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LONG-TERM ASSESSMENT OF ENGINEERING ENTERPRISE PRODUCT TECHNOLOGICAL COMPETITIVENESS

Abstract. This article is devoted to the development of a method of long-term assessment of technological competitiveness of mechanical engineering enterprises taking into account the indicators of absolute and specific technological value of mechanical engineering products by areas of manifestation and using a scenario approach. The aim of the study is to develop a long-term assessment of the method of technological competitiveness of the machine-building enterprise based on indicators of absolute and specific technological costs of machine-building enterprise products by areas of manifestation and using a scenario approach. Technological competition, which exists at the macro-, meso- and micro-levels of the economic system, improves the solution of problems of economic and organizational development and strengthens the market position of machine-building enterprises. Economic and mathematical modeling is carried out by combining asynchronous elements of situational modeling and features of the Zeidel method as the most effective way to model the technological competitiveness of products, companies and clusters in the national competitiveness system as a complex system. The outlined combination allows to obtain combinational equations at all stages of the iteration, as well as to form alternative calculations that describe the state of the finite elements of the state in cases of statistical and other failures and changes during the implementation of a particular scenario. This makes it possible to identify the most important elements of the effect of increasing technological competitiveness. Implemented in this study modeling of material consumption and technological competitiveness of remote starters ACURA allowed to present scenario algorithms for determining the promising limits of reducing the cost of the project chip at retail prices per unit and the consequences of the proposed scenarios in making management decisions. Assessment of prospects for technological competitiveness of machine-building enterprises should be based on the following determining factors: cost according to the type of technological competitiveness of products based on material consumption, including all costs; along with the absolute technological costs, it is advisable to use a specific technological cost in accordance with the areas of its manifestation. The results of the study will allow machine-building enterprises to assess the prospects of technological competitiveness of products based on absolute technological costs and specific technological costs in the areas of its manifestation.

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ДОВГОСТРОКОВА ОЦІНКА ТЕХНОЛОГІЧНОЇ КОНКУРЕНТОСПРОМОЖНОСТІ ПІДПРИЄМСТВ МАШИНОБУДУВАННЯ

Анотація. Присвячено розробленню методу довгострокової оцінки технологічної конкурентоспроможності підприємств машинобудування з урахуванням показників абсолютної та питомої технологічної вартості продукції машинобудування за сферами прояву і з використанням сценарійного підходу. Метою дослідження є розроблення довгострокової оцінки методу технологічної конкурентоспроможності підприємства машинобудування на основі показників абсолютних і питомих технологічних витрат продукції підприємства машинобудування за сферами прояву та із застосуванням сценарійного підходу. Технологічна конкуренція, яка існує на макро-, мезо- і мікрорівні економічної системи, поліпшує розв’язання проблем економічного та організаційного розвитку і зміцнює ринкові позиції машинобудівних підприємств. Економіко-математичне моделювання здійснюється шляхом поєднання асинхронних елементів ситуативного моделювання та особливостей методу Зейделя як найбільш ефективного способу моделювання технологічної конкурентоспроможності продукції, компаній та кластерів у національній системі конкурентоспроможності як складної системи. Окреслена комбінація дозволяє отримати комбінаційні рівняння на всіх етапах ітерації, а також сформувати альтернативні розрахунки, що описують стан кінцевих елементів стану в разі статистичних та інших збоїв і змін під час реалізації певного сценарію. Це уможливлює визначення найважливіших елементів ефекту підвищення технологічної конкурентоспроможності. Реалізоване в нашому дослідженні моделювання матеріаломісткості та технологічної конкурентоспроможності пристроїв дистанційного пуску ACURA дозволило представити сценарійні алгоритми визначення перспективних меж зниження вартості проєкту технологічного чіпа в роздрібних цінах за продаж одиниці продукції та наслідки реалізації запропонованих сценаріїв при ухваленні відповідних управлінських рішень. Оцінка перспектив технологічної конкурентоспроможності підприємств машинобудування повинна базуватися на таких визначальних факторах: вартість відповідно до виду технологічної конкурентоспроможності продукції на основі матеріаломісткості, включаючи всі витрати; поряд з абсолютними технологічними витратами доцільно використовувати конкретну технологічну вартість відповідно до сфер її прояву. Результати дослідження дозволять машинобудівним підприємствам оцінювати перспективи технологічної конкурентоспроможності продукції на основі абсолютних технологічних витрат та питомих технологічних витрат у сферах її прояву.

