E. STANIEWSKA

ISSN 0543-5846
METABK 46 (2) 141-144 (2007)
UDC - UDK 669.1.013.5:658.5/.7=111

THE LOGISTICS OF THE STRATEGIC MATERIALS SUPPLY IN THE METALLURGICAL ENTERPRISE

Received - Primljeno: 2006-06-21
Accepted - Prihvaćeno: 2006-08-20
Professional Paper - Strukovni rad

In conditions of market economy the supply has to achieve new challenges because the quality and efficiency of functioning in this area influences in a large degree all fields of enterprise activity and its results. The supply issue and the cost reduction should be one of the basic elements of the enterprise strategy. In the article the purchase policy and supply aspects of logistics in strategic materials in the metallurgical enterprise are discussed.

Key words: *strategic materials supply, purchasing policy, steel plant, forecasting*

Logistika strateške opskrbe materijalima u metalurškom poduzeću. U uvjetima tržišne ekonomije opskrba mora ispuniti nove izazove, jer kvaliteta i efikasnost/funkcioniranje u ovom području uvelike utječe na sva područja aktivnosti poduzeća i na njegove rezultate. Opskrba i smanjenje troškova trebaju biti među osnovnim elementima strategije poduzeća. U članku se raspravlja o aspektima politike nabave i aspektima dobave logistike strateških materijala u metalurškom poduzeću.

Ključne riječi: *opskrba strateškim materijalima, politika nabave, postrojenje za prerađivanje čelika, predviđanje*

INTRODUCTION

Within its activity, a metallurgical undertaking must be supplied with materials and raw materials from the outside and the quality and economic impact of the supplies may determine the quality of the final product and the financial performance of the company.

Particularly in the supply phase, there are considerable possibilities of control; therefore the assurance of the proper quality of purchased materials is one of the priorities of the Purchasing Department of a Still Mill. Within quality assurance, the main objectives of the Purchasing Department include the selection of appropriate suppliers and delivery control.

The level of detail of procedures applied in the selection of supply sources (suppliers) must, however, correspond to the role and relevance of a particular material in the undertaking's economics. Assortment items constituting the crucial component of material costs require detailed (analytical) procedures for the selection of supply sources. A definite majority of materials do not require detailed procedures, and the criterion of selection may be the price and ease of purchase.

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Thus, the basis for the formulation of policy concerning the purchases of strategic materials of an metallurgical undertaking should be a detailed analysis of the supply situation. To this end, it should be necessary to: identify critical (strategically important) materials, analyze the sources of demand coverage and decide on the rules of cooperation with suppliers. Factors that are indispensable in the case strategic materials include:

- involvement of the highest-level management in the undertaking in decision-making related to supplies,
- good knowledge of the market (detailed market analyses and studies) and suppliers,
- close cooperation with suppliers (creation of a logistic supply chain), long-term and stable partnership relationships,
- long-term demand and supply forecast,
- applying any possible methods aiming at optimization,
- strict logistic control (the purchasing process, inventories, suppliers).

Of fundamental importance for the policy of maintaining inventories is the selection of the appropriate method of forecasting demand. Therefore, an essential issue in the logistics of supply is to define the character of material demand in a metallurgical undertaking by means of selected forecasting methods.

PURCHASING POLICY IN THE SELECTED METALLURGICAL UNDERTAKING

The strategic importance of supply results from the fact that it encompasses several activities, including qualifying suppliers, purchasing materials and monitoring execution. The supply process in the undertaking under study can be represented as a set of activities, comprising: occurrence of a demand, defining and assessing of the user's needs, making a decision on the purchase of a particular good, defining the type of purchase, performing market analysis, defining potential suppliers and making their preliminary selection, carrying out the purchasing process and receiving the product delivery.

Within the framework of purchasing policy, the Purchasing & Supply Office of the metallurgical undertaking under consideration has classified the materials in terms of the effect of particular materials on the financial result and importance for the production. The consequence of this selective approach has been the isolating material groups that are subject to more or less strict rules of purchase control. The differential treatment of individual material groups allows the reduction of purchase-related expenditures, which has a substantial influence on the reduction of costs incurred in the storage process. At the same time, a group of strategic materials have been distinguished, which play a decisive role in assuring the continuity of the production process and substantially contribute to the economic performance of the company, while being characterized by a periodically occurring risk associated with their acquisition. Such materials include chiefly:

- metallic scrap - due to repeating periodical shortages of this raw material, caused either by its excessive exports or by withholding deliveries until a price advantageous to the seller has been negotiated, the policy of maintaining a larger stock of this material has been put in place;
- HBI (iron-bearing material) briquettes - on account of a great distance from the producer's site and a related long delivery time, and in order to reduce the freight costs, it has been decided that the optimal batch of delivered material should amount to 3000 tonnes, therefore the maintained stock of HBI briquettes is much higher than that of e.g. ferroalloys.

