ECONOMIC IMPLICATIONS OF PROVIDING ORDER DRIVEN PRODUCTION WITH METALLURGICAL MATERIALS

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Abstract

One of the objectives of the optimization of material, energy, information and financial flows in logistics and supply chains is ensuring economic efficiency of the activities carried out. The established manner of the flow in the chain and the method of carrying out logistics activities are, however, determined by the specific conditions prevailing in enterprises of the links involved. Chains operating on the basis of win-win approach take into account the specifics of the links involved; however it is the link with the greatest bargaining power in the chain that usually plays the decisive role in shaping the results. The paper describes the results of a primary research focused on the economic impact resulting from the implementation of production based on the build-to-order principle, requiring flexible provision of inputs. At the same time, it specifies the implications of this production in the cooperation with direct suppliers of steel material, who must adapt their supplies to this production while taking also into account the specifics of their own metallurgical production.

Keywords: material management; inventory management; made-to-order; supply chain management

1. INTRODUCTION

The current competitive environment is forcing management of enterprises to build effective long-term competitive advantages. Due to the global availability of information on new products and technologies, however, it is increasingly difficult to create a competitive advantage only on the basis of a unique product or technology. A quality product and unique know-how of the enterprise need to be supported also in terms of optimization of flow of material, energy, information and funds. The constant pressure to shorten delivery times is also apparent in the metallurgical industry where it raises a number of economic consequences, particularly in the area of stockholding and working capital management [1]

Goals, Scope and Background. A decision of the management of the metallurgical enterprise to build a competitive advantage based on rapid response to customers' wishes necessitates the adoption of production based on the made-to-order principle. With the company management requesting to minimize working capital, there is a fundamental conflict in securing a sufficient amount of stock of metallurgical material. In many cases, the solution to this conflict causes changes in the supply chain, where it is necessary to negotiate specific conditions for the supply of material, or pass on the cost of stockholding to the supplier, while respecting the win-win strategy. This paper describes the results of a primary research aimed at defining economic contexts that are caused by the requirement for immediate execution of orders from customers while respecting the need to minimize working capital in a manufacturing company that processes and produces bulk quantities of metallurgical material in serial production process.

Methods. Theories, annual reports, financial reports (balance sheets, income statements), conference proceedings and empirical findings (realized one-to-one interviews) from relevant fields of research are used to address the validity of theoretical problems and assumptions. Based on theoretical basis concerning practices and specific circumstances in supplier relationships in the supply of high volumes of metallurgical materials in metallurgical industry, a preliminary research was realized with managers of metallurgical company through structured one-to-one interviews. The company manufactures metallurgical materials in a cold working process into products intended primarily for the engineering, construction, automotive, and

other industries and therefore also manufactures and produces metallurgical materials. The respondents were Logistics Director and the Director of the company. The research was conducted in the period December 2014 - February 2015. Information obtained was processed using content analysis. The first set of questions inquired into the company's ability to detect and possibly model the expected demand for its products. The second set of questions investigated the range of stock of finished products. The third set of questions focused on determining the extent of inventories of raw materials. The last set of questions investigated conditions in production that must provide the required flexibility.

Results. The paper defines the principles of cost-effective approaches to ensure production on the made-to-order principles while meeting the requirement for rapid response to customers' wishes as well as meeting the requirement for minimizing working capital. The structured one-to-one interviews were used to identify missing information and specifics influencing the process of production of metallurgical products. Necessary requirements were defined for working with suppliers who also require economic efficiency of own productions and delivery processes. This preliminary research creates a foundation for a future qualitative research into the economic context not just in relation to the manufacturer, but also in relation to the suppliers and other supply chain participants.

Conclusions. Setting efficient production processes of metallurgical bulk materials poses considerable challenges for the management of these enterprises. The success of the strategy of building a competitive advantage based on rapid response to customers' wishes while meeting the requirement for minimizing working capital depends on the bargaining power and the ability to effectively develop cooperation with suppliers, but also along the entire supply chain. Only cooperation, communication and information sharing can provide cost-effective results for both producers and suppliers [2].

2. PROBLEM FORMULATION

The requirement for rapid response to a specific request from the customers raises the need for the enterprise to produce on the made-to-order principles and primarily address the ability to prepare finished products for shipping in time, which in turn raises the need to provide enough material for production. Both of these requirements can be easily solved by the creation of adequate stock of both inputs into the production process and finished products. [3] In case of fast and flexible production, it is sufficient to keep only the stock of material, while in case of a lengthier yet flexible production process we need to build up the stock of work in progress in various parts of the production process, depending on the possibility of shifting the decoupling point as close to the customer as possible [4]. In case of a lengthy process, without the possibility of flexibility, the stock of finished products is basically inevitable.

