

MODELING PROCESS OF PLANNING FINISHED PRODUCT SALES VOLUMES AT INDUSTRIAL ENTERPRISES IN MODERN ECONOMIC CONDITIONS

*Kateryna Udachyna*¹

*Nina Rizun*²

*Larysa Savchuk*³

Abstract

This article presents improving the existing system of planning finished products sales volumes. The influencing factors of the sales volumes in modern economic conditions have been determined: falling world oil prices, the reduction of pipe consumption in the domestic market, the global pandemic. The algorithm of planning finished products sales volumes has been constructed. Calculations based on the Holt forecasting method has been done, which allows to make forecast with trend. Calculations based on real data have been conducted, the model has been adapted to modern pandemic conditions, and impact factors have been identified. The plan of finished products sales volumes with factors of influence has been made. Forecast results obtained have been corrected and presented on periods and on markets. System of planning finished product sales volumes at industrial enterprises in modern economic conditions has been improved.

Keywords: plan, finished products, realization, forecast, Holt method, modeling.

¹ Narodowa Akademia Metalurgiczna Ukrainy, Wydział Systemów Komputerowych, Energetyki i Automatyki / National metallurgical academy of Ukraine, Faculty of Computer systems, energy and automation

² Politechnika Gdańska, Wydział Zarządzania i Ekonomii / Gdansk University of Technology, Faculty of Management and Economics

³ Narodowa Akademia Metalurgiczna Ukrainy, Wydział Systemów Komputerowych, Energetyki i Automatyki / National metallurgical academy of Ukraine, Faculty of Computer systems, energy and automation

1. Introduction

Dynamic changes in the world economy require using various approaches, methods and models to plan finished products sales volumes of industrial enterprises for future periods.

As the market becomes saturated with products and competition intensifies, production do not determine sales, but on the contrary possible sales are the basis for developing a production program. The company must produce only those products and required volume that it can actually and profitably sell. Product sales are the link between the producer and the consumer. The volume of production product also depends on the sale process and demand on the product. The growth rates of sales directly affect the amount of costs, profits and profitability of the enterprise. The sales indicators analysis is important for company.

Thus, the purpose of this article is building a plan for the sale of finished products in the markets in modern unstable economic conditions.

2. Literature Review and Problem Statement

Finished products volume planning is the most important tool in business management, which allows truly realize the production capacity, the relevance of entrepreneurship and its competitiveness.

According to accounting standards, finished product is a type of inventory. Finished product is a processed, packed, tested, accepted by the customer on time, matches to the technical conditions and contract Factor.Media, 2019).

Planning is a process of development and establishment by the company's management the system of quantitative and qualitative progress indicators, which shows the paces, proportions and trends of enterprise growth in the current and future period (Encyclopedia).

Main purposes of improving the system:

- reduction amount of time to manage the selling products process;
- effective control of finished products sales;
- long-term information storage about product sales;
- planning and forecasting the sale of finished products of enterprise.

Many scientists studied ways of product sales planning. V.V Druzhinin (Druzhynina V.V., Riznichenko L.V., 2010) and I. A Gorchakov (Horchakova Y.A., Khasnutdynova A.M., 2010) have proposed models for short-term forecasting of sales. O.G Yankovy have considered the planning process exactly for machine-build- ing enterprises (Yankovyi O.H., Hura O.L., 2009).

A. I. Ivanova studied the planning of sales in the field of services. She proposed a planning mechanism based on correlation-regression analysis of the relationship between sales growth rates and inflation rates (Ivanova A. I., 2013).



There are 4 main approaches to planning sales of finished products (Clientbridge, 2010-2020):

- planning based on the company's costs;
- planning based on market potential;
- planning based on the company's past sales;
- planning based on the sales funnel.

Sales planning based on the company's costs means that the owner sets priorities, calculates internal costs, determines plans for their own profits. The plan formed based on these calculations. The sales department has to execute this plan to supply consumer's demand. Strategic goals are also used for the plan preparation.

Sales planning based on market potential: before presenting the plan has to be done analysis of information about the opportunities of priority markets and competitive analysis. The forecast of sales managers on the client base is also considered. All together allows you to predict opportunities to grow or preserve existing positions.

