An approach to assessing the level of competitiveness of a timber industry innovative enterprise based on the methodology of economic and mathematical modelling

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Abstract. The article proposes an approach to assess the level of competitiveness of timber industry enterprises, as an example, furniture enterprises that carry out innovative activities and produce innovative products are considered. The principles of economic and mathematical modelling form the basis for the assessment of the improved methodology. In the improved methodology, a group of weighting coefficients is proposed that make it possible to most accurately determine the level of competitiveness of an innovative enterprise according to the proposed economic and mathematical model, but taking into account the implementation of all stages in the algorithm developed by the author to increase the level of competitiveness of an innovative forestry enterprise. The general integral indicator of the level of competitiveness of the analysed enterprise is calculated. Based on the formed economic and mathematical model, an assessment of the level of competitiveness of an innovative furniture enterprise was carried out. It was determined that in the analysed enterprise it is necessary to pay attention to the factors of competitive and strategic positioning (0.61 in 2020) and trade and production efficiency (0.82 for the reporting period), the values of the coefficients of which are at the minimum level.

1 Introduction

In the current economic conditions, the main goal of any timber industry enterprise is to win in a competitive market. This victory should be characterized neither by one-off nor by chance, but should be incorporated into the competitive development strategy of the enterprise and act as a logical result in the form of the results of the enterprise's constant and goal-oriented efforts. It is possible to achieve the required level of competitiveness by increasing the competitiveness of manufactured commercial products, as well as by increasing the competitiveness of the timber industry enterprise itself.

The degree of development of the problem. The theoretical and scientific basis of the essence of assessing the level of competitiveness is reflected in the scientific works of:

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Bykov V.A., Gerchikova N.I., Gorbashko E.A., Korobov Yu.I., Manevich V.A., Safiullina L.N., I. Ansoff, P. Doyle, P. Drucker, etc [1].

The main scientific provisions for assessing the level of competitiveness of innovative enterprises are studied in the works of the following scientists: G.L. Azoeva, M.I. Bukhalkova, I.B. Gurkova, I.V. Ershova, P.V. Zabelina, G.A. Krayukhina, N.I. Tretnikova, A.Yu. Yudanov, R. Kaplan, G. Mintzberg, D. Norton, M. Porter, P. Sraffa, A. Thompson.

The study assessed the competitiveness of an innovative timber industry enterprise engaged in the production and sale of furniture products in the Voronezh region of the Russian Federation.

2 Material and methods

The dynamic method is defined as the main component of the study, which allows, when assessing the level of competitiveness of a forestry innovative enterprise, to take into account the influence of various factors on the position of the enterprise in the context of each market segment, taking into account the specifics of the activity.

Having assessed the competitiveness of the analysed enterprise, it was concluded that there is a decrease in most indicators and the enterprise has an "Average potential for the company's competitiveness". On the basis of a set of methods considered in the course of the study, it was determined that the dynamic method would be the most suitable, this method was taken as a basis and ways to improve the methodology for assessing the competitiveness of timber industry enterprises were proposed, using the example of the furniture industry.

The use of an improved methodology made it possible to assess the level of competitiveness of the enterprise under study with a set of the most accurate indicators. On this basis, it is possible to form key sources and reserves aimed at increasing the level of competitiveness of the timber industry enterprise. The proposed approach allows, when calculating the level of competitiveness of an innovative forestry enterprise, to take into account the impact on the position of the enterprise in the context of each market segment, taking into account the main indicators that reflect the efficiency of production activities and the validity of the use of specific technological operations, using selected weighting factors. Figure 1 shows an algorithm for increasing the level of competitiveness of a forestry innovative enterprise.

The weight coefficients are based on the share of i, j, e-th manufactured innovative and marketable products. In the methodology, the revenue indicator is taken as the basis, namely, the manufactured innovative products in the context of all manufactured products at the enterprise. The specific value of the i,j,e-th indicator in the commodity market niche in the competitive market is taken into account, in the structure of the total sales of manufactured products [2].

