UDC 339.1.003.13

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OPTIMIZATION OF COMMODITY STOCKS THE ENTERPRISE BY MEANS OF HML-FMR CLUSTERING

Abstract. The article examines the process of formation inventory of the enterprise and determines the optimal volume of commodity resources for sale. A generalization of author's approaches to the formation and evaluation of inventories of the enterprise is carried out. The marketing-logistic approach was applied for the purpose of distribution groups of commodity resources due to the risk of non-fulfillment the order for the supply of goods of the enterprise. In order to ensure an effective process of commodity provision of the enterprises, the costs associated with the formation of inventories are determined. The formalized scheme of the formation commodity provision and the process of optimization inventory of the enterprise is offered. The analysis the structure of the company's inventory is carried out, the volume of goods turnover is defined, the stocks are grouped for various clustering characteristics. To conduct the study, statistical information was used on commodity resources of the enterprises, statistical methods (grouping, structure analysis, estimation of dynamic series), tools for assessing the efficiency of inventory use, HML-FMR clustering were used. The necessity of using XYZ and ABC analysis is indicated in order to obtain more reliable results and forecast values of the product support of the enterprise. Economic-mathematical modeling is applied and graphically shown the difference in the formation of commodity resources by various features of HML-FMR clustering. The calculations allow the enterprise to determine the optimal amount of commodity resources in accordance with the needs of consumers and their solvent demand, to plan financial resources for the formation of inventories, to develop assortment policy in accordance with demand for products and their implementation. The results of calculations the volume of merchandising of the enterprise, taking into account the HML-FMR clustering affect the formation of final financial performance of the enterprise — income and profits.

Keywords: commodity stocks, financial result, costs, optimization, clustering, enterprise.
JEL Classification C40, C46, L81, P42
Formulas: 0; fig.: 4; tabl.: 4; bibl.: 30.

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ОПТИМІЗАЦІЯ ТОВАРНИХ ЗАПАСІВ ПІДПРИЄМСТВА ЗА ДОПОМОГОЮ HML-FMR КЛАСТЕРИЗАЦІЇ

Анотація. Досліджується процес формування товарних запасів підприємства і визначається оптимальний обсяг товарних ресурсів для продажу. Здійснено узагальнення авторських підходів до формування та оцінки товарних запасів підприємства. Застосовано

маркетингово-логістичний підхід з метою розподілу груп товарних ресурсів через ризик невиконання замовлення на поставку товарів підприємства. Для забезпечення ефективного процесу товарного забезпечення підприємств визначено витрати, які пов'язані з формуванням товарних запасів. Запропоновано формалізовану схему процесу формування товарного забезпечення і процесу оптимізації товарних запасів підприємства. Проведено аналіз структури товарних запасів підприємства, визначено обсяг товарообігу, згруповано товарні запаси для різних ознак кластеризації. Для здійснення дослідження використано статистичну інформацію про товарні ресурси підприємств, застосовано статистичні методи (групування, аналіз структури, оцінка динамічних рядів), інструменти оцінки ефективності використання товарних запасів, HML-FMR кластеризація. Вказано на необхідність застосування XYZ- та ABC-аналізу з метою отримання більш достовірних результатів і прогнозних значень товарного забезпечення підприємства. Застосовано економіко-математичне моделювання та графічно показано відмінність у формуванні товарних ресурсів за різними ознаками HML-FMR-кластеризації. Розрахунки дозволяють підприємству визначати оптимальний обсяг товарних ресурсів відповідно до потреб споживачів та їхнього платоспроможного попиту, планувати фінансові ресурси для формування товарних запасів, розвивати асортиментну політику відповідно до попиту на продукцію та її реалізацію. Результати розрахунків обсягу товарного забезпечення підприємства з урахуванням HML-FMR-кластеризації впливають на формування кінцевих фінансових показників діяльності підприємства — доходів і прибутку.

Ключові слова: товарні запаси, фінансовий результат, витрати, оптимізація, кластеризація, підприємство.

Формул: 0; рис.: 4; табл.: 4; бібл.: 30.

