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ANALYSIS OF MATERIAL AND INFORMATION FLOWS IN THE LOGISTIC SYSTEM OF A SELECTED STEELWORKS

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Tough competition on the steel product market causes the functioning of steelworks largely to depend on their abilities to respond flexibly to the market needs and offer the right product, at the right price and in the right time. A tool which is more and more commonly used for achieving this goal is logistics. The function of logistics in a production company is the optimal shaping of the stream of materials and information flowing through the company. The article reports the result of an analysis of material and information flows on the example of a selected metallurgical enterprise.

Key words: *material flow, information flow, logistic system*

Analiza materijala i protoka informacija u logističkom sustavu neke odabrane čeličane. Jaka konkurencija na tržištu čeličnih proizvoda dovodi do toga da funkcioniranje čeličana uvelike ovisi o njihovoj sposobnosti da fleksibilno odgovore potrebama tržišta i ponude pravi proizvod po pravoj cijeni u pravo vrijeme. Sve se više koristi za postizanje tog cilja logistika. Funkcija logistike u nekom proizvodnom poduzeću je u tome da osigura optimalan protok materijala i informacija kroz poduzeće. Članak predstavlja rezultat analize protoka materijala i informacija na primjeru jednog metalurškog poduzeća.

Ključne riječi: *protok materijala, protok informacija, sustav logistike*

INTRODUCTION

The logistic system of the metallurgical enterprise is very diverse and involves the cooperation of several subsystems considerably differing from each other. Material goods appearing at the output of one subsystem (such as the steelmaking plant), as final goods, are needed at the same time at the input of another subsystem (e.g. the rolling mill) as being necessary for carrying out production activity, thus forming an internal chain of material flows.

The complexity of material and information transfer processes is the cause of various disturbances occurring between particular flow phases and their corresponding organizational units in the enterprise's structure. Analysis of those processes allows the identification of disturbances occurring in the flow and enables actions to be undertaken to improve it.

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CHARACTERISTICS OF THE ENTERPRISE AND THE MATERIAL AND INFORMATION FLOW

The metallurgical enterprise covered by this study is a leading manufacturer of hot-produced flat products in Poland with a 70 % share in the overall sales. Technologies applied in the works permit high-standard products to be obtained. The enterprise maintains contacts with numerous purchasers both home and abroad. The analysis covered two plants cooperating in the process of manufacturing the final product, namely the steelmaking plant produced semi-finished products, including flat ingots used for the production of plates, and the rolling mill producing plates. The production capacities of both plants are as follows [1]:

- the steelmaking plant - 700 thousand tons of crude steel per year,
- the rolling plant - approx. 1 million tons of rolled products per year.

The logistic system of the selected metallurgical works features strong links with the production system, which is superior to the logistic system. Coordination of flow pro-

cesses occurring within the production system is the primary task of the production & logistics manager, who, together with his subordinated personnel, assures the continuity of production. The role of this department is, above all, to adjust the production plan to the requisition submitted by the sales department, which receives orders from customers in advance.

Orders are realized in the enterprise in a traditional manner, i.e. particular processes of supply, production and sales proceed sequentially, with each of phases commencing after the preceding phase end of, which considerably lengthen the order delivery time. The first information stream is the initial steel balance prepared every month in order to define the steelmaking plant's production plans, considering demand for steel in a given period. After having been formally and substantially accepted, the order is entered into the computer files [2]. Based on the data stored in the files and on sale forecasts, and considering the production capabilities of the steelmaking plant, a plate production plan is drawn up. The specification resulting from this plan, containing the amount of charge in particular grades and formats is sent to the steelmaking plant. Orders for ingots, accepted for realization, constitute a basis for planning purchases in the steelmaking plant. About 70 % of all purchases made by the enterprise concern the steelmaking plant. Their major part, i.e. 90 % of purchased raw materials, is constant, which considerably facilitates planning.