The developed methodology for assessing the level of competitiveness of an innovative forestry enterprise includes developed indicators that affect the process of assessing the key performance indicators of an innovative enterprise: the coefficient of innovative development, the competitive and strategic positioning of a forestry enterprise, the economic and financial stability of an innovative enterprise in a competitive market). In the course of the study, all calculations were carried out taking into account the commodity-market niche occupied in the competitive market of the investigated timber industry enterprise engaged in innovative activities. In the previously developed methods for assessing the level of competitiveness, these coefficients and indicators were not used, therefore, it is proposed to take into account these indicators when assessing the level of competitiveness of a forestry innovative enterprise.

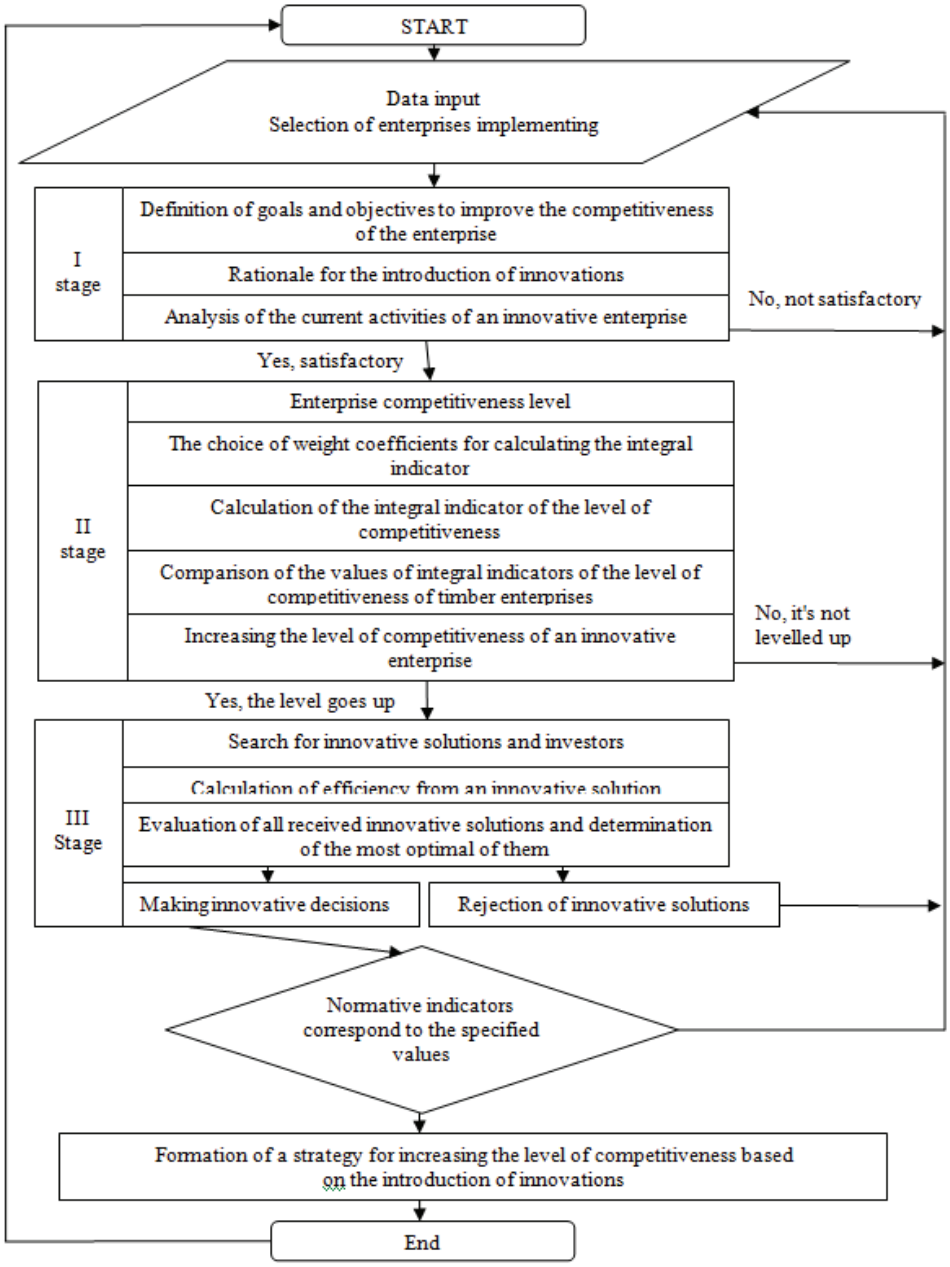

Fig. 1. Algorithm for increasing the level of competitiveness of a forestry innovative enterprise.

In view of the foregoing, the assessment of the level of competitiveness of a furniture innovative enterprise was carried out on the basis of the proposed elements in accordance with the above steps in the algorithm aimed at increasing the level of competitiveness.

At the first stage, it is necessary to formulate the main objectives of the task for their implementation, aimed at increasing the level of competitiveness of an innovative forestry enterprise, the possibility of introducing existing innovative solutions is assessed. One of the tools at this stage is the analysis of current production activities and the degree of efficiency of introducing existing innovative solutions into the technological process. The

study proposes to supplement standard methods for assessing the level of competitiveness of enterprises with developed weighting factors that take into account the effectiveness of innovative activities of a timber industry enterprise.

Based on the foregoing, in the course of the study, the coefficient of innovative optimality was proposed, which is calculated as the ratio of the indicator of the level of innovative development of the analysed timber enterprise individually to a similar indicator, but taking into account the position of the timber enterprise in the competitive market. The calculation of the coefficient of innovative optimality, taking into account the occupied commodity market niche in the competitive market, is carried out according to the formula (1) [3]:

