

ALGORITHM FOR THE PROCUREMENT AND INVENTORY MANAGEMENT IN THE DISTRIBUTION SUPPLY CHAIN

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Abstract

This paper is devoted to practical testing of the developed method of harmonized volumes of purchased products in the retail networks. The problem is connected with a difficulty of forecasting demand and inventory products based on the existing methods. The peculiarity of this paper is to present a developed method of harmonic prediction of the volume and variety of the purchased and sold products in retail networks in non-stationary demand, which contributes to the development of the methods ABC and XYZ classifications. To apply the developed method of harmonization in order to optimize the inventory of the products, an algorithm for the application of the harmonization method in the supply chain has been developed and described. This allows reducing the time intervals in procurement, optimizing inventory, expediting information acquisition, improving the level of logistics services and ensuring sustainable operation of enterprises in the value chain, having the changing demand and supply.

Key words: inventory management, procurement management, supply chains, product groups, harmonization matrix

1. INTRODUCTION

The necessity to improve the distribution networks of the companies is due to market trends, where currently the main competitors have equal opportunities and potentials.

The market success largely depends on an effective system of procurement and inventory management in supply chains of commodity production, which is based on the strategic assets of logistics management.

Strategic assets of the logistics management of the company are, above all, management resources, exceeding similar resources of the competitors; and strategic competencies are strategically significant activities for the company, where the improvement of the system of management of commodity flows takes place. Thus, there is an actual task of working out the algorithm of procurement and inventory management in the distribution network and recommendations for improving the system of inventory management that may eventually become the basis for creating sustainable competitive advantage for the company in the foreseeable future in the market.

2. PREREQUISITIES TO IMPROVING DISTRIBUTION IN THE SUPPLY CHAINS

It is known that the main functions of distribution logistics are the following:

- 1) definition of consumer demand and its satisfaction;
- 2) establishment of economic relations on the supply of goods, rendering of services to consumers;
- 3) building an organizational scheme of distribution channels;
- 4) accumulation, sorting and arrangement of stocks of the finished products;
- 5) transportation of the finished products, returnable containers;
- 6) consolidation and dispersal of goods;
- 7) choice of the rational forms of physical distribution and trade organization;
- 8) maintaining quality standards of the finished products and logistics services;
- 9) monitoring and information support of the distribution.

From the list of functions one can identify the basic function group responsible for the inventory, stock and the dynamic compliance of the supply and demand of goods on the consumer market, namely, points 1,3, 4, 6, 9, that is five points out of nine, or about 60% of the activities in the distribution.

The most important principle is the principle of consistency, which allows improving the distribution process. The distribution system is not an arbitrary combination of elements, but a combination of interrelated and interdependent parts of the whole.

The set of distribution goals has three dimensions: economic goals generally coincide with the company's goals and aim at the maximization of profits; quantitative goals — sales increase, increase of the firm's share in a certain market segment, increasing the speed of turnover, etc.; quality goals — quality of service, reliable customer feedback, precise knowledge of customer's requirements to company goals. These goals are specific to each company. They can also include such tasks as accelerating the sale of the most profitable goods, getting rid of excessive stocks of the finished products, giving regularity to the sales of seasonal products, reviving the sale of goods, etc. The principle of adequacy of the logistics distribution channels with market demands is in the basis of these tasks.

The main stages in this system are the following:

- planning using forecasting, and monitoring of actual performance in distribution channels of the network;

- working out a schedule for providing the subjects of distribution channels with specific dates, number of products, range of products;
- calculation of the necessity of stocks of the material resources.

The participants of the distribution channel must work together to ensure the market requirements to the product line, i.e. qualitative and quantitative composition of the products, aimed at meeting the specific needs of the consumer considering the demand factors associated with the arrangement of retail businesses such as:

- town planning – city size, population density, location of administrative and cultural buildings;
- transport - main directions and intensity of traffic flows, growth of individual transport, availability of public transport bus-stops;
- social - demographics of the population, reducing the time for acquisition of goods, creating the conditions for a high service culture;
- economic – efficiency of commercial and warehouse areas, increasing the profitability of stores, material incentives for the staff.

The plurality of factors defines the tasks of marketing analysis in distribution supply chains:

- forecasting of market development;
- analysis of the competitiveness of the products;
- forecasting of competitors' actions;
- forecasting of consumer's preferences;
- commercial risk analysis.

