Optimization of Complex Operations in the Supply Chain Through the Implementation of Advanced Planning System

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Contemporary variability of the environment and market dynamics force enterprises to optimize operations in the supply chain. Advanced IT systems such as the Advanced Planning System are a powerful tool that supports many areas in supply chain management. An efficient supply chain is a key element in gaining a competitive advantage in the market. Therefore, the foundation of the material and information flow regulation in manufacturing enterprises is the efficient exchange of information with both the internal and external environment of the organization. The article presents the optimization process of complex operations taking place in the supply chain by implementing the Advanced Planning System in the examined enterprise. It also enumerates significant benefits resulting from the implementation.

Keywords: enterprise, optimization, supply chain, information flow, IT systems, APS, planning, scheduling.

1. INTRODUCTION

Nowadays, every company is looking for opportunities to improve its operations and processes. The IT technology becomes extremely useful because it gives the possibility of optimizing the supply chain. This is due to the fact that today's global and, above all, competitive economy requires ensuring efficiency, liquidity and transparency of processes occurring in the logistics supply chain. The existence of a modern enterprise on the market, especially its development, is inherently connected with quick access to real data. Such opportunities are offered by IT tools that support supply chain management [4].

Available IT technology has a great impact on the functionality of many operations taking place in the supply chain and is an important factor enabling efficient functioning of the supply chain [2, 11]. Fast data exchange between different parts of the supply chain is the basic task of advanced information technology, and efficient supply chain management allows companies to reduce costs, ensure timely deliveries, increase efficiency and improve the operating result of the company. Thanks to the available information technology, the supply chain becomes dynamic, which means that its pace of change is faster. These changes can take place either by adapting to the transforming environment, or by forward-looking initiatives aimed at gaining an advantage over competition [9].

Each enterprise, in order to be able to function efficiently and react quickly to market changes, should optimize complex operations in the supply chain thanks to obtaining up-to-date information on available resources, planned and actual costs, liabilities to suppliers, as well as other factors affecting its current condition and future activities [4]. Having reliable information at the right time and place is crucial for the performance of a given supply chain. Only then supply chain managers are able to make the right decisions on their basis. However, such conditions can only be created when modern information technology is used [10].

The aim of the study is to present the optimization of complex operations taking place in the supply chain by implementing the Advanced Planning System (APS) in the surveyed enterprise and presenting the significant benefits resulting from the implementation.

2. ADVANCED PLANNING SYSTEMS - ADVANCED PLANNING AND SCHEDULING

Current production processes are more and more complex. They constitute a very demanding area of business activity. In every production enterprise, manufacturing processes require continuous observation, in-depth analyses and immediate reaction in order to minimize losses, machine and equipment downtime as well as maintain a position in a competitive market. Many enterprises are currently looking for rational solutions contributing to market success. One of the many factors that largely conduces to achieving market success is the implementation (and/or integration) of advanced information technology. Currently, information technology is an inseparable element of the execution of many processes in the supply chain and organizational structures of each enterprise.

One of the information technology tools supporting supply chain management are Advanced Planning (and Scheduling) Systems (APS) [10]. APS systems are a powerful tool for

systems allow them to manually adjust the automatically generated plan [6].

APS applications cover many aspects of supply chain management, from strategic planning, synchronization of operational procurement plans, production and distribution to scheduling shipments, including information from all participants in the chain. APS systems are a development of Enterprise Resource Planning (ERP) with mechanisms to optimize processes within the supply chain, due to the inclusion of a number of conditions and limitations omitted in ERP systems. APS systems enable the analysis of trade off relations between individual elements of the logistics system and, on this basis, preparation of supply chain optimization scenarios. By taking into account information from the chain partners through APS systems, it is possible no only to verify the adopted objectives, resource constraints and changes in demand but also to change from the rules of planning based on historical data on the demand volume (push system) to systems where the flow of products in the chain is activated based on information about actual demand (pull system) [14].
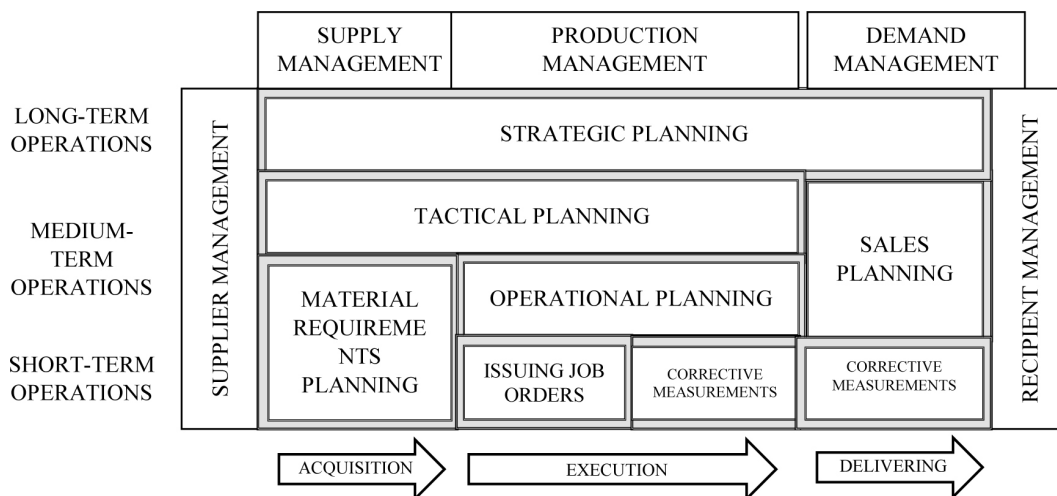