$$A_{Vi,j,e} = \frac{V_A}{V_{Si,j,e}}, \quad (1)$$

Where $A_{Vi,j,e}$ is the coefficient of innovative optimality of the i,j,e-th indicator, taking into account the position of the timber enterprise in the competitive market;

V_A - An indicator of the level of innovative development of the analysed enterprise for the reporting period;

$V_{Si,j,e}$- Is an indicator of the innovative efficiency of the innovative solutions used in the sample of the i,j,e-th indicator of the position of the enterprise in the occupied market niche for the reporting period.

The coefficient of trade and production efficiency, according to the sample, taking into account market segments, is carried out according to the formula (2) [4]:

$$V_{Si,j,e} = \frac{V_{Si,j,e}}{E_{Si,j,e}}, \quad (2)$$

Where $V_{Si,j,e}$is the value of trade and production efficiency, reflecting the impact of the degree of use of available resources on the position of the enterprise in the occupied market niche;

$V_{Si,j,e}$- Is the value of the annual revenue from sales of manufactured commercial products of the i,j,e-th indicator, taking into account the position of the enterprise in the market niche it occupies [3];

$E_{Si,j,e}$ - Are the costs associated with the production of marketable products for the main activity, including the costs associated with the sale of manufactured products. The analysed costs are included in the cost price in the necessary order, this indicator also takes into account non-operating expenses, taxes, fees, determined in the form of the i, j, e-th indicator [7].

As another estimated indicator, the coefficient of competitive and strategic positioning of a timber enterprise is proposed, formula 3 [5]:

$$K_{Ii,j,e} = \frac{I_A}{I_{Si,j,e}}, \quad (3)$$

Where $K_{Ii,j,e}$- is the competitive-strategic positioning of the timber enterprise in terms of the i,j,e-th indicator;

I_A - The degree of change in the dynamics of the value of the annual revenue from sales of marketable products for the reporting period;

$I_{Si,j,e}$ - The degree of change in all costs for the production and sale of products of the i,j,e-th indicator.