The solution of marketing analysis tasks involves the use of extensive methodologies. One identifies the following quantitative methods:

- multivariate methods (factor and cluster analyses) are used to survey marketing solutions, which are based on numerous interrelated variables;
- method of statistical theory of decision making (Queuing theory, game theory) is applied to probabilistic description of the consumers' response to the changes in the market;
- deterministic methods of operations research (linear and nonlinear programming) are used to make optimal decisions having many interrelated variables;
- simulation methods are used when the elements that define a marketing situation, are not amenable to analytical solutions;
- regression and correlation methods are used to determine relationships between the variables describing the marketing activities;
- models of network planning and management are used to determine the sequence of work in dealing with various marketing tasks.

The idea of balance between supply and demand of goods in the market is the unifying beginning of the analysis and forecasting methods.

In this case the evolution of algorithms of procurement and inventory management shows that researchers often use the algorithms based on regression and correlation analysis. In the centre of the optimization phase of the algorithms is a well-known formula of Wilson-Harrison, which is often called the formula of optimization the procurement size EOQ. Limitations of the applicability conditions of the specified expression, observed in the works by D. J. Bowersox (Bowersox, 2005) and V. S. Lukinsky (Lukinsky, 2007) are associated with the static representation of the

business process in the form of sale and purchase transactions. Their findings can be applied to a single enterprise in the stationary conditions of supply and demand in a limited time interval. What should be used in dynamic supply chains with seasonal variations? The answer to this question is presented in this study.

3. MATRIX METHOD OF HARMONIZATION OF STOCK AND PROCUREMENT SIZE

The problem of assessing and monitoring the balance of commodity flows indicators was to some extent investigated in some works (Footlik, 2004; Sergeev, 2001; Sterligova, 2008; Kharitonov, 1999). Unlike the published materials, the authors of the present study investigated the conditions for the application of harmonic approach to solving this problem.

To synthesize the method of balanced indices there were used the Pareto principle, methods of ABC - and XYZ - classifications, the Fibonacci number series and the proportions of the “Golden ratio”.

There are studies that describe the Pareto principle, or 80/20 rule (Footlik, 2004; Kharitonov, 1999). The application of this rule to the management of resources is called the ABC-classification. As noted by T. Vasilenko, “the system of ABC-classification is the most developed application of the 80/20 rule” (Vasilenko, 2004). A detailed history and interpretation of this principle can be found in (Koch, 1995).

This method of classification has developed due to its versatility and efficiency. As classification criteria there may be: the purchase price; sales revenue; profit share; share of total turnover; return on sales; the average inventory level; the share in the created stocks; the period (speed) of the turnover of the stock.

Based on the analysis of selected criterion, the groups of products or services are combined according to the degree of influence on the overall result to subgroups A, B, C. The basis of grouping in business is most often the amount of sales revenue earned in a particular group.

The basic approach of applying ABC classification, in our opinion, is the harmonization of quantitative values for a range of products in each group classification in accordance with demand.

The definition of assortment groups in the modern method of ABC - classification is based on the Pareto principle (tab.1). According to it in the analysis of income one distinguishes three groups: group “A” (about 20% of stock keeping units (SKUs), the amount of shares with the cumulative total of which makes up the first 80% of total income), group “B” (about 30% of SKUs, the amount of shares with the cumulative total of which is about 15% of total income) and group “C” (the remaining 50% of SKUs, the amount of shares with the cumulative total of which is about 5 % of total income). To assess the dynamics of changes in the sales structure it is also possible to compare the results of the ABC - classification for the current period and for the previous one.

Table 1. Grouping of goods by income shares

Group on the level of sales	Number of goods (% of total)	Cost of sales (income as % of total income)
A	20	80
B	30	15
C	50	5

Source: Lukinykh, 2008.

There is an important statement that “recommendations for the inventory management items with ABC classifications are of universal character” (Sterligova, 2008, p.89), that allows making the algorithms of management decisions in relation to the inventory movement, and making recommendations for the inventory management of the operational type in subsystems of the distribution channels of supply chains in retail networks.

The use of ABC classification for harmonization of a stock-list and inventory is an effective tool for analysis, but it is problematic for prediction. Therefore, we investigated the relationship of ABC, XYZ classifications and Fibonacci numerical series based on the trading industry data.