Planning based on the company's past sales. Sales planning anticipate the presence of sales history and an active customer base. So it is convenient based on factual data of the previous period to plan sales for the next period. This method can be the main method of sales planning in companies which operate in established markets or in companies with a significant share in their market.

Planning based on the sales funnel. The sales funnel is a good way to evaluate not only the activity and quality of the sales department, but also to plan the sale of products.

Also used for planning: direct calculation, based on expert evaluation, economic and statistical, regulatory (Ivanova V.V., 2006).

The method of direct calculation is based on rational norms of consumption per capita and the size of the region.

Expert assessment methods are used to plan and forecast the future in cases:

- statistical or reporting data are missing or incomplete;
- for the quantitative measurement of such events, processes and phenomena for which there are no other methods of measurement. For example, in assessing the importance of the goals and benefits of individual methods of promoting a product or service;
- it is necessary to choose one of the possible ways to solve the problem under study with an uncertain or very large number of alternatives;
- when developing long-term forecasts.

The use of economic and statistical planning methods involves the calculation of the forecast. Yu. A. Kharchenko (Kharchenko Y.A., 2013) have improved the system of planning the sales of industrial enterprises by building economic and mathematical forecasting models, which constantly take into account the factual data of the previous period.



The extrapolation method is based on the average annual growth rate of the company's sales in previous years. When using it, you will need statistics for the last few years.

The normative method of sales planning is used in those companies that calculate key performance indicators (KPIs) in the field of sales (Syniaieva V.M., 2009).

Industrial enterprises are actively implementing ERP-systems designed for production planning and sales, focused on continuous balancing and optimization of enterprise resources with a specialized integrated application software package that provides a common model of data and processes for all areas of activity.

Existing approaches, methods, systems of sales planning and forming appropriate plans (Shevchenko O, Shcherbinina S., 2020, Kobets S.P., Luzina A.O., 2019, Kharchenko, Y.A. 2013) for a certain period often do not comply with modern requirements: there is no possibility to compare sales data of finished products in different periods, to have a sales plan of finished products based on demand, resources and capacity especially in the context of a global pandemic that requires the development of research in this area.

Thus, the improvement of the existing system of planning the sales of finished products is an urgent task today that needs attention.

3. Methodology

The plan should be based on clearly defined goals and actions that need to be realized to achieve them. It based on concrete figures, analysis and detailed calculations. Planned indicators must be in monetary terms. Having a sales plan allows to clearly define the area of specific actions of each organization's employee and departments, divisions and working groups.

To automate the process of planning sales volumes, it is proposed to develop a calculation and analytical model based on forecasting methods. Using of forecasting methods allows you to solve only one of the planning stages. Therefore the planning process is more complex than forecast.

The proposed model includes the following steps:

1. Statistical information gathering for previous periods;
2. Defining goals;
3. Forecast of finished products sales;
4. Checking the consistency of the predicted values to goals.
5. Adjustment of the marketing program as needed.

External and internal factors should be taken into account when planning. External factors: seasonality, political, economic, legislative factors, market changes, competition. Internal factors: assortment policy, pricing, team, marketing changes (Ivanova V.V., 2006).



To choose a forecasting method, it is necessary to determine the presence of trend. the difference between the average levels was checked to detect the presence of trend (Dehtiareva N.A., 2018). Table 1 presents the results.