Also, the developed coefficient of economic and financial stability of an innovative enterprise, calculated according to formula 4, is included in the system of evaluation indicators for increasing the level of competitiveness of a forestry innovative enterprise:

$$K_{Li,j,e} = \frac{L_A}{I_{Si,j,e}}, \quad (4)$$

Where $K_{Li,j,e}$ is the coefficient of economic and financial stability of the innovative enterprise of the i,j,e-th indicator in the competitive market;

L_A - The value of the current liquidity indicator of the enterprise under study for the analysed period;

$I_{Si,j,e}$ - The value of the indicator of innovative activity of the i,j,e-th indicator for the industry as a whole for the analyzed period.

The calculation of the indicator of change in the level of influence of the volume of annual proceeds from the sale of marketable products on innovative activity is carried out according to formulas 5 and 6.

$$I_{Si,j,e} = \frac{S_{Si,j,e}}{S_{oSi,j,e}}, \quad (5)$$

Where $I_{Si,j,e}$ - is the indicator of change in the level of influence of the volume of annual proceeds from the sale of marketable products on the innovation activity of the i,j,e-th indicator [6];

$S_{Si,j,e}$ - The value of the annual revenue from sales of marketable products of the i,j,e-th indicator, taking into account the position of the enterprise in a competitive market, in the reporting period;

$S_{oSi,j,e}$ - Is the value of the annual proceeds from sales of manufactured commercial products of the i,j,e-th indicator, taking into account the position of the enterprise in the competitive market in the previous period.

$$L_{Si,j,e} = \sqrt{\frac{CA_{Si,j,e}}{CL_{Si,j,e}}}, \quad (6)$$

Where $L_{Si,j,e}$- Is the value of the indicator of innovative activity of the i, j, e-th indicator of the enterprise under study for the analysed period.

$CA_{Si,j,e}$ - The amount of working capital used in the production of innovative products i,j,e-th indicator for the analysed period [7];

$CL_{Si,j,e}$- The amount of attracted short-term liabilities in the production of innovative products of the i, j, e-th indicator for the analysed period.

At the second level of the proposed algorithm, it is supposed to calculate the integral indicator of the level of competitiveness, as well as to compare the values of the integral indicators of the level of competitiveness of timber enterprises. To increase the level of competitiveness of an innovative enterprise, the necessary calculations are carried out.

On the basis of the study, an economic and mathematical model for assessing the level of competitiveness of a forestry innovative enterprise is proposed, which is presented below (formula 7) [8]:

$$K = \left(\frac{R_A}{\sum R_{Si,j,e} \times Y\partial_{i,j,e}}\right) \times \left(\frac{I_A}{\sum I_{Si,j,e} \times Y\partial_{i,j,e}}\right) \times \left(\frac{L_A}{\sum L_{Si,j,e} \times Y\partial_{i,j,e}}\right), \quad (7)$$

Where, K the level of competitiveness of the forestry innovative enterprise;

$Y\partial_{i,j,e}$ - The value of the share of innovative manufactured products in the overall structure of the revenue of the analyzed enterprise for the reporting period.

The values of the weight coefficients are calculated on the basis of determining the share of each type of innovative product in the sales revenue of the timber industry enterprise (formula 8):

$$Y\partial_{i,j,e} = \frac{B_{i,j,e}}{B}, \tag{8}$$

Where $Y\partial_{i,j,e}$ - The value of the share of the i,j,e-th indicator of innovative products in the total revenue of the timber industry enterprise [9];

$B_{i,j,e}$ - Proceeds from the sale of i,j,e-th products (goods, works, services) of the company in the i,j,e-th market segment, at the end of the reporting period;

B - The value of the total amount of proceeds received from the sale of marketable products for the main type of activity, for the analysed period [9].