The principle of stock differentiation in the method of demand analysis of XYZ is different. Because this method affects the stochastic sphere of market relations, namely the dependence of demand on the varieties of stock, in this case, the entire stock requested by the consumers is divided into three groups depending on the demand stability. Thus, group X includes the goods with stable demand and deviation of not more than 20% from the average demand. Group Y includes the goods with the size of the deviation from the average demand in the interval of 20-50% and group Z - with a size of deviation of 50 % or more (tab. 2).

Table 2. The algorithm of differentiation on XYZ groups

Groups	Interval of demand variation, %
X	less than 20%
Y	from 20 to 50%
Z	more than 50%

Source: Lukinykh, 2008.

To assess the deviation indicators from the average demand, the coefficient of demand variation Y is used, which is determined by the following formula, taking into account the standard deviation:

$$Y = \frac{\sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n}}}{\bar{x}} 100 \%, \quad (1)$$

where X_i is the i -th value of demand by the estimated position; x – average demand estimated position for the period n , for example, in days; n – size of an assessed period (e.g., in days).

Combining the results of the analysis of the ABC - and XYZ - classifications allows us to generate a matrix values table for the analysis and forecasting of the demand and stock-list (table 3).

The possibility of application of this table is interpreted in the existing literature as follows: subgroups AX, AY, AZ require individual management; subgroups CX, CY, CZ are controlled by a year planning with a monthly availability control; subgroups BX, BY, BZ require less rigid planning and control than in the first subgroups, and more rigid planning and control than in the second sub-groups (Sterligova, 2008).

Table 3. Harmonization matrix of ABC-XYZ-classifications

20	20 AX	30 AY	50 AZ
30	BX	BY	BZ
50	CX	CY	CZ

Source: Lukinykh, 2008.

We can say that this interpretation of the combining of groups analysis of ABC - and XYZ - classifications into a single table doesn't have quantitative forecasting as necessary.

It is proposed to improve this method and supplement it with the ratios of ABC - and XYZ – classification like 20:30:50. This offer is substantiated by the fact that the ratio of the values of the subgroups in the vertical and horizontal rows is close enough to number F – number of the Golden ratio underlying the Fibonacci numerical series, that is, reflect the harmonization effect. It is proposed to express this method in the form of a table and call it as a harmonization matrix, because it combines the Pareto principle and Fibonacci numerical series, and that is related to the concept of harmonization in the terms of constant demand. In this case, the values of the parameters ratios of the two neighboring subgroups are in accordance with the criterion of stability of the system studied.

The criterion of stability of the distribution system is determined on the basis of preserving the ratios between the yields of commodity groups in adjacent sectors of the harmonization matrix as follows. As can be seen from table 3 the ratio of the number of SKUs between the groups lies in the number of 0.6, namely: range of group A refers to the range of group B as 0.6. Similarly, the range of group B refers to the range of group C = 0.6. This coefficient is correlated with a universal stability criterion of the system known as "Golden ratio". Further, based on the principle of Pareto group A is about 80% of the revenue, group B – about 15%, group C – about 5%. It is seen that the ratio 80/15 is equal to 5 and 15/5 is equal to 3, and the coupling ratios of 3/5

