APPLICATION OF ABC-XYZ ANALYSIS IN THE PROCESS OF FORMING A PRODUCTION PROGRAM OF THE ENTERPRISE

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Abstract. The article generalizes theoretical and methodical approaches to the formation of the enterprise's production program; a substantiated optimum assortment structure of production based on the use of ABC-XYZ analysis. The paper uses the methods of economic and statistical analysis to determine the system of interconnections of the parameters of optimization of structure and size of enterprises and tendencies of changes in dynamic characteristics of their functioning. ABC and XYZ methods were used to analyze the range of goods. Based on the analysis data, it was found that Class A and B goods provide the company's main turnover. Therefore, it is necessary to ensure their constant presence.

Keywords: ABC-XYZ analysis, production program, enterprise, models of production.

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Introduction

Growing market competition influences the formation of demand for enterprise products, and the limited resources force it to seek new ways and ways of planning a production program and its rationale for achieving targeted results. The complexity of the planning conditions is connected, on the one hand, with the fact that the production program should be responsible for the volume and range of products for its sales plans, and, on the other hand, to provide sufficient resources of the required quality and production capacities of the enterprise.

Basic Material

Accordingly, satisfaction of consumer needs, increase of efficiency of the enterprise activity and strengthening of its market positions are the initial factors, ie those for which the production process actually takes place. The order of planning the production program depends on the size, ownership and management structure of the enterprise *(Chaun, Bondar, 2010)*.

The most well-known are the following schemes for the formation of a production program:

— centralized or policy planning (from top to bottom) implies that the formation of a comprehensive production plan for the entire enterprise, its detailing by direct executors and bringing to separate units and workplaces is carried out by the highest level of corporate governance;

— decentralized planning ("bottom-up") is that the process of developing a production program originates from the lower levels of management and is gradually generalized;

— combined (interactive or counter-planning) involves a combination of the two above-mentioned schemes and provides participation in the planning process of senior management of the enterprise, employees of the functional and operational units, as well as direct executors. The application of this scheme of production planning allows to eliminate the shortcomings of the first two and ensures that both the general goals and directions of enterprise development, as well as the potential of each employee are taken into account.

Proceeding from the main provisions of the scientific research of domestic and foreign scientists on the problems of production planning, the actual vision of the process of forming a production program of an industrial enterprise was proposed (Fig. 1).