Introduction. In modern conditions enterprises are trying to provide a stable volume of goods turnover of different producers, maximally satisfying the needs of customers, taking into account their solvent demand. Formation of commodity resources occupies an important place in the operational activities of retailers and allows the development of an effective commodity (assortment) policy, taking into account the system of marketing and marketing of products to end users. Accordingly, the provision of commodity resources of enterprises is influenced by a multitude of factors that business entities must take into account when implementing their own activities. The optimum product range of products of enterprises is determined by the mechanisms on which the pricing system depends, the volume of goods turnover and profit.

Commodity stocks the enterprise (in trade) is represented by finished goods, which economic entities purchase from producers and form their volume in accordance with demand, consumer income and other criteria. The subject of their evaluation is the definition of the optimal volume of commodity resources, the calculation of indicators of turnover of commodities, the study of factors of influence on turnover due to acceleration or slowdown of turnover, improving the structure of the product range and determining the optimal level of trade margins, developing directions for accelerating turnover and normalization of inventories, etc.

The problem research is the determination of the optimal volume of commodity stocks in accordance with the needs of consumers and their effective demand. The purpose of the study is: to determine the product positions of the enterprise and optimize them according to the effective demand of the consumer, which allows buying the appropriate product, the formation of optimal commodity assortment the enterprise, based on the financial resources. Research methods: comparative analysis of commodity positions the enterprise, cluster analysis.

The urgency of this problem is determined by the practical aspect of managing the enterprises in the conditions of competition. Retail companies constantly experience a shortage of their own working capital because of their high cost in order to provide commodity resources in addition; there is a change in the conditions of supply of products, pricing systems, and sometimes the dictation of the producer on sales of its products.

The efficiency of providing commodity resources of enterprises is influenced by consumers 'solvent demand, their needs and preferences of one or another group of goods, redistribution of

customers' costs for the purchase of the corresponding products, provision of high-quality service, level of mark-ups, marketing tools, etc.

The valuation of commodity stocks is the main methodological method of accounting. With it, the value measurement and generalization of the facts of the economic activity of the enterprise are provided. The assessment makes it possible to determine the level of economic efficiency of managerial decisions on investments in commodity stocks. The correctness of the choice of evaluation significantly affects the company's activity, its financial stability and liquidity.

Literature review. Generalization of author's approaches to valuation commodity stocks the enterprise. Initial assessment of purchased or manufactured commodity stocks is their cost ... Independently of the commodity stocks system, in practice, there is a problem assessing the expense of commodity stocks, since the cost of their acquisition (purchase, production) in periods — different (Golov, Kostiuchenko, 2002). The following valuation methods are used to determine the value of commodity stocks: Historical cost, Current cost, Cost of implementation (Orlova, Savich, Kostetskaya, 2004). When the stocks are released to production, sale and other sold out, their valuation is carried out using one of the following methods: the identified cost of the corresponding unit of commodity stocks; average weighted cost; the cost of the first time in commodity stock inflows (FIFO); selling prices (Krupka, Zadorozhny, Melnik, 2008). Commodity stock valuation is directly related to the definition of the cost of production. In accounting commodity stock valuation is possible at a different cost (Tkachenko, 2007). Commodity stock valuation is an important prerequisite for organizing the accounting of this site, since it affects the accuracy of financial results of the enterprise (Liubkina at al., 2019; Masharsky at al., 2018; Vasylieva at al., 2018). The valuation of commodity stocks by their individual species should be considered at the following stages of their movement: at the receipt of commodity stocks; at the disposal of commodity stocks; on the date of reporting (Butinets, Kuzhelny, Osadchy, 2002).

I. Blank considers the analysis of commodity stocks as one stage of inventory management. The latter, in turn, is an integral part of the management of the company's current assets. Inventory management tools the policy of inventory management. The policy of inventory management includes a number of consecutive works: a) analysis of inventories in the previous period; b) definition of the objectives of stock formation; c) optimization of the total amount of commodity stocks assets formed at the expense of working capital; d) construction of effective systems of control over the movement of reserves in the enterprise (Blank, 2000).