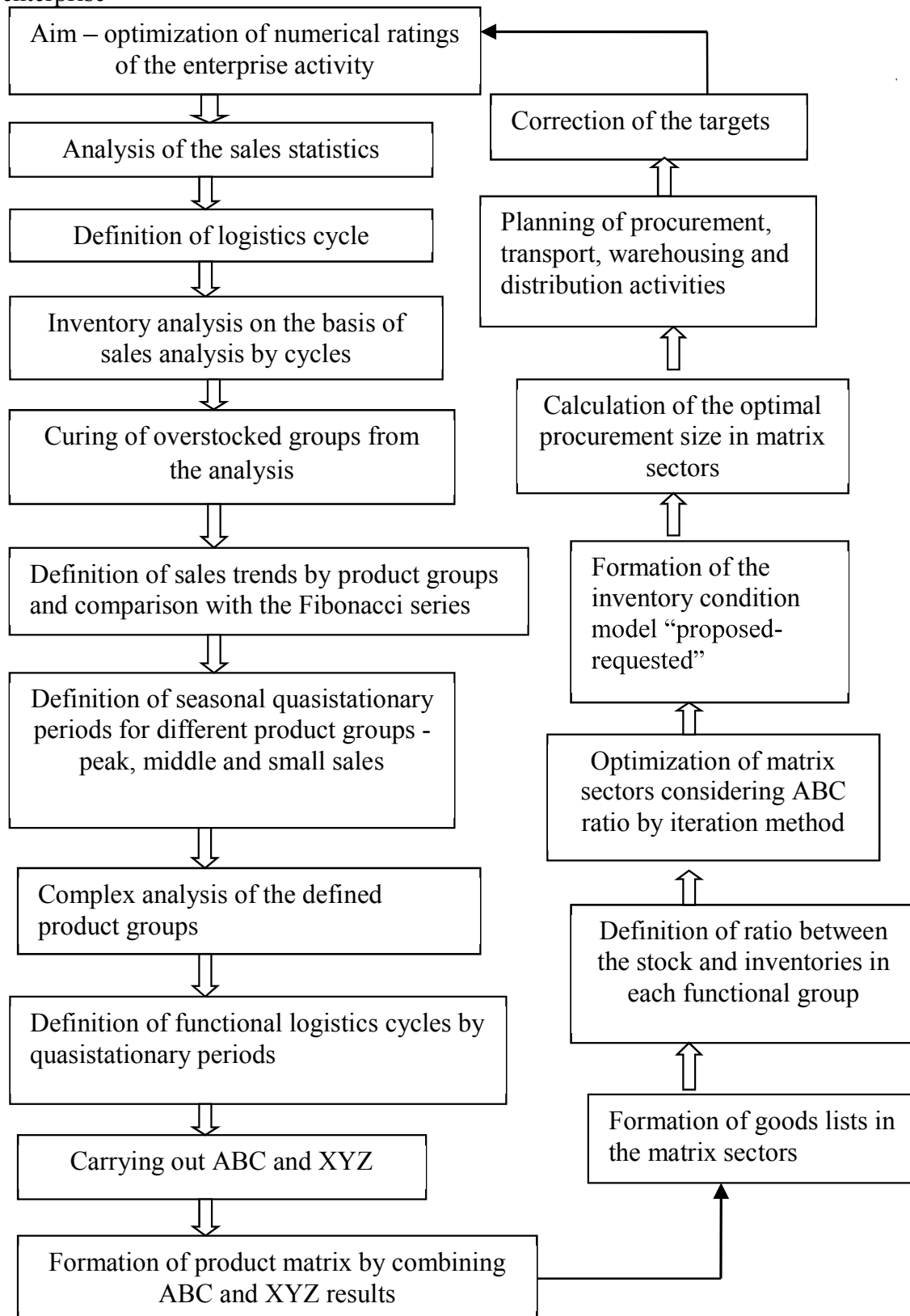
gives the parameter of 0.6. As a result of our observations, it was concluded that support in practice the above ratios characterizes the stability region of supply and demand in the local retail market with stochastic demand. These ratios are shown in table. 3.

Thus, turning to the analysis of the applicability of ABC, XYZ classifications, it is possible to determine that the use of the harmonization matrix is identified as a method allowing to distribute the available resources in the system by the rules close to the harmonious ones at the enterprises, i.e. to ensure the allocation of system resources which can best ensure its harmonized and, as a consequence, sustainable development.

The method is developed for coordination between the manufactured products and the demanded ones in the market. ABC - and XYZ – classifications are considered as the ones which express evaluation of the products offered in the market (ABC) and real stochastic market demand (XYZ), respectively. The optimality criterion of the relationship between two analyzed evaluations is a cumulative curve diagram of ABC classification with the settings of the Fibonacci series, and the quantitative relations are defined using the matrix method of harmonization. In this interpretation it is possible to carry out forecasting of the product matrix ABC–XYZ for the selected market segments and product groups on the basis of statistical data of sales results.

This method of forming the nomenclature matrix captures the essence of the harmonic approach to the balance of supply and demand in a market environment when generalized economic indicators of the company are given. It can be considered as an applied method on the wording “made–requested”, which allows predicting the inventory item groups of goods in the trade enterprises. For the method “proposed–requested” the algorithm of harmonization of stocks and market resources is developed (Fig. 1) (Lukinykh, 2008).

Figure 1. The algorithm of stock-lists and market resources harmonization in the enterprise



Source: Lukinykh, 2008.

