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A new approach on implementing TPM in a mine – A case study

*E. Chlebus, J. Helman *, M. Olejarczyk, M. Rosienkiewicz*

Wrocław University of Technology, Faculty of Mechanical Engineering, ul. Łukasiewicza 5, Poland

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ABSTRACT

The paper presents selected results of the adaptation of Lean Manufacturing methods to the mining industry conditions. The research was carried out within the framework of R&D project ''Adaptation and implementation of Lean in the copper mines.'' The article focuses on the key issues related to the Total Productive Maintenance. TPM in a mine according to Authors' approach should be based on 3 main pillars: improvement of the environment of work, autonomous and planned maintenance and standards in development.

In order to adapt TPM method to mining conditions several steps were taken. In the first step failure analysis was conducted. On the basis of its results, a pilot group of machines was selected. To ensure the best environment for implementing the method a holistic approach was applied. Three types of activities were performed in parallel – designing a room for pilot area machines, daily service process optimization and repair standardization.

The coherent TPM methodology developed within the framework of Lean Mining project is so universal that it can be successfully implemented in the other mining companies, specializing in the underground and open pit mines and quarries, in order to increase their profitability and introduce continuous improvement approach.

1. Introduction

The research results presented in the paper concern the problem of adaptation Lean Methodology (LM) to mining industry (MI). The research was carried out within the project ''Adaptation and implementation of Lean Methodology in copper mines'' co-financed by Polish National Centre for Research and Development. Due to the fact that worldwide there were only few attempts of implementing Lean in the mining environment – in Rio Tinto entities [12] and in a fluorspar mining company in Santa Catarina State [9] – the problem discussed in the article is up-to-date and needs solving. The study on adapting LM to the copper mine was conducted for the first time in Poland. The project was realized in the consortium of industry and university which assured its scientific nature. The conducted research addressed several problems. Firstly, the Lean Mining methodology does not exist. Secondly, there was a question if implementing Lean methods and tools in the mining environment makes sense at all. Thirdly, the major problem was how to adapt LM to the MI regarding the fact that it differs significantly from other types of industries. Thus the main aim of the research was to develop a new, coherent methodology of Lean Mining that

* *Corresponding author*. Tel.: +48 71 320 43 84; mobile: +48 608 17 11 12.
E-mail address: joanna.helman@pwr.edu.pl (J. Helman).

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Table 1 – Comparison of specificity of the mining and the automotive industry [7].

Mining industry	Automotive industry
Work of customers cannot be stopped, thus production at the mine is the push system	The assembly line can be stopped, so transformation to pull system is possible
Continuous production	Production in cycles
Unstable/variable operating conditions	Stable operating conditions
Variable work environment	Permanent work environment
Geological hazards can stop the production	No environmental threats to production
High volatility of the availability of materials	Controlled availability of materials
Large dispersion of work (up to several km)	Working in a relatively small factory
Mine customers are other industrial companies	Sales of products primarily to individual customers

could be comprehensively applicable in other mining companies.

What needs underlying is the fact that Lean, being part of management field, forces the researchers who deal with related issues, to work on living objects (organization, company, etc.). Production management differs from others sciences because it touches simultaneously aspects belonging to areas of technology, economy and HR. Therefore research conducted in this field always needs to be very practical and applicable. Implementing LM to a mine, just like many other scientific problems related to MIs and their needs, stems from the lack of clear guidelines or methods which would consistently describe how to address such issues [20].

Presented paper refers to the conducted research in the scope of Total Productive Maintenance (TPM). The main goal of this article was to answer the question how to adapt TPM method to mining environment and implement it underground. What is more the paper tries to fill the gap of scientific guidelines describing how to approach implementing TPM in a mine in the way it is applicable and replicable by other mining entities.

The main aim of the research presented in the paper was limited by several constraints. First of all, despite numerous publications on TPM, literature related to the problem addressed in the paper is very limited. This is why critical evaluation of advantages and disadvantages of different approaches on TPM implementation in the mines is nearly impossible. Moreover, the MI is far different from other types of industry. The MI in which earth-moving plays a fundamental role is constantly under pressure to improve productivity, efficiency and safety [1]. The MI, like other sectors of the global economy, is a subject of the general laws of market economics. However, due to its specific character, it adapts in a different way to the needs of modern management concepts. Without taking into consideration the specific nature of the MI, dealing with the issues of economic efficiency may lead to erroneous decisions and actions. Besides all changes, both technological and managerial, that could be made in a mine have to be conformant with the mining law. In particular underground mining is far different from other industries, which is mainly caused by the fact that the manufacturing process is carried out in the natural environment, thus is characterized by high volatility and uncertainty. This affects directly the technology used to operate, the organization of the production process and its continuity in time. Nevertheless, taking into account full advantage of the horizontal nature of manufacturing technologies and management methods, allows further application of existing methodologies into other industries. This is why the Authors assumed that, after proper adaptation, implementation of LM (including TPM) should be possible and in the long period of time beneficial and profitable for the mines. MI competitiveness could be enhanced by using some elements of LM, which basic message is to avoid any kind of waste through continuous improvement of the entire company and its environment, by elimination of the non-value-added activities [7]. LM is widely used in many industries, especially in the manufacturing and automotive industry, where it brings great results in improving production and business processes, which in turn leads to cost reduction, processes flexibility enhancement and competitive advantage gain [23]. To elucidate the distinctness of the MI, a comparison of specificity of the mining and the automotive industry is presented in Table 1.

Presented comparison clearly shows why LM, especially TPM, needs special adaptation before it can be implemented in the MI. The paper presents the summary on Authors approach developed to adapt and implement selected elements of TPM.

2. TPM adaptation

The aim of TPM is to improve machines' effectiveness by:

- early equipment management and maintenance prevention,
- shifting the routine activities of machinery operation and maintenance for their operators [8],
- increase the engagement of employees participation in those processes [7,14].

When failures and defects are eliminated, the rate of operating speed of machines will rise, operating costs will be reduced and productivity will increase [2,15].

While analyzing different sectors of economy, it can be noticed that especially companies from the underground MI suffer from very high machines failure rate [10]. It is caused by very specific environment – defined as all the external variable physical conditions among which a technical object operates [16] – in which machines work: they are in almost constant motion, break down very often due to high temperatures, high level of humidity and poor state of routes. The environment is particularly important, because it is the factor that the mostly influences on the failure rate. TPM adaptation and implementation should be a solution to high failure frequency problem.

TPM in a mine, in comparison to standard ''TPM House'', according to Authors' approach should be reduced to 3 main