L. Elina stresses that in the process of managing and analyzing of commodity stocks, attention is focused, first of all, on checking the reliability and integrity of the counterparty. Enterprises are not spared the need to be cautious when concluding contracts with suppliers. Often unscrupulous contractors refer to trade secrets when they do not, ignore the opinion of the other contracting party (Elina, 2002).

In EU countries, in theory and in practice, economic analysis of commodity stocks is built into the creation of a chain of values in enterprises. For example, L. Girardo recommends the following five steps to improving inventory management in small businesses. The first step is to forecast sales and, on this basis, determine the commodity stocks for the forecasted sales level. The second step is the elimination of data entry errors in operating systems. It is advisable to use the «cyclic counting» technique, i.e. select several types of goods and compare their actual availability with a fixed amount in the database. The third step is to highlight the commodity stocks items that give the greatest sales, and pay special attention to them. The fourth step is to eliminate the conditions under which the communication of sellers among themselves leads to a distortion of the electronic tables of inventory accounting. The fifth step is to save the data in stocks in copies (Girardo, 1998).

Formation of commodity stocks the enterprise. In order to increase the effectiveness of formation commodity provision for enterprises use of marketing-logistics approach based on the allocation of groups commodity resources by the risk of non-fulfilment the order for the supply of goods.

According to the proposed approach it is advisable to distinguish between:

commodities with high risk characterized by significant fluctuations in demand and supply disruption;

medium-risk commodity stocks which include stocks with fairly high accuracy of forecasting, the presence of trends and seasonal fluctuations or a high degree of availability in terms of purchasing opportunities, which in both cases avoids non-fulfilment of the order;

low-risk commodity stocks which include stocks with a stable consumption level and sufficiently high reliability of supply.

The analysis of the three proposed to distinguish groups of commodity stocks of enterprises allows you to identify the main reasons for their formation which include: discrepancy in the volumes of supply of goods to the volume of one-time consumption; contradiction between the continuous nature of the consumption of goods and the discrete nature of their receipt to the place of consumption; changes in market conditions that lead to the necessity of formation of commodity stocks as a result of price changes; seasonality of consumption processes, etc.

In our opinion, one of the problems of the formation of commodity provision for retailers is to establish an optimal balance between the use of funds for the purchase of commodity stocks and the level of consumer satisfaction.

Important in the process of formation of commodity provision of enterprises is the definition of costs associated with commodity stocks (*Table 1*).

Table 1

Components and characteristics costs for formation commodity provision enterprises

Type of cost	Characteristic	Elements of cost
Costs for order formation	This type of costs is related to the placing of orders for the supply of commodity stocks.	accounting documentation; preparatory and final operations; transport costs for the movement of goods between enterprises and warehouses;
Storage costs	By investing in the formation of commodity stocks, the enterprise thus refuses to use these funds for another purpose.	cost of capital materialized in commodity stocks; storage costs of commodity resources in stock; other expenses related to the physical presence of goods;
Cost of covering the deficit	These costs arise when the demand for goods exceeds its presence in a trading room or in a warehouse. One of the commonly used indicators to control the cost of covering a deficit is the level of customer service.	lack of profit if the buyer decides to buy a product from a competitor.

Source: determined by the author.

Information *Table 1* shows that the expenses for the formation of commodity provision of enterprises are attributed to us: the cost of formation of orders, storage costs and the cost of covering the deficit. Minimization of the indicated costs can be used as a criterion for optimization in solving problems with the formation of commodity provision of enterprises.

It should also be noted that economic-mathematical modelling can be used as a tool for the formation of commodity provision of enterprises under conditions of competition.

