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Evaluation of Maintenance Culture in Manufacturing Industries in Akure Metropolitan of Nigeria

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Abstract

The appraisal and the evaluation of maintenance culture, enhancing productivity through optimal machine availability and utilization in manufacturing industries has been carried out in the Akure metropolitan. Mathematical models were used to assess the performance of maintenance personnel in the four prominent manufacturing industries in Akure, Nigeria. The results obtained indicated that production machines are already getting old, thereby resulting to frequent breakdown. Maintenance analysis were generally poor due to poor review or monitoring of maintenance performance, low degree of planning, improper execution of preventive maintenance, lack of necessary spare parts, and inadequate maintenance personnel. Some useful suggestions were made in order to increase the effectiveness of maintenance in the industries.

Keywords: Maintenance culture, Manufacturing industries, Evaluation, Akure metropolitan

1. Introduction

As the population is fast growing, technological advancement (in quality and quantity) should also be growing in like manner, for this reason, production engineers and manufacturers are working round the clock seeking for technical ideas of maintenance to meet up with ever increasing demand of the populace. The maintenance of production machinery and equipment and assurance of availability of spare parts are becoming increasingly important (Ramdeen and Pun, 2005). Maintenance management is a data-intensive activity. Maintenance forms an important aspect of human and non-human resources development as it is considered one of the major catalysts of the continuous existence of all forms of resources in the universe (Uma, 2009). With the increasing specialization and complexity of equipment and other facilities used in manufacturing, the need to develop effective maintenance culture in the industries had become imperative (Olatunbosun and Abimbola, 2005).

Maintenance is the work necessary to keep the body, equipment and machines in proper and safe operating conditions (Usman, 1998). Therefore, maintenance is seen as a vital part and a necessity in human and non-human resources management if they are to be continuously functional. Maintenance can be summarized as the repair and upkeep of existing equipment, buildings and facilities to keep them in a safe, effective as designed condition so that they can meet their intended purpose (Eti et al., 2004; Adeniyi et al, 2004). Any equipment or facility has a predetermined expected standard of performance, and maintenance supports for the equipment or facility to meet this performance standard. The effectiveness of maintenance refers to the extent to which the maintenance objectives are met as regards the satisfaction of both internal, external and customer requirements (Oluleye and Olajire, 1999).

In financial perspectives, maintenance is classified as an operating expense while the other non-maintenance activities such as process optimization, manufacture of replacement parts, relocation, upgrading, modification and installation of equipment (plant engineering functions) are capitalized. A good maintenance culture ensures that machinery function properly even when depreciation is assured. Cost saving can be enormous if basic maintenance procedures are put in place (Ikpo, 2000). Appropriate maintenance culture, proper repair and preventive maintenance of industrial machinery and equipment will not totally prevent their breakdown and failure but it would reduce it to a barest minimum. Also, the cost of preventive maintenance would be returned in many folds in form of better performance, greater reliability and long equipment useful life. It may even enhance less down time during peak operating period (Adigun and Ishola, 2004).

The concept of maintenance culture focuses on the design and implementation of a technical procedure that supports the prevention or correction of premature failure of engineering systems with least cost and time without compromising the system performance and safety parameters. Developing good maintenance culture in industries requires a human resources organizational framework. The strategies would be based on definite corporate focus and objectives while the functionality of the human element depends on factors like qualification, motivation, inter-personal relationships, training and retraining. It has been found that a good production system is usually backed up by an effective maintenance system; therefore, evaluating maintenance culture is an important ingredient in the effort to enhance profitability in the manufacturing industries (Kelly et al., 1997 and Sodiki, 2001).

Usman (1998) grouped maintenance into two classes consists of preventive maintenance and corrective maintenance. Maintenance carried out at predetermined intervals in order to reduce the likelihood of an item not meeting acceptable condition is referred to as preventive maintenance. This maintenance is necessary in order to extend the life and improve the overall availability of the equipment (Sharma and Bahadoorsingh, 2005). It involves a number of component tasks that could be broadly classified either as performance monitoring or maintenance tasks. The performance monitoring tasks include inspection and non-destructive testing (NDT) while the maintenance tasks include lubrication, routine cleaning, adjusting of machines and minor components replacement (Tomlingson, 1993).

Corrective maintenance has been described as the maintenance carried out to restore (including adjustments and repair) an item which has ceased to meet an acceptable condition (Igboanugo and Aigbe, 2003). Corrective maintenance is usually associated with terms like overhauling, refurbishing and turn-around-maintenance (TAM). Preventive maintenance is normally planned while corrective maintenance may or may not be planned.

