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An Empirical Investigation of Maintenance Performance of Lubcon Ltd. Ilorin, Kwara State, Nigeria

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Abstract

The focus of the study is empirical investigation of maintenance performance of a fast growing independent lubricant blending company in Nigeria. The study was designed primarily to determine whether or not the company has met its maintenance performance targets. Nominal Group Technique (NGT) was used in composing the overall criteria on which maintenance activities of the company were evaluated. The criteria were manpower utilization, plant and equipment performance, amount of services provided and degree of planning. These criteria were assessed using the following performance ratios: equipment availability, cost of spares and supplies, maintenance to production, equipment shut - down intensity, emergency shut - down intensity, and break - down workload. The study revealed that the company was able to operate fairly within the targeted performance ratios set by the company.

Keywords: Performance, Target, Ratios, Satisfactory, Unsatisfactory

1. Introduction

Maintenance is defined as a combination of actions carried out to retain an item or restore it to an acceptable standard. This standard includes safety, reliability, and quality of output. The primary function of maintenance is to ensure that production facilities (equipment structure etc) are in good and safe condition and are available for production at minimum cost. Efficient and effective utilization of installed production facilities is a contributory factor to the promotion of industrial growth. One of the prerequisites to ensure availability of installed production for effective use is to have effective maintenance engineering system. With the advent of mechanization and automation coupled with high cost of capital investment, this prerequisite seems to be claiming more attention than in the past. Other factors which make effective maintenance system to be very important include the needs for increased production level, increased machine utilization and market competition.

Lack of effective maintenance system in a manufacturing enterprise gives rise to several undesirable consequences, some of which are excessive machine breakdown, frequent emergency maintenance, shortened life span of the production facilities, disproportionate investment in spare parts and maintenance materials, poor utilization of maintenance staff, loss in production output, failure to meet delivery dates, lower quality products, excessive overtime cost and ever rising of manufacturing cost.(Gopalakrishnnan and Banerj, 1991)

All these lack of effective maintenance consequences contribute to high costs of production and loss of profit, which is basically due to long duration of plant down - time. In planning for availability of production capacity of plant, some elements of down - time need to be taken into consideration, because that down - time will result in loss of production. If down - time can be minimized, the company stands to improve upon output and revenue, reduce production cost, and thus improving profit. This presupposes that other factors of production are available and that company can sell all that she produces.

If however, due to absence of an effective maintenance system, the down - time increases more than what has been planned, the level of activity will reduce. This will result to loss of the budgeted profit. Increase in down - time will also lead to increase in volume of maintenance tasks to be undertaken. This will increase the overall budgeted maintenance costs and therefore further reduces the budgeted profit. The aim of effective maintenance system therefore is to achieve increased plant availability through better management at low cost relative to increased profit.

Maintenance can be categorized into: (1) Emergency maintenance, planned maintenance, corrective maintenance and preventive maintenance (BSI, 1974). Emergency maintenance is necessary to put in hand immediately to avoid serious consequences. Serious consequences could be loss of production, extensive damage to assets, or for safety reason;

(2) Planned maintenance is the one that is organized and carried out with forethought with the use of records to a predetermined plan;

(3) Corrective maintenance is a maintenance carried out to restore (including adjustment and repairs) an item which has ceased to meet an acceptable condition;

(4) Preventive maintenance is carried out at predetermined intervals or to other prescribed criteria, and intended to reduce the likelihood of an item not meeting an acceptable condition. It is normally planned.