Taking into account the aforementioned approaches the process of formation of commodity provision of enterprises can be presented in the form of a scheme (*Fig. 1*).
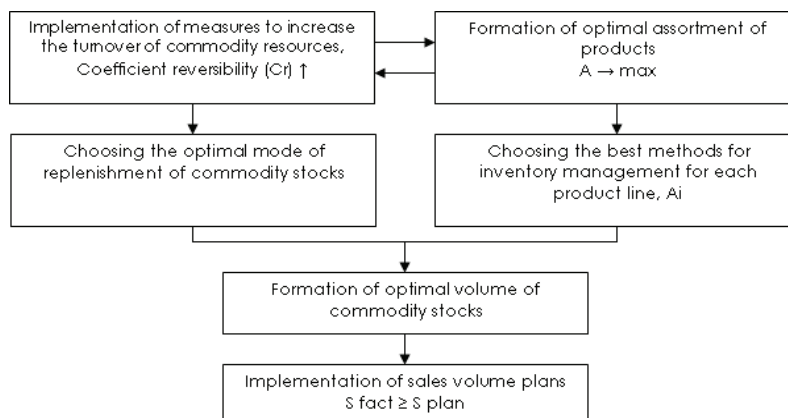

Fig. 1. Improvement formation commodity stocks enterprises
Source: author's illustration.

Information on *Fig. 1* shows that the organization of the process of formation of commodity stocks of enterprises is aimed at supporting the necessary and sufficient volume of commodity resources to implement the volume of trade turnover. For each nomenclature position must choose a method of managing commodity resources. The use of this method will mitigate the risks associated with forecasting and subsequent planning of volumes of trade. In order to implement the plan of volumes of goods turnover it is expedient to choose the appropriate method of replenishment of commodity stocks.

Methodology. Taking into account the current state of enterprises and the existing methodical tools for the formation of commodity stocks it is necessary to develop an effective model of their optimization aimed at more fully satisfying the needs of consumers and changing their solvent demand. The basis of this model, in our opinion, should be the principle of systemicity with the presence of elements of analysis, planning and regulation, which determine the appropriate mechanisms, and in the process of its development and implementation, the following tasks will be addressed:

analysis of assortment structure in dynamics with the selection of perspective nomenclature groups and assortment positions according to the criteria: volume of goods turnover, maximum quantity of goods sold, profitability;

definition of nomenclature groups and commodity positions in accordance with the analyzed commodity structure and implementation of planning of volumes of commodity stocks, taking into account price competition, sales segments, consumers' solvent demand;

use of the system of planned settlements providing commodity stocks through regulation of volumes of deliveries of goods, fulfilment of terms and terms of deliveries, carrying out of financial calculations, etc.;

management of commodity stocks through the establishment of an effective process of selling goods, use of marketing measures, provision of quality trade services, obtaining a positive result.

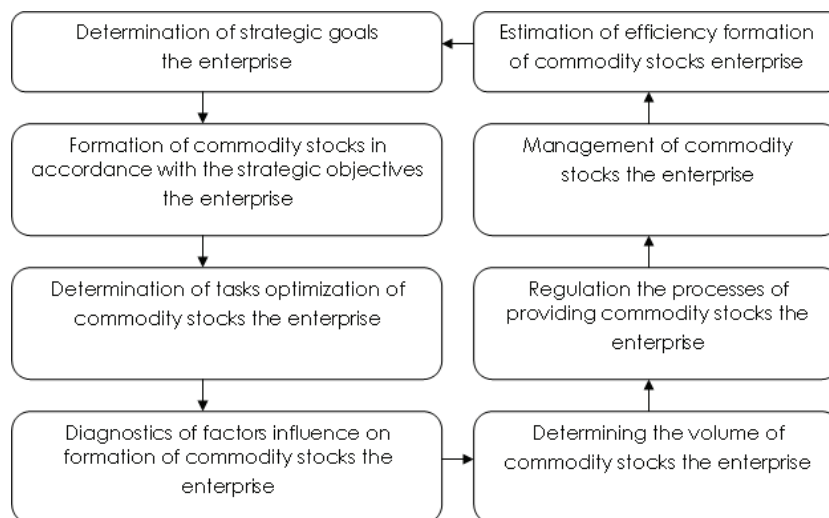The process optimizing of commodity stocks can be as follows (*Fig. 2*).

