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OPTIMIZATION OF THE PRODUCTION PROCESS EXECUTION THROUGH THE IMPLEMENTATION OF MANUFACTURING EXECUTION SYSTEM

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S u m m a r y

Management of production processes in modern enterprises is a very complex issue. Efficient and effective functioning of enterprises is possible through optimization and automation of production processes. The proper organization of production processes and the ability to adapt to continuous changes in the business environment provide a competitive edge for a company. This article presents the optimization of the manufacturing process execution through the implementation of the Manufacturing Execution System in the audited company and the effects of changes as well as resulting benefits. The system of the MES class implemented in the company has contributed to improvement of many areas of company's operations.

Keywords: company, production, optimization, visualization, MES, ERP, OEE, SCADA

Optymalizacja realizacji procesu produkcyjnego poprzez wdrożenie Systemu Zarządzania Produkcją

S u m m a r y

Zarządzanie procesami produkcyjnymi w nowoczesnych przedsiębiorstwach jest złożonym zagadnieniem. Sprawne i efektywne funkcjonowanie przedsiębiorstw jest możliwe dzięki optymalizacji i automatyzacji procesów produkcyjnych. Odpowiednia organizacja procesów produkcyjnych i umiejętność dostosowania się do ciągłych zmian w środowisku biznesowym zapewnia przewagę konkurencyjną dla firmy. W artykule przedstawiono optymalizację procesu produkcyjnego poprzez wdrożenie Systemu Zarządzania Produkcją w firmie oraz określono efekty zmian, także wynikające z nich korzyści. System klasy MES wdrożony w firmie przyczynił się do poprawy wielu obszarów jej działania.

Słowa kluczowe: firma, produkcja, optymalizacja, wizualizacja, MES, ERP, OEE, SCADA

1. Introduction

The dynamic development of industry observed in the recent years has resulted in the increased complexity of technological processes and tightening requirements for quality, efficiency and timeliness of production. The huge

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competition prevailing among the biggest industrial tycoons on the global market forces the use of more and more modern, safer and more reliable production process execution systems [1].

Optimization issues currently involve many areas. It is almost every day that the increase in importance and of the number of available tools on the market, systems and technologies to optimize industrial processes are observed. The current quality of the tools to optimize technological processes enables acquisition and processing of production data directly from production lines in a way independent from the process itself. The acquisition of real-time data from the technological process execution is an important element of information systems enabling tracing productivity of both machines and employees.

The efficient and effective functioning of companies is possible only due to a wide use of the possibilities offered by the systems and technologies to streamline processes in enterprises. Today, the prerequisite for success of many companies on the market is continuous improvement of processes. The optimization of manufacturing processes is necessary to remain competitive on the market. Moreover, there are many examples which indicate that optimization may determine the existence of a company in the future.

The aim of this article is to present the optimization of the manufacturing process execution through the implementation of the Manufacturing Execution System (MES) as well as effects, changes and resulting benefits.

2. The examined manufacturing company

The investigated manufacturing company was created in 1997 and employs 167 people. It specializes in mass manufacturing of products of metal sheets, steel strips, tubes and rods made by stamping, bending, punching and welding, which can be welded, riveted and installed. The Company is classified as one of the most dynamically growing businesses in Poland, which is confirmed by the membership in the elite club of Business Gazelles. The policy in the production process of metal products for the automotive industry and general use, devices and steel structures is implemented according the Quality Management System ISO/TS 16949:2009 and the international standard for Environmental Management System ISO 14001:2015.

3. Functional problems of the company manufacturing process

The analysis of all stages of the production process revealed a number of functional problems. It was found that even apparently well-functioning company has many areas which require optimization.

One of the main problems of functioning of the production department of the audited company was an inefficient system of the ERP class (Enterprise Resource

Planning). The ERP system had production modules but they had not typical characteristics of the software needed the effective management of the production process. The frequency of data processing in the ERP system was relatively low and insufficient (as for production conditions) and the data were entered manually, which was not optimal and insufficiently reliable for production. It was the way how the records of all necessary production operations resulting from planning, manufacturing and quality control were kept, which significantly reduced the effectiveness of production management. Daily manual entering data from production into the ERP system was increasingly burdensome and there were frequent mistakes and gaps in the data flow.