In the metallurgical undertaking under analysis, two supply units function, namely:

- the Scrap Purchasing Office - involved solely in the purchase of steel scrap,
- the Purchasing and Supply Office - that carries out purchases of the remaining materials.

The strategic material supply market can be characterized as territorially dispersed, which has a considerable influence on supply costs. However, owing to the synchronization of the assortment production and the material delivery schedules, the Purchasing and Supply Office quite effectively prevents the accumulation of excessive stocks.

Planning of the purchasing volumes of steel scrap and the remaining strategic materials, as well as other assortment items of considerable impact on the financial result is carried out using a computer program (forecasting purchases) and involves drawing up an annual, a monthly and a weekly assortment plans and handing it over to the Purchasing Offices. Based on the plan and the data and indices of consumption of particular materials, material requirements are established and a supply schedule is drawn up. Data on the consumption and supplies of materials are entered to the computer program on an ongoing basis, and on this basis any revisions of the supply schedules are made, as required. When establishing material requirements, the following are also taken into account:

- the lead time,
- the minimum stock of a given material,
- the optimal size of the delivery batch.

QUALIFICATION AND ASSESSMENT OF SUPPLIERS IN THE METALLURGICAL UNDERTAKING

The main objective of the undertaking's Supply is to find material suppliers, who guarantee supplies to conform to the requirements, be delivered on time and in agreed amounts, are capable of introducing modifications to orders even shortly before their delivery, and maintain readiness for completing an incomplete or nonconforming delivery at a competitive price.

An adopted rule applicable within the quality assurance in the Steel Mill under discussion is to carry out the supplies of scrap, metallic and non-metallic additives, graphite electrodes and process consumables only from qualified suppliers.

In the framework of the procedure for the qualification of a supplier meeting the most important criteria, or the quality criteria, a "Supplier Assessment Questionnaire" has been prepared in the Steel Mill, which contains questions concerning chiefly the supplier's Quality Assurance System.

Responses received in the Questionnaire are used for assessing a particular supplier and putting him on the qualification list. In the case of regular suppliers, criteria concerning the quality, the price level and the timeliness of deliveries play a decisive role. The weight of each criterion in supplier assessment is shown in Figure 1.

The condition for putting a supplier on the Qualified List A is obtaining by him a mark in the range of 29 - 38 scores, as well as a minimum of 7 scores from the assessment of quality during reworking. In the case of a supplier obtaining a mark in the range of 15 - 28 scores, he can be put on the Reserve List B. Obtaining a result below 15 scores gives grounds for crossing the supplier in question off the list of suppliers to the Steel Mill.

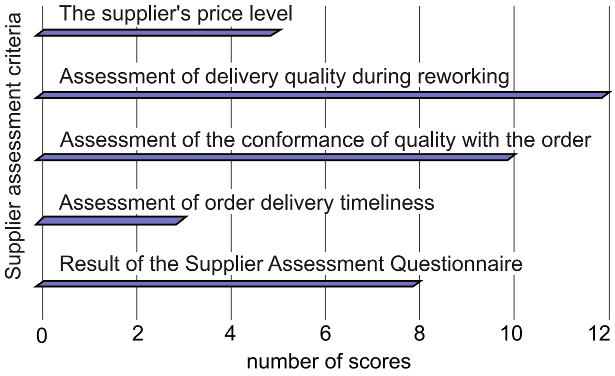

Figure 1. **Supplier assessment criteria adopted in the metallurgical undertaking**
Slika 1. **Postavljanje kriterija opskrbe prilagođene u metalurškom poduzeću**

FORECASTING OF MATERIAL DEMAND

The main objective of forecasting in the economy is to evaluate the probability of occurrence of economic developments and processes in the future. One of the areas requiring the application of forecasting is the sphere of supply. Establishing the demand is, at the same time, on of the most difficult logistic problems. At present, however, owing to the widespread use of computers and a wide range of specialist IT programs, forecasting methods have dynamically developed.