Fig. 2. Sequence determination volume commodity stocks enterprise
Source: author's illustration

Information on the *Fig. 2* shows, that the proposed sequence allows to determine the volume of commodity stocks and to provide a position on the consumer market regarding competitors, to make a preliminary choice of possible segments sales, while the final decision is made taking into account the internal capabilities of the enterprise.

One of the main issues the formation commodity stocks the enterprise is the diagnosis of

factors affecting their formation, which allows you to determine the required volume. In our opinion, the main factors of influence should be considered: volume of demand and supply on the consumer market, share the enterprise in the consumer market, the level of pricing, profitability of sales, the level of growth the needs, the level of solvent demand, the state of competition, etc.

In international practice there are methods of cluster analysis that enterprises do not currently use in assessing commodity stocks, although they allow deepening research tools and obtaining qualitative results for further forecasting of the optimal volume of commodity resources. They include:

HML clustering — at the cost of a unit of commodity stocks (H — High, M — Medium, L — Low);

FMR clustering (F — Fastest, M — Medium, R — Rare), which facilitates the analysis of commodity stocks for the duration of turnover. Sometimes FSN clustering (Fast Moving, Slow Moving, Non Moving) or FNS (Fast Moving, Normal Moving, Slow Moving) is used.

Results. Proposals for the formation of commodity stocks through the optimization of commodity resources were tested at the enterprise LLC «LIGROS LTD», which sales a food group of goods. In order to optimize the product resources at LIGROS LTD, we used the HML and FMR clustering. Data is taken from the enterprise's accounting and statistical information. The results of calculations are presented in *Table 2* and *Table 3*.

Table 2

Indicators optimization commodity stocks LLC «LIGROS LTD» using HML clustering

Name	HML clustering		
	H	**M**	**L**
Meat and poultry are fresh and frozen	-	7,8	12,6
Meat smoked, salty and sausage wares	3,2	9,4	15,4
Fish and seafood food	2,8	8,7	13,5
Milk and milk products	-	11,3	14,8
Cheese is sliced, fermented and sour milk	2,5	3,7	10,5
Butter	-	10,2	16,7
Vegetable oils	2,7	8,4	9,6
Margarine	-	5,6	7,3
Eggs	-	-	10,3
Sugar	-	8,7	-
Confectionery	4,6	7,3	11,2
Ice-cream	-	3,7	9,5
Flour	-	2,7	6,3
Bakery products	-	5,3	10,6
Groats	-	6,8	13,8
Noodles	2,3	4,2	10,8
Fresh vegetables	-	9,2	13,4
Fresh fruits, berries, grapes, nuts	3,2	8,6	12,9
Vodka and alcoholic beverages	3,8	8,7	11,5
Low alcohol drinks	-	7,5	10,4
Fault	1,8	5,3	7,8
Cognac	2,4	6,7	9,5
Sparkling Wines (Champagne)	-	5,1	8,3
Beer	-	8,5	13,2
Tea	-	5,4	8,5
Coffee	-	6,8	9,6
Soft drinks	-	7,3	11,7
Mineral waters	-	5,8	9,2
Tobacco products	-	6,5	8,9
Together in groups	29,3	195,2	307,8
Total	532,3		

Note: monetary units.
Source: calculated by the author.

According to the data of *Table 2*, the volume of inventory stocks of LLC «LIGROS LTD» is determined according to the high, average and low cost according to the needs of consumers and their solvent demand. Calculations show that the majority of commodity resources of the non-food group are represented by products that have a comparatively low cost (57.8%), goods with an average cost of 36.7%, and expensive — 5.5%. The total cost of commodity stocks of LLC «LIGROS LTD» is 532.3 monetary units, which is 53.8% more than in last year. The increase in the volume of commodity stocks is due to their increase in value and the growth of consumer needs.

Using information about the turnover of commodity stocks in the *Table 3*, three groups of clusters have been formed, which shows that commodities with fast turnover occupy the largest share in the overall structure — 64.3%, average — 33.2%, slow sales — 2.5%.