Number of employees in maintenance department depends upon the size and nature of the activities. For example in processing organizations like thermal power stations, cement plants, iron and steel making where there is continuous work throughout the year the maintenance department is big and work round the clock. In mass production industries it will be moderate and in medium and small industries maintenance staff will be in single digit. The designation of department head varies from maintenance engineer to General manager or Chief Maintenance Engineer, depending upon importance and size of the company. Badi and Badi (2006) listed some of the main responsibilities of maintenance department as evaluation/inspection, engineering and development, total maintenance work, power supply, administrative work, automobiles and safety. The specific responsibilities to be carried out are enumerated below under each of the main responsibilities.

a. Evaluation/ Inspection

- Periodic check of plant facilities to examine their working condition to take corrective action.
- To check safety factors for machinery and operators.
- Ensure that important spares like belts, bearings, bushes which are frequently required as per quality and quantity.
- To check if spares purchased for imported and high value machinery are from original source.
- Obtain information from senior operators, absorb any unusual sound or trouble from machines.
- Components and other maintenance items received as spares to be checked thoroughly by specialists.

b. Engineering and Development

- Maintenance engineers should be innovative and think for changes in arrangements to improve machines' utility and quality of workmanship.
- In civil/mechanical/electrical installations maintenance staff should take it up like a project assignment and take better care of cost and time factors.
- If production engineers fill deviations are due to machines the maintenance engineers should involve in trouble shooting to keep machines in efficient condition.

c. Total Maintenance Work

- Taking care of breakdown maintenance (repair work), planned productive maintenance of machinery and equipments.
- Scheduled overhauling of major equipment.
- Maintenance of building facilities stores yard compound for safety and better work environment.
- Attending project assignments for know how on future maintenance needs.
- Replacement, reconditioning disposal decisions.

d. Power Supply

- Duration and distribution of power to plant, machinery and colony (wherever applicable).
- UPS for computer section and minimum lighting.

e. Administrative Work

- Personal and Administration work of the department.
- Records, drawing specifications of various department related work.
- Spares list for various machines, import list; budget costs etc. files to be maintained.
- Record of machinery insurances to be kept.

f. Automobiles

- Up – keep in running condition of buses, cars, trucks etc. belonging to the company.
- Keep spares generally used for these vehicles

g. Safety

- Safety from fire, water, pollution etc
- Housekeeping, maintenance of building and open yards.

According Chary (2007), in order that the maintenance in general should succeed, the following conditions are necessary:

1. Good cooperation and coordination between the production and maintenance functions, in general, is essential.
2. Maintenance function should not be under production management.
3. Proper equipment records should be kept giving details such as breakdown-statistics, and maintenance carried out.
4. Spare parts inventory should be controlled properly, so that adequate numbers are available for maintenance purpose.
5. To ensure good control, the maintenance work (preventive and breakdown) should be standardized as much as possible.
6. Good research in materials is a helpful accompaniment to maintenance.
7. Many plants have reported excellent results with good operator training in inspecting his own machine /equipment and carrying out minor preventive maintenance job on it.

Output in maintenance is intangible which makes maintenance performance difficult to assess. In evaluating maintenance performance, surrogate measures are most commonly used. Such measures have been found to correlate strongly with other performance criteria, such as productivity, efficiency, effectiveness among others (Oloruniwo and Lorentz, 1991). In sharp contrast to production, the performance of maintenance activity does not lend itself easily to expression in simple unified figures.

Priel (1974) classified surrogate measures as those that give the most effective means by which the maintenance performance of industrial organizations can be measured. In this study, the criteria surrogate measures are used.

Benefits of good maintenance are mostly immeasurable and sometimes intangible and the quality of the service cannot be assessed except indirectly. Even, if we could show management total value of the service performed compared to what a contractor would have charged, this would show only the cost of the service but not the many benefits derived. The effects of good maintenance on the work force such as improved morale and less accidents cannot be quantified. Neither can we measure the value of the neat appearance of plant, improved housekeeping and smoother operation in production. Another benefit that is equally elusive but nevertheless important is the improved decision – making process at various levels of management as a result of reliable maintenance data (Lawal and Adeyemo, 2002).

Although the output of the maintenance department can be quantified in hours, frequencies and cost, total benefits remain immeasurable. For example, what is the value of routine check which intercepts a serious failure? If as a result of an inspection we carry out a certain repair, have we just spent money or did we contribute to savings? Therefore, there is no answer to management's quest of a justifiable expenditure.