Table 1. **Characterization of selected forecasting methods [2, 3]**
Tablica 1. **Karakteriziranje odabranih metoda predviđanja [2, 3]**

Forecasting method characteristics	Forecast equation	Forecast equation estimators
Brown model	$\hat{y}_{t+T} = a_t$	$a_t = \alpha y_{t+T} + (1-\alpha)a_{t-1}$
Holt model	$\hat{y}_{t+T} = a_t + b_t T$	$a_t = \alpha y_t + (1-\alpha)(a_{t-1}+b_{t-1})$ $b_t = \beta(a_t+a_{t-1}) + (1-\beta)b_{t-1}$
Winter model	$\hat{y}_{t+T} = (a_t + b_t T)S_{t-K+T}$	$a_t = \frac{\alpha y_t}{S_{t-K}} + (1-\alpha)(a_{t-1}+b_{t-1})$ $b_t = \beta(a_t+a_{t-1}) + (1-\beta)b_{t-1}$ $S_t = \frac{\gamma y_t}{a_t} + (1-\gamma)S_{t-K}$

Inventory control in supply is a repeatable process which, in fact, runs in an operational scale, thus short-term forecasting of demand should play an essential role. The choice of a proper demand forecasting method is of fundamental significance in the policy of maintaining of stocks. A high forecasting accuracy, or small deviations of the actual demand from the forecast value, enables the reduction of safety stocks. It is therefore advisable to explore the possibility of applying selected forecasting methods and then to choose the optimal method for the specific character of the steel plant's material demand. The models that have enjoyed great popularity in recent years include models relying on the so called exponential equation of time series, initiated by R.G. Brown [1].

The models applied in the case of the steel plant under discussion included: forecasting with the use of the movable arithmetic mean, and Brown's (the stationary time series forecasting method), Holt's (allowing for significant trend changes) and Winter's (allowing for the seasonality phenomenon) models. The characterization of the forecasting methods used in the study is given in Table 1., where:

- y_t - last execution of the forecast variable,
- a_{t-1} - means, as calculated exponentially after the periods t and $t-1$,
- b_t, b_{t-1} - trend change means, as calculated exponentially after the periods t and $t-1$,
- S_t - seasonality index,
- α, β, γ - exponential equation parameters taking on values from the range <0;1>,
- $\hat{y}_{t+T}$ - forecast of the variable y in the period $t+T$ (for $T = 1, 2, ...$).

Table 2. **Results of material demand forecasting using selected forecasting methods**
Tablica 2. **Rezultati predviđanja potražnje za materijalom pomoću odabranih metoda predviđanja**

Material	Forecasting model	Forecasting measures		
		$\bar{e}_t$	s_t	V / %
Scrap	Mov. arith. mean	7003,1	18028,0	18,6
	Brown model	3502,2	13292,7	13,7
	Holt model	2049,7	13597,0	140
	Winter model	24,0	136,1	0,2
Iron - bearing charge mater.	Mov. arith. mean	90,3	1022,2	38,4
	Brown model	– 58,1	879,3	33,1
	Holt model	– 20,3	887,0	33,4
	Winter model	1,94	105,9	3,9
Ferromanganese	Mov. arith. mean	38,5	100,1	18,6
	Brown model	16,2	80,3	14,9
	Holt model	8,9	83,0	15,4
	Winter model	0,1	0,85	0,2
Ferrosilicon	Mov. arith. mean	11,0	59,5	21,6
	Brown model	90,0	59,5	21,6
	Holt model	3,7	62,0	31,0
	Winter model	0,1	2,1	0,8
Graphite electrodes	Mov. arith. mean	10,2	59,9	300,0
	Brown model	6,8	49,8	24,9
	Holt model	2,9	520,0	260,0
	Winter model	0,1	1,4	0,7

The selection of the optimal values of the exponential equation parameters α, β, γ - in particular forecasting models was determined by the trial and error method, where the objective was to obtain the smallest magnitudes of forecasting errors.

Material demand forecasting for selected strategic materials was carried out for real time series, as recorded within a period of three years. The results of forecasting using selected forecasting methods are given in Table 2. The basic measures used in the evaluation of forecasting accuracy were:

$\bar{e}_t$ - mean forecast error,
s_t - standard forecast error,
V - relative variation coefficient.

The basic forecast measures given in Table 2., as obtained by using selected forecasting methods, indicate that only Winter's method yields satisfactory results for the analyzed time series of demand for selected materials. At the same time, the obtained results indicate the lack of grounds for applying forecasting models that allow for significant changes in the trend of activity of the steel plant chosen.

CONCLUSION

Mutually advantageous interrelations between the undertaking and its suppliers enhance the ability of the both parties to create the added value and to shape the quality.

The selected supply-related problems encountered in the metallurgical undertaking, discussed in the present paper, allow the improvement of utilization of financial resources and the reduction of funds frozen in inventories without impairing the continuity and reliability of supplies.

The selection of a forecasting method appropriate for the specific character of the steel plant's demand enables the optimization of the inventory level in the supply sphere. In developing forecasts for the determination of safety stocks, the forecast mean value and the standard error can be used; the higher demand forecast and forecast error, the higher safety stocks must be assumed.

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