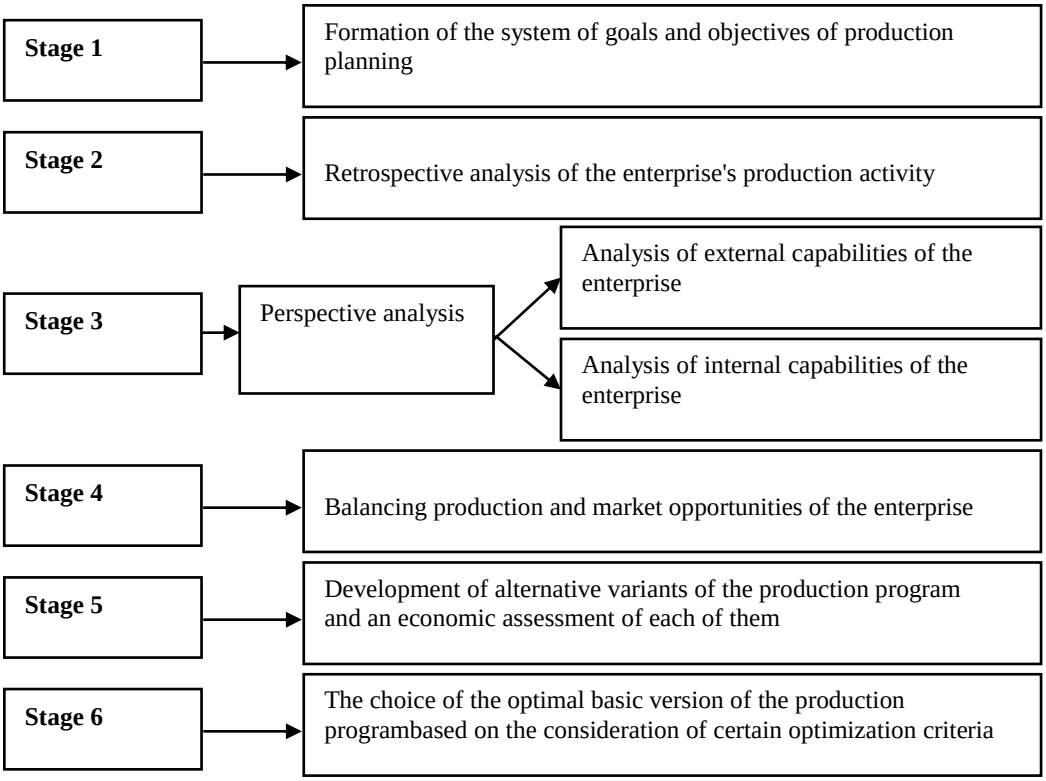

Fig. 1. The process of forming a production program of an industrial enterprise

Given the time parameters of the analysis, within the framework of production planning it is expedient to distinguish two areas of analysis: retrospective and perspective.

The purpose of the long-term analysis is to assess the company's internal production potential in terms of its ability to produce the volume of production anticipated by the production program, as well as to conduct market research on the market opportunities of the enterprise in terms of the implementation of its products.

In turn, the purpose of the retrospective analysis is to assess the enterprise's production activity in the past, to calculate the level of performance of the indices of the production program, as well as to analyze the reasons that led to the deviation of the actual indicators from the planned ones.

Based on research by researchers *(Shvaika, 2014)*, in Table. 1 outlines the main models of production behavior of the enterprise in the conditions of dynamic changes in market conditions *(Pushkar, 2008)*.

Table 1

Basic models of production behavior of the enterprise

Model of production behavior	Description of the model of production behavior	Features of the firm's behavior in changing market conditions		Place of application of the model of production behavior
		Increase in market demand	Reducing the volume of market demand	
Sustainable production model	Constant production at constant production potential	Reduce the size of finished product stocks	Increase in the size of finished product stocks	Products that for a long time do not lose their consumer qualities: machine building
Model of variable production	Variable output in line with changes in market demand with constant production potential	Intensification of production: overtime work, transfer of production functions to contractors	Decrease of production rates: on-give of rest, additional leave for employees, lease of property	Workforce and high-tech manufacturing, where it is impossible to create stocks: aircraft, shipbuilding, publishing
Variable Potential Model	Variable output in accordance with the change in market demand for variable production capacity	Growth in production through additional hiring of employees, purchase and leasing of equipment	Reducing production by releasing workers, selling property and renting it out	Enterprises with a seasonal nature of production: the sugar industry

The described models of production behavior of the enterprise are rather generalized and, as a rule, do not exist in their pure form. In practice, in the process of forming a production program, an enterprise can follow one of the described patterns of production behavior or choose an individual model of production behavior for each individual assortment position.

An important stage in the process of industrial planning in the enterprise is the optimization of the production program, which is carried out in order to increase the efficiency of production activities by forming an optimal assortment-nomenclature structure of the production plan on the basis of rational use of production and market opportunities of the enterprise.

At the final stage of the production planning process, a choice is made of the optimal variant of the production program, which involves maximally taking into account the

optimality criteria, thus ensuring the fulfillment of the strategic objectives of the enterprise, observance of the principle of production efficiency, and compliance of the production program with the existing production potential and the most likely scenario of the development of the environment. The possibility of transitioning an enterprise to an alternative variant of the production program in the event of unforeseen circumstances is also substantiated, and the scheduling is carried out, that is, specification in terms of time periods, volumes and performers.

Summing up, it can be argued that the formation of a production program of an industrial enterprise is not simply planning of production volumes for a certain period of time, it is a search for prospects and new opportunities; it is a whole complex of various complex, interconnected and interdependent production, technical, marketing, administrative and financial decisions, in the end, this is a choice from the list of alternatives for the most optimal.

An overview of the scientific sources on the subject matter confirms that to date there is a significant amount of methodological developments related to the calculation of the planned indicators of the production program, describes the methods and technologies of marketing research, various approaches to the construction of economic forecasts, etc., but most of them borrowed from foreign economic literature, and therefore often not fully adapted to the peculiarities of the national economy.

Describe economic-statistical, factor-analytical, balance, normative and economic-mathematical methods of calculating the planned indicators of a production program *(Chaun, Bondar, 2010)*. Also offered are methods for designing a production program, including a method of structuring goals, analogies, organizational modeling, block, expert-analytical, parametric, graph-analytical, analytical-calculation, mathematical-statistical and normative (Getman, 2007) emphasize the application of such methods of forming a production program as level of forecasting, consistent decision making, situational planning, linear programming, product and market diversification, etc. *(Shvaika, 2014)*.