Fig. 1. APS software application [13].

creating optimal, and what is equally important, possible to implement production plans. APS systems allow companies to manage resources more efficiently, reduce production costs and shorten the time of order execution. These systems automate many planning activities, without limiting the freedom of planners to create a schedule. System users (thanks to the ability to determine the priorities, criteria and rules by which planning takes place) retain full control over the entire process. In addition, if necessary, APS

APS class systems are mainly used in industries in which production processes constitute a competitive advantage. Their advantage is faster response of the entire supply chain to the changing needs of customers or in the conditions of the appearance of additional, unexpected orders. An important advantage of APS is the integration of production plans with distribution plans [8].

All in all, APS systems cover the entire advanced planning process from strategic, tactical to operational. APS systems contain mathematical optimization solvers - mainly IBM ILOG. APS

systems contain a very advanced analytical environment. They enable forecasting and planning of demand, inventory planning, production planning, procurement planning, short-term and long-term scheduling, and S&OP balancing (Sales and Operational Planning). These systems provide team planning, consolidation of plans, planning for many organizational units, such as numerous warehouses, many production halls, many production plants, etc.

3. FUNCTIONAL PROBLEMS OF A PRODUCTION COMPANY

The studied production company was established in 1987. It employs over 780 people. The variety of owned machines and devices as well as the versatility of the employed technical and production staff give it a very wide production capacity. Thanks to this, the company can satisfy the needs of clients from various industry sectors, i.e. automotive, machine and metal. The company's products are sold both on the domestic market and on foreign markets (mainly European and Asian). The company is constantly expanding its range of products and ensures high quality of manufactured products in order to meet expectations of customers. The high quality of manufactured products is confirmed by the ISO 9001:2015 quality certificate obtained by the company. The main goals of the company are continuous expansion of production capacity, transparent organization of production processes, continuous development through the introduction of innovative solutions in production processes, cost optimization, timely execution of orders and maintaining active customer relationships.

Wanting to stay in a competitive market and dynamically develop, the company has implemented tools to optimize production processes such as TPM (Total Productive Maintenance), TQM (Total Quality Management), SMED (Single Minute Exchange of Die), SixSigma method and 5S over several years. In addition, the company has also implemented IT techniques and systems such as ERP, MES (Manufacturing Execution System), CRM (Customer Relationship Management) and RFID (Radio Frequency Identification) over the last dozen of years.

Despite many years of presence on the market, several functional problems were diagnosed in the analysed enterprise. It was noticed (due to the large variety of manufactured products) that the ERP system owned by the company turned out to be insufficient and required the expansion of functional capabilities - despite the fact that in its scope it offered a wide potential for managing the enterprise. Very often there were discrepancies between the data in the system and the current inventory levels, resulting from the execution of production orders. The ERP system possessed limited analytical capabilities because it did not provide precise information on production orders and technological operations and the production planning process, including the data obtained. A huge problem in the company was the lack of a coherent platform for information exchange in the supply chain. Various production departments worked on separate databases, and the flow of information was insufficient. It caused many misunderstandings and difficulties in the effective operation of the company. Oftentimes, there were losses due to the sub-optimal layout of production orders. The next problem that constituted a large barrier for the company included the area of maintaining production continuity, disturbances in the area of material demand (necessary for production) and difficulties in correct and detailed planning and production scheduling. Frequent changes in production plans and the necessity to modify them resulted in many problems in terms of order execution (constantly growing customer expectations), which had a negative impact on the company's reputation. In addition, the company, wishing to be prepared for the rapid implementation of each type of order, ordered a lot more of materials than it was currently needed. Estimation of the size of such orders was made intuitively by the company. Therefore it was burdened with many errors (larger than the expected time horizon of forecasting), which resulted in storage of materials in the warehouse.