Another problem was maintaining continuity of production and problems with increasing labor productivity. There were many disturbances in the production line, which resulted from failures of machinery and equipment. It resulted in frequent downtimes, the lack of control of the work of the entire production line and the lack of reliable information on the performance of the production line and each machine.

The next problem was associated with the area of the manufacturing process execution (difficulties with the use of own potential); there were frequent losses caused by not optimal planning of production orders, problems with the effective management of production orders (orders were transferred to production in a paper form) and the lack of reliable information on operators and their results. An increasing difficulty was the delayed access to real-time data from every day of production.

The problems found generated additional costs and resulted in the lack of development opportunities for the company. Due to the need to optimize the manufacturing process execution, the company decided to implement the software of the MES class.

4. Manufacturing Execution System

The software of the MES class (Manufacturing Execution Systems) is a source of reliable information from production lines. The MES systems enable tracking of production processes, machine performance and production quality. The production data are collected automatically which guarantees the reliability of the information obtained and then they can be used to improve the effectiveness of existing resources and increase production capacity while maintaining a high quality of manufactured products [2, 3]. The MES systems ensure coordination of the use of resources (employees, machines, tools and materials) and synchronize the key production tasks in real time in order to avoid any delays [4, 5]. The use of MES in the company should give a lot of effects. Among them are [6]:

- reducing the number of manufacturing defects.
- improvement of quality,

- easily obtain information to improve the production process, increase productivity,
- extending the traceability of the product,
- reduction of paper documents and enabling automatic driving typical calculations eg. Overall Equipment Effectiveness (OEE).

Furthermore, the MES coordinates tasks associated with the physical flow of materials within the entire enterprise from the production workshop through warehouses and ending with loading of the means of transport. The system allows for combining „transactional planning area with planning and management of physical events occurring in milliseconds" [7].

It is very that MES systems are an excellent support for ERP systems. It translates into a significant increase in labor productivity and efficiency of production processes. Furthermore, the management comfort increases and decreases the risk of jams and mistakes in production is reduced.

5. Implementation of the Manufacturing Execution System in the examined company

The main challenge faced by the company was the fast implementation of the MES system, which would integrate all the areas of the company operations and create consistent environment which would enable efficient flow of data, dynamic growth of production and would cooperate with the ERP system.

After a thorough analysis of the potential MES class software providers, the company decided to implement the Mattec MES system of the Epicor company. The choice of the software of the Epicor company resulted from the fact that the Epicor is a leader in developing innovative software and offers solutions carefully tailored for manufacturing companies. The implementation of the Mattec MES system covered records and control over all stages of the production process.

The beginning of the Mattec MES implementation in the examined company took place in July 2015. The system was based on a standalone server and the remote mobile access via the Internet was provided beside the desktop access. The implementation of the MES system included, among others:

- analysis of all levels of the organizational structure: from the management board to the operators of machines and equipment;
- integration with the ERP system: including the management of the production schedule, automatic creation of production batches and information on the production execution, tracking materials and processes, monitoring of machinery and equipment operations;
- implementation of the database server for archiving process data from production;
- development and implementation of the data access interface for data support;

- development and implementation of the SCADA system for visualization of the current and historical production state.

The Mattec MES implementation process in the manufacturing company took about 8 months and was completed successfully in February 2016. The implementation of the MES system solved many common functional problems in the company enabling real time control over the current extent of the production process execution. The implementation of the MES in the company has increased production efficiency of machinery and devices through elimination of losses associated with their use. The reduction in the number of unplanned downtimes and failures as well as an increase in productivity, improvement of quality and reduction of costs of production were achieved. The real-time access to data provided new possibilities. The company has gained an automatic information flow and the acquired data from the production process enable the analysis of key performance indicators and give in real time and obtain a true picture of the production potential of the company.