Another obstacle in understanding the benefits of good maintenance is the fact that the merits and shortcomings of a service are not immediately apparent (British Standard Institute, 1984). The first year of a good lubrication system will pay off in the following years and the effect of poor lubrication is seen when a mis -hap occurs. Thus it is hard to give credit or lay the blame for what was done many years ago unless a clear cut connection does exist. Many factors play an interactive role and the adverse ones cannot be identified. This is in contrast to production where a faulty output can easily be traced to either tools, materials or the operators and promptly corrected. An action (such as the replacement of a component or an overhaul) will be seen to have been corrected not only in retrospect and not when it takes place.

Also according to Redford and Richardson (1977), conditions are never stable. Trouble – free running can either be credited to sustained good servicing, to a change in operating conditions or to a needed type of lubricant. The non – occurrence of a failure cannot be relevant to one simple cause. More importantly still, a non occurrence cannot be recorded. Figures may show a decrease in the frequency of break downs or in their severity but that could have been due to the latest operator – training programme or to recent improved supervision. Thus, because of the time lag effect, maintenance cannot "sell" itself. Priel (1974) however, affirmed that difficulties in appraising maintenance value can be overcome by instituting a well organized system if proper control is exercised and plotted on a chart. According to Priel, this will substitute facts for vague erroneous impressions and thus pave the way for a better understanding.

2. Statement of Research Problem

Despite the role that effective maintenance system or management can play in manufacturing organizations, there is common assertion in the business circle that maintenance departments of Nigerian manufacturing organizations have not been able to meet their performance targets. Maintenance is always neglected. It is only when a machine breaks down that maintenance is considered important. This always leads to low availability and utilization of plant equipment which always result in increase in production cost.

Judging from the importance of meeting maintenance performance targets by manufacturing companies, it is surprising to note that no meaningful research has been carried out to appraise any of the manufacturing companies in Nigeria regarding meeting their maintenance performance targets. A critical look at the scenario depicted so far would indicate that there is need to embark on a study to assess one of the companies in Nigeria regarding the extent to which they have met their performance targets.

3. Research Objective

The study aims at determining whether or not one of the leading manufacturing companies in Nigeria has met her maintenance performance targets. The specific objectives are the evaluations of the following performance ratios: equipment availability, cost of spares and supplies, maintenance to production, equipment shut - down intensity, emergency failure intensity, and break - down workload.

4. Research Setting: LUBCON LIMITED

The company chosen for this study is LUBCON LIMITED. The company was incorporated on the 8th of August 1991 as a limited liability company to carry out the business of blending automobile and industrial lubricants together with lifting, distribution and sales of petroleum and allied products that meet international standards. These include: automotive lubricants, industrial lubricants of all grades and types, marine lubricants of all grades, custom blended products, greases, gear oil etc, marketing of petroleum and allied products and retail development. The company commenced business on the 3rd of January 1995.

The company is the biggest and fastest growing independent lubricant manufacturing company in Nigeria. The company has a technical partnership agreement with REPSOL YPF Spain (a leading oil and gas company in Europe). In 2002, the company became the first indigenous company to be certified by the Standards organization of Nigeria (SON). The company is a member of Independent Lubricant Manufacturing Association (ILMA) of USA. In 2000, the company product (Performa XY 50) became the first lubricant brand to win the Nigeria Industrial Standard (NIS) certification for product quality. The company has an ultra modern blending plant of 10 000 000 litres capacity per annum and a mini plant of about 2.5 million litres capacity per annum.

