THE LOGISTICS OF THE STRATEGIC MATERIALS SUPPLY IN THE METALLURGICAL ENTERPRISE

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 Steel 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.

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 receiv-
ing the product delivery.

Within the framework of purchasing policy, the Purchas-
ing & 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 expendi-
tures, 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 pur-
  chase of steel scrap,
- the Purchasing and Supply Office - that carries out pur-
  chases of the remaining materials.

The strategic material supply market can be character-
ized as territorially dispersed, which has a considerable
influence on supply costs. However, owing to the syn-
chronization 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 re-
quirements 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 require-
ments, 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 assur-
ance 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 con-
cerning 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 assess-
ment 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.

The supplier's price level
Assessment of delivery quality during reworking
Assessment of the conformance of quality with the order
Assessment of order delivery timeliness
Result of the Supplier Assessment Questionnaire

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, one 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.

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].

Table 1. Characterization of selected forecasting methods [2, 3]

<table>
<thead>
<tr>
<th>Forecasting method characteristics</th>
<th>Forecast equation</th>
<th>Forecast equation estimators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown model</td>
<td>( \hat{y}_{t+1} = a_t )</td>
<td>( a_t = y_{t-1} - (1-\alpha)a_{t-1} )</td>
</tr>
<tr>
<td>Holt model</td>
<td>( \hat{y}_{t+1} = a_t + b_tT )</td>
<td>( a_t = y_{t-1} + (1-\alpha)(a_{t-1} + b_{t-1}) ), ( b_t = \beta(a_t + a_{t-1}) + (1-\beta)b_{t-1} )</td>
</tr>
<tr>
<td>Winter model</td>
<td>( \hat{y}<em>{t+1} = (a_t + b_tT)S</em>{x,t} )</td>
<td>( a_t = \alpha y_{t-1} + (1-\alpha)(a_{t-1} + b_{t-1}) ), ( b_t = \beta(a_t + a_{t-1}) + (1-\beta)b_{t-1} ), ( S_{x,t} = \gamma y_{t-1} + (1-\gamma)S_{x,t-1} )</td>
</tr>
</tbody>
</table>

Table 2. Results of material demand forecasting using selected forecasting methods

<table>
<thead>
<tr>
<th>Material</th>
<th>Forecasting model</th>
<th>Forecasting measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scrap</td>
<td>Mov. arith. mean</td>
<td>Mov. 7003,1 18028,0 18,6</td>
</tr>
<tr>
<td></td>
<td>Brown model</td>
<td>3502,2 13292,7 13,7</td>
</tr>
<tr>
<td></td>
<td>Holt model</td>
<td>2049,7 13597,0 140</td>
</tr>
<tr>
<td></td>
<td>Winter model</td>
<td>24,0 136,1 0,2</td>
</tr>
<tr>
<td>Steel</td>
<td>Mov. arith. mean</td>
<td>Mov. 90,3 1022,2 38,4</td>
</tr>
<tr>
<td></td>
<td>Brown model</td>
<td>-58,1 879,3 33,1</td>
</tr>
<tr>
<td></td>
<td>Holt model</td>
<td>-20,3 887,0 33,4</td>
</tr>
<tr>
<td></td>
<td>Winter model</td>
<td>1,94 105,9 3,9</td>
</tr>
<tr>
<td>Ferromagnesite</td>
<td>Mov. arith. mean</td>
<td>Mov. 38,5 100,1 18,6</td>
</tr>
<tr>
<td></td>
<td>Brown model</td>
<td>16,2 80,3 14,9</td>
</tr>
<tr>
<td></td>
<td>Holt model</td>
<td>8,9 83,0 15,4</td>
</tr>
<tr>
<td></td>
<td>Winter model</td>
<td>0,1 0,85 0,2</td>
</tr>
<tr>
<td>Ferro silicon</td>
<td>Mov. arith. mean</td>
<td>Mov. 11,0 59,5 21,6</td>
</tr>
<tr>
<td></td>
<td>Brown model</td>
<td>90,0 59,5 21,6</td>
</tr>
<tr>
<td></td>
<td>Holt model</td>
<td>3,7 62,0 31,0</td>
</tr>
<tr>
<td></td>
<td>Winter model</td>
<td>0,1 2,1 0,8</td>
</tr>
<tr>
<td>Graphite electrodes</td>
<td>Mov. arith. mean</td>
<td>Mov. 10,2 59,9 300,0</td>
</tr>
<tr>
<td></td>
<td>Brown model</td>
<td>6,8 49,8 24,9</td>
</tr>
<tr>
<td></td>
<td>Holt model</td>
<td>2,9 520,0 260,0</td>
</tr>
<tr>
<td></td>
<td>Winter model</td>
<td>0,1 1,4 0,7</td>
</tr>
</tbody>
</table>
The selection of the optimal values of the exponential equation parameters $\alpha$, $\beta$, $\gamma$ - 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:

$\hat{\varepsilon}$ - mean forecast error,
$\chi$ - standard forecast error,
$\nu$ - 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.

**REFERENCES**