4. METHOD APPROBATION

The method was tested in “SuperSport” company which was founded in 2001. It includes eight sports shops that specialize in the sale of goods for the following kinds of sports: Alpine skiing, snowboarding, cross-country skiing, hockey, figure skating, biking, hiking, boxing, swimming, tennis, soccer, fitness and many others. The stock includes more than 20,000 kinds of goods for sports and rest. The company is engaged in retail and wholesale of sporting goods. The company operates on two sites of online stores, participates in the auctions. It has its own distribution warehouse. Today, there are 8 stores in five cities in the region. All stores are united in a retail chain of sports shops.

Trade policy of the company includes the necessary stock of sporting goods in accordance with the market situation, both in depth and breadth in most demanded SKUs.

Pricing policy is aimed at providing highly profitable activity of the company on the sports market, quick adaptation to the changing market conditions considering the average level of prices for the same products of the major competing companies in the region. There is a tendency taken into account that the location of stores in strategic places is a factor whose value is becoming smaller. A much more important factor is the breadth of product range.

Practice shows that currently the technology sales has reached a level that competing products do not differ in their consumer properties from each other. Therefore, in order to win the competition active market participants resort most frequently to two methods. For example, the famous Western marketers propose to use the method of integrated marketing communications (IMC). Marketing program based on this method is a single, multi-channel and synchronized communication, focused on the establishment of personified bilateral relations with different target audiences, for each of which its own model is selected. This implies that various elements of marketing communication, such as direct marketing, sales promotion, trade shows, advertising in media, public relations, live communication with potential customers have to be well coordinated. The skillful synthesis and coordination of various marketing communication tools makes a so-called synergy effect, when the combined use of marketing tools leads to a stronger and stimulating effect than their inconsistent use. The inherent advantages of each tool of marketing communications in this scheme reinforce each other, and the disadvantages of individual instruments are offset and disappear.

The second method is based on reducing overall distribution costs and improving customer service, primarily through the proper use of logistics tools. In this case the main emphasis is on improving the usefulness of the material product and the related service from the point of view of the consumer that requires a change of management style in the direction of establishing deeper and sustainable relationships with consumers, formation of material and service systems with flexible management structures, which are able to respond quickly to the increasing consumers demands.

Characteristics of effective sports activities on the market are:

- maximum use of modern information technologies, which are the main base of progressive forms of product distribution;

- a constant search for the optimum ratio of the useful effect of product distribution with the costs on its organization, taking into account the company's chosen strategic priorities;

- the optimal combination of specialization and diversification to meet the ever increasing demands of consumers in the better way;

- development of infrastructure, contributing to the reduction of the cycle of products and services distribution from a producer to a consumer.

Given this, it is advisable to list the basic managerial tasks of the company "Super Sport" which should include:

1. Constant study of the condition and trends of development of the market of sporting goods not only on the regional, but also on the international market.

2. A study of potential target audience`s demand in three main parameters: segmentation; the motives of demand; unfilled demands.

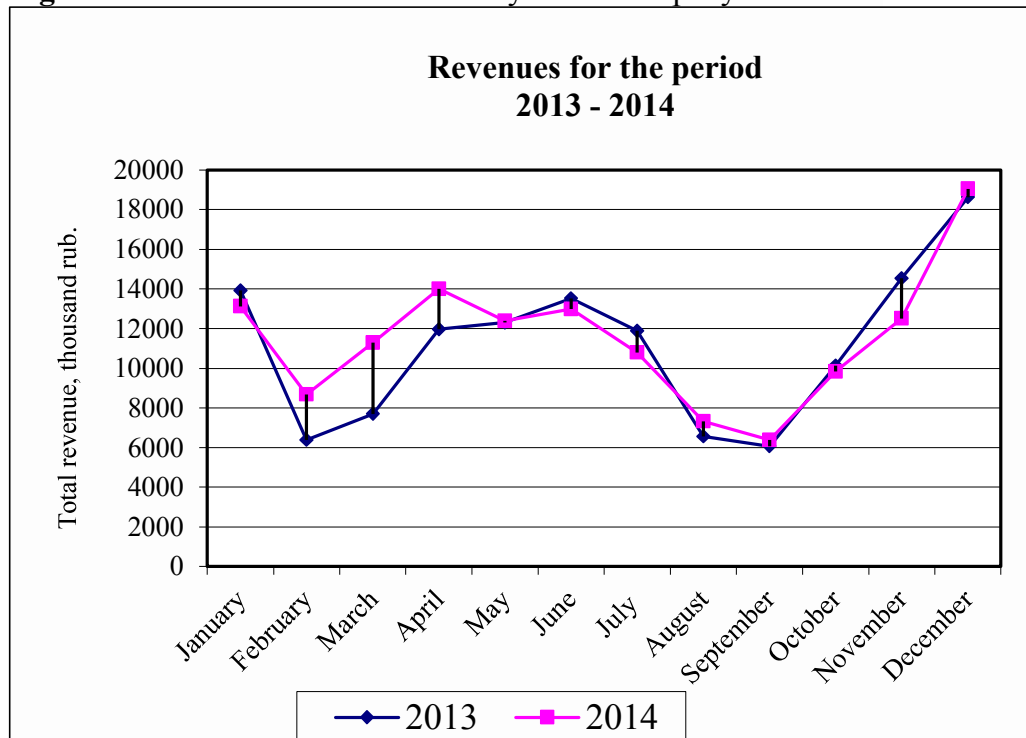
3. The analysis of competitors ' activities, and quick response to certain circumstances.

