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THE EFFECT OF IMPLEMENTATION MAINTENANCE CARDS IN PERFORMANCE OF MACHINES IN SELECTED PRODUCTION COMPANY

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Abstract:
Intelligent development should become an inherent part of the policy of each enterprise which wants to develop and maintain its position on the competitive market. The article presents investigations related to the implementation of one of Total Productive Maintenance system elements. Reasons for introducing a new procedure for circulating information about machine inspections and overhauls planned, the major element of which are work sheets for key machines taking part in the production process, have been presented. The effectiveness of the new procedure was subjected to analysis by comparing particular machines' work times and downtimes before and after the implementation of new procedures. The conducted research revealed an increased effectiveness of machines' work, which resulted from shortened downtimes, especially the duration of a failure.

Key words: *inspection, schedule, maintenance, TPM, documentation, overhaul, lean manufacturing*

INTRODUCTION

To maintain their position on the market, management boards of corporations are forced to constantly search for savings in many aspects of enterprise activity. A road to success cannot be redundancies or cheaper materials. Solutions must be more intelligent, combine customer satisfaction and the influence of an enterprise's environment, take into consideration the changing conditions of enterprise functioning and be based on resources owned by the enterprise. This continuous process is supported by solutions, methods and tools included in the concept of Lean Manufacturing [1].

One of the ways to improve the situation of enterprises and, in consequence, increase the production and profits of the company is by analysing and eliminating mistakes committed in production and maintenance management. An example of this is ineffective time of machines' work, their downtimes caused by failures, losses of speed and idle work [5]. This part of the company's work is mainly dealt with by the maintenance department. By introducing the principles of intelligent "Lean" management in the form of a TPM system and its tools, an enterprise can make measurable savings in the form of increased accessibility of machines taking part in the production process and reduced costs involved in their use [6].

The aim of the article is to compare the effectiveness of two systems for circulating information about overhauls of machines and devices in a company manufacturing preinsulated pipes. The existing procedure of information circulation has been compared with a new procedure created for the needs of the company, which is a part of the TPM (Total Productive Maintenance) system introduced in the investigated company. The formulated hypothesis according to which the new procedure is more effective than the previously applied one has been examined.

DOCUMENTATION OF INSPECTIONS

The Maintenance Department and its functioning did not fully satisfy the employees and the management of both this department and the whole company. The major drawback of the old system resulted from the fact that it was difficult to predict whether a device could be excluded from production within a specified period of its control. With long-term production planning the terms of routine maintenance were not known, so sometimes such overhauls could not be performed. The production management were not always able to make particular machines available to Maintenance Department workers for inspection within a term when an inspection was supposed to take place. Lack of access to information about inspections early enough to plan the production and downtime of a machine for the time of its inspection frequently caused delays in the performance of machine inspections. The operator of a machine, not being involved in the program of supervision over his working tool, usually did not take any steps to improve the efficiency of the machine. The shortcomings of this procedure also include the fact that the ordering of parts necessary for overhauls as well as the time of their delivery to the company have not been taken into consideration. Frequent postponing of the dates of inspections of machines located in the production halls caused a greater number of failures and obligatory downtimes of machines [3]. It was necessary to undertake actions in the form of TPM system elements in order to improve this state of affairs. It was among others based on the introduction of work sheets for particular employees of the maintenance department which are directly included in

the new system of circulating information about planned machine inspections.

Machine inspections documentation is kept separately for each part of the machine and its components. It includes: photographs of parts and machine components, a description of the task for the inspecting person as well as the term (week numbers) of the overhaul or inspection planned. Visualisation helps new employees and persons who are not directly involved in the conducting of service works or inspections to become better acquainted with the machine. The cards contain dates of inspections for each machine and, separately, for each of its subassemblies. Work sheets specify the term in a form of week number, while the maintenance support computer system automatically assigns the exact date of service works. In some cases, it is necessary to order materials or subassemblies needed for overhaul relatively earlier to carry out the machine service. For this purpose, the inspection documentation contains additional periods (week numbers) in which a maintenance department employee must order the subassemblies so that the machine overhaul can be performed within a prescribed term. It allows eliminating technicians' mistakes which involve too late ordering of the parts necessary to perform a machine overhaul.

