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BUILDING MATERIALS INDUSTRY FORECAST-BASED SHORT-TERM PRODUCTION PLAN DEVELOPMENT TOOLKIT

The article considers the methods and tools for the short-term planning of the production and economic activity of the building materials industry of the Republic of Belarus. The building materials industry is currently facing difficulties in the marketing of production. The solution these problems requires the coordination of the production of the building materials with their consumption by the construction industry. The high seasonality of the both considered sectors requires synchronization of the plans for the production of building materials and their consumption in construction.

The planning is proposed to be based on the forecasting of the activities of the industries. The forecast of production is checked for compliance with the requirements of construction. In case of their inconsistency the numerical values of the differences and the months when they appear are revealed and specific measures to change the forecast of production of building materials for it to be coordinated with the construction are planned.

A software tool has been developed to calculate the forecasts of the two sectors and check their synchronization. The average forecast accuracy indices is 3.17% for the building materials industry and 7.44% for the construction, that is rather high. The developed planning toolkit is proposed to be used by the planning authorities of the Ministry of Architecture and Construction of the Republic of Belarus.

Keywords: planning, forecasting, synchronization, building materials industry, construction, index, time series.

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ИНСТРУМЕНТАРИЙ КРАТКОСРОЧНОГО ПЛАНИРОВАНИЯ ПРОИЗВОДСТВЕННОЙ ДЕЯТЕЛЬНОСТИ ПРОМЫШЛЕННОСТИ СТРОИТЕЛЬНЫХ МАТЕРИАЛОВ, ОСНОВАННЫЙ НА ПРОГНОЗИРОВАНИИ

В статье рассматриваются методы и инструменты для краткосрочного планирования производственно-хозяйственной деятельности промышленности строительных материалов Республики Беларусь. В настоящее время промышленность строительных материалов испытывает трудности со сбытом продукции. Решение этой проблемы требует согласования производства строительных материалов с их потреблением строительством. Высокая сезонность деятельности обеих рассматриваемых отраслей приводит к необходимости синхронизации планов производства строительных материалов и их потребления в строительстве по объемам и времени.

Предполагается, что планирование будет основано на прогнозировании деятельности отраслей. Прогноз производства строительных материалов проверяется на соответствие требованиям строительства по их потреблению. В случае нарушения таких требований выявляются числовые значения различий и месяцы их появления и намечаются конкретные меры по изменению прогноза производства строительных материалов для его согласования со строительством. Согласованный прогноз принимается в качестве индикативного плана, который предоставляется предприятиям, производящим строительные материалы.

Разработан программный инструмент для расчета прогнозов производства в двух отраслях и проверки их синхронизации друг с другом. Технически он реализован в виде программного модуля на языке VBA в прикладном пакете MS Excel. Проведена оценка точности прогноза методом ретроспективного прогнозирования. Средние показатели отклонения прогнозных значений от фактических составляют 3,17% для промышленности строительных материалов и 7,44% – для строительства, что является достаточно высоким показателем. Разработанный инструментарий планирования предлагается использовать органам планирования Министерства архитектуры и строительства Республики Беларусь в процессе отраслевого управления.

Ключевые слова: планирование, прогнозирование, синхронизация, промышленность строительных материалов, строительство, индекс, динамический ряд.

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Introduction. The importance of the building materials industry as a sector of the national economy is determined by the fact, that it acts as the resource base for the functioning of the construction, and the construction is the industry that has a significant multiplier effect for the development of the national economy [1]. The building materials industry creates industrial products to be consumed by the construction industry, that creates housing and other facilities using them [2, 3]. The building materials industry, however, is currently facing significant difficulties. The rate of deterioration of the fixed assets and material consumption is high, the labor productivity and profitability has been decreasing lately [4, p. 48–49, 52–53]. It results in the high costs of the maintenance of the fixed assets. The building materials industry is an energy-intensive sector of the economy of the republic, natural gas being the most commonly used source of energy [5]. All of the above results in the decrease of profitability of the building materials industry.

The building materials industry is currently also experiencing complications in acquiring the financial resources to overcome its problems. The President of the Republic of Belarus has paid attention to the importance of development of the system approaches to solving the problems of the building materials industry now [6].

As the construction materials are largely consumed in the domestic market, the solution of the marketing problems of the building materials industry requires the coordination of its production with the consumption of the materials by the construction industry. This, in its turn, requires the appropriate planning of production in the building materials industry: the planning has to take into account the peculiarities of the business cycle of the building materials industry and construction.

The definition of the planning as an independent form of management activity has been carried out since the very beginning of the formation of management as a scientific discipline [7, 25]. The researchers have been noting since very beginning that the planning itself could not change the state in the future – it was only the basis for the actions that bring the desired future closer [8, p. 17–36]. The importance of planning in modern conditions is also stated by the researchers [9–12].

The researchers state out that the increasing availability of the modern digital tools in the can be used for planning production [13, 14] and their use can fosters the effectiveness of the economic activity [15, 16].