In the evaluation process, it is necessary to take into account the fact that the value of the coefficient of the level of competitiveness should tend to the highest criterion value [3]. Accordingly, a value in the range from 0 to 1 indicates a low level of competitiveness of the forestry innovative enterprise, provided that the value of the criterion coefficient for assessing the level of competitiveness is close to or equal to 1, then the level of competitiveness of the enterprise is at the level of selected enterprises in the sample [10]. If the value of the coefficient is significantly higher than one (1.5 or more), then the level of competitiveness at the analysed enterprise is higher than that of the selected competing enterprises in the sample.

The third stage of the proposed algorithm (Figure 1) involves the search for innovative solutions and investors, making calculations from the effectiveness of the innovative solution, and evaluating all the innovative solutions received, with the determination of the most optimal of them.

Calculation of the coefficient of optimality of the resources used in the production of innovative products, taking into account the commodity market niche in the competitive market (formula 9):

$$K_S = \sum R_{Si,j,e} \times Y\partial_{i,j,e} \times \sum I_{Si,j,e} \times Y\partial_{i,j,e} \times \sum L_{Si,j,e} \times Y\partial_{i,j,e}, \tag{9}$$

Where K_S - the optimality of the resources used in the production of innovative products, taking into account the product market niche in the competitive market.

The study used a detailed approach, which took into account the influence of each factor on the competitiveness of the forestry innovative enterprise, taking into account the specifics of the enterprise, for each product line (formula 10) - general integral index:

$$K_{S_{i,j,e}} = R_{Si,j,e} \times Y\partial_{i,j,e} \times I_{Si,j,e} \times Y\partial_{i,j,e} \times L_{Si,j,e} \times Y\partial_{i,j,e}, \tag{10}$$

Based on the above improved methodology using the dynamic method in the context of indicators by market segments, an assessment was made of the level of competitiveness of an innovative timber industry enterprise engaged in the production and sale of furniture products. Within the framework of this methodology, a general assessment of indicators is carried out and indicators are evaluated for each segment of the commodity market.

3 Results and Discussion

The calculation of indicators was carried out, as mentioned earlier, in several stages. At the initial stage, it is necessary to calculate a group of key indicators of the financial and economic activity of the enterprise, they include such indicators as the coefficient reflecting the trade and production efficiency, calculated using formula 2. At the same stage, the competitive and strategic positioning coefficient of the timber industry enterprise is calculated, calculated from using formula 3 and a coefficient reflecting the economic and financial stability of the analysed organization (formula 4).

Table 1. Indicators for assessing the level of competitiveness of a furniture innovative enterprise for 2017-2020 and forecast 2021-2023.

Index	Periods				Forecast		
	2017	2018	2019	2020	2021	202	2023
1	2	3	4	5	6	7	8
General integral indicator taking into account all market segments							
V_A	0.99	1.00	1.01	1.02	1.03	1.04	1.05
I_A	0.94	0.73	0.90	0.92	0.91	0.92	0.93
L_A	9.24	6.33	5.87	5.61	4.47	3.82	3.27
V_S	0.92	1.08	1.31	0.82	0.98	0.96	0.94
I_S	1.00	0.90	1.21	0.72	0.80	0.75	0.70
L_S	1.84	1.94	1.77	1.82	1.78	1.76	1.73
K_A	9.49	5.14	5.92	5.83	4.61	4.04	3.54
K_S	1.88	2.09	3.11	1.19	1.54	1.40	1.27
K_R	1.01	0.88	0.92	0.74	0.71	0.65	0.59
K_I	0.90	0.77	0.80	0.61	0.58	0.52	0.46
K_L	4.77	3.10	3.15	2.94	2.39	2.07	1.79
K	4.80	2.34	2.58	1.47	1.08	0.77	0.54

Further, according to formula 10, the assessment of the level of competitiveness of an innovative timber industry enterprise engaged in the production and sale of furniture products is calculated, taking into account its dynamics. The results of calculations are presented in Table 1.