Ключові слова: високотехнологічна продукція, експорт, кластеризація високотехнологічної продукції, підприємства машинобудування.

Формул: 0; рис.: 5; табл.: 1; бібл.: 23.

Introduction. The ability to create, to effectively attract, and to use technological innovation contributes to enterprise competitiveness, which is a significant advantage in the highly competitive environment. Technological competition, which exists at the macro-, meso- and micro-levels of the economic system, improves solving economic and organizational development problems and strengthens the market position of engineering enterprises. In this context, the need for assessment of mechanical engineering enterprise technological competitiveness is relevant.

Analysis of research and problem statement. In research [1; 2], it is proposed to determine the competitiveness of products under static conditions adjusted for the share of the *i*-th product in sales volume over the studied period, the importance rate of the *j*-th market in which the product is presented and the competitiveness of the *i*-th product in the *j*-th market. The disadvantage of the differential approach is its inability to determine the impact of parameters on consumer preferences. The combined method enables to express the ability of the product to compete under certain market conditions through comprehensive quantitative rate — competitiveness indicator [3; 4]. For a diversified enterprise that produces a variety of products, competitiveness indicator of the mass of commodities can be calculated as an average weighted of competitiveness indicators of each product using a formula [1; 5]. The paper [6; 7] considers a method of enterprise competitiveness assessment, which is represented as the ratio of properties of products to the amount of claims to them; the technology of a product is determined according to its characteristics: economic, technical, environmental, socio-psychological and legal ones. The competitiveness is defined as the average geometrical of the competitiveness indicators of each factor group. Other researchers define the problem of enterprise competitiveness assessment the way that stated it: to determine the values of competitiveness indicators, one should identify the numbers of most similar ones relative to the reference enterprises [8—10]. Competitiveness indicators mentioned were as follows: return on assets, on investments, on fixed assets, on production; capital productivity; turnover ratio of current assets, autonomy, flexibility and absolute liquidity. Some researchers suggest to use a model approach for integrated competitiveness indicators determination, the essence of which is to develop economic and mathematical model of the competition object, for example, such as the problem of the effect of the acquisition and use of the optimization of a product, the maximizing of the market share which is occupied by this or another manufacturer and comparison of the model (forecasting) indicators of economic development or state. According to [11—13], the application of an individual indicator system is objectively stipulated by the complexity and ambiguity of this level, and he proposes to combine technical indicators with a scientific approach and, as a result, to consider the scientific and technological level of production.

The purpose of the article is developing a long-term assessment of mechanical engineering enterprise technological competitiveness method on the basis of indicators of absolute and specific technological cost of mechanical engineering enterprise products according to areas of manifestation and with the use of scenario approach.

Unsolved aspect of the problem. Technological competitiveness of products, enterprises and clusters in the national competitiveness system is a complex system, because it consists of a significant number of interacting components; consequently, it acquires some qualitatively new features which are not typical for each of its constituents considered in isolation from others. This statement is confirmed by research.