COMPARISON OF SYSTEM EFFECTIVENESS

To verify the correctness of the formulated hypothesis, investigations were conducted during which the system of the maintenance department functioning was analysed with the results of analyses of machines' effective work time. The research was carried out before and after creating the new procedure for circulating the information about machines' planned routine maintenance – work sheets with inspection visualisation, which is one of the five major areas of TPM system – Planned Maintenance. Work sheets with visualization of machines and their components were prepared for two major machines in the company subjected to examination: foaming machine HK 650 and HK 1250.

To investigate the working machines' time losses, an element of OEE indicator was used. OEE (Overall Equipment Effectiveness) indicator is a key measure describing the effectiveness of equipment used in an enterprise. This indicator applies to three major areas of a company business activity: availability, usage effectiveness and the quality of manufactured products. In the case being described, the indicator was examined so as to find out about the losses of production availability, usage and quality of a machine in relation to the gross time of its work. The OEE indictor is also a measure of implemented improvements and allows benefits resulting from improvement and elimination of particular problems to be easily calculated [4]. To calculate the indicator, it is necessary to properly collect the production data. Machine operators noted all the downtimes and recorded the data in an appropriate form. Any downtimes are recorded by the operator in an appropriate column in the form of vertical bars corresponding to five-minute downtimes [2]. The form presents three groups of machine downtimes:

1. Availability losses: failures, retoolings, adjustments.
2. Usage losses: idle work, semi-automatic work, lack of material, stoppage, start-up.
3. Quality losses: defects, scrap, corrections, technological trials.

Data contained in the form provide a basis for calculating the OEE indicator.

The author of the study as well as the company management focused on calculating the value of particular components of losses, neglecting the calculation of their coefficients (which are a basis for calculating the OEE indicator). This method enables a simpler and less consuming comparison of both systems (the old and the new one), as the analysis allows comparing only the most important losses for the company. The value of particular components of losses is calculated in the following way:

$$\frac{S_i}{gross \cdot available \cdot time} \times 100\% \quad (1)$$

where:
S_i – downtime due to i-th cause

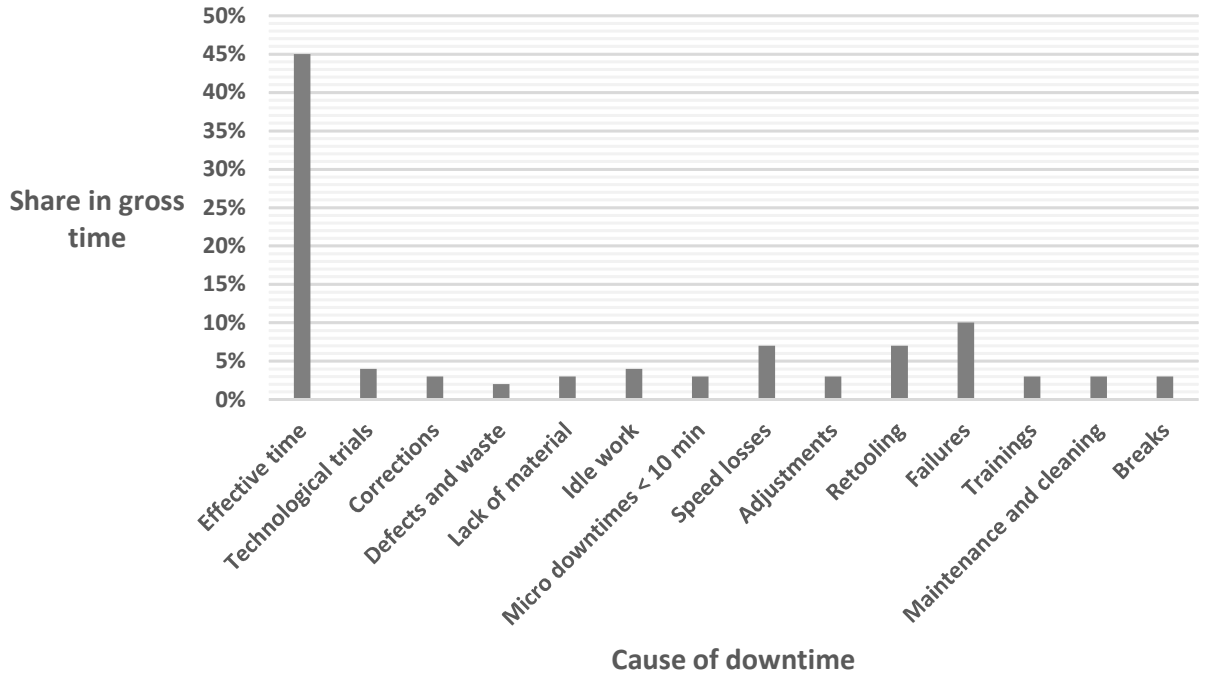

Fig. 1 Time of work and downtimes of the foaming machine HK 650 before introducing the changes

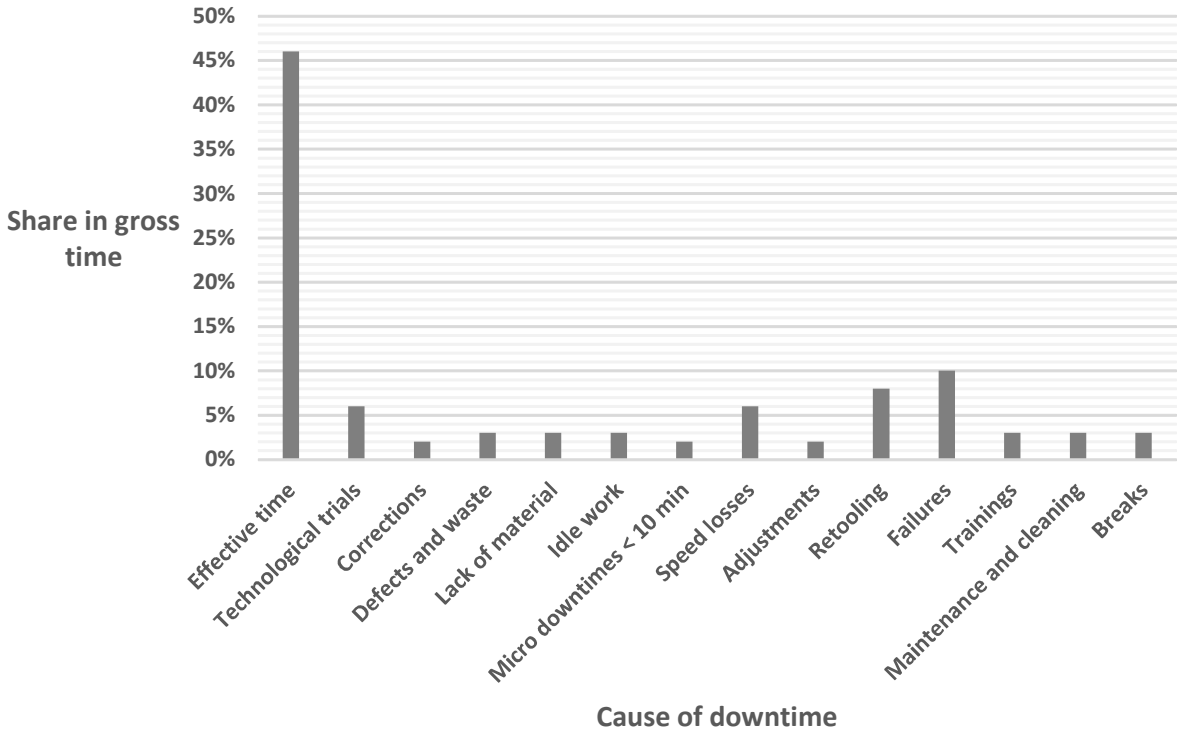

Fig. 2 Work times and downtimes of the foaming machine HK 1250 before introducing the changes