5. Research Methodology

Data related to production and maintenance activities in the company were acquired by administering questionnaires and interviews to maintenance, production and account/finance Personnel of the company. Nominal Group Technique (NGT) suggested by Oloruniwo and Lorentz (1991) was used in composing the overall criteria on which maintenance activities of the company were evaluated. The criteria are manpower utilization, plants and equipment performance, amount of services provided and degree of planning. These criteria were assessed using the following performance ratios:

i. Equipment availability = Running - time / Running - time + Down – time

ii. Cost of spares and supplies = Total cost of supplies and / Total maintenances expenditure

iii. Maintenance to production ratio = Total maintenance direct hours / Total Production hours

iv. Equipment shut - down intensity = Down - time from shutdown/ Active time

v. Emergency failure intensity ratio = Down - time from frequent failure / Operating time

vi. Break - down workload = Total hours spent on break - down repairs/ Total clocked maintenance hours

For each of the performance ratios, the company gave target. These enabled us to evaluate maintenance performance against the targets. The quarterly data collected for the period between 2001 and 2006 were summed up to find the average for each year. The summed up averages as well as the company's targeted ratios for 2001 to 2006 are depicted in tables 1 – 6.

The following research questions were formulated to serve as a guide in achieving the stated objectives of the study: 1. What were the target ratios set by the company for the maintenance department? 2. What were the performance ratios achieved by the maintenance department? 3. To what extent did the company's maintenance department achieve performance target ratios? and 4. What were the problems which might have hindered the maintenance department from meeting the performance target ratios?

For each of the six ratios employed for assessing the performance of the company, an hypothesis that the performance ratios achieved by the company were not significantly different from the targeted ratio was formulated.

Student t – test was employed to test the hypotheses.

6. Results and Discussions

The summaries of results of the findings of the performance ratios measured are presented in tables 1 -6 Table 1 shows Equipment availability Ratios and percentages of performance target ratios achieved by the company. The company achieved a ratio of 0.74 (92.50%) in 2001. Thereafter, the ratio rose such that by 2004 it was 0.88 (110%). It stood at 0.88(110 %) in 2005 before it declined to 0.80 (100 %) in 2006. From the table, it is glaring that the availability of equipment throughout the period covered by the study was above the target except in 2001 when it was below the target and in 2006 when it was the same as the target. According to the company, the below target ratio achieved in 2001 was a result of frequent breakdown caused by mal - operations of some operators on the job training.

Table 2 shows cost of spares and supplies ratios and percentages performance target ratios achieved by the company. The company achieved a ratio of 0.85 (141.67 %) in 2001. Thereafter, the ratio declined such that by 2005 it stood at 0.61(101.67 %) before it rose to 0.75 (125 %) in 2006. From the table, it is obvious that the cost of spares and supplies ratio were higher than the company's target throughout the period covered by the study. According to the company, the reduction after 2001 was as a result of the step the company took to machine some of the spare parts which subsequently reduced the cost of spare parts. The implication of this is that the company ought to have increased its performance target ratios in order to make allowance for reduction of the cost of spare parts.

Table 3 shows maintenance to production ratios and percentages of performance target ratios achieved by the company. A close look at the nominator and denominator of the ratio will show that ratio which value is above target ratio is not satisfactory while ratio which value is below the target ratio or equal to the target ratio is not satisfactory. Based on the above, a ratio of 0.17 (106.25%) recorded in 2001 was not an acceptable one, while the ratios achieved in 2002 to 2006 were satisfactory.

According to the company, the improvement in performance of the company's maintenance staff is as a result of in – house training organized for them.

Table 4 shows equipment shut - down intensity ratios and percentages of the performance target ratios achieved by the company.

An examination of the nominator and denominator of the ratio will indicate that ratio which value is above the target ratio is not satisfactory. Based on the above, the ratios of 0.14 (116.67 %), 0.13 (108.33 %) and 0.13 (108.33 %) recorded in 2001, 2004 and 2006 respectively were not satisfactory, while the ratios of 0.12(100 %), 0.11(91.67 %) and 0.12 (100 %) achieved in 2003, 2004 and 2005 respectively were satisfactory.