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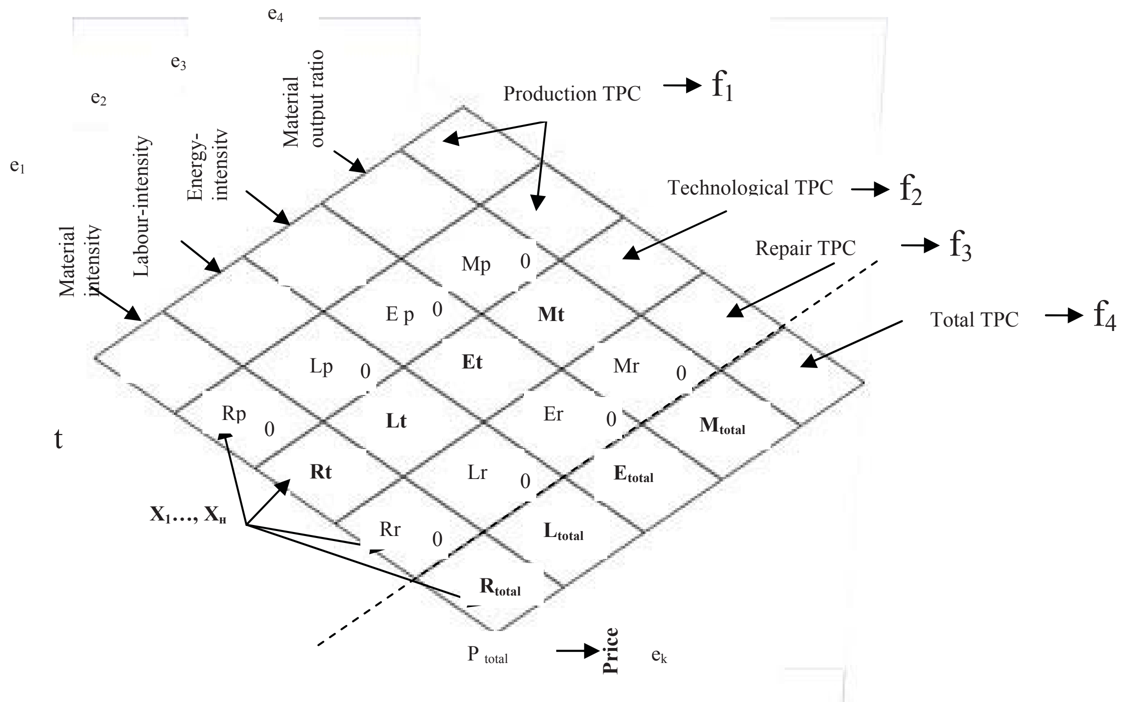
Research results. Andreeva [14] gives a more complete definition of product competitiveness: «competitiveness is a characteristic of the product-competitor depending on compliance with competitive public needs and with cost to meet it». Besides, the measure of product compliance with public needs for various markets is different, which is not included in the definition. These shortcomings are eliminated in the following definition [15]: «competitiveness is nothing else than demonstration of product quality in the market relations; it is defined by the ability of products to be sold in a particular market to the maximum possible extent and without losses for the manufacturer». A systemic definition of product competitiveness is provided by [16]: «Competitiveness of a product is estimated by the ability to outperform, at some time, without losses, in terms of quality and price, the characteristics of the counterparts in a particular segment of the market». From our point of view, the most comprehensive description of competitiveness is its definition as a market product feature, which represents its demand in the market, the ability to bring profit [17; 18]. Competitiveness is the ability to stay ahead of competitors in the market and to ensure the efficiency of enterprises activity through technological innovations, scientific and innovative potential management, technical level of production, technological capabilities, information activities. It is closely related to financial and organizational competencies, whereby technological product competitiveness is a set of competitive advantages of technological, technical, qualitative nature, corresponding to its functionality and customer value.

During modelling technological competitiveness of products, enterprises and clusters, it is reasonable to be guided by the following determinants: 1) all material intensity indicators define the cost value according to the type of technological construction of products; 2) a work package to reduce the labour-intensity and technological cost of products in use includes the application of design solutions that help reduce the cost of training and make-ready, technical control, transportation of products; reduce resource consumption, replace components of the product while maintaining its quality; enhance harmonization and standardization of the product components; facilitate and simplify conditions for maintenance and repair in order to limit the requirements for personnel qualification; 3) technological production cost is determined in monetary terms as the sum of all expenditure and used when the cost parameters are essential for the enterprise or cluster to improve its technological competitiveness; or it is determined as a percentage of the total production cost; 4) along with the absolute technological cost, the technology specific cost is applied for the area of its manifestation. Therefore, we propose to carry out mechanical engineering enterprise product technology competitiveness modelling in order to assess the competitiveness potential of the entity and its possible changing after taking a number of strategic measures.

During the implementation of situational modelling technological competitiveness of products, companies and clusters with asynchronous nature, one includes in the scheme functional (logical) elements, and their individual components in their integrated form (as a multitude) in the outputs of the scheme, are designated as $x_1, x_2, ..., x_n$. Thus, $e_1, e_2, ..., e_k$ are characteristics of the system. For example, technological competitiveness of certain products in the system of national competitiveness (as a simple multitude of elements) can form a scheme with a single output pole that characterizes its value during certain change, where e will respectively have two values: 0 (constant value) and 1 (variable value) at the output. To characterize the technological competitiveness of enterprises and clusters, we can form a scheme with four poles, which characterizes 16 states (e_1, e_2 ... e_{16}); thus, each element of the scheme has to perform a certain function of the current multitude $f_1, f_2, ..., f_k$. The function is understood as a system of logical equations from the description of a single parameter of enterprise or cluster technological competitiveness.