Table 3

Indicators optimization commodity stocks LLC «LIGROS LTD» using FMR clustering

Name	HMR clustering		
	F	M	R
Meat and poultry are fresh and frozen	15,3	5,1	-
Meat smoked, salty and sausage wares	14,8	11,5	1,7
Fish and seafood food	12,5	10,3	2,2
Milk and milk products	19,3	6,8	-
Cheese is sliced, fermented and sour milk	9,5	5,9	1,3
Butter	17,6	9,3	-
Vegetable oils	10,5	8,4	1,8
Margarine	8,5	4,4	-
Eggs	10,3	-	-
Sugar	8,7	-	-
Confectionery	11,8	7,8	3,5
Ice-cream	10,1	3,1	-
Flour	9,0	-	-
Bakery products	15,9	-	-
Groats	12,7	7,9	-
Noodles	9,7	7,6	-
Fresh vegetables	14,3	8,3	-
Fresh fruits, berries, grapes, nuts	16,5	8,2	-
Vodka and alcoholic beverages	15,3	6,2	2,5
Low alcohol drinks	9,6	8,3	-
Fault	8,5	6,4	-
Cognac	10,4	8,2	-
Sparkling Wines (Champagne)	7,5	5,9	-
Beer	15,9	5,8	-
Tea	7,3	6,6	-
Coffee	8,6	7,8	-
Soft drinks	10,3	8,7	-
Mineral waters	12,5	2,5	-
Tobacco products	9,5	5,9	-
Together in groups	342,4	176,9	13,0
Total	532,3		

Note: monetary units.
Source: calculated by the author.

Discussion. According to the results of research on the enterprise LLC «LIGROS LTD», it has been established that in the formation of commodity stocks, it is worth paying attention to Low Cost (HML clustering) and Fastest Turnover (HMR clustering) positions, which will allow the enterprise to determine the optimum product range. Other positions can be taken into account in the event of a high profitability of sales.

Using data *Table 2*, *Table 3* and the «Summary tables» in Excel, we have formed a Table 4 that allows you to compare Low Cost and Fastest Turnover product positions. The results show that the vast majority of commodity positions have a greater turnover of commodity stocks (from 29 positions — 19), which indicates a positive dynamics of growth in volumes of commodity

assortment that exceed the cost of commodity stocks. The amount of turnover commodity stocks the enterprise exceeds the amount of their value, which indicates the priority of taking into account the rate of turnover in optimization of commodity stocks the enterprise.

Table 4

Low Cost (L) and Fastest Turnover (F) product positions (commodity stocks) LLC «LIGROS LTD»

Name	Cluster	
	F	L
Meat and poultry are fresh and frozen	15,3	12,6
Meat smoked, salty and sausage wares	14,8	15,4
Fish and seafood food	12,5	13,5
Milk and milk products	19,3	14,8
Cheese is sliced, fermented and sour milk	9,5	10,5
Butter	17,6	16,7
Vegetable oils	10,5	9,6
Margarine	8,5	7,3
Eggs	10,3	10,3
Sugar	8,7	-
Confectionery	11,8	11,2
Ice-cream	10,1	9,5
Flour	9,0	6,3
Bakery products	15,9	10,6
Groats	12,7	13,8
Noodles	9,7	10,8
Fresh vegetables	14,3	13,4
Fresh fruits, berries, grapes, nuts	16,5	12,9
Vodka and alcoholic beverages	15,3	11,5
Low alcohol drinks	9,6	10,4
Fault	8,5	7,8
Cognac	10,4	9,5
Sparkling Wines (Champagne)	7,5	8,3
Beer	15,9	13,2
Tea	7,3	8,5
Coffee	8,6	9,6
Soft drinks	10,3	11,7
Mineral waters	12,5	9,2
Tobacco products	9,5	8,9
Together in cluster	342,4	307,8

Note: monetary units.
Source: calculated by the author.

