, 5.5%, 30.1%, 11%, 4.1% and 49.3% agree on weekly, monthly, half-yearly, yearly and other schedule respectively.

On brewery industry and turnaround maintenance, 22.4%, 31.1%, 24.7%, 20% and 1.6% agree on weekly, monthly, half-yearly, yearly and other schedule respectively. On routine maintenance, 30.5%, 38.9%, 22.1%, 7.9% and 0.5% agree on weekly, monthly, half-yearly, yearly and other schedule respectively. On preventive maintenance, 27.5%, 48.1%, 16.4%, 7.4% and 0.5% agree on weekly, monthly, half-yearly, yearly and other schedule respectively. On curative maintenance, 29.4%, 40.1%, 16.6% and 13.9% agree on weekly, monthly, half-yearly and yearly schedule respectively. On other maintenance, 4.3%, 25.5%, 12.8%, 12.8% and 44.7% agree on weekly, monthly, half-yearly, yearly and other schedule respectively.

		Weekly	Monthly	Half-yearly	Yearly	Others
Cement	External Service	82(32.4%)	92(36.4%)	55(21.7%)	21(8.3%)	3(1.2%)
Industry	Engineer					
	In-house Service	76(30.0%)	100(39.5%)	40(15.8%)	33(13.0%)	3(1.2%)
	Engineer					
	Manufacturer's	54(21.3%)	74(29.2%)	73(28.9%)	46(18.2%)	6(2.4%)
	Service Engineer					
	The three (3) types of	40(16.2%)	86(34.8%)	73(29.6%)	48(19.4%)	-
	Maintenance Service					
	Engineers above					
	Outside Service	44(17.5%)	92(36.7%)	50(19.9%)	50(19.9%)	15(6.0%)
	Constructions					
	Others please specify	7(14.0%)	4(8.0%)	20(40.0%)	4(8.0%)	15(30.0%)
Paper	External Service	67(27.0%)	94(37.9%)	59(23.8%)	21(8.5%)	7(2.8%)
Industry	Engineer					
	In-house Service	79(31.9%)	109(44.0%)	33(13.3%)	23(9.3%)	4(1.6%)
	Engineer					
	Manufacturer's	46(18.4%)	100(40.0%)	61(24.4%)	37(14.8%)	6(2.4%)
	Service Engineer					
	The three (3) types of	42(17.3%)	94(36.9%)	43(17.7%)	59(24.3%)	5(2.1%)
	Maintenance Service					
	Engineers above					
	Outside Service	29(11.9%)	94(38.7%)	69(28.4%)	39(16.0%)	12(4.9%)
	Constructions					
	Others please specify	6(9.1%)	9(13.6%)	14(21.2%)	4(6.1%)	33(50.0%)
Brewery	External Service	48(25.3%)	85(44.7%)	32(16.8%)	22(11.6%)	3(1.6%)
Industry	Engineer					
	In-house Service	70(36.8%)	77(40.5%)	28(14.7%)	14(7.4%)	1(0.5%)
	Engineer					
	Manufacturer's	40(21.3%)	77(41.0%)	49(26.1%)	21(11.2%)	1(0.5%)
	Service Engineer					

**Table 5:-**Maintenance Engineers Retained in Various Industries

The three (3) types of	38(20.4%)	79(42.5%)	36(19.4%)	30(16.1%)	3(1.6%)
Maintenance Service					
Engineers above					
Outside Service	28(15.3%)	82(44.8%)	42(23.0%)	22(12.0%)	9(4.9%)
Constructions					
Others please specify	1(2.5%)	8(20.0%)	5(12.5%)	4(10.0%)	22(55.0%)

Source: field survey, 2018

Table 5 above shows the frequency distribution of respondents to types of maintenance engineers retained in various industries. On cement industry and on external service engineer, 32.4%, 36.4% and 21.7% agree on weekly, monthly and half-yearly retained maintenance engineers respectively, while 8.3% and 1.2% agree on yearly and other retained maintenance engineers, respectively. On in-house service engineers, 30%, 39.5% and 15.8% agree on weekly, monthly and half-yearly service engineers, respectively, while 13% and 1.2% agree on yearly and other service engineers, respectively. On manufacturer's service engineers, 21.3%, 29.2% and 28.9% agree on weekly, monthly and half-yearly service engineers respectively, while 18.2% and 2.4% agree on yearly and other service engineers, respectively. On the three types of maintenance engineers, 16.2%, 34.8%, 29.6% and 19.4% agree on weekly, monthly, half-yearly and yearly service engineers, respectively. On other maintenance service engineers in cement industry, 14% agree on weekly, 8% agree on monthly, 20% agree on half-yearly, 8% on yearly and 30% on others. On outside service constructions, 17.5%, 36.7%, 19.9%, 19.9% and 6% agree on weekly, monthly, half-yearly, yearly and other maintenance engineers in cement industry, 14%, 8%, 40%, 8% and 30% agree on weekly, monthly, half-yearly, yearly and other service engineers in cement industry.