Among the research methods there are general sciences (system analysis, complex approach, programmatic planning) and analytical and forecasting methods (communication theory, linear programming, mass service theory, business game methods, probability theory, network planning, economic and mathematical modeling, economic and statistical methods), as well as methodical techniques borrowed from various branches of science: sociology, psychology, anthropology, ecology, aesthetics and design *(Sviatnenko, Kovalev, Voitenko, 2011)*.

Also describe specific methods of analysis: functional cost analysis, benchmarking, cost chain analysis, business analysis, comparative analysis of enterprises and comparative industry analysis, and among methods for forecasting the environment, one-and multi-stage qualitative methods, single- and multi-parameter quantitative methods and combined methods (scripting engineering, early warning system). Consequently, the analysis of scientific works of domestic and foreign authors suggests that research methods are not so much a scientific category, as to a greater extent practical activity, which arose on the demand of the market.

One of the complex approaches to the formation of retail outlets is the creation of "product portfolios" of the company.

Under the notion of "commodity portfolio" should be understood as a collection of all goods (commodity groups, types and varieties of goods), for the release of which there are opportunities within the organizational, economic and technological conditions of this production (Fig. 2).

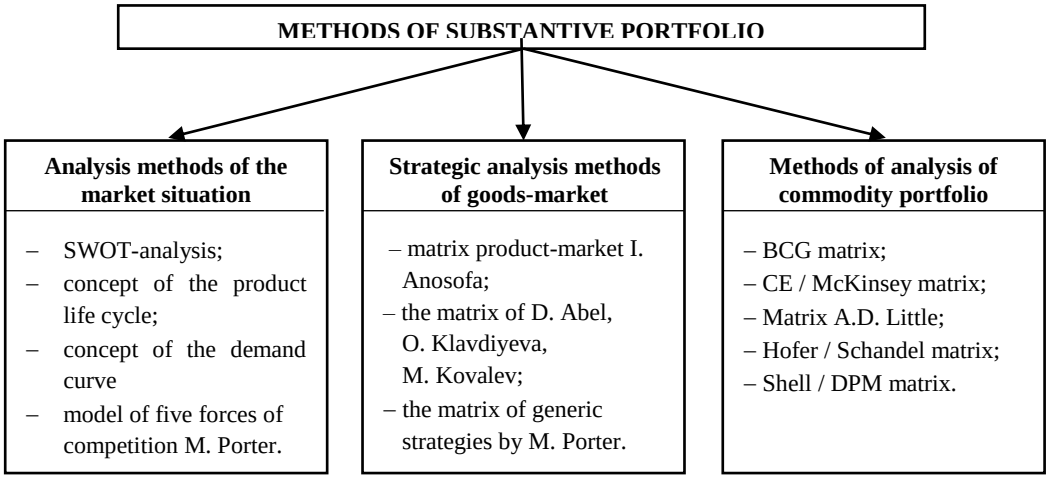

Fig. 2. Methods of a commodity portfolio justification

The following methods of strategic analysis have been used for practical application: BCG matrix, MS-Kinsey 9-section matrix (GE-matrix), matrix A.D. Little, Hofer / Schandel matrix, Shell / DPM matrix.

Among the most common methods of developing a production program at industrial enterprises are: level prediction, consistent decision-making, situational planning, linear programming, and others.

The method of level forecasting is to develop three alternative variants of the enterprise's production program: maximum, probable and minimal, depending on the possible development of the market situation.

Situation planning involves the formation of a normal and situational (alternative) production plan, which will be transferred in the event of an unforeseen situation.

Statistical (correlation-regression analysis, trend-building) and econometric-mathematical (linear programming) methods play a significant role in the methodological and methodological planning system of production planning (Fig. 3).