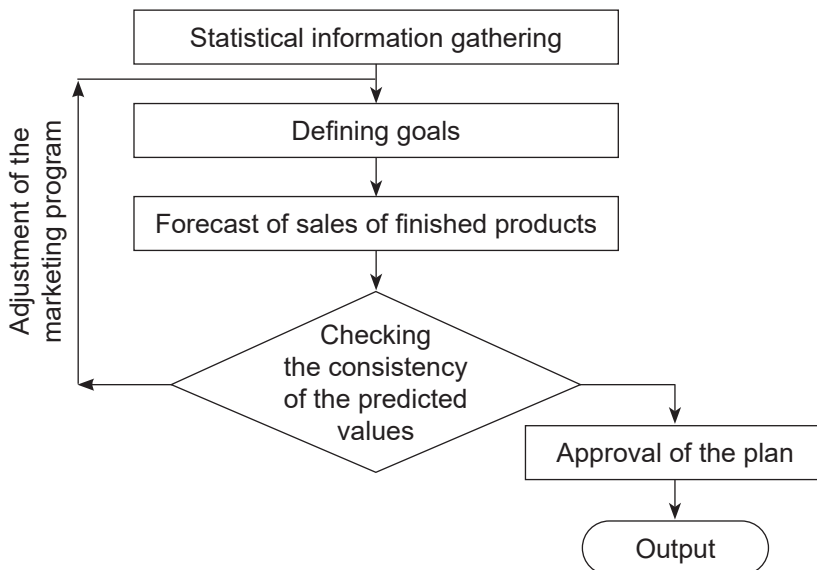


Fig. 1. Planning process algorithm of the finished products sales

Source: own work

Table 1. The results of checking the time series of the dynamics for the presence of trend

Enterprise \ Criterion	Fisher’s criterion		Student’s criterion	
	F_{calc}	F_{table}	t_{calc}	T_{table}
Enterprise 1	1,28	3,43	0,79	2,12
	The hypothesis of homogeneity is accepted		There is no trend	
Enterprise 2	1,09	3,43	3,19	2,11
	The hypothesis of homogeneity is accepted		There is trend	

Source: own work

If there is no trend, then you can use the Brown method, which is a special case of the Holt model (Dehtiareva N.A., 2018).

There is a tendency of development of the analyzed indicator for the second industrial enterprise. It is suggested to do forecast based on the Holt method. That is improved method of exponential smoothing. This method is quite suitable for forecasting these products because pipe and wheel products do not depend on the season and the demand for them is constant persists the whole year.

The forecast by Holt method has several stages (Kobets S.P., Luzina A.O., 2019):

1. Calculating the exponentially smoothed series:

$$L_t = \alpha * Y_t + (1 - \alpha) * (L_{t-1} + T_{t-1}), \quad (1)$$

where L_t is the smoothed value for the current period;

α is the smoothing coefficient of the series;

Y_t is the current value of the series;

L_{t-1} is smoothed value for the previous period;

T_{t-1} is trend value for the previous period.

2. Calculating the trend value:

$$T_t = \beta * (L_t - L_{t-1}) + (1 - \beta) * T_{t-1}, \quad (2)$$

where β is trend coefficient.

3. Constructing forecast:

$$Y_p^* = L_t + p * T_t, \quad (3)$$

where p is sequence number of the forecast period.

For the accuracy estimation of the model it is necessary to calculate the forecast values for the periods for which known sales volumes. Mean absolute percentage error:

$$MAPE = \frac{\sum_{i=1}^n \frac{|Y_p - Y_p^*|}{Y_i}}{n} * 100\%, \quad (4)$$

n – number of actual periods.

For selection trend coefficient and smoothed value it is necessary to iterate all the values in the range from 0 to 1 and find the combination in which accuracy of the forecast is maximized to 100%.

During sales volumes plan creation, the factors of influence should be taken into account, the obtained forecast values should be adjusted and the results should be presented by periods and by markets.

The proposed algorithm for planning finished products sales allow to do the company plan by month or by markets in detail, taking into account the trend and data for previous periods.



4. Results

The following factors of influence are considered for production planning:

- falling world oil prices that leads to suspend production and reduction of pipe consumption;
- reduction of pipe consumption in the domestic market;
- a global pandemic, according to which most companies have suspended activities.

Table 2 presents the forecast for 6 months based on statistics data.