Main part. The sectoral planning in the Republic of Belarus is currently implemented on the base of the top-down principle [17, 18]. The planning of the business activities of the building materials industry is carried out by the Ministry of Architecture and Construction [19]. The basis for planning is the National Strategy for the Sustainable Socio-Economic Development of the Republic of Belarus up to 2030 [20]. The Program for the Socio-Economic Development of the Republic of Belarus is been developed on its base and is adopted by the Council of Ministers of the Republic of Belarus [21]. The Ministry of Architecture and Construction of the Republic of Belarus draws up annual work plans of enterprises subordinate to it on the basis of the mentioned Program [22]. The Ministry of Architecture and Construction of the Republic of Belarus draws up the work plans of enterprises that subordinate to it. Later the enterprises report to the Ministry on the implementation of the plans. The process of drawing up plans is aimed at bringing the values of the indicators of to subordinate enterprises and obliging them to achieve the specified values [23].

One should take into account the peculiarities of activity of the building materials industry and construction. Significant cyclic fluctuations in production volumes and production efficiency during the year due to the influence of seasonality are an essential feature of the building materials industry. The amplitude of seasonal fluctuations is about 40% of the average annual output and it reaches 100% of the annual output for certain enterprises in some years [24]. The presence of cyclic fluctuations in the production and business activity of the building terials industry and corresponding sectors requires mataking them into account while framing the production plan. The adoption of this proposition allows us to obtain a short-term plan for the production of building materials, in which the dynamics of their production is synchronized with the dynamics of their consumption. This requires taking a month as the period of planning.

The next proposition is the basing of the planning on forecasting the activities of the industries. Forecasting the production determines the volumes that can be achieved by the building materials industry. Then the plan is justified and confirmed by the industry capabilities. Forecasting the construction of buildings determines the volumes of activity that consumes the materials.

The forecast of production of the building materials industry is checked for compliance with the requirements of construction. In case of their inconsistency the numerical values of the differences and the months when they appear are revealed and specific measures to change the forecast of production of building materials for it to be coordinated with the construction are planned. The implementation of these measures allows the building materials industry to fulfill the tasks that construction has set before it. The forecast of production of the building materials industry is carried through again after the implementation of these measures, it is checked for compliance with the construction. The cycle continues until the forecast of production of the building materials coordinates with the forecast of construction – this final forecast is taken as the plan to be fulfilled.

Research tools. The realization of the proposed forecasting and planning system requires the appropriate math tools. The econometric science uses a variety of methods for analyzing and predicting the dynamic series of indicators subject to the influence of cyclic fluctuations. The majority of methods use the seasonal decomposition, that postulates the independence of the trend and seasonal components. However, the results of studies indicate that the classical seasonal decomposition is not necessary correct. The research [25, p. 75] confirms that seasonal fluctuations can affect long-term economic cycle trends, changing them. The statement of the significant influence of seasonal fluctuations on the fundamentals of the production and economic activity of the building materials industry is taken into account in the given article.

In this case we consider that attention should be paid to Nikitin's business activity index calculated by the Bank of Russia [26]. The method proposes the calculation of the time-series of individual indices that reflect the changes in the monthly dynamics of production of specific types of products. The group indices are formed by aggregating individual indices. They characterize the change in the total economic activity of the sectors. The method also includes the forecasting tool. The predicted values of the production indices are calculated by the next formula, according to it:

$$n_{x,y} = \frac{n_{x,y-1} \cdot \left(a \cdot \frac{\left(n_{x-1,y}\right)^a}{\left(n_{x-1,y-1}\right)^a} \right) + b \frac{\left(n_{x-2,y}\right)^b}{\left(n_{x-2,y-1}\right)^b}}{a+b}, \quad (1)$$

where $n_{x,y}$ – index of production for year x month y; x – number of year; y – number of month; a – correcting coefficient for year x–1; b – correcting coefficient for year x–2 [27].

The a and b coefficients are calculated from the former years data. This instrument is a powerful tool, that considers the trend and the seasonal changes as the whole, without seasonal decomposition. However, the formula (1) postulates the invariability of the shape of the seasonal cycle. The calculation of the a and b coefficients by simply taking all indexes of production in the formula (1) from the sets of the former years data and solving the resulting equation does not satisfy us either. In this case we propose to introduce the changes into Nikitin's forecast model. The resulting formula has the following form:

$$n_{x,y} = n_{x,y-1} \cdot \left(a_y \cdot \frac{n_{x-1,y}}{n_{x-1,y-1}} \right), \quad (2)$$

where a_y – correcting coefficient for month y of year t–1.