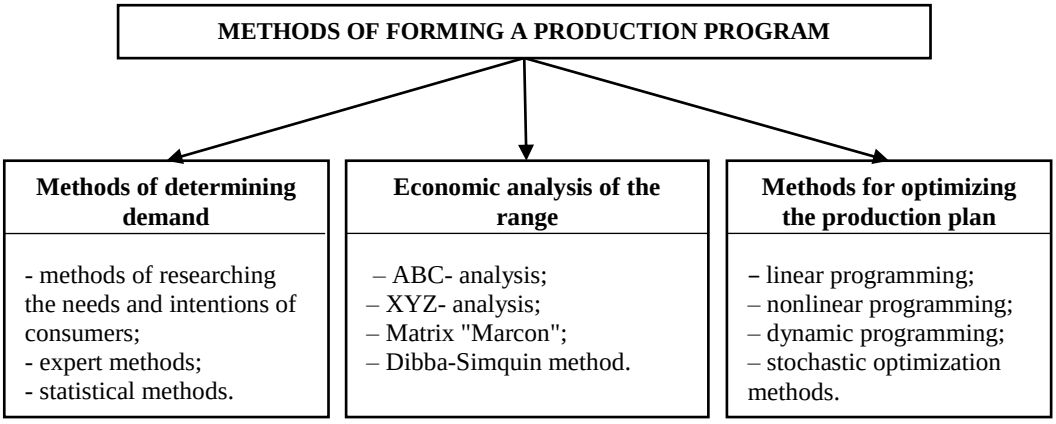

Fig. 3. Methods of forming a production program

With the help of a linear programming model, an enterprise can determine the optimal production program for the quantity and assortment of products to obtain the maximum result at standard resource costs.

Taking into account the forms of dependence of factors on the volume of production for the formation of the optimal production program, models of other types can also be used: in the nonlinear forms of dependence of the result of the operation on the main factors - the model of nonlinear programming; if necessary, inclusion in the analysis of the time factor - a model of dynamic programming; with the probabilistic influence of the factors on the result of the operation - a model of mathematical statistics (correlation-regression analysis).

Optimization of the enterprise's production program is carried out in order to increase the level of profitability of production activities and provides for the formation of the most rational in terms of economic efficiency of the nomenclature-assortment structure of the production plan and the most productive use of the production potential of this enterprise.

The dynamics of volumes of production are influenced by intensive and extensive factors. To the intensive factors include: labor productivity, return on fixed assets and material returns. Extensive - change in the number of employees, the cost of fixed assets and material costs.

The economic substantiation of the enterprise's production program in terms of providing it with the necessary labor, material, financial and investment resources is, in general, reduced to the general need for them and their effective use. Evaluation of the production program is carried out in terms of its implementation in the reporting period.

An important criterion for evaluating an enterprise's production program in market conditions is its optimality. According to the *(Semenov and others, 2016)*, "the optimal is called a production program that is most closely in line with the structure of resources and provides the best results by any criterion"

Scientists describe the economic and mathematical methods for solving the problems of optimizing the production program *(Moskaliuk, 2005; Tarasiuk, Shvab, 2005)*.

- simplex-method of linear programming, in which the optimization criterion may be the maximum profit or volume of production, the uniform loading of equipment, and the limitation is the production capabilities of the enterprise;

- the method of "branches and constraints", that is, the gradual selection of different variants of the production program with the sifting of ineffective;

- the method of optimal formation of a production program with the help of integral indicators up to the implementation of a certain optimality criterion.

At the heart of the general model of optimization of the production program, lies the principle of ensuring maximum profitability of the production activity of the enterprise *(Chaun, Bondar, 2010)*:

$$\sum_{i=1}^{n} P_i \cdot X_i \Rightarrow max, \quad (1)$$

where i - index of product type (i = 1, 2… n); P_i – profit from the sale of the unit of production of the i-th type; X_i – number of products of the i-th type.

The adoption of the optimal decision regarding the choice of a particular version of the enterprise's production program is based on a system of interconnected optimization criteria, among which *(Chaun, Bondar, 2010)*:

1. Conformity of planned volumes of production to existing market demand reflected by such equation:

$$\sum_{i=1}^{n} X_i \le \sum_{i=1}^{n} Q_i \le \sum_{i=1}^{n} D_i \,, \tag{2}$$

where Q_i – the volume of sales of products and -th type, D_i – demand for products of the i-th type, formed by the conclusion of contracts for the supply of products.

Thus, according to the first criterion of optimization, such a production program is optimal, when the volume of manufactured products does not exceed the possible volume of its realization, and the volume of realized, accordingly, does not exceed the volume of market demand for it. It is clear from this that the precondition for the formation of an optimal production program is to focus on the probable magnitude of market demand in the planned period, which, in fact, is based on marketing research.