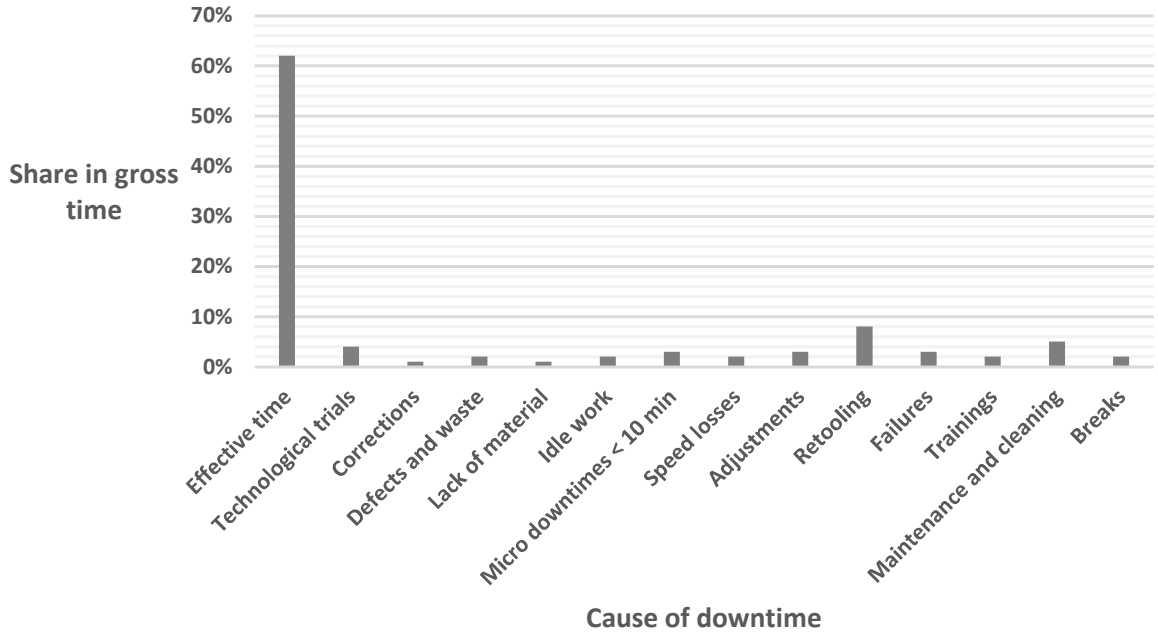

Fig. 3 Work times of the foaming machine HK 650 after introducing the new procedure

Below have been presented graphs of machines' work time before introducing the new procedure for circulating information about planned overhauls of machines and devices. Figure 1 presents the results of investigations into the time of work of the foaming machine HK 650.

The effective time of this machine work is 45%, whereas the total time of losses reaches 55% – for more than a half of the time planned for work, the machine is excluded from production. The results of work for the other examined foaming machine have been given in Fig. 2. The results are very similar to those obtained for the foaming machine HK 650. Also in this case the work time losses exceed the effective time. The difference is 1% in favour of production availability of HK 1250 (46% of the effective time) compared to the foaming machine HK 650.

After introducing the new procedure for circulating information about planned routine maintenance of machines, investigations into work effectiveness were carried out. The obtained data have been given in the graphs. Figure 3 presents changes in the time of work of the foaming machine HK 650 after introducing the new system in the maintenance department.

The data has changed for the better and reaches 62% for the effective time of the machine's work (a 17% increase) and 38% for downtimes. Losses caused by failures (3%) are lower by as much as 9% after introducing the new procedure for circulating information about planned routine maintenance of machines and devices. Speed losses have dropped by 6%.