4. Standardization of the consumer`s service based on the concept of total quality control of products sold.

It should be noted that the company lacked an effective and flexible method of matching supply and demand in the whole network of stores.

SKU range varies by the seasons both by offer and demand. There are two main seasons on the range at the sporting goods market: fall / winter and spring / summer. Fig.2 reflects the turnover for two years on a monthly basis.

Figure 2. The nature of the seasonality of the company's revenues



Source: data of the company "SuperSport"

It can be seen on the graph that the highest peak of shopping is in December or January. It is due to the fact that at this time Russians celebrate the main holidays such as New Year and Christmas, consequently people buy gifts for themselves and their relatives and friends. It should be noted that there are off-season periods, when the demand for a range of sporting goods decreases, correspondingly does the revenue. This tendency is annually observed as can be seen in figure 2 for the period of 2013 and 2014. Therefore, procurement of the key seasonal items and sustaining the range should be based on primary seasons.

Analysis of the development conditions of the distribution network of the company showed some discrepancy between the volumes of the purchased goods and the realized ones. That allowed introducing the harmonized method of making goods volumes to increase sustainability of sales volumes. It was recommended to optimize stocks by moving goods between the stores on the basis of the matrix ABC - XYZ analysis.

To optimize the range of products, matrix ABC - XYZ analysis for each store was made separately by product groups. According to the analysis, each store varies in the number and revenue on the priority commodities, and the demand for them. This difference is influenced by geographic location, income level in the region, trade area and the range.

