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Role of Market Demand and Added Value in Optimizing the Iron Products

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Abstract

In today's industrial and competitive world, the optimal use of time, resources, and timely and correct response to market needs are crucial. On the other hand, the importance and necessity of optimizing production based on market demand will reveal the need to manage high-value-added products. Regarding this fact that the steel industry is one of the basic industries and has a great influence upon the other industries, its productivity can affect itself as well as the other industries. The scope of this study is Isfahan Steel Corporation which is considered as one of the greatest plants throughout the country manufacturing steel products such as iron beams. Thus in this study, the corresponding documents and proofs were examined to optimize the beam products of Isfahan Steel Corporation based upon the market demand and increased value, and considering the records, opinions of production and sale experts, customers, and suppliers, a questionnaire was prepared to estimate the types of beam and distributed among customers and suppliers and analyzed. Then, the added value of beams was calculated and finally, the number of beam products was calculated based on estimated market demand using the model ARIMA.

1 Introduction

In many industries, the amount of production is not tuned with the market demand. In other words, either the production rate is so high that causes the capital of the company is wasted and leads to more costs such as storing the excess supply or the production rate is lower than the demand rate that leads to lose the customers and the market share [1,2]. On the other hand, the companies' management does not pay necessary attention to manufacture the products with high added values. So, this study tries to optimize the production rate based on the demand market and added value [3,4]. To achieve these goals, the following approaches are done:

1. Gathering, recording, calculating and analyzing data and information.
2. Preparing the questionnaires to estimate the demand of beam types.
3. Calculating the added value.
4. Modelling.

We discuss about the above items in the following sections.

2 Gathering, recording, calculating data and information

The process of gathering, recording and calculating data and information was done as follows:

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1. Extracting and calculating the data related to the sale rate of beams from the documents and proofs of the company and metal stock exchange.
2. Extracting and calculating the data related to the price rate of beams from the documents and proofs of the company and metal stock exchange.
3. Extracting and calculating the data related to the demand rate of beams from metal stock exchange.
4. Calculating the costs of raw materials, energy and fuels, amortization and other paid costs such as office costs and sale department and so on.

3 Preparing the questionnaires to estimate the demand of beam types

we know that the definition of the market demand is: the whole market demand for a production consists of the whole amount of products which is purchased by finite customers in a finite geographic region at a defined period of time, under the clear marketing environment and determined marketing program [5,6]. To design and prepare the questionnaire, the first step was to examine and study a great deal of literature, books, and researches related to the demand estimation, then some interviews were done with the production and sale experts, suppliers and customers. By summing up the researches and studies and views of above persons, a questionnaire prepared with 7 items and each item included 5 properties: size (usual, special), length (standard, normal), cross section (H, I), type of beam (rolled, plate), and the manufacturer. In estimating the type of beam, the following qualitative methods were used:

1. Examining the sale personnels' views (suppliers and mediators).
2. Examining the aims and goals of customers (potential purchasers).

The questionnaires were offered to 10 purchasers of Isfahan Steel Corporation (the major whole salers of the beams). The validity for the questionnaire of demand estimation was estimate 0.944 indicating the high validity for the used tool. To validate the questionnaire, it was used the content validity. The content validity is a test usually used by the experts in the subject. So the content validity is depending to the experts' opinions.

3.1 Results from estimation questionnaire for demand of beam type

After gathering the data through the questionnaire, they were analyzed by Excel and SPSS software and the following results were obtained for beams according to the above mentioned properties: common size, standard length, **I** cross section, and rolled beams: Common sizes were 14, 16, and 18. The standard length was 12 meter. Therefore, regarding the results, the beams of **I** form with the sizes 14, 16, and 18 and 12 meter in length were requested more by the customers.

4 Calculating the added value

We know that definition of the added value is as follow: it is the surplus of the value which is added to the goods during each process of the production procedure [6-8]. To calculate the added value, the various forms of beams were categorized according to their sizes in 9 categories. The sizes were 12, 14, 16, 18, 20, 22, 24, 27, and 30. The method of calculation was based on the following formula:

added value = net sale rate - [(wear costs + expenditures + raw materials' costs) + (stock at the beginning of the year - stock at the end of the year ± adjustments of added value)].

4.1 Categorizing the parameters of the formula for calculating the added value

Net sale rate = (gross sale) - (selling the returned items and discounts)

Paid costs = (office and sale department costs + common costs of production and paid expenditure) - (costs added to the manpower share + amortization costs)

Amortization costs = (amortization costs related to the production costs) + (amortization costs related to the office and sale department costs)

Stock at the beginning of the year/ Stock at the end of the year = stock at the beginning and the end of period (produced goods, purchased goods, and goods in the production procedure)

Adjustment rate of added value = the rate of adjustment of sale amounts or sale costs, transferred amounts to the other accounts and the difference of costs and adjustments by adding or reducing the shortfalls.