Maintenance has been classified as follows: breakdown, routine, planned, preventive, predictive, corrective, design out maintenance, total productive maintenance and contracted out maintenance (Westerkamp, 1999). The type of maintenance that can be employed by any industry depends on the maintenance objectives of that industry. Also, the specific and operational objectives of maintenance are determined by the nature of the organization’s business. Therefore, in order to ensure effectiveness, the objectives of maintenance must be clearly defined to be understood by all stakeholders in the organization. Maintenance is primarily:

- to sustain equipment and facilities as designed, in a safe, effective operating condition;
- to ensure production targets are met economically and on time;
- to prevent unexpected breakdown of machinery and equipment
- to extend the useful like of equipment; and
- to ensure the safety of personnel using the system.

The need for reliability and dependability of equipment as well as compulsion to save cost in all areas are satisfied by these objectives.

The United Nations Industrial Development Organization’s report on maintenance and repairs in developing countries indicated that one of the strongest factors responsible for poor utilization of installed machines and equipment was the considerable downtime of machinery resulting from breakdowns and stoppages. The poor maintenance of these physical facilities accelerated deterioration and shortened their useful life. The report also noted that improving maintenance culture in developing nations would be one of most important and effective methods of stimulating industrial development (World Bank, 1995). Therefore, in this work, the maintenance culture in some selected manufacturing industries in Akure, Nigeria was evaluated in order to proffer solutions to the maintenance problems facing most industries in developing countries and recommend appropriate maintenance culture to facilitate continuous improvement of the system.

2. Mathematical model of evaluating the maintenance culture

Some useful mathematical models used for the analysis of the data collected are summarized below. Machine's availability is given by Wolf (1994) as

$$Availability = \frac{\text{MTBF}}{\text{MTBF} + \text{MTTR}} \tag{1}$$

where MTBF = mean time between failure; and MTTR = mean time to repair.

To achieve high level of availability i.e. those approaching unity or 100%, the MTTR value must be reduced and this implies that the system can be maintained relatively easily. Wolf (1994) defined failure rate, as the rate at which failures occur in a specified time interval. Failure rate is also known as hazard rate. The failure rate per year is expressed as

$$\lambda = \frac{\text{Number of failure}}{\text{Number of years of operation}} \tag{2}$$

According to Benjamin and Wolter (1998) when the duration of repair times is exponentially distributed, the maintainability function, M(t) is given by:

$$M(t) = 1 - \exp\left(\frac{-t}{MTTR}\right) \tag{3}$$

Where (t) is the variable repair time, M(t) denotes the probability that when repair begins at time t = 0 it will be accomplished successfully in good time. For the exponential case, the mean time to repair is given by

$$MTTR = \frac{1}{\mu} \tag{4}$$

where μ is the repair rate

$$\text{Average mean value } \bar{x} = \frac{\sum fx}{N} \tag{5}$$

$$\text{Average unit cost} = \frac{\text{Sum of unit cost}}{\text{No of spare part available}} \tag{6}$$

$$\text{Average total cost} = \frac{\text{Sum of total cost}}{\text{No of spare part available}} \tag{7}$$

These equations were used to evaluate the performance of maintenance culture in the selected industries.

3. Materials and methods

Maintenance departments of some selected industries in Akure metropolitan, Nigeria were visited for field survey and data acquisition. These industries are Tisco Industries Limited, Delko Steel and Wire Industry limited, Afolabi Dinehin and sons Limited and Titiayo Plastics Industry Limited. This order was not followed during the analysis, so as to keep the companies' secret, which is part of the condition for releasing their data for this study. These industries involved in the manufacture of engineering materials, plastics, papers, foods, beverages and chemicals. The maintenance procedures and management information system including logbooks, work orders, operating statistics and cost reports were thoroughly examined. Information on production and maintenance activities were collected. Data were also gathered through interview granted by the maintenance personnel and other management staff in the selected industries.

4. Results and discussion

Nine performance ratios were selected in assessing the overall performance of the maintenance department in the selected industries. These performance ratios consist of equipment availability, equipment short down intensity, emergency failure intensity ratio, overtime ratio, maintenance–production ratio, maintenance cost component, direct maintenance labour cost, cost of supplies and spare parts, and monthly stock turn over.

Virtually, all the performance ratios indicated poor performance in each production/maintenance section. Table 1, shows the types of machines and facilities used in production and their functions. As shown in this table, the year of purchase of these machines lies between 1973 and 1998. The number of time of breakdown of the machines lies between 2 to 9 times per year. Number of overtime per day lies between 1 to 12 hours and it varies from one machine to another. Table 2 shows the evaluation of the average age of the machines used in the production as extracted from Table 1. The average age of the machines is 15.

The average overtime hours of operation per day of 10 hours, as it is calculated from Table 1 and Table 3 is too high, this causes break down of machines due to over stressing. Furthermore, Table 4 shows the incessant break down of machine, which is due to poor maintenance. The average rate of breakdown of each machine per year is six times, that is, machines are breaking down every two months. Poor performance of machines was also due to non-availability of necessary spare parts and inadequate personnel, which take 50% and 22% of total problems facing the maintenance department respectively (Table 5). These problems at the long run leads to machines shut down.