With the requirement for minimizing working capital, stockholding is perceived as unacceptable and economically inefficient. The management of the company must find ways to transfer or at least spread the burden of stockholding to another entity and the solution is clear:

- on the side of finished goods inventory, systematically deepen relationships with customers in order to effectively estimate demand and joint planning,
- on the side of material stock, systematically work to deepen relationships with suppliers of material, [2]
- on the side of stock of work in progress (during the actual production process), achieve the maximum possible degree of flexibility and speed of the production process, as well as the maximum effectiveness of other business processes,

On the customer side, the enterprise needs to develop, in marketing terms, relations with them while working with market information efficiently enough to create models and estimates of demand as accurate as possible for subsequent periods and joint plans. Relevant demand forecasting is a fundamental and

essential tool for an effective economic solution in consequence of the reduction of excess inventory in all possible forms, but it is not always possible to estimate demand [5] and plan together due to the sector-specific circumstances and relationships in the supply chain.

Depending on the producer's bargaining power it is necessary to involve suppliers in sharing information [6] and coordinating plans and, if possible, continuously improve material flow in the chain through the implementation of modern methods such as Quick Response, VMI, CRP, CPFR. The focus of these methods lies in vertical channel integration to achieve some of the efficiencies of coordinated systems without ownership [7]. Implementation of methods requires adapting to the specifics of each supplier-customer value chain [8].

However, it is not always possible to achieve this ideal coordination, as it is necessary not only to respect the needs, wishes and requirements of the manufacturer, but also comply with restrictions and specific conditions on the side of the supplier [9].

Adapting the actual production process always represents a strategic, time-consuming and costly process requiring significant changes across the enterprise and its surroundings, so it is not always in the interest of the management to intervene in the production process. Significant changes in the flexibility and speed of production are not a very common and applied way to reduce inventories.

2.1 Specifics of Metallurgical Production

Specific factors arising from the conditions of the particular chain and the chosen strategy of customer service are largely determined by the specific conditions of the industry. The metallurgical industry is characterized by significant specifics resulting from the nature of the processed materials and raw materials and manufactured products. Most businesses of the metallurgical industry process or resell large volumes of material, binding significant amounts of funds. These input conditions then give rise to a number of specifics having a significant impact on economic efficiency of stockholding and management thereof [10,11,12]:

- The nature of production resulting from the processing of large volumes of materials and raw materials causes a significant limitation to any flexibility.
- At the same time, starting with metallurgical manufacturing of the majority of metallurgical materials in large batches owing to the economical managing of the production (melting) process, these high-volume batches are characteristic for most of the successive links in the supply chain.
- A wide range of products is produced, mainly due to the requirements for different chemical composition of metallurgical products, but also because of other requirements for the shape, size, finish, packaging, etc.
- Large volumes of the material and the product require adequate warehouse space as well as handling and transport capacities.

Equally significant are the specifics characterizing the global market for metallurgical products. The many specifics include:

- Basic raw materials and semi-finished products are now freely tradable worldwide. As a result of the global market, the competitive pressure is significantly higher than it was in the past.
- The relatively unstable demand for metallurgical products has a significant impact on creating effective demand forecasting. [13]
- The nature of the product and the manufacturing technology used do not produce in most cases sufficient guarantee of product differentiation and subsequent formation of the competitive advantage on the basis of the utility properties of the product.

These factors greatly reduce the possibility of eliminating the creation of inventories in the supply chain and the associated negative economic effects that are characteristic for the metallurgical industry. Still, with intensified cooperation along the supply chain, it is possible to substantially reduce inventories in the chain and associated costs [3], however, it is necessary to meet some of the fundamental conditions for the system solution of this cooperation.

2.2 Theoretical assumptions

On the basis of the defined specifics and theoretical assumptions, it can be assumed that the enterprises in the metallurgical industry must build a competitive advantage as a multi-criteria one and based on complex CRM [14]. The chosen strategy of rapid customer service necessitates the adoption of principles of demand-driven production (Pull Strategy), resulting in several theoretical assumptions for a successful strategy thus formulated to build a competitive advantage. With the requirement for minimizing working capital during mass production in a batch process, it can be assumed that businesses must particularly:

- promote an effective system of estimating the demand for products due to elimination of stock throughout the production process, despite the often unpredictable situation on the market for metallurgical products [2]; it can be assumed that businesses will build stronger relationships with customers in order to obtain relevant market information. The economic impact of effective demand forecasting does not limit only to the minimisation of stock, but undoubtedly also to the ability to efficiently plan the production and generally all business processes, using thus the resources of the company optimally,
- minimize finished goods inventory due to the inability to hold them for their high volumes in the company's storage; we can assume that not only large volumes of finished goods inventory, but particularly high values of this inventory trigger measures to spread economic cost of stockholding to the downstream links of the supply chain. The economic impact is created not only by the actual locked-up capital, but also the costs associated with stockholding (storage areas, handling, security, etc.),
- minimize the stock of materials and raw materials again due to their large volumes and high value, particularly through closer cooperation with the immediate suppliers; it can be assumed that the company depending on its bargaining power will spread the burden of high economic demands of stockholding to the supplier, either by:
    - reducing the stock using methods such as Quick Response, VMI, CRP, CPFR in order to receive the material when needed; in this case, economic effects are significant in terms of low level of locked-up capital, but the introduction of these systems is associated with investments in their implementation and operation,
    - or arranging a consignment storage with suppliers; in such a case, materials are then fully available and there is no company's capital locked-up by them, but it must at least bear some of the costs incurred by the consignment storage (handling, storage space, insurance, etc.),
- maximize the actual production rate and shift the decoupling point as close to the customer as possible, particularly in metallurgy the ability to shift the decoupling point depends on the geometric characteristics, material characteristics and product characteristics [9]; it can be expected that, for fast, flexible and small batch or single-piece manufacture it is possible to significantly reduce the need for inventory, conversely with a decreasing rate and flexibility along with an increase in the extent of the individual batches of metallurgical products it is not possible to avoid inventory of work in progress and finished goods.

In addition to this economic context, it is clear that managing the production on the made-to-order principles will require managing many other business processes and activities, particularly with regard to transport of materials and finished products, production programme coordination, reliable communication with suppliers during replenishment with respect to their own limitations in the production of raw materials, optimization of the planned amount of stock on the tactical and operational level of the management and others.

3. CONDITIONS FOR ENSURING ECONOMIC EFFICIENCY OF PRODUCTION ON THE MADE-TO-ORDER PRINCIPLES IN METALLURGY - RESEARCH FINDINGS

The research was conducted in a manufacturing company, which is a major direct purchaser of metallurgical products, both ferrous and non-ferrous metals (it annually processes more than 100 thousand tons of metallurgical materials), producing (using its high-quality know-how for material cold working) products machined with precision based on steel and other metals. A competitive advantage consists in a complex ability to produce, in high quality and in the shortest possible time (within 48 hours) at a reasonable cost, products according to specification and send them to the logistics centre where they are distributed to customers. Although the products are divided into five separate groups, they do not differ significantly in terms of technological processing; the groups differ, in particular, in the material used and depending on the composition of the chosen method of treatment. Since the resulting products can be manufactured in a wide range of chemical composition (the content of individual elements in the input metallurgical material) as well as a variety of shapes, a wide range of products is produced within these groups intended for different uses. Using a single technology, the production itself is relatively simple with a reasonable degree of flexibility.

The first group of questions revealed significant negative constraints complicating the achievement of economic efficiency in sales. The company is not able to estimate the development of demand for various products, not even in an elementary form. It only creates annual framework production plans for individual production groups, but it is unable to elaborate them in greater detail in terms of structure of the range of products or shorter time horizon. The reason is mainly the inability to establish closer contact with customers who are unknown to the enterprise. In addition, the demand throughout the industry is characterized by significant variability and instability. These factors severely limit the company's ability to minimize the amount of stock.

The second group of questions investigated the range of finished goods inventory. It was clearly confirmed that the company is not interested in forming finished goods inventory. The reason is the inability to estimate their sales, a lack of storage space and the resulting economic inefficiency. Only a small proportion of the produced assortment with a relatively permanent offtake can be made to stock, nevertheless the overall finished goods inventory do not comprise more than 5 percent of all inventories.