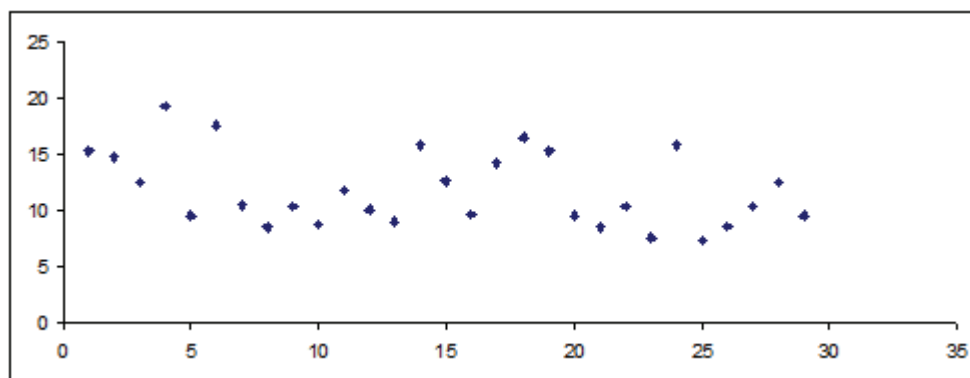This is also verified graphically on *Fig. 3* and *Fig. 4*.

Fig. 3. **Fastest Turnover (F) product positions (commodity stocks) LLC «LIGROS LTD»**
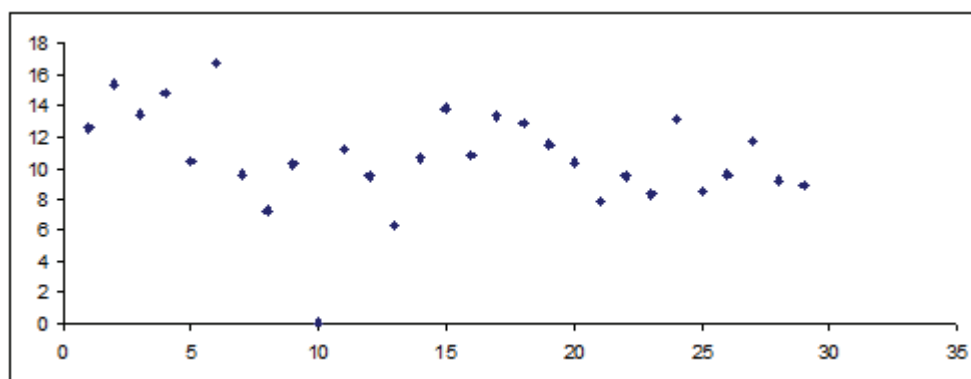*Source*: author's illustration.

Fig. 4. **Low Cost (L) product positions (commodity stocks) LLC «LIGROS LTD»**
Source: author's illustration.

When optimizing the product range and planning of commodity stocks the enterprise using HML-FMR clustering, a combination of tools ABC and XYZ analysis is promising, which will greatly increase the efficiency of the calculations and provide a more accurate version of the forecast.

Conclusion. The calculations allow the enterprise to determine the optimum volume of commodity stocks in accordance with the needs of consumers and their solvent demand, plan financial resources for the formation of inventory, develop an assortment policy in accordance with demand for products and its implementation, establish organizational and economic relations with suppliers of commodity resources, which in general ensures the effective functioning and development of the enterprise.

The marketing-logistic approach to the formation of commodity resources of the enterprise is outlined in terms of the degree of risk of non-fulfilment of the order (supply). A description of the elements of costs for the formation of commodity stocks of enterprises is given. Used HML-FMR clustering to ensure the efficient formation commodity providing the enterprises by identifying the best product range, recruitment commodity stocks and implementation plans turnover.

For the purpose of effective formation of commodity stocks and improvement of the assortment policy of enterprises, an appropriate methodical toolkit is based on the use of groups' methods of statistical analysis methods, methods based on financial indicators and optimization mathematical methods.

The formation of mechanisms for the provision of commodity stocks of enterprises is based on the use of a systematic approach to the definition of relevant product assortment with the use of analysis, planning and management.

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Статтю рекомендовано до друку 31.08.2020   © *Брітченко І. Г., Безпарточний М. Г.*

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The article is recommended for printing 31.08.2020   © *Britchenko I., Bezpartochnyi M.*