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ABOUT THE ECONOMIC INDICATORS OF EFFICIENCY IN MAINTENANCE MANAGEMENT

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Abstract. Given the increasing complexity and automation of equipment, the integration of technology and their steady progress, the increasing system reliability and increasing cost of investments, it is necessary to distinguish the main categories of indicators of efficiency in maintenance. The indicators of efficiency of the maintenance activities are divided into two categories: technical indicators and economic indicators. The paper presents some of the economic indicators of efficiency.

1. INTRODUCTION

The industrial maintenance is a set of measures and actions that enable the prevention, proper equipment maintenance or its restoration into a foreseen state or into a state which allows it to provide a particular service by minimizing maintenance costs. The scope of this definition generates the following conclusions:

- to restore has the meaning of "correction", imposed by the change in the baseline of the operating parameters of the equipment;
- foreseen state or particular service involve the predetermination of the operating parameters or those of the service to be performed, with the quantification of characteristic levels;
- to minimize maintenance costs reflects the economic aspect of the business;
- prevention implies a set of operations which avoid the unavailability status of the equipment;
- good maintenance in a foreseen condition implies the implementation of methods, procedures, steps and actions to advance maintenance in the four priority directions: less accidental downtime, lower costs, increased availability, maximum quality services.[1]

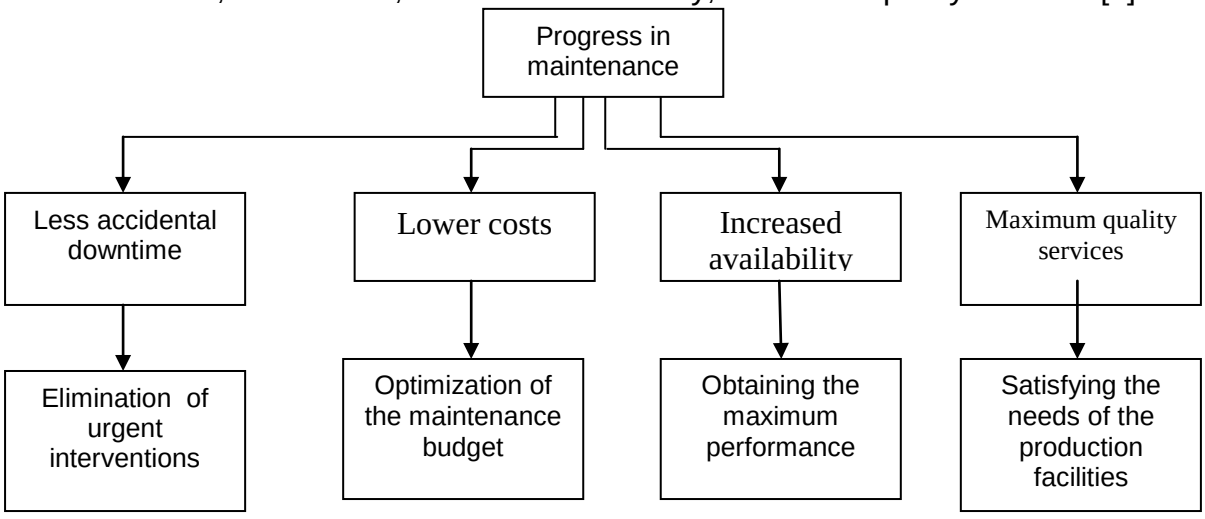

Fig. 1. Progress in maintenance [1]

The maintenance activity involves carrying out all operations to help maintain the technological and productive conservation status of facilities, machinery and equipment, at an age compatible with the level of efficiency, in order to ensure continuity and quality. When the equipment registers a decline in terms of its operating capacity, the maintenance and repair activities envisage its removal from the critical state.

The organizational concept for machinery maintenance and repair is in constant evolution. Currently through this activity, one aims to reduce costs to a minimum, focusing on the prevention of faults, because it appears that prevention of a failure is cheaper than its cure by corrective maintenance activities. The efficiency of maintenance work is characterized by technical indicators as well as by economic indicators.

2. TECHNICAL INDICATORS OF EEFICIENCY IN THE MAINTENANCE ACTIVITY

Given the importance of the maintenance activity, due to the influences it has on the most important economic indicators characterizing the activity of an industrial enterprise, its efficiency must be increased.

The volume of expenses incurred in maintenance and repairs of equipment is influenced by two factors: the number of repairs carried out and the volume of preventive maintenance activities during operation. To obtain a decrease in maintenance costs, it is necessary to act simultaneously on two factors.