5. Conclusion and recommendation

5.1 Conclusion

This overall result of the appraisal and evaluation indicated that production machines are getting old and this resulted in frequent break down of machines. Overall maintenance and analysis were generally poor, this point out that there is no proper evaluation, review or monitoring of maintenance performance, low degree of planning, improper execution of preventive maintenance, lack of necessary spare parts and in adequate maintenance personnel. Generally, most of the industries lack effective maintenance program, which results to loss of production. For effective maintenance of engineering systems in industries, maintenance function must have top management support. Industries will perform better if greater attention is paid to the simple principles of maintenance engineering.

5.2 Recommendation

Based on the findings of this study the following recommendations are made:

- Execution level of preventive maintenance should be improved. This will drastically reduce frequent breakdown of production machines.
- Worn out spare parts should be sent to forging and fabrication shop for reclamation.
- Level of supervision of maintenance programs should be increased to enhance the performance of maintenance personnel
- Standard procedure should be established for maintenance activities. This can be done by applying work-study to establish standard time for each job.
- The industry should give best training to their maintenance personnel on modern techniques in industrial maintenance engineering to enhance their performance.

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Table 1. Types of machines and facilities used in production and their functions

Industry	Name of machine	Machine's function	Time of Purchase	No of time of break down per year	No. of hour of operation per day	No. of hour of overtime per day
A	Bekum	Blowing of Plastic	1992	4	20	12
	Dr. Boy 15	Injection of Plastic	1992	4	20	12
	Tooth brush machine	Tooth brush Production	1993	6	19	11
	Loko rub filling machine	Loko rub Production	1992	8	11	3
	Stony Craft bench grinder	For grinding irons	1994	5	3	-
	J. Evans tooth brush machine	Production of tooth brush	1992	6	19	11
	Grafil Machine	Liquid filling	1992	8	8	-
B	Tolley Jack	For lifting loads	1987	4	6	-
	Air compression Machine	To blow dirt and Wash components	1988	8	6	-
	Engine jig	To remove and fix engine into charges	1993	8	6	-
C	Cutting machine	T cut nails into different sizes	1993	8	16	8
	Drawing machine	To draw wire into different sizes	1993	2	20	12
	Welding machine	For joining wires	1993	8	20	12
	Blowing Machine	To wash nails	1993	5	16	8
	Wafious Machine	Drawing	1993	9	18	10
	N6 Wafious machine	Cutting	2000	6	20	12
	N4 Wafious Machine	Cutting	1999	6	20	12
	N3 Wafious Machine	Cutting	1999	6	20	12

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Table 1. Types of machines and facilities used in production and their functions (continue)

Industry	Name of machine	Machine's function	Time of Purchase	No of time of break down per year	No. of hour of operation per day	No. of hour of overtime per day
D	Kautex blowing machine	Production of jerry-can, coolers, buckets	2000	6	18	10
	Ankerwerke injection machine	Caps, plates, spoons	2001	6	18	10
	Welloyed kettle machine	Kettles, Ragolis bottles	2001	6	18	10
E	Prince grinding machine	Grinding	1976	5	19	11
	Berco boring machine	Boring	1991	2	6	-
	Berco polishing machine	Polishing	1976	8	8	-
	Milling Machine	Milling	1983	8	4	

Table 2. Average age of the Machines

S/N	Time of Purchase	Age (x)	Frequency (f)	f(x)
1	1976	31	2	62
2	1983	24	2	48
3	1987	20	1	20
4	1988	19	1	19
5	1991	16	2	32
6	1992	15	6	90
7	1993	14	6	84
8	1995	12	1	12
9	1999	8	2	16
10	2000	7	2	14
11	2001	6	2	12
			$\Sigma f = 27$	$\Sigma f(x) = 409$

Table 3. The average overtime hour of operation per day

No of Overtime (x)	**Frequency (f)**	**f(x)**
12	7	84
11	3	33
10	4	40
8	4	40
3	1	3
2	1	2
	Σf = 18	Σf(x) = 178

Table 4. The breakdown of machine

No of time of Break down (x)	Frequency (f)	f(x)
9	2	18
8	8	64
6	8	48
5	3	15
4	3	12
2	3	6
	ΣF = 27	ΣF(x) = 163

Table 5. Problems facing maintenance department

PROBLEMS	INDUSTRY					TOTAL	PERCENTAGE (%)
	A	B	C	D	E		
Management attitude	1	1	-	-	-	2	11.1
Inadequate tools	1	-	1	-	-	2	11.1
Inadequate Personnel	1	-	1	1	1	4	22.2
Difficulties in locating faults	-	-	-	-	1	1	5.6
Non-availability of spares	3	1	3	1	1	9	50.0