The reason given by the company for low performance in 2001, 2002 and 2006 was frequent equipment/machinery shut - down as a result of avoidable and unavoidable delays aside maintenance. This shut - down, according to the company, was due to lack of raw material and incessant power outage from the utility power that led to frequent shutdown of production machines.

Table 5 shows emergency failure intensity ratios and percentages of performance target ratios achieved by the company. A close look at the nominator and denominator of the ratio will indicate that any ratio that is above the target ratio is not satisfactory, while the ratio that is below or equal to the target ratio is satisfactory. Based on the above, the performance of the company was not satisfactory in 2001 and 2002. This is an indication that the machines broke down most frequently in 2001 and 2002. According to the company, the factors responsible for lack of satisfactory performance in 2001 and 2002 were: the company not shutting down all its production operations just to repair and service the machinery and equipment.

Table 6 shows Break - down workload ratios and percentages of performance target ratios achieved by the company. An examination of the nominator and denominator of the ratio will show that any value of the ratio that is above the target ratio is not satisfactory, while ratios which value is less or equal to the target is satisfactory. In view of the above, the ratios of 0.27(122.73 %) and 0.26 (118.18 %) recorded by the company in 2001 and 2002 respectively were not satisfactory, while the ratios of 0.19 (86.36 %), 0.15 (68.18 %), 0.16 (72.73 %) and 0.16(72.73 %) recorded by the company in 2003, 2004, 2005 and 2006 respectively were satisfactory. The company ascribed lack of satisfactory performance in 2003, 2004, 2005 and 2006 to the following factors: not shutting down all its production operations just to repair and service the machinery and equipment, lack of preventive maintenance program and not having schedule for maintaining and servicing all the machinery and equipment.

Table 7 shows the result of the hypotheses tested.

At 1% level there were no significant differences between the performances achieved and the targeted performances of the company regarding all the ratios assessed by the study.

At 5% level there were no significant differences between the performances achieved and the performance targets of the company in respect of all the ratios assessed except for spare parts to production ratio.

7. Conclusion and Recommendations

In the foregoing, an attempt has been made at appraising the maintenance performance of a fast growing independent lubricant blending company in Nigeria (Lubcon Limited, Ilorin Kwara State) between 2001 and 2006.

The study indicates that the company's performances were satisfactory regarding equipment availability and maintenance to production ratios in 2002 to 2006, cost of spare parts ratio in 2001 to 2006, equipment shut – down intensity ratios in 2003 to 2005 and emergency failure intensity ratio as well as breakdown workload ratio in 2003 to 2006. The failure of the company to achieve equipment availability target ratio in 2001 was due to frequent breakdown of some machinery as a result of some operators who were on the job training. The company's inability to meet the maintenance to production target in 2001 was caused by inadequate training of maintenance staff. The company failed to attain equipment shut-down intensity target ratio in 2001, 2002, and 2006 as a result of shortage of raw material and incessant power outage from the National electric power grid. In 2001 and 2006, the company could not achieve emergency failure intensity target ratio because it did not at any time stop production operation to repair its machinery and equipment. The company failed to achieve performance target regarding breakdown workload ratio in 2003 to 2006 because it did not at anytime stop production operation to repair its machinery and equipment and lacked preventive maintenance programme for its production facilities.

The results of the test of the hypotheses formulated shows that there was no significant difference between the performance ratios achieved and performance target ratios for all ratios assessed except for the cost of the spare parts and supply ratio at 5% level of significance. The implication of the results of the hypotheses tested is that the company's performance was best in respect of the cost of spare parts and supplies ratio during the period covered by the study. To enable the company obviate the shortcoming of not achieving the maintenance performance ratios enumerated above in future, the following recommendations are made: the company should make it's maintenance staff to undergo appropriate training that would equip them with knowledge and attitude required for comprehensive maintenance of the company's production facilities regularly. Equipping the maintenance staff with training and installation of planned and scheduled maintenance program by the company will assist the maintenance staff tremendously towards avoidance of repeating failure of not meeting equipment availability ratio experienced in 2001. To equip itself against the occurrence of inability of not meeting the equipment shut -down target in 2001 and 2006, the company should take steps that will enable it to secure regular supply of raw materials in future and should acquire dependable electric generator that will keep its machinery and equipment running whenever there is power outage by the National electric grid.