Based on the evaluation of the third group of questions, it was surprisingly found that the company was able to significantly shift the costs of holding these inventories to their suppliers. The research confirmed that, with regard to the range of supplied materials and in particular the lack of flexibility of producers of metallurgical material, there is no supplier who could smoothly supply material when needed through the use of methods such as Quick Response, VMI, CRP, CPFR, and the only solution is to create a sufficient stock of materials, at least for over the next three weeks to one month. This would constitute a disproportionate economic burden for the company and in line with the aim of reducing working capital, the company managed by building long-term relationships to persuade all suppliers of key materials to accede to consignment storage. Due to the variability in consumption , it is crucial for the company to negotiate with suppliers the degree of discretion when replenishing these storage houses. In many cases, the input materials for the production with individual suppliers are mass-produced only on certain days of the week or the month, and it is therefore necessary, by mutual agreement with the supplier, to respect the supplier's interest to ship and deliver this material in high volume, which is contrary to the interest to replenish the storage when demanded by the production company. Only with long lasting negotiations and sustained relationship-building it can ensure

mutual economic benefits. It is thanks to long term relationships and cooperation that the company to date takes 85 percent of all materials and raw materials and essentially 100 percent of all key materials for production from the consignment storage. With each of the supplier it has negotiated a specific strategy to restock these storage houses where the primary interest of the company to restock the storage houses if demanded can be adjusted by the specifics of production on the part of the supplier. Thanks to that, the company holds only 30 percent of all corporate inventories in the stock of material, and it has almost completely eliminated the risk of material shortages.

Economic consequences of consignment stores consist in elimination of the capital locked up in inventory; nevertheless the actual cost of consignment storage is divided between the suppliers and the manufacturer. The supplier bears the cost of shipping of material (shipping is included in the agreed price of the material), only rarely is transport shipped by the purchaser of material, shipping costs depend mainly on transport distances. The suppliers also provide certificates for supplied inputs, which demonstrate compliance of parameters with the required specification. The manufacturer bears the cost of input control of purchased materials, storage costs (lighting, heating, security, maintenance, etc.), costs in connection with the registration, being responsible for loss, and pays insurance. The economic advantage is also in negotiating long maturities for the purchase of material, moreover the beginning of maturities is always determined after the material is actually taken from the storage house.

The last set of questions investigated conditions in production, which must provide the required flexibility. Not even the elimination of inventories of input materials can affect the economic burden caused by the nature of production. With the material reprocessing rate, the production time for a number of orders would exceed the required lead time, so it is necessary for the production company to create surprisingly high inventories of work in progress. With an appropriate adjustment of the production process, however, it managed to move the inventory of work in progress almost to the end of the manufacturing process, before the final operations, which are customized dimensions and packaging of the product. Even though it is a significant economic burden due to holding a broad spectrum of an almost finalized product, it is not desirable to eliminate that inventory, even though it would probably be possible to optimize the amount of the inventory (representing 65 percent of all business inventories) through mathematical modelling. The economic consequences of high inventories of work in process are undeniably negative, nevertheless due to the high rate of turnover of each inventory usually in 7-10 days (one month maximum) for the majority of key products it is an acceptable and tolerable burden.

The high costs associated with the inventories of work in progress are acceptable for the manufacturing enterprise also in terms of understanding the requirements of its customer, who is neither willing nor able to accept delivery of a high-value product where the sale has not been secured and negotiated. And similarly, a relationship is built on the input side; shifting the cost to the supplier of metallurgical materials had to be negotiated with guarantees of stability of the business relationship, the size of purchases and requirements for consistent quality of the material. Only under these conditions it would be economically feasible for the supplier to accept the consignment storage.

CONCLUSIONS

Theoretical and empirical findings and research found that the success of the strategy of building a competitive advantage based on high quality and rapid response to customer demand while minimizing working capital depends, to a large extent, on the flexibility and rate of the production process. If the rate and flexibility of production threatens the desired delivery time, the inventory of finished goods and work in progress is inevitable and economically costly. Consequently, it is desirable for the company to develop cooperation with its customers, especially in terms of demand forecasting and planning. However, the research has shown that it is often not possible to establish and develop cooperation in the sector, which means for the company to focus more on its own flexibility and collaboration with its suppliers.

If the manufacturer is limited in terms of flexibility of production, it needs to build up inventories of work in progress, but also those of the input materials. The manufacturer needs to develop cooperation with suppliers in order to manage inventory of inputs, allowing it to spread the burden of material stockholding among other participants in the supply chain. This is possible if it has a sufficient bargaining power in relation to its business partners, however, given the constraints of flexibility on the part of the supplier, a systematic and long-term cooperation and communication is necessary. The research has shown that it is worth investing effort to build long-term relationships between the manufacturer and the supplier, in order to achieve not only the stability of the material quality, but also the flexibility of supply.

The benefit, however, also consists in the understanding of the production process and economic performance of the entire supply chain. The cost of holding stock with a high financial value need to be divided equally among the participants in the logistics chain to make sure that individual links share the economically negative consequences of stockholding. Otherwise, one of the companies in the supply chain may, due to disappointing economic results, reduce or terminate its activities, thereby jeopardizing the long-term operation of the entire chain.

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