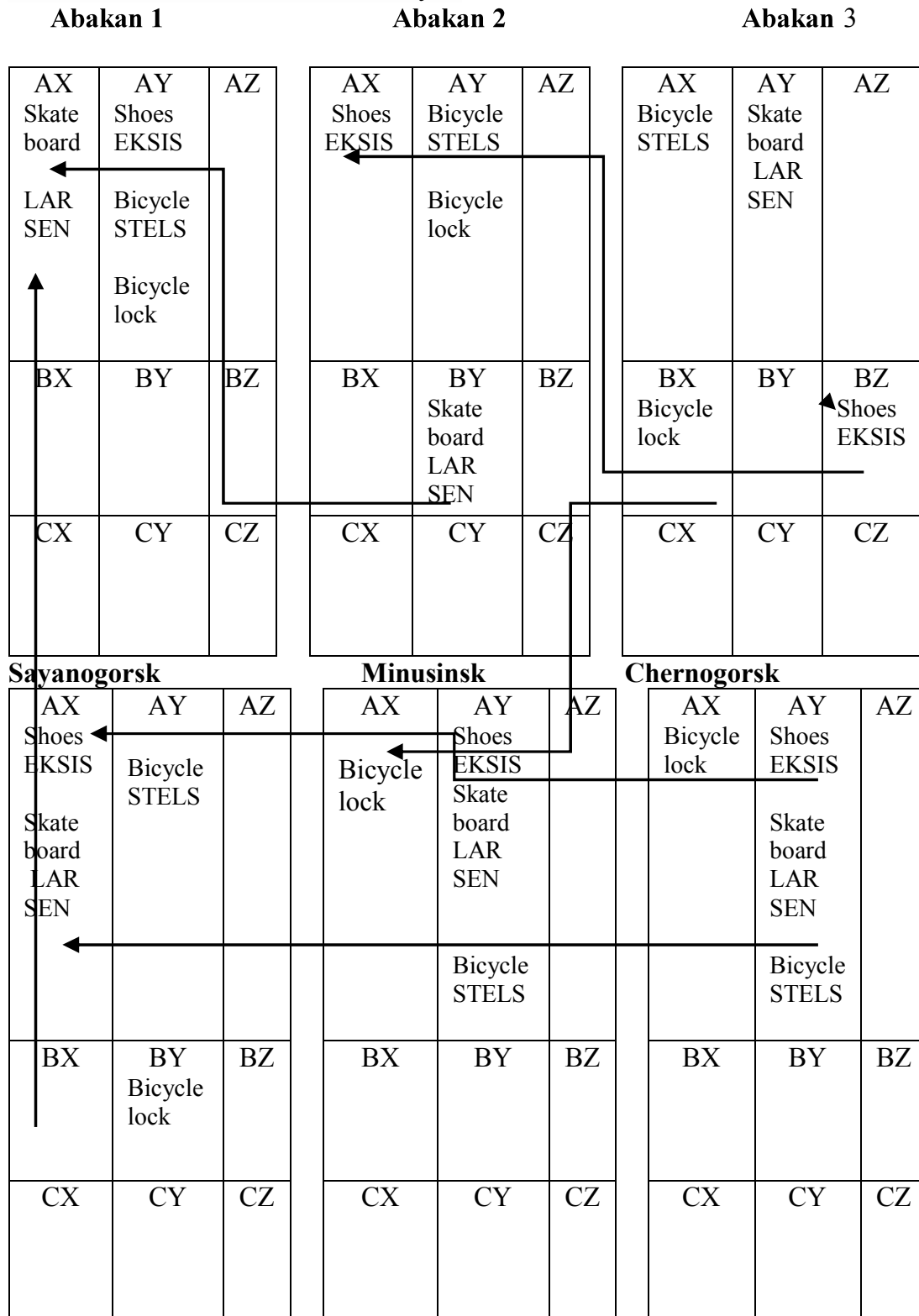
Method of moving goods between the stores will be designed on the basis of the matrix of the ABC-XYZ analysis. Let us demonstrate the method of moving on the example of four product groups of the sports goods: skateboard LARSEN, shoes EKSIS, bicycle STELS, a bicycle lock. Let's define the location of each product group by demand and supply in ABC-XYZ matrix in each store according to the summer season 2014 (Fig.3).

As can be seen from Fig.3, product groups are located in different sectors of the matrix on the stability of demand in different stores. Accordingly, the demand for goods is different in different cities. Considering the data of the analysis, the product from the store with a lack or unstable demand should be moved to the store with a steady demand. For example, the product group "Skateboard" has a stable demand in the stores "Abakan 1" and "Sayanogorsk", and the lowest demand for this group is in stores "Abakan 2" and "Chernogorsk". Accordingly, the priority should be given to the stores with the highest demand.

The arrows in the figure show the suggested movement of goods analyzed in four product groups. After this movement the reduction of the turnover of goods is observed, which leads to a growth of financial indicators such as profit and profitability.

Holding the suggested activities regularly, allows maintaining a harmonious range in the sports supermarkets network, thereby accelerating the turnover, increasing revenue, profits and profitability of sales by 10-15%. This harmonious distribution will allow the company to be competitive.

Figure 3. The movement of goods between the stores of different cities on the basis of the matrix of the ABC - XYZ analysis



Source: authors' development

5. CONCLUSION

It is shown in the paper that along with the existing marketing methodological tools for the formation and forecasting of goods demand in retail networks, one can effectively use the harmonic method of supply and demand. It allows predicting a range of frequently demanded goods in retail networks and, most importantly, generating simultaneously the optimum size of the multiproduct inventory of goods in terms of non-stationary demand. The main limitations in the application of the harmonic method can be in the following situations: small range (less than 50-100 items); the lack of competition in the market for the analyzed group of products; incorrect choice of the duration of the logistic cycles of commodity groups in the analysis (the analysis time must be a multiple of the period of circulation of goods on the market); the widespread use of software to ABC – analysis without taking into account the above limitations.

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