The remaining part of materials, including alloy additions, changes depending on the grade structure of planned production. Orders are broken up and delivered by many suppliers. In the case of basic materials, the purchasing department maintains qualification lists of suppliers, which include a small group of suppliers, selected based on offers and the history of contacts with customers; however, there is no formal system enabling the assessment and classification of suppliers. In the supplies, a trade organization of stocks is functioning, which means that purchasing orders are made out by a respective trade specialist. Each time, the trade specialist contacts a chosen supplier to agree delivery details and then monitors the order until the material has been received to the store. Such an order must be at the same time accepted by the sales manager, the sales director and the board member. The flow of information is not monitored, which often results in such an order being held up at a certain organizational unit (most often at the board of management). From requisitions received from individual departments a consolidated list is created, which, upon review, becomes a monthly purchasing plan.

A characteristic feature of the steelmaking plant is the occurrence of a large number of storage yards (with scrap in different classes, pig iron, lime, ferroalloys, etc.). The stocks are kept at the level of so-called the minimum stock on hand, whose level is determined at a rough approximation. The steelmaking plant's costs account for approx. 60 % of the enterprise's overall costs; therefore, it is essential that particular consideration be given to the proper organization of purchases and the storage and management of supply materials.

However it is also noteworthy that inquiries placed by customers, except for those accepted for realization in a particular period, are not recorded. There is no customer database, which would contain basic information on the customer. No actual market studies are conducted, neither, which could determine customer needs and help to search for new customers.

The transport of charge materials between the steelmaking plant and the rolling mill takes place by rail on short distances, if both plants are situated in the same location. The lead-time of an order for charge delivery is 1 day. The percentage of deliveries conforming to the order was 82,7 % last year. The remaining charge was also fully utilized by the rolling mill. The causes of nonconformities[1] being the steelmaking plant's fault include [3]:

- shrink holes (0,002 %),
- cracks (0,023 %),
- weight not conforming to the order (2,6 %),
- the last slab in a sequence (1,4 %),
- an incompletely cleaned slab (2,9 %),
- a transitory slab (4,3 %),
- other causes (10,3 %).

Irregularities in the flow of materials between the plants under consideration concern most often deliveries inconsistent with the order. Any deviations from the adopted plan, relating to the properties of the ordered material, create a necessity of utilizing this material, and this most often means the making of a finished product, for which a purchaser will have to be searched for.

Plates are manufactured as:

- crude (40 %),
- normalized (52 %), and
- toughened (8 %).

The average delivery time of an order for plates is 30 days, being dependent on:

- the plate ordered (for regular customers or those paying in cash, time priorities are adopted, with the order delivery time in this group -of customers not exceeding 14 days),
- the grade of steel of which the plate was made,
- plate dimensions,
- heat treatment type,
- rolling mill production capabilities,
- steelmaking plant production capabilities.

[1] Nonconformity is a failure to meet specified requirements related to physicochemical, mechanical or dimensional characteristics.

Internal disturbances in the flow of materials concern products requiring an explanatory procedure to be completed and products waiting reworking. In this situation, a need of the storage of those materials arises, which, to a large extent, contributes to making the control of material flow difficult. The most common causes of occurring irregularities included:
- surface flakes, or formless metal surface layers,
- either unbound or only partially bound with the bulk of metal - (0,1 % of nonconforming feedstock),
- cracks on the surface or at the edges - (1,05 %),
- plates too short or too narrow after the defect has been cut out - (1,7 %),
- blowholes - (0,01 %),
- material discontinuities revealed during ultrasonic testing (internal material defects) - (0,7 %),
- pits + indents + scratches - (0,06 %).

CHARACTERISTICS OF FINISHED PRODUCT SALES

The range of products manufactured in the analyzed metallurgical enterprise includes:
- shipbuilding plates (32 %),
- boiler and pressure equipment plates (5 %),
- large-diameter pipeline plates (1 %),
- special plates (2 %),
- constructional plates of enhanced strength (25 %),
- constructional plates of ordinary quality (35 %).

These are plates of the following sheet dimensions:
- thickness - 6 - 40 mm (and plates of up to 150 mm in thickness),
- width - 1500 - 3150 mm,
- length - 500 - 12000 mm (with a possibility of up to 18000).