Functional problems generated additional costs, resulted in the inability to effectively plan production and control its course in complex supply chain operations. They limited development opportunities of the company and implied difficulties in obtaining a competitive advantage on the market.

4. IMPLEMENTATION OF ADVANCED PLANNING SYSTEM IN THE SURVEYED ENTERPRISE

After analysing the functional problems of the surveyed enterprise and having in consideration the ERP and MES IT systems owned by the company,

an optimization solution suggesting implementation of the APS system was introduced. The company got acquainted with the proposed solution and decided to optimize its strategic areas connected with complex operations of the supply chain. After thorough analysis of many available on the market IT solutions (in terms of the company's needs and possibilities of integration with existing software), the company decided to implement the advanced ASPROVA APS system. The choice of this particular software was dictated by the fact that the system stands out against the competition with its wide application possibilities as well as scalable and flexible configuration. In addition, the system easily integrates with the systems already implemented by the company. It also enables comprehensive transparency of operations and improves responsiveness of the entire supply chain to changing market conditions.

The implementation of the ASPROVA APS system in the company took some time. Each optimized area was individually analysed. The main challenge for the company was to implement the APS system efficiently and effectively, make it compatible with the company's ERP and MES software and use existing production resources optimally.

The beginning of the implementation of the ASPROVA APS system in the analysed enterprise took place in March 2016. The implementation of the system was carried out in stages and included:

1) pre-implementation analysis:
   a. analysis of needs, requirements and problems related to the processing of large amounts of data,
   b. analysis of the previous method of scheduling,
   c. defining specific features of the production process, manufactured products and technical infrastructure,
   d. developing a concept - a vision of solutions, taking into account the specific nature of the company's operation.
2) commencement of implementation works:
   − installation and preparation of the APS system for work (creating a list of users and assigning them appropriate roles in the system),
   a. entering data into the APS system and integration of databases,
   b. entering data covering the available resources of the enterprise,
   c. entering data including:

   − parameters of sales orders - quantity, dates;
   − parameters of processed raw materials - suppliers, average delivery times;
   − parameters of manufactured products - quantity, dates.
   d. integration and synchronization of the APS system with the ERP and MES systems used by the company.
3) technical tests checking the operation of the APS system:
   − availability of resources (human and material resources, sockets, machines, devices), efficiency,
   − real-time monitoring.
4) introduction of technical improvements to the system,
5) re-conducting technical tests,
6) training employees from the list of users,
7) performing functional tests of the APS system.

The implementation process of the ASPROVA APS system in a production company lasted 7 months and ended successfully (according to the set date) in October 2016. The implementation of the APS system was very complex and time-consuming, as it required the precise determination of all technological processes and their implementation times. In addition, the implementation had to guarantee the accuracy of data entry and required a lot of work to identify irregularities and eliminate them. Integration and synchronization of the APS system with the ERP and MES systems was also very time-consuming and complicated, because it had to provide a connection with the company's existing IT systems in real time in order to transfer the collected data. Due to the structure of the system's functioning, technical tests checking the operation of the system were carried out very carefully in order to identify inaccuracies and make technical improvements to the system. The implementation of the APS system solved many functional problems occurring in the enterprise, enabling immediate access to one cohesive information exchange platform throughout the supply chain. The implemented APS system has definitely automated planning and scheduling, which is very important when the number of production operations performed does not allow planners to effectively manage them. In addition, the APS system made it possible to analyse in real time all the appearing changes and to make adjustments to

the plan, which was connected with keeping the declared deadlines for finished products. APS also contributed to greater use of the company's potential and resources, improved punctuality and predictability of temporary product deliveries to customers as well as reduced stock levels and optimized the supply. Integration of the APS system with the ERP system contributed to relieving the ERP, which, with a very large amount of data processed, was a "bottleneck" in the effective planning of the management of the entire company's resources. On the other hand, the integration of the APS system with the MES system allowed for sending work plans directly to individual production positions and informing planners about the ongoing production process, which enabled them (if necessary) to immediately correct the schedules. Thanks to the implementation of the APS system in the production company, it was possible to carefully plan each production stage, which largely contributed to the increase in production efficiency.

5. SIGNIFICANT BENEFITS RESULTING FROM THE IMPLEMENTATION OF THE APS SYSTEM

The analysis of the significant benefits resulting from the implementation of the ASPROVA APS system in the enterprise in the span of 13 months (from November 2016 to November 2017) showed: efficient and consistent data flow and information exchange; transparent common database; minimization of distortions and errors as well as functional problems occurring in the implementation of many activities taking place in the enterprise. The greatest benefits from the implementation of the ASPROVA APS system (considering the time of 13 months after the implementation of the system) were identified in the following areas:
- reduction of planning time by 25%,
- increase of planning scope by 30%,
- reduction of production costs in progress by 25%,
- increase in work efficiency by 30%,
- increase in timely order execution by 80%.
- reduction of inventory by 60%.