The added value of beam produced by Isfahan Steel Corporation in 9 groups was calculated based on the size in 1384 and 1385 and is shown in the table 1.

5 Designing the model

The ARIMA was first developed in the late 60s but was systemized by Box and Jenkins in 1976. ARIMA can be more complex to use than other statistical forcasting techniques, although when implemented properly can be quite powerful and flexible [8-14].

The method for designing an optimizing model for production of beams based on market demand and added value was investigated. It should be noted that the optimization of the rate and the type of beam production is performed based on the demand estimation and considering the added value. The designed model for Isfahan Steel Corporation was ARIMA. This model is designed based on optimized demand function. The independent and key variables of the model include:
1- The demand rate of beams in previous months or years.
2- The added value of beams in previous years.

Row	Type of beam	AV in 1384	AV in 1385
1	I12	2084091600	1867054000
2	I14	9234718480	148307000000
3	I16	79679629180	133706000000
4	I18	65004619332	102472000000
5	I20	11419137529	20822341874
6	I22	808336035	28755233302
7	I24	8132184247	11978187892
8	I27	10131582878	13714483260
9	I30	3533696870	130801090

Table 1: Added Value (AV) of beam through 1384 and 1385.

The construction of an ARIMA model follows a methodology which is well-known. In the first phase the model is identified, then its parameters are estimated and, finally, the model is validated and possible corrections are identified on the bases of the residuals obtained. An ARIMA $(p,d,q)(P,D,Q)s$ indicates a model with p-order autoregressive(AR) operators, q-order MA (Moving Average) operators, d-order differencing operator. Analogously for the seasonal component, if present, P and Q indicate the order of seasonal AR and MA operator and D the order of seasonal differencing operator with period s. Optimal designing model for Isfahan Steel Corporation is ARIMA model as follows:

$$Z_t^* = W_{1,t-1}W_{2,t-1}...e^{N_t}$$

in which Z_t^* is the total optimized demand forcasting in real terms, $W_{1,t-1}$ is beam demand of preceding year, $W_{2,t-1}$ is beam added value of the preceding year and e^{N_t} is amount of error. Now, we convert the the above model to a the linear logarithm model. The various models of ARIMA were tested. Finally, the model ARIMA (2, 1, 0) with the lowest standard error was obtained. That is

$$Y_t^* = f(c, I_{14,t-1}^*, I_{16,t-1}^*, I_{18,t-1}^*, I_{20,t-1}^*, V_{1,t-1}) * ARIMA(2,1,0)$$

In this model the variables are
Y_t^* = log (Y_t) = estimating the whole optimized demands per year t.
Log $(I_{14,t-1}) = I_{14,t-1}^*$ = the amount of demands for beam no. 14 in previous year.
Log $(I_{16,t-1}) = I_{16,t-1}^*$ = the amount of demands for beam no. 16 in previous year.
Log $(I_{18,t-1}) = I_{18,t-1}^*$ = the amount of demands for beam no. 18 in previous year.
Log $(I_{20,t-1}) = I_{20,t-1}^*$ = the amount of demands for beam no. 20 in previous year.
$V_{1,t-1}$ = the amount of added value for the previous year.
c = constant value.
In model ARIMA (2, 1, 0), the number 2, 1, 0 indicate the order of auto-regression, the order of difference, and the order of average movement, respectively.
The results from solving the model by SPLUS is as follows: $Y_{1386}^* = 11542216$ means that the estimated optimized demand for whole beams in the end of 1386 is equal to 11542216. To calculate the amount of optimized demand for the all type of beam at the end of 1386, a simple regression model was established between the variables $I_{12,t}, I_{14,t}, I_{16,t}, I_{18,t}, I_{20,t}, I_{22,t}, I_{24,t}, I_{27,t}, I_{30,t}$ and Y_t. The results are as follow:

$$\begin{aligned}
Y_{12,t}^* &= 5426 - 0.002Y_t^* \\
Y_{14,t}^* &= -31135 + 0.39Y_t^* \\
Y_{16,t}^* &= -15563 + 0.298Y_t^* \\
Y_{18,t}^* &= -1535 + 0.198Y_t^* \\
Y_{20,t}^* &= 5297 + 0.026Y_t^* \\
Y_{22,t}^* &= 5262 + 0.035Y_t^* \\
Y_{24,t}^* &= 14128 + 0.026Y_t^* \\
Y_{27,t}^* &= 11628 + 0.028Y_t^* \\
Y_{30,t}^* &= 6489 - 0.004Y_t^*
\end{aligned}$$

According to the regression model and substituting Y_{1386}^* in above formulas, the amount of demand for each type of beam at the end of 1386 is obtained. ($I_{14,1386}^*$: the estimated optimized demand for beam no.14 at the end of 1386). In the above regression models, it is seen that the coefficient of Y_t^* in beams $I_{12,t}$ and $I_{30,t}$ is negative.