Table 2. Smoothing of series and trend values calculating

Period	Sales volumes, hrn	Exponentially smoothed series	Trend values / Deviations
1.	900340,00	900340,00	0,00
2.	943290,00	934700,00	13744,00
3.	917650,00	918311,20	1690,88
4.	1003290,00	985956,06	28072,47
5.	975760,00	972184,72	11334,95
6.	1037130,00	1021873,95	26676,66
7.	1046650,00	1036359,46	21800,20
8.	1078740,00	1065903,85	24897,88
9.	1107233,33	1093987,86	26172,33
10.	1200166,67	1173696,44	47586,83
11.	1214410,00	1196749,92	37773,49
12.	1254238,00	1235185,69	38038,40
13.	1232766,67	1225642,79	19005,88
14.	1214340,00	1212799,38	6266,17
15.	1271386,67	1258415,98	22006,34
16.	1285500,00	1275681,93	20110,18
17.	1114083,33	1142381,02	-41254,26
18.	1094700,00	1112487,05	-36710,14

Source: own work

Going through the coefficients α and β from 0 to 1, a combination was found that gives the maximum value of the accuracy of the forecast: $\alpha = 0.8$, $\beta = 0.4$. Table 3 presents accuracy of the forecast model is 99.7.

Table 3. Results of forecast accuracy

Period	Actual value, hrn	Estimated value, hrn	Model error	Δ error	MAPE, %
1.	900340,00	900340,00	–	–	0,3
2.	943290,00	900340,00	42950,00	0,00	
3.	917650,00	948444,00	–30794,00	0,00	
4.	1003290,00	920002,08	83287,92	0,01	
5.	975760,00	1014028,54	–38268,54	0,00	
6.	1037130,00	983519,66	53610,34	0,00	
7.	1046650,00	1048550,62	–1900,62	0,00	
8.	1078740,00	1058159,66	20580,34	0,00	
9.	1107233,33	1090801,73	16431,60	0,00	
10.	1200166,67	1120160,19	80006,48	0,00	
11.	1214410,00	1221283,27	–6873,27	0,00	
12.	1254238,00	1234523,41	19714,59	0,00	
13.	1232766,67	1273224,09	–40457,42	0,00	
14.	1214340,00	1244648,67	–30308,67	0,00	
15.	1271386,67	1219065,55	52321,12	0,00	
16.	1285500,00	1280422,31	5077,69	0,00	
17.	1114083,33	1295792,11	–181708,78	0,03	
18.	1094700,00	1101126,76	–6426,76	0,00	

Source: own work

In a pandemic, there is a decline in demand in the global market for pipe products. Over the last year, production at this enterprise decreased by 9.3%. It is planned that in the next two quarters sales will decrease by 4%. As for sales markets, 10% of products are exported to CIS countries and 90% to European countries.

Table 4 presents the product plan by markets taking into account the above conditions.



Table 4. Product sales plan

Period	Total sales, hm	Export to CIS, hm	Export to European countries, hm
1.	1043503,61	104350,36	939153,25
2.	1007894,78	100789,48	907105,30
3.	972285,94	97228,59	875057,35
4.	936677,11	93667,71	843009,40
5.	901068,27	90106,83	810961,45
6.	865459,44	86545,94	778913,50

Source: own work

Therefore the monthly finished products sales plan has been defined. It is based on Holt's method taking into account global factors of influence markets.

5. Conclusions

During the study of the finished products sales planning system at the metallurgical enterprise it was proposed to improve it by developing an economic and mathematical model of planning based on the Holt's forecasting method.

This model is relevant in a global pandemic and allows to take into account the following factors of influence: falling world oil prices, suspension of production, reduction of pipe consumption.

From management the point of view using of the offered model will allow to carry out control for timely change of actions; will help to analyze and compare previously accumulated and fresh data, make logical conclusions, predict potential losses, adaptively adjust actions; increase employee motivation, structure business processes and distribute responsibility for each unit between relevant departments and professionals. Having a sales plan will determine the real capabilities of the company, its structural components and individual employees.

Therefore the proposed system can be implemented in the activities of metallurgical enterprises to automate the process of planning finished product sales volumes.

References

1. Clientbridge (2010–2020). Sales planning methods – which to choose; retrieved from: <https://www.clientbridge.ru/blog/metody-planirovaniya-prodazh/> (in Russ), (date of access: 08.12.2020).