The installation of planned and scheduled maintenance program earlier recommended will also assist the company immensely towards obviating the incidence of not meeting emergency failure intensity target ratios in 2001 and 2006 and breakdown workload ratios in 2003 to 2006. This type of maintenance program will minimize costly unscheduled down workload, unscheduled down – time, reduce maintenance costs, increase machine productivity and safety.

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Table 1. Equipment availability ratios and percentages of performance target ratios achieved

Year	Performance ratios achieved	% of performance target ratios achieved
2001	0.74	92.50
2002	0.82	102.50
2003	0.85	106.25
2004	0.88	110.00
2005	0.88	110.00
2006	0.80	100.0

Annual performance target ratio was 0.80

Source: Researchers' survey 2007 – 2008

Table 2. Cost of spares and supplies ratios and percentages performance target ratios achieved

Year	Performance ratios achieved	% of performance target ratios achieved
2001	0.85	141.67
2002	0.78	130.00
2003	0.75	125.00
2004	0.62	103.33
2005	0.61	101.67
2006	0.75	125.00

Annual performance target ratio was 0.60

Source: Researchers' survey 2007 – 2008

Table 3. Maintenance to production ratios and percentages performance target ratios achieved

Year	Performance ratios achieved	% of performance target ratios achieved
2001	0.17	106.25
2002	0.15	93.75
2003	0.15	93.75
2004	0.14	87.50
2005	0.14	87.50
2006	0.16	100.00

Annual performance target ratio was 0.16

Source: Researchers' survey 2007 – 2008

Table 4. Equipment shut - down intensity ratios and percentages of performance target ratios

Year	Performance ratios achieved	% of performance target ratios achieved
2001	0.14	116.67
2002	0.13	108.33
2003	0.12	100.00
2004	0.11	91.67
2005	0.12	100.00
2006	0.13	108.33

Annual performance target ratio was 0.12

Source: Researcher's survey 2007 – 2008

Table 5. Emergency failure intensity performance and percentages of performance target ratios achieved

Year	Performance ratios achieved	% of performance target ratios achieved
2001	0.28	112.00
2002	0.26	104.00
2003	0.13	52.00
2004	0.10	40.00
2005	0.11	44.00
2006	0.15	60.00

Annual performance target ratio for 2001 – 2006 was 0.25

Source: Researchers' survey 2007 – 2008

Table 6. Break - down workload ratios and percentages performance of target ratios achieved

Year	Performance ratios achieved	% of performance target ratios achieved
2001	0.27	122.73
2002	0.26	118.18
2003	0.19	86.36
2004	0.15	68.18
2005	0.16	72.73
2006	0.16	72.73

Annual performance target ratio for 2001 – 2006 was 0.22

Source: Researchers' survey 2007 – 2008

Table 7. Results of the Hypotheses in Respect of Performance Ratios

RATIOS	$\bar{d}$	Sd	ese(d)	Test statistics	t- table values	
					Levels	
					1%	5%
Equipment availability	0.028	0.054	0.022	1.273	4.032	2.571
Cost of spare parts to production	0.127	0.094	0.038	3.3.42	Ditto	Ditto
Maintenance to production	-0.088	0.012	0.005	-1.600	Ditto	Ditto
Equipment shut – down intensity	0.005	0.010	0.004	1.250	Ditto	Ditto
Emergency failure intensity	-0.078	0.078	0.032	-2.438	Ditto	Ditto
Breakdown workload	-0.022	0.053	0.022	-1.00	Ditto	Ditto