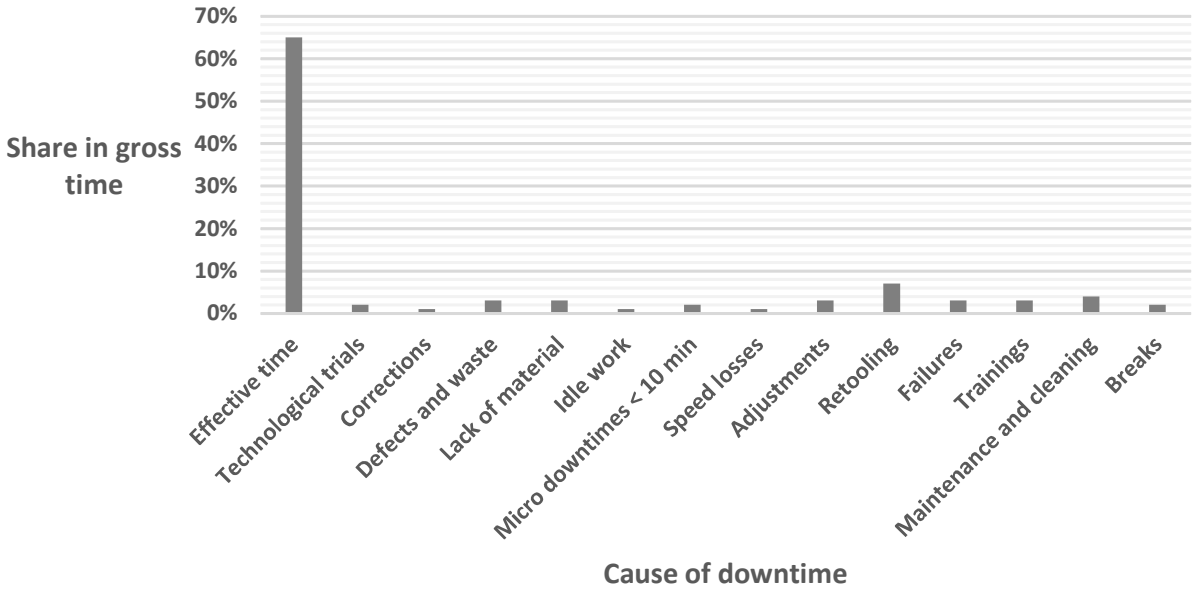

Fig. 4 Work times of the foaming machine HK 1250 after introducing the new procedure

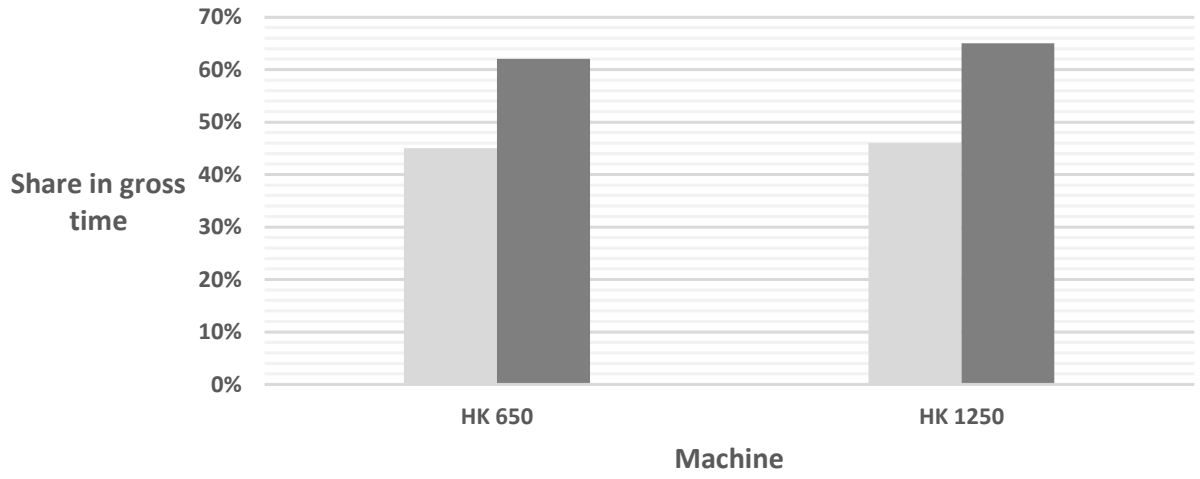

Fig. 5 Effective time of work of the examined machines before and after introducing the new procedure