Last year's sales totaled to 350 thousand tons (214 grades, and over 1000 purchasers). The sale was conducted through two basic distribution channels: direct sale and sale through agents. The activity of agents included purchasing finished or semi-finished products, as a rule, in large amounts, and then reselling them to end purchasers in smaller batches, diversified in terms of product range, or reselling them directly to end users. The sale of plates in the domestic market was conducted, above all, based on:
- yearly framework delivery contracts with terms and conditions specified for quarterly periods,
- orders and order confirmations.

Distribution of the flow of plates through respective distribution channels in Poland is shown in Table 1.

Comparison of the data shows that the main plate distribution channel was the direct sale to end users (50,8 %). A relative large share in the sales, i.e. above 43 %, belonged to independent agents. This is an unfavorable situation, as the product reaches a customer unknown to the steelworks and at higher prices (increased by the agent's margin).

Table 1. **Distribution of the flow of plates through respective distribution channels / %**
Tablica 1. **Raspored protoka limova odgovarajućim kanalima (u %)**

	End users	Wholesalers with their own store houses	Agents without store houses
Contracts	26,6	4,8	11,2
Without contracts	24,2	1,2	32,0

Export sale (29 %) was conducted under contracts for the delivery of plates with defined specifications through domestic or foreign agents.

About 20 % of the sales value was gained thanks to two main customers of the analyzed enterprise. In turn, the value of sales for other twelve purchasers accounted for 1 to 6 %, whereas the sale to the remaining purchasers did not exceed 1 % of the sales value. Last year, 0,63 % of the market was a lost for competitors.

The enterprise under study strives for a situation, where production will be realized in such an amount, as indicated by orders placed by purchasers. In that case, there is usually no need for prolonged storage of finished products. Such a need appears at manufacturing of plates for which there is no demand at a particular moment. Over the year, there are several thousand tons of plates in average the finished-product storage area, for which there are no orders. These are plates occurred as a result of [4]:
- over-rolling, where e.g. an order for two plates was received, while three plates were obtained because of the divisibility of the rolled strip,
- a customer giving up the order,
- an nonconformity due to failing to achieve specified parameters, or occurred defects,
- waiting for domestic and foreign receipts,
- fragmentation - single sheets intended for small-sized purchasers are rolled at different times and are thus required to be completed,
- errors in identification,
- recovery of good plates of smaller overall dimensions from a larger plate which had a defect possible to be cut out.

As a result of occurred nonconformities or technological allowances, small-format plates occur, which also await purchasers. A main problem in the management of the plate storage in the rolling mill is the absence of detailed real-time information of the place of storage of particular plate sheets. A computer system is operated in the department,

which contains detailed data on each plate sheet (such as the melt number, steel grade, dimensions, quality parameters, etc.) in its databases. There is no system in place, however, that would enable the unique identification of the position of a single plate sheet, which, to a considerable extent, makes the management of the finished-product storage area difficult.

SUMMARY

The flow of materials and information in the studied enterprise is entirely subordinated to the production function, which is a considerable obstacle to the development of logistic activity toward the integration of all areas of the enterprise's activity. Disturbances in flow appear between particular flow phases (such as supplies, production and sales), where the absence of integration of logistic processes and functions is conspicuous. An added difficulty is the lack of a separated organizational unit with responsibility for logistics.

At the same time, the following conclusions have been drawn from the analysis:

- the enterprise should strive for concluding long-term contracts with raw-material suppliers, particularly in the case of regular purchases. At the same time, orders should be properly grouped and placed with a smaller number of suppliers, which will increase the bargaining power of the steelworks;
- problems related to the correct management of finished-product stocks and the distribution system require special attention. The analyzed enterprise should attempt to eliminate unnecessary intermediate links. For some agents, and particularly wholesalers constituting an important link of the enterprise's logistic distribution channels, greater emphasis should be placed on the need of - developing a better cooperation with them;
- it is possible to shorten the order lead time by improving the flow of information and the coordination of deliveries;
- a difficult situation in the metallurgical industry and the poor financial condition of some enterprises hampers the implementation of concrete logistic solutions to improve the performance of particular areas of the enterprise.

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