The use of the array of a_y coefficients instead of a single a value allows to take into account the change of the shape of the seasonal cycle. The array of a_y coefficients is calculated using the software tool, that solves the following task with a 4 decimal places accuracy:

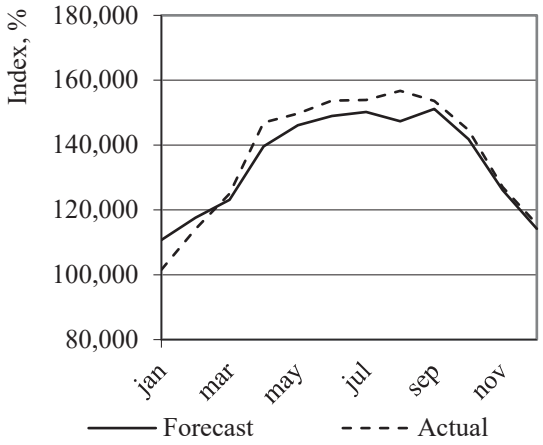
$$\sum \left(\frac{n_{x,y}}{n_{x,y-1}} - a_y \cdot \frac{u_{x-1,y}}{u_{x-1,y-1}} \right) \to 0. \quad (3)$$

The proposed software tool has been implemented as the MS Excel module written in VBA programming language. The available indices for the 4 former years are used as the study sample for the a_y calculation. The obtained set of a_y coefficients is used for the forecasting of the values of the production indices for the next 2 years.

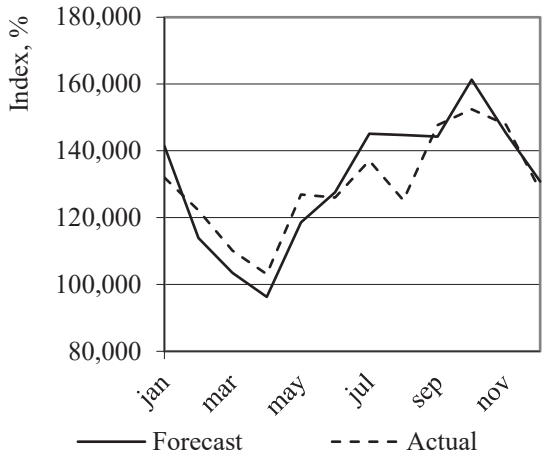
The next step is the correlation and regression analysis. As the result the regression model, where the construction index is a dependent variable and the building materials industry is an independent variable, is made. Later the forecasted indices of the production of the building materials industry are checked for compliance with the requirements of construction. It is fulfilled by comparing of the forecasted construction indices with its indices, calculated according to the regression model, taking the forecasted building materials industry indices as the independent variables. If the indices according to the regression model are not less than the forecasted indices, than the building materials industry provides the construction with material resources at the right time and in the right quantities.

Calculations and results. The forecasts of the production of the building materials industry and construction have been fulfilled using the proposed program module. The obtained forecasted indices have been afterwards compared to the actual indices of the named sectors. This has given the possibility

to check the accuracy of the model using the external criterion. The average difference between the forecasted and actual production indices is 3.17% for the building materials industry and 7.44% for the construction. The forecasted and actual indices of production for the building materials industry and construction are shown in the fig. 1, 2.



Note – Source: own development
Fig. 1. Forecasted and actual production indices of the building materials industry



Note – Source: own development
Fig. 2. Forecasted and actual production indices of the construction

The displayed charts and average difference values indicate high accuracy of the forecasts obtained using the proposed toolkit.

The correlation and regression analysis of the observed time-series of the production indices of the building materials industry and construction has been fulfilled using the statistical tools of MSExcel data analysis. The charts of the time-series of the two sectors coincide in phase, have the same period equal to one year, but they are shifted by several months relative to each other, which indicates the presence of the dynamics lag between these indicators. The maximum value of the correlation coefficient between the indices of production of these sectors is when the dynamics of the building materials industry is two months ahead of the dynamics of the construction. This period can be considered as the average value of the time of usage of the building materials: the selling, transportation, preparation and use in construction. The following regression model has been made:

$$BUIL = 16{,}956 + 0{,}889\ BMI,\quad \text{at } F = 496{,}868,\ \alpha = 0{,}999, \tag{4}$$

where *BUIL* – shifted 2 month into future construction index, %; *BMI* – building materials production index, %.

The model is statistically significant according to the *F*-value and high α.

The values of the construction indices according to the regression model (4) are higher than the forecasted indices, that means that the building materials industry is going to give the related sector enough material resources at the right time on a monthly basis and no corrections are necessary. This means that the building materials industry will fulfill its role in the national economy and the monthly forecast of the building materials industry production indices should be taken as the plan.

Conclusion. The developed toolkit is proposed to be used by the planning authorities of the Ministry of Architecture and Construction of the Republic of Belarus to improve planning work in the organizations of the building materials industry. The proposed planning tools have high accuracy of the forecasts. The main part of economic effect of the applied use of the proposed planning toolkit is the indirect one. It is in making management decisions more appropriate to the future operating conditions. The planning using the proposed methods allows to scientifically substantiate resource plans for the activity of the construction. The implementation of the proposed methods via the developed software modules in the Microsoft Excel reduces the complexity and increases the efficiency of calculations. The further development of the proposed toolkit is in the determination of the results of the changes introduction into the observed dynamics of the economic activities of the sectors under consideration in a formalized form with a monthly period, which allows to supplement the made forecasts by calculating an unlimited number of changed plans for the scenario planning.

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