Also with substituting Y^*_{1386} in their regression model, the estimated optimized demand for these beams will be negative. It can be said that the model ARIMA(2, 1, 0) has not estimated any amount for beams $I_{12,t}$ and $I_{30,t}$. The amount of estimated optimized demand for beams $I_{14,t}, I_{16,t}, I_{18,t}, I_{20,t}, I_{22,t}, I_{24,t}, I_{27,t}$ at the end of 1386 is as follows:

$$
\begin{aligned}
Y^*_{14,1386} &= 4470329 \\
Y^*_{16,1386} &= 3424017 \\
Y^*_{18,1386} &= 2283823 \\
Y^*_{20,1386} &= 305394 \\
Y^*_{22,1386} &= 409239 \\
Y^*_{24,1386} &= 314225 \\
Y^*_{27,1386} &= 334810
\end{aligned}
$$

6 Results

From the above modeling we get the following results.

1. $Y^*_{14,1386} = 4470329$ means that the estimated optimized demand for total beams in the end of 1386 is equal to 11542216 and the amounts of the estimated optimized demand per ton for beams $I_{14,t}, I_{16,t}, I_{18,t}, I_{20,t}, I_{22,t}, I_{24,t}, I_{27,t}$ at the end of 1386 are as above. So, to optimize the production of beams, it is better to produce the amount of beams according to the estimated demands.

2. Considering the results from the linear regression model, it can not estimate any optimized demand for I_{12} and I_{30} . Therefore, according the falling trend of the added value of beams I_{12} and I_{30} and the loss of demands for this type of beams, it can conclude that it is better to produce little or no amount of this type of beams.

3. The added values of any type of beams and of whole beams were calculated for 1384 and 1385. Based on the found results, the added value for beams I_{12} and I_{30} reduced and the added value for beams $I_{14,t}, I_{16,t}, I_{18,t}, I_{20,t}, I_{22,t},$ and $I_{27,t}$increased comparing to 1384 and 1385.

4. In general, the added value of all type of beams for 1384 and 1385 was calculated 280415000000 and 462022000000, respectively. So, the added value of all type of beams for 1385 versus the same for 1384 has increased by 64 % and this indicates that the trend was ascending.

5. According to the general formula for added value, it was established a simple linear regression which showed the relation between the costs and the sales with increased value. The results from regression showed that the material cost had the greatest share in decreasing the added value by a coefficient of -1.38.

Appendix

The back-shift operator, B, is very useful for the notation of ARIMA processes. The B operator shifts the time of the series one step back so that $BY_t = Y_{t-1}$ or in general $B^iY_t = Y_{t-i}$. With the back-shift operator the first order differencing of a time series results $Y_t - Y_{t-1} = (1 - B)Y_t$. The first differencing of a time series is necessary to remove a linear trend if it is present. In the ARIMA modelling, the time series must be stationary which, in simple terms, means that the mean, variance and autocovariance of the series do not depend on time. With the back shift operator the following definitions can be used:

the d-order differencing operator:

$$(1-B)^d$$

the p-order AR operator:

$$\varphi(B) = 1 - \varphi_1 B - \varphi_2 B^2 - \ldots - \varphi_p B^p$$

the q-order MA operator:

$$\theta(B) = 1 - \theta_1 - B - \theta_2 B^2 - \ldots - \theta_q B^q$$

the D-order seasonal differencing operator with period s:

$$(1-B^s)^D$$

the P-order seasonal AR operator:

$$\phi(B^s) = 1 - \phi_1 B^s - \phi_2 B^{2s} - \ldots - \phi_p B^{Ps}$$

the Q-order seasonal MA operator:

$$\Phi(B^s) = 1 - \Phi_1 B^s - \Phi_2 B^{2s} - \ldots - \phi_Q B^{Qs}$$

Using these definitions, the general ARIMA$(p,d,q)(P,D,Q)_s$ process for time series Y_t is

$$\varphi(B)\Phi(B^s)(1-B)^d(1-B^s)^D Y_t = C + \theta(B)\Phi(B^s)N_t$$

where C is the constant term and N_t is the series of the residuals. For example, an ARIMA(1,1,1) model results:

$$(1-\varphi_1 B)(1-B)Y_t = C + (1-\theta_1 B)N_t$$

This notation means, removing the parenthesis,

$$(1-\varphi_1 B - B + \varphi_1 B^2)Y_t = C + N_t - \theta_1 B N_t$$

or

$$Y_t = C + (1+\varphi_1)Y_{t-1} - \varphi_1 Y_{t-2} + N_t - \theta_1 N_{t-1}$$

remembering that $BY_t = Y_{t-1}, B^2 Y_t = Y_{t-2}$ and $BN_t = N_{t-1}$. The previous equation is the explicit expression of the ARIMA(1,1,1) model. An iterative method allows the calculation of the coefficient φ_1 and θ_1 and the constant C with their statistics.

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