2. Achievement of the target level of profitability of production activity of the enterprise. A mathematical expression of a criterion is a model:

$$\sum_{i=1}^{n} Q_{min} \prec \sum_{i=1}^{n} X \leftrightarrow \sum_{i=1}^{n} Q_{target\ profit} \,, \tag{3}$$

where Q_{min} – the minimum volume of sales of products, which ensures self-sufficiency ("break-even point"); $Q_{target\ profit}$ – planned volume of sales of products, which ensures receipt of target profit ("target profit point").

According to the second optimization criterion, such a production program is considered optimal, when the assortment set and production and sales volumes determined by it allow the company to be in the zone of break-even and provide the expected level of efficiency.

3. Compliance of the production program with the existing production potential of the enterprise. The third criterion for optimizing the production program can be expressed in the form of a production function, which, in fact, describes the relationship between the involved productive resources and the resulting production of economic benefits. The mathematical interpretation of the production function is the equation:

$$f(d_1, d_2, d_3 ... d_m \cdot x_1, x_2, x_3 .... x_m) = 0 \tag{4}$$

where d – factors of production; m - number of factors of production; x - volumes of production; n - the number of types of products produced.

The purpose of each company's activity is to obtain the maximum possible profit. The method of achieving this goal is to effectively manage the production activity of the enterprise, and the means that increases the efficiency of management is the formation of the required amount of information about the external and internal business environment and the use of multivariate analysis of the impact of alternative management decisions on the expected profit. The first and foremost important decision for each enterprise is to determine the volume and range of products to be produced, that is, to draw up an optimal business plan.

To analyze the range of products, "prospects" of customers, suppliers, and debtors methods are used ABC and XYZ.

ABC- analysis is a method of increasing the efficiency and effectiveness of the company's sales system. The most common method of ABC analysis is used to optimize the range of goods (assortment) and its inventories in order to increase sales. In other words, the purpose of ABC analysis is to identify the most promising goods (or groups of products) that bring the maximum profit for the company.

This type of analysis is based on the laws revealed by the economist Pareto: "20% of the products provide, 80% of the company's profits." The purpose of the company in conducting this analysis is to identify key goods, and guide this 20% group, which will control 80% of cash inflows. Sales and cash management directly affects the financial stability and solvency of the company.

In conducting product analysis, all goods are divided into three groups:

Group "A" - the most valuable goods, occupy 20% of the range of products, and bring 80% of sales profits;

Group "B" - low-value goods, occupy 30% of the range of products, and provide 15% of sales;

Group "C" - not demanded goods, occupy 50% of assortment, and provide 5% of sales profits.

The products of the group "A" are targeted, and require maximum attention to their production and sales: their availability in stock supplies, operational supplies, planning and organization of production and quality control of this product.

Stages of ABC-analysis of product range and sales of the company are as follows:

1) Define the purpose of the analysis (for example, optimization of the range).

2) Definition of the object of analysis (for example, goods).

3) Select the parameter (criterion) on which the objects are analyzed (revenue).

4) Sort objects in descending order of value of the parameter: (arrange goods in descending order of revenue).

5) Calculation of the total amount of parameters on the list: the amount of proceeds.

6) Calculate the share of the parameter for each item in the list in the total amount: (Revenues by product) / (amount of revenue) * 100%.

7) Calculation for each item of the list share by incremental sum. For example, for the tenth commodity: (share of the first commodity) + (share of the second commodity) + ... + (share of the 10th commodity). For the last product, the share of the incremental result is 100%.

8) Finding a list of positions, in which the share in the incremental result is closest to 80%. This will be the lower limit of group A. The upper limit of group A is the first position in the list.

9) Finding a list of positions in which the share of the growing sum is closer to 95% (80% + 15%). This will be the lower limit of group B.

10) Everything below is a group C.

11) Calculation of the number of items in the list in each group (the number of product names in each group).

12) Calculation of the number of positions in each group from the total number. (Number of items per group) / (total number of items) * 100%.

LLC "Firm DIAMANT LTD" in its range of about two dozen varied products. Based on the nomenclature of goods and the size of the proceeds for each of the species for 2017, an ABC analysis was carried out to identify the most significant in the given product groups

product categories of products, those that should be addressed and resolve their next place in the assortment of the store. The results of the study are presented in Table 2.