2. Dehtiareva N.A. (2018). Analysis models and forecasting on the basis of time series. Cheliabinsk: Yzd-vo ZAO «Byblyoteka A.Myllera, 160 (in Russ).
3. Druzhynina, V.V., Riznichenko L.V. (2010). Forecasting the export potential of machine-building enterprises in order to increase their competitiveness. Aktualni Problemy Ekonomiky (Current economic problems), 7, 246–252 (in Ukr).
4. Encyclopedia. Methods and types of planning Retrieved from: <http://www.grandars.ru/college/ekonomika-firmy/metody-planirovaniya.html> (in Russ), (date of access: 08.12.2020).
5. Factor.Media (2019). Accounting for finished products; retrieved from: <https://i.factor.ua/ukr/journals/nibu/2019/december/issue-99/article-105874.html> (in Ukr), (date of access: 12.12.2020).
6. Horchakova, Y.A., Khasnutdynova A.M. (2010). The method of exponential smoothing as a means of improving the accuracy of the forecast of sales of rolled metal. Ekonomichnyi Prostir: Zbirnyk Naukovykh Prats (Economic space: a collection of scientific papers), 38, 185–191 (in Ukr).
7. Ivanova A.I. (2013) Planning and analysis of the dynamics of sales of implementation in the field of services: features, problems and ways of solution. Efektyvna ekonomika (Efficient economy); retrieved from: <http://www.economy.nayka.com.ua/?op=1&z=2623> (in Ukr), (date of access: 12.12.2020).
8. Ivanova V.V. (2006) Planning of enterprise activity:tutorial. Kyiv: Center for Educational Literature, 472 (in Ukr).
9. Kharchenko, Y.A. (2013). Improvement of the Planning of Volumes of Sales by Industrial Enterprises. Ekonomichnyi Visnyk Donbasu (Economic Bulletin of Donbass), 1, 229–238 (in Ukr).
10. Kobets S.P., Luzina A.O. (2019). Application of adaptive models for net sales income forecast products. Efektyvna ekonomika (Efficient economy); retrieved from: http://www.economy.nayka.com.ua/pdf/4_2019/42.pdf (in Ukr), (date of access: 08.12.2020).
11. Shevchenko O, Shcherbinina S. (2020). Application of updativ forecasting methods for planning small enterprise activities. Infrastruktura rynku (Market infrastructure), 43, 476–483; retrieved from: http://www.market-infr.od.ua/journals/2020/43_2020_ukr/87.pdf (in Ukr), (date of access: 08.12.2020).
12. Syniaieva V.M. (2009). Commercial activity; retrieved from: https://stud.com.ua/73453/marketing/metodi_planuvannya_prodazhiv_skladannya_treyd_marketingovogo_byudzhetu (in Ukr), (dDate of access: 12.12.2020).
13. Yankovyi, O.H., Hura O.L. (2009). Improving planning at the enterprise with the help of mathematical and statistical forecasting methods. Aktualni Problemy Ekonomiky (Current economic problems), 1, 229–238 (in Ukr).

MODELOWANIE PROCESU PLANOWANIA SPRZEDAŻY WYROBÓW GOTOWYCH W PRZEDSIĘBIORSTWACH PRZEMYSŁOWYCH

Streszczenie

W artykule zaproponowano usprawnienie istniejącego systemu planowania sprzedaży wyrobów gotowych. Określone są czynniki wpływające na wielkość sprzedaży we współczesnych warunkach ekonomicznych: spadek światowych cen ropy naftowej, zmniejszenie



zużycia rur na rynku krajowym, globalna pandemia. Konstruowany jest algorytm planowania wielkości realizacji wyrobów gotowych. Obliczenia dokonywane są w oparciu o metodę prognozowania Holta, która pozwala na wykonanie prognozy z uwzględnieniem trendu. Przeprowadzono obliczenia na podstawie rzeczywistych danych, model dostosowano do współczesnych warunków pandemii i zidentyfikowano czynniki wpływu. Sporządza się plan wielkości produkcji z uwzględnieniem czynników wpływu, koryguje otrzymane prognozy oraz przedstawia wyniki okresowe i według rynków. Usprawniono system planowania wolumenów sprzedaży wyrobów gotowych w przedsiębiorstwach przemysłowych w nowoczesnych warunkach ekonomicznych.

Słowa kluczowe: plan, wyroby gotowe, realizacja, prognoza, metoda Holta, modelowanie.