Other benefits include precise scheduling, planning and control of complex operations in the supply chain. The next important benefits are automatic synchronization of supply and production as well as optimization of supply. The key benefit is the integration of the APS system with existing ERP and MES systems in the enterprise. Thanks to the system integration, the company has been able to monitor the flow of materials in real time, respond to market volatility and modify orders on an ongoing basis, effectively use the hidden business potential, increase its operation efficiency and competitiveness.

Summing up, it should be noted that thanks to the implementation of advanced IT systems it is possible to improve company's efficiency in many areas at the same time. In addition, it enables gaining full control over the company and gives it the prospect of further undisturbed development [3].

6. CONCLUSIONS

The aim of the study was to present optimization of complex operations taking place in the supply chain through the implementation of APS in the surveyed enterprise and present significant benefits resulting from the implementation.

The functioning of the supply chain in the surveyed production enterprise has been optimized due to the implementation of the APS system and its integration and synchronization with the existing ERP and MES systems. Thanks to the implementation of the APS system, functional problems in the company were eliminated. The data flow has been streamlined and now it creates a common information structure, which enables the company to make rational decisions in real time. In addition, the company has gained many important benefits: it has improved its key areas of business processes; it has obtained ongoing control and analysis of processes and it has increased the usage of its existing business potential.

Increasing market demands and the fight against competition force companies to look for newer and newer solutions that allow them to attract and retain customers and increase the capital of the organization. Coordination of various activities in the implementation of production processes becomes more complicated. It becomes even more difficult when the production system has to adapt to rapidly changing market needs [5].

Therefore, the foundation of material and information flow regulation in manufacturing enterprises and the basic condition for the integration of activities related to the implementation of the production process is the

use of IT systems supporting acquisition, data processing
and information transfer. Computerisation of complex operations in the supply chain helps to meet growing competitiveness and is one of the ways for enterprises to develop [12]. Modern IT tools that facilitate the decision-making process, business management and quick response to changes in the environment are one of the success factors of today's manufacturing companies [7].

REFERENCES

[1] Blog IBM Impact. Blogs.ilog.com. (accessed on 4 December, 2017).

[2] Bowersox D., Close D.J., Cooper M.B.: Supply Chain Logistics Management, 2nd edition. McGraw Hill International New York 2006.

[3] Chwesiuk K.: Analiza zastosowań systemów informatycznych klasy ERP w logistyce. Logistyka no 4, Poznań 2011.

[4] Cywka M.: Narzędzia informatyczne a efektywność zarządzania w logistycznym łańcuchu dostaw, Biuletyn Wojskowej Akademii Technicznej, Vol. 56, no sp.1, Warszawa 2007, p. 263-274.

[5] Dohn K.: Problem planowania i sterowania przepływem produkcji w kontekście spadku zamówień w łańcuchu dostaw, Logistyka no 4, Poznań 2011, p. 181-189.

[6] http://decyzje-it.pl/artykuly/system-aps-niezbedne-narzedzie-planistow/1022 (accessed on 5 December 2017).

[7] https://astrafox.pl/business-intelligence-dla-produkcji/ (accessed on 5 December, 2017).

[8] https://www.log24.pl/artykuly/czym-sie-roznia-mes-i-aps,6996 (dostęp na dzień 08.12.2017).

[9] Moore J.F.: The Death of Competition. Harper Business, New York 1996.

[10] Rudnicki J.: Systemy zaawansowanego planowania i harmonogramowania w zarządzaniu łańcuchem dostaw, http://www.ioz.pwr.wroc.pl/pracownicy/ rudnicki /default_pliki/APS %20systemy%20Zakopane. pdf (accessed on 3 December, 2017).

[11] Simchi Lev D., Kaminsky P., Simchi Levi E.: Managing the supply chain. McGraw Hill, NY 2003.

[12] Stadtler H., Kilger C. (ed.): Supply Chain Management and Advanced Planning – Concepts, Models, Software and Case Studies. Springer, Berlin 2005.

[13] Wasielewski M.: Zastosowanie zintegrowanych narzędzi informatycznych dla optymalizacji planowania procesów produkcji, http://science.lpnu.ua/sites/default/files/ journal-paper/2017/jun/4217/wasyelewskym.pdf (accessed on 10 December, 2017).

[14] Witkowski J.: Zarządzanie łańcuchem dostaw. Koncepcje, procedury, doświadczenia. Wydawnictwo PWE, Warszawa 2003.

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