Based on the results of the calculations presented in Table 1, it can be seen that the final values of the integral indicator for assessing the level of competitiveness demonstrate a downward trend in the reporting period (2020). The highest value of the integral indicator is noted in 2017, the total value for the furniture innovative enterprise was 4.8.

Analysing the values of indicators in the context of market segments, it can be noted that they are decreasing, as well as with the general integral indicator. The decline could be caused by instability in the financial markets and social restrictions. Figure 2 shows the results of calculations of the general integral indicator in the dynamics of the level of competitiveness of a furniture innovative enterprise for 2017-2020.

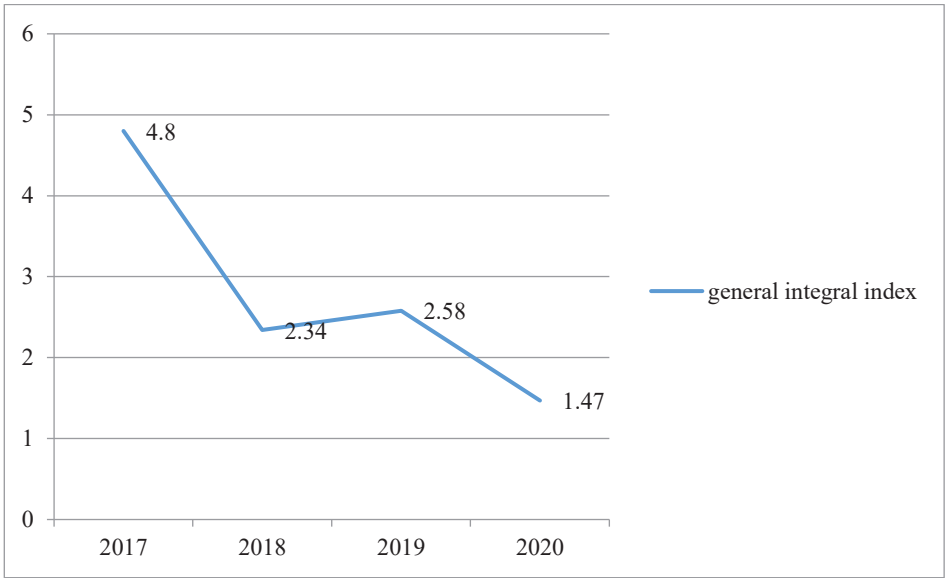

Fig. 2. Dynamics of the level of competitiveness of a furniture innovative enterprise for 2017-2020 (general integral indicator)

Based on the data interpreted in Figure 2, one can see a downward trend in the overall level of competitiveness of the analysed furniture company. If in 2017 the overall level of competitiveness was 4.8, then by 2020 it is already 1.47. The decline is due to the instability of economic processes and changes in consumer preferences, as well as the transition to online sales and demonstration of manufactured products. In 2019, there is a slight increase compared to 2018 (2.58 to 2.34).

4 Conclusion

When assessing the level of competitiveness, innovative enterprises of the timber industry complex need to use effective modelling and forecasting methods, the most optimal approach would be the approach proposed by the author using economic-mathematical modelling and the dynamic method.

In order to identify the reasons for the downward trend in the level of competitiveness of the analysed enterprise, at the next stage we will analyze the results obtained and the values of the indicators in the context of the main sources (coefficients) that determine the competitiveness of the enterprise (formulas 3.1-3.6) and the optimality coefficient that determines the efficiency of using all available resources in the sample, taking into account market segments (formula 9). It should be noted that the assessment of the required indicators was carried out both in the total population and separately for each market segment (formula 10).

According to the calculations, it can be concluded that the observed decrease in the competitive positions of the analysed furniture enterprise is caused by the low level of the coefficient of competitive and strategic positioning of the furniture innovative enterprise (K_I = 0.61), as well as the coefficient that determines the value of trade and production efficiency (V_S = 0.82) and the level of influence of the volume of annual proceeds from the sale of marketable products, for innovative activities (I_S = 0.72).

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