Table 2

Results of application of ABC analysis

Product	Receipts	Specific weight, %	Specific weight in incremental sum, %	Group	Number of products in the group	Specific weight of goods in the group, %
Flour is oatmeal	13 931,80	33,01	33,01	A	3,00	13,04
Oatmeal flakes	9 811,74	23,25	56,26			
Wheat flour	8 971,94	21,26	77,52			
Macaroni	3 329,66	7,89	85,41	B	6,00	26,09
Croup is oatmeal	1 015,27	2,41	87,82			
Oat bran	835,58	1,98	89,80			
Flour is corn	724,58	1,72	91,52			
Tallow is oatmeal	649,90	1,54	93,06			
Kutya winter	565,50	1,34	94,40			
Kuta Yara	468,44	1,11	95,51	C	14,00	60,87
Buckwheat flakes	458,38	1,09	96,59			
Rice	409,36	0,97	97,56			
Groat buckwheat	375,59	0,89	98,45			
Flour is buckwheat	195,25	0,46	98,91			
Corn flakes	143,49	0,34	99,25			
Wheat flakes	118,17	0,28	99,53			
Wheat flakes	71,74	0,17	99,70			
Rice flakes	37,99	0,09	99,79			
Wheat	25,33	0,06	99,85			
Groat flour	21,10	0,05	99,90			
Pea flakes	16,89	0,04	99,94			
Wheat bran	12,66	0,03	99,97			
The crust is hot	10,65	0,03	100,00			
Together	**42 201,00**	**100,00**			**23,00**	**100,00**

After analyzing the results of the ABC analysis for each of the three product groups, one can draw a conclusion: the group A can include three nomenclature positions, which occupy 13.04% of the product range and 77.52% of the sales volume. This group includes oat flour, oat flakes and wheat flour.

Group B consists of a joke of nomenclature positions, which occupies 26.09% of their total number and brings to the enterprise 16.87% of gross income. It should be noted that this group includes such nomenclature positions as: macaroni, oat groats, oat bran, corn flour, oatmeal and octopus.

Group C is the most quantitative: 60.87% of the nomenclature or fourteen nomenclature positions provide the company with only 5.60% of gross income. But this result does not yet indicate the need for the ill-considered exclusion of the nomenclature positions of the Group C from the range. This group includes: kutya yara, buckwheat flakes, rice,

buckwheat, buckwheat flour, corn flakes, millet flakes, wheat flakes, rice flakes, wheat flour, whole wheat flour, pea flakes, wheat bran and millet.

In order to take into account the randomness of sales, XYZ analysis is used. This method evaluates the stability of certain objects or processes (product sales, customer behavior, employee efficiency, etc.). For example, the XYZ analysis provides the ability to group the products of the company depending on the demand for them over a period of time. The algorithm of the XYZ analysis consists of the following steps *(Kharchenko, 2017)*:

1. Determination of coefficients of variation of indicators of sales of goods for specified periods.
2. Grouping of goods in accordance with the growth of the coefficient of variation.
3. Distribution by categories X, Y, Z.

Group X is goods that are characterized by stable demand (volume of sales), therefore there is a high probability of correct forecasting of sales. The value of the coefficient of variation is in the range from 0 to 10%.

Group Y is a commodity with some fluctuations in sales volume, characterized by average probability of their forecasting. The value of the coefficient of variation is in the range of 11 to 25%.

Group Z - products with irregular and unstable demand, therefore, have low accuracy of forecasting of sales. The value of the coefficient of variation is higher than 25%.

The results of XYZ analysis are shown in Table. 3.