The estimation of economic efficiency of maintenance is achieved by using two types of indicators: current and budget indicators.[4]

2.1. Current calculation indicators of economic efficiency

1).Efficiency of the maintenance service (E_M) is an indicator used to establish the maintenance budget, which is defined as the ratio between the total value of maintenance costs and the value of the equipment repaired.

$$E_M = \frac{\sum_i C_i}{V_{act}} \qquad (1)$$

where:

C_i = cost of the i type of maintenance system (curative or preventive);
V_{asset} = asset value of the goods to maintain.

The importance of this indicator is that it represents a benchmark that allows comparisons regarding the effectiveness of the maintenance activity between enterprises with the same profile.

2). *Effectiveness of the maintenance activities E_{AM}* - a ratio between the cost of failure and that of maintenance that is the relationship between intervention and consequences. The relationship of calculation is as follows:

$$E_{AM} = \frac{C_d}{\sum_i C_i} \qquad (2)$$

where

C_f = cost of failure,

$\sum C_i$ = total cost of activities related to the i maintenance policies.

In order to reduce costs for maintenance and repairs, the liquidation of poor execution of repairs is needed. The poor quality of repairs increases the total volume of maintenance activity, as operators will add an extra working time, and on the other hand this will increase the interval the equipment is out of order for repairs.

3. *Effectiveness of the preventive activity* E_p - expresses the general principle that when maintenance costs increase, the repair costs and the costs due to equipment shutdown decrease. Prevention of premature wear and accidental disruptions are directly influenced by the rules of maintenance and quality of technical revisions.

This indicator expresses the influence of preventive maintenance activities on the maintenance costs and is calculated with the relation:

$$E_p = \frac{C_p}{\sum_i C_i} \quad (3)$$

where C_p is the cost of preventive maintenance. The value of this indicator is intended to be one.

4. *Efficiency of the curative activity (E_c)* - expresses the proportion of total curative expenditure in maintenance costs. It is calculated with the relation:

$$E_c = \frac{C_c}{\sum_i C_i} \quad (4)$$

where C_c is the cost of the curative maintenance. The value of this indicator is desirable to strive towards zero. Between the two indicators, E_p and Ec, there is the relationship:

$$E_p + E_c = \frac{C_p}{\sum_i C_i} + \frac{C_c}{\sum_i C_i} = \frac{C_p + C_c}{\sum_i C_i} = 1 \quad (5)$$

Performing the repairs of the equipment after the occurrence of failure determines increased costs, due to the unforeseen removal from production of the machine, which determines the disruption of the production process. In terms of cost, the curative activity is acceptable in the case of rarely used equipment.

5. *Outsourcing the maintenance activity* (O_M) - characterizes the impact of outsourcing on maintenance and is expressed with the following relation:

$$S_M = \frac{C_s}{\sum_i C_i} \quad (6)$$

where C_O is the cost of the outsourced work.

An important issue related to the maintenance activity is to determine, based on analysis, which is the most effective solution in two situations: performing their works in their own maintenance department, or outsourcing to specialized units. The second solution is recommended in the case of complex work that requires high level of equipment and qualified personnel.

2.2. Budget indicators

1) To express the share of maintenance costs in the added value of production, the indicator may be used:

$$I_1 = \frac{C_m}{VA} \quad (7)$$

where AV is the added value.

This indicator is useful for comparing the efficiency within various maintenance departments and within the production departments having different activities.

2). The share of maintenance costs in the company's turnover is the ratio:

$$I_2 = \frac{\sum C_i}{CA} \quad (8)$$

where CA is turnover.

3). The distribution of maintenance costs on each product is given by:

$$I_3 = \frac{C_m}{Q} \quad (9)$$

where: Q is the quantity of products manufactured, C_m are the total costs of maintenance expressed by the following relation:

$$C_m = \sum C_i \quad (10)$$

4). The consequences on production, determined by the cost of the equipment unavailability, is expressed by the indicator:

$$I_4 = \frac{C_m + I}{CA} \quad (11)$$

where I - is the cost of unavailability.

5). If the production is homogeneous, the distribution of the overall cost to each product and type of equipment is defined by the relation:

$$I_5 = \frac{C_{gr}}{Q_k} \quad (12)$$

where: ORC is the overall reduced cost, Q_K is the amount of products made by machine k

This indicator is useful for determining the optimal replacement age of equipment, its value decreases as it approaches the optimal age for replacement, as the overall reduced cost (ORC) increases and the amount of products made by the machine Q_k decreases.[4]

3. CONCLUSIONS

A modern management of the maintenance activity requires continual preoccupation in terms of increasing economic efficiency, expressed by two indicators: technical and economic.

The efficiency indicators of activity are mutually dependant on the company's maintenance work, therefore maintenance must regain its place among the leading priorities of economic activity.

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