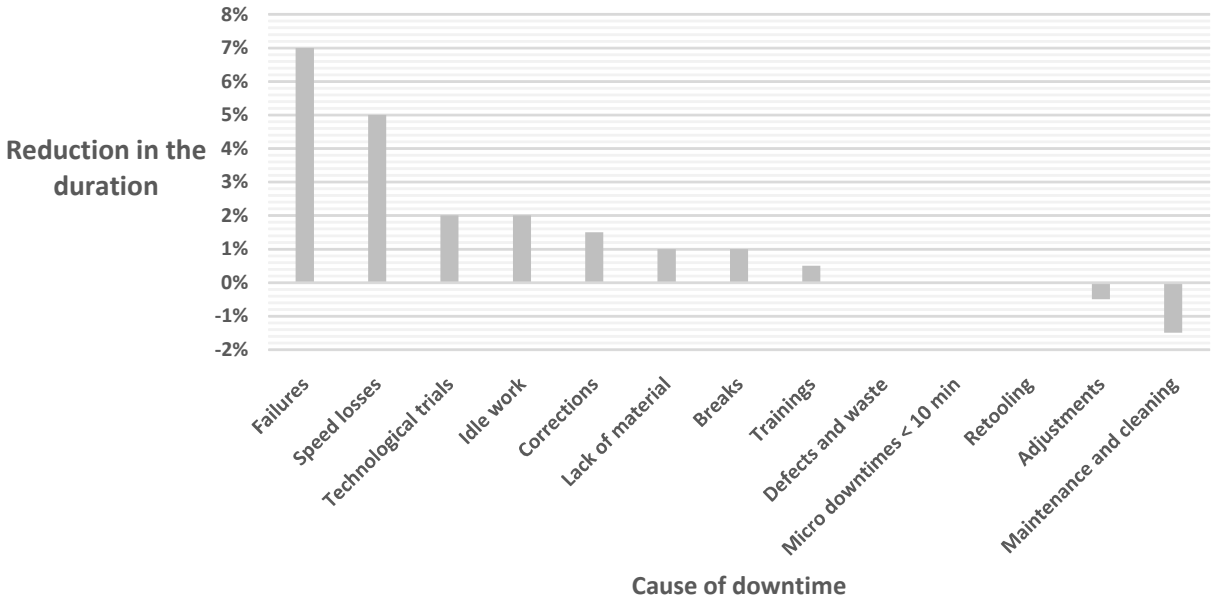

Fig. 6 Reduction of downtimes duration

Fig. 4 presents percentage results of the effective time and work losses for the other foaming machine (HK 1250).

Also in the case of this machine the results are more favourable in comparison with the results of investigations into the old system of maintenance functioning. The effective time of work (65%) has increased by 19%.

Changes in the effective time of work for all the examined machines are presented in Fig. 5.

The most significant average drops in the duration of downtimes expressed in percentage points for particular recorded events have been presented in Fig. 6.

The most significant reduction in the duration of the examined machines' downtimes was observed in the case of failures (by 7%) and speed losses – 5%. Time needed for adjustments and maintenance was increased but no more than by 1.5%.

CONCLUSIONS

The research results allow concluding as follows:

The new procedure for circulating information about planned overhauls of machines and devices has improved the effectiveness of the repair planning process, increased the effective time of machines' work and reduced the frequency of failures.

Owing to implementation of the new procedure, the production availability of the examined machines increased by an average of 19%.

The largest reduction in the duration of downtimes was observed in the case of failures and speed losses – an average of 7% and 5% respectively.,

Implementation of the new procedure provided a possibility to plan overhauls well in advance, which allowed reducing losses of the machines' working time.

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