6. Important effects and benefits resulting from the implementation of the Manufacturing Execution System in the examined company

While analyzing important effects and benefits resulting from the implementation of the MES in the examined company over 7 months (from March to September 2016), it was noted that the productivity, quality and sales had increased. The implementation of the MES enabled the automatic collection of data on downtimes and calculation of the current value of the OEE indicator, which contributed to elimination of errors resulting from measurements and calculations performed manually to a large extent (Fig. 1).

Through integration of the MES with the ERP, the company obtained many benefits. The following ones should be mentioned: improvement of production capacity and timeliness; better handling of events during production process execution; improvement of production management in real time. Other benefits are detailed information about processes, the consistent data flow and the reduced time of reporting as well as faster decision making.

Thanks to the use of the database server, it is possible to store data on the production process, which may be used for data mining in the future. While the implementation of the SCADA system has provided an intuitive interface to control production processes in the company. Thanks to the visualization technique, it is possible to control, diagnose and monitor production processes. The SCADA system can be accessed from anywhere in the company so the traffic maintenance service can faster diagnose failures and faults, which improves the productivity of machinery and equipment. Moreover, the management has gained the possibility to control current processes in the company on-line.

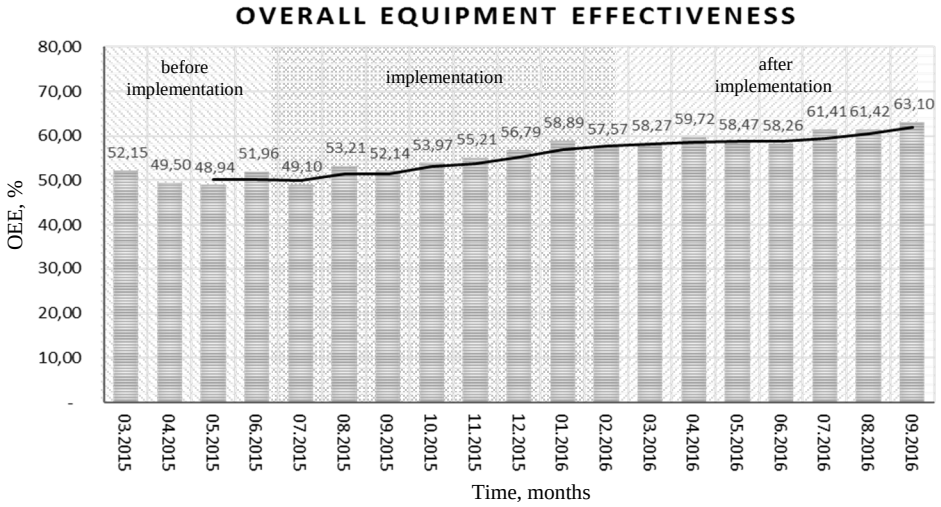

Fig. 1. The distribution of OEE in the audited company with a moving average of the three periods

As can be seen in Fig. 1 to implement MES system improved OEE in the company by 9.64% (in the analyzed period). The company achieved the desired value above 60%, which is the starting point for all activities related to the continuous improvement of the value stream in terms of machinery and equipment.

7. Conclusions

The aim of this article was to present the optimization of the manufacturing process execution through the implementation of the Manufacturing Execution System as well as effects, changes and resulting benefits. The implementation of the Mattec MES system in the examined company enabled many substantial changes.

The MES system has enabled improvement and growth in functioning of the company in many areas at the same time. The optimization through the MES system carried out contributed to the effective monitoring of the production process execution. MES system has enabled the automatic collection of information on downtime and calculating the real value of OEE along with its components (availability, performance and quality), eliminating the mistakes arising from the measurements and calculations performed by hand.

The MES system integrated with the ERP system provided a fast and reliable data exchange enabling an increase in the flexibility and effectiveness of the production. The implementation of the MES system contributed to obtaining gains in production potential of the machine park and to developing improvements

within traffic maintenance. The operations, which did not added value, have been also eliminated. The efficiency in the use of machinery and production equipment as well as the focus on productivity and profitability by reducing production costs were increased.

The production process visualization using the SCADA system provides valuable information on the process in a transparent and comprehensible way. The company has gained a possibility to take quick and at the same time more accurate decisions in the context of the events, which occur in the production.

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