For paper industry and on external service engineers, 27%, 37.9%, 23.8%, 8.5% and 2.8% agree on weekly, monthly, half-yearly, yearly and others respectively, maintenance service engineers. On in-house service engineers, 31.9%, 44%, 13.3%, 9.3% and 1.3% respectively agree on weekly, monthly, half-yearly, yearly and others maintenance engineers. On manufacturers, service engineers, 18.4%, 40%, 24.4%, 14.8% and 2.4% agree on weekly, monthly, half-yearly, yearly and others engineers, respectively. On the three types of maintenance service engineers, 17.3%, 36.95%, 17.7%, 24.3% and 2.1% agree on weekly, monthly, half-yearly, yearly and others engineers, respectively. On outside service constructions, 11.9%, 38.7%, 28.4%, 16% and 4.9% agree on weekly, monthly, half-yearly, yearly and others service engineers, respectively. On other maintenance engineers in paper industry, 9.1%, 13.6%, 21.2%, 6.1% and 50% agree on weekly, monthly, half-yearly, yearly and others service engineers, respectively.

On brewery industry, and for external service engineer, 25.3%, 44.7%, 16.8%, 11.6% and 1.6% agree on weekly, monthly, half-yearly, yearly and other service engineers, respectively. On in-house service engineers, 36.8%, 40.5%, 14.7%, 7.4% and 0.5% agree on weekly, monthly, half-yearly, yearly and others maintenance engineers, respectively. On manufacturer's service engineers, 21.3%, 41%, 26.1%, 11.2% and 0.5% agree on weekly, monthly, half-yearly, yearly and other maintenance engineers, respectively. On the three types of maintenance engineers, 20.4%, 42.5%, 19.4%, 16.1% and 1.6% agree on weekly, monthly, half-yearly, yearly and other maintenance engineers, 15.3%, 44.8%, 23%, 12% and 4.9% agree on weekly, monthly, half-yearly, yearly and other maintenance engineers, respectively. On other maintenance engineers in brewery industry, 2.5%, 20%, 12.5%, 10% and 55% agree on weekly, monthly, half-yearly, yearly and others maintenance engineers in brewery industry.

		Yes	No
Cement	Keep Maintenance History	237 (94.4%)	14 (5.6%)
Industry	Indicate other types of Maintenance History you keep	75 (45.2%)	91 (54.8%)
Paper	Keep Maintenance History	209 (91.3%)	20 (8.7%)
Industry	Indicate other types of Maintenance History you keep	82 (52.2%)	73 (3.9%)
Brewery	Keep Maintenance History	174 (96.1%)	7 (3.9%)
Industry	Indicate other types of Maintenance History you keep	51 (45.1%)	62 (54.9%)

Table 6:-Maintenance History of the Plants in Various Industries

Source: Field Survey

Table 6 showing the maintenance history of the plants in various industries. On keeping maintenance history, 94.4% claimed yes while 5.6% claimed no. On other types of maintenance history the respondents keep, 45.2% claimed yes while 54.8% claimed no. On paper industry, on keeping maintenance history, 91.3% claimed yes while 8.7% claimed no. On other types of maintenance history the respondents keep, 52.2% claimed yes while 46.5% claimed no.

On brewery industry, on keeping maintenance history, 96.1% claimed yes while 3.9% claimed no. On other types of maintenance history the respondents keep, 45.1% claimed yes while 54.9% claimed no.

### Discussions from Findings, Recommendations and Conclusions

## **Discussions:-**

Comparing analysis of three industries, namely, brewery, cement and paper, was made for Ogun and Lagos States for purposes of maintenance practice in these industries. As indicated, factors affecting useful life of plant and machinery in these industries, frequency of usage was ranked first in cement and paper industries and second in brewery industry, with mean ranks of 4.38, 3.92 and 4.07 respectively. Shifting of business centres and others were ranked least with number 10 in maintenance practice in process plants in brewery, cement and paper industries in Ogun and Lagos States.

On maintenance schedules in these three industries, most agree that monthly schedule is the best in the brewery, cement and paper industries for all types of maintenance, apart from others.

Also, most agree that retainership for all types of service engineers should be on monthly basis for maintenance in brewery, cement and paper industries.

### **Recommendations:-**

Surveyors and property managers should be aware of the rankings 1 - 10 as they affect maintenance practice in brewery, cement and paper industries in Ogun and Lagos States

They should also note that it is best to do monthly maintenance on these process machines. Retainership of service engineers should also be on monthly basis. Adequate records for service and maintenance should also be kept in their maintenance register.

### **Conclusion:-**

While the study has succeeded in analysing maintenance practice in brewery, cement and paper industries in Ogun and Lagos States of Nigeria, it has also comparatively analysed these three industries also in these two states of Nigeria. This is a pioneer study which not only contributed to knowledge on maintenance of process plants in brewery, cement and paper industries but has also presented an opportunity for further study that will be of help to estate surveyors and property managers in their valuation and management briefs.

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