Table 3

Results of XYZ analysis

Product	Receipts	I quarter	II quarter	III quarter	IV quarter	Coefficient variation, %	Group
Kuta Yara	441,32	112,43	126,48	117,11	112,43	4,90%	X
Wheat flour	8 452,56	2 422,42	2 242,99	2 063,55	2 242,99	5,66%	
Macaroni	3 136,91	765,82	865,71	899,01	799,12	6,32%	
Wheat flakes	111,33	30,72	31,91	28,36	27,18	6,32%	
Rice	385,66	90,06	106,43	102,34	110,53	7,48%	
Corn flakes	135,18	35,87	41,61	34,44	31,57	10,20%	Y
Oat bran	787,21	175,47	225,61	200,54	233,96	10,95%	
Rice flakes	35,79	7,98	11,02	9,12	9,88	11,66%	
Flour is corn	682,63	202,88	195,64	181,14	144,92	12,33%	
Groat buckwheat	353,85	105,17	101,41	93,90	75,12	12,33%	
Wheat	23,86	7,09	6,84	6,33	5,07	12,33%	
Buckwheat flakes	431,84	96,26	105,43	123,76	132,93	12,65%	
Wheat flakes	67,59	14,35	17,22	19,37	20,81	13,56%	
Wheat bran	11,93	3,419026	3,798918	2,912504	2,532612	15,23%	
Flour is oatmeal	13 125,29	3 343,63	2 647,04	3 761,59	4 179,54	16,25%	
The crust is hot	10,03	2,02	2,56	2,87	3,19	16,25%	
Groat flour	19,88	4,85	6,12	7,39	5,06	17,16%	
Flour is buckwheat	183,95	62,48	46,86	37,10	48,81	18,55%	
Croup is oatmeal	956,50	192,90	243,67	253,82	324,89	18,55%	
Kutya winter	532,76	147,0291	180,9588	130,0642	107,4443	18,97%	
Tallow is oatmeal	612,28	103,98	227,47	168,97	149,48	27,28%	Z
Oatmeal flakes	9 243,74	1667,995	1962,348	3532,226	2649,169	29,26%	
Pea flakes	15,91	2,70	5,40	5,57	3,21	30,33%	

As a result, the following classification of goods has been obtained: kutya ravine, wheat flour, macaroni, millet flakes and rice have the most stable demand. That is, sales volumes declined by 6% on average over the months. Companies should pay particular attention to inventory of these goods.

To the group "Y" got a lot of different types of products, the company should quickly track stockpiles. Z Group products are not sold regularly, their stocks can be reduced and the company can work on a pre-order.

Conclusions and suggestions

XYZ analysis has proven to be good in practice inventory management and assortment of goods, and it is often combined with the ABC analysis, which allows for the two-criterion group of goods. The combined ABC-XYZ analysis results in grouping goods into 9 classes.

The results of the combined ABC and XYZ analysis are shown in Table. 4.

Table 4

Results of combined ABC and XYZ analysis

	A	B	C
X	Wheat flour	Macaroni	Kutya Yara Rice Wheat flakes
Y	Flour is oatmeal	Oat groats Oat bran Flour is corn Kuta winter	Buckwheat flakes Buckwheat groats Flour is buckwheat Corn flakes Wheat flakes Rice flakes Wheat Wheat flour Bran wheat Corn is hot
Z	Oat flakes	Thicken oatmeal	Pea flakes

The combination of data on the relationship between the quantity and cost of ABC analysis stocks with the data on the relationship between the amount and the uniformity of consumption of the XYZ analysis allows you to obtain valuable planning, control and management tools for the supply system as a whole and inventory management in particular.

Goods Class A and B provide the main product turnover of the company. Therefore, it is necessary to ensure their constant presence. It is generally accepted that when goods of Class A create an excess stock, and for goods in Group B it is sufficient. The use of XYZ analysis allows you to more precisely customize the inventory management system and thereby reduce the total inventory.

For goods in the group of AX and BX characterized by high trade turnover and stability. It is necessary to ensure the permanent availability of goods, but for this there is no need to create an excessive insurance stock. Consumption of goods in this group is stable and well-predicted.

Products of AY and BY group at high commodity turnover have insufficient consumption stability, and as a consequence, in order to ensure a permanent presence, it is necessary to increase the insurance stock.

AZ and BZ products with high commodity turnover are characterized by low predictability of consumption. An attempt to ensure the guaranteed presence of goods of this group only due to the surplus of insurance commodity stocks will lead to the fact that the average inventory of the enterprise will increase significantly.

Products of Group C make up the majority of the range of the company. The use of XYZ analysis can greatly reduce the time that a manager spends on managing and controlling the products of this group.

On the goods of the group CX it is possible to use a system of orders with a constant frequency and reduce the insurance product stock.

On the goods of the CY group, you can switch to a system with a constant amount (volume) of the order, but at the same time form an insurance stock, based on the company's financial capacity.

New products, goods of spontaneous demand, delivered to order, etc. fall into the CZ product group. Some of these goods can be seamlessly removed from the range, and the other part needs to be regularly monitored, because it is from the goods of this group that there are illiquid or hard-to-sell stocks that the company is losing. It is necessary to deduce from the assortment the remnants of the goods taken under the order or that are not already produced, that is, the remnants of the goods, which usually fall into the category of "drains".

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