Let us carry out modelling the material intensity and the technological competitiveness of ACURA PJSC «Stakhanov Wagon Works» remote starting devices with the conditions given in *Fig. 1*.



Where: j conditions of uniform changing by the end of 2016 are:

Therefore, it is possible to implement 2 scenarios:
1) the introduction of new technological equipment, which will allow to reach the next uniform indicators reduction by 2016: Rt (2%); Lt (-5%); Mt (-3%);

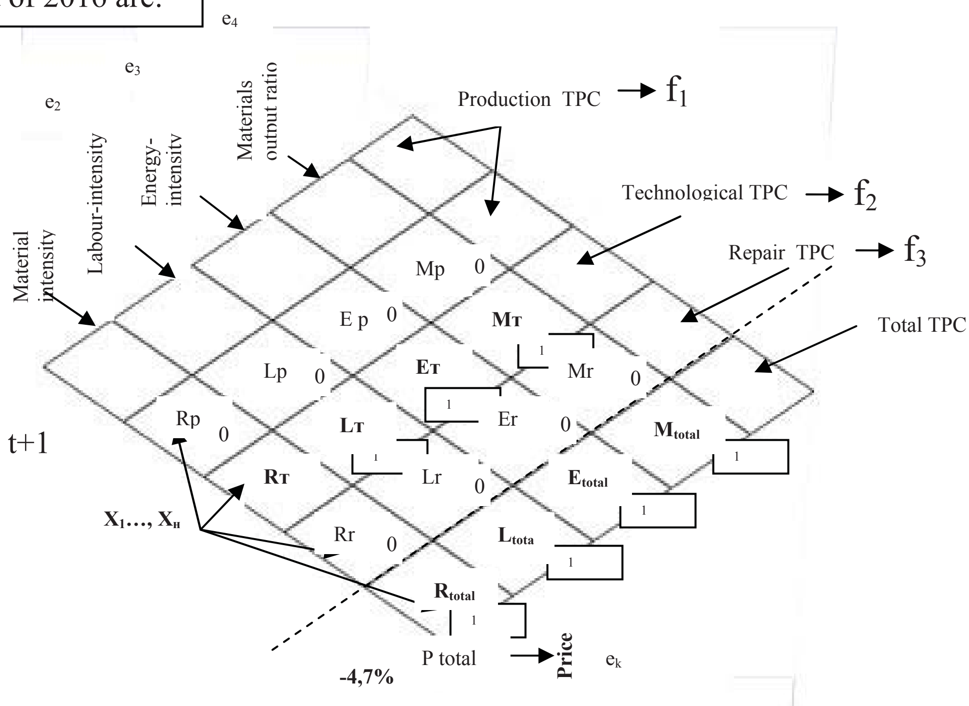


Fig. 1. **Scheme of the material intensity and TPC of ACURA devices modelling**

We presented the input data for modelling the material intensity and the overall technological design of ACURA devices in *Table*.

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Table

The input data for modelling the material intensity and the overall technological design of ACURA devices

e_2	Value	e_3	Value	e_4	Value
R_p	0,09	E_p	0,1	M_p	0,06
R_t	0,10	E_t	0,09	M_t	0,06
R_r	0,08	E_r	0,05	M_r	0,01
$\boldsymbol{R_{total}}$	**0,27**	$\boldsymbol{E_{total}}$	**0,24**	$\boldsymbol{M_{total}}$	**0,13**

Source. Compiled by the author.

Based on the results of modelling the material intensity and the overall technological design of ACURA remote starting devices (for scenario 1), we can conclude that only 2.4% reduction of the planned technological chip design cost reduction in the retail price per ACURA unit sales can be achieved. Thus, enterprise will not achieve the planned increase of technological competitiveness of ACURA remote starting devices in the national market, although some positive effect of these activities will be observed (see *Fig. 1*) (adapted by the author on the basis of [19]).

Let us work out a mathematical equations system, which evaluates the changing of state factors for the 1-st scenario (*Fig. 2*).

Changing of e	Changing of R_{total}	Changing of $e_к$ total per unit.	period
		Base 10,15	t
0,09*1+0,1*1+0,06*1= 0,09*1+0,1*1+0,06*1 0,1- (0,1*0,004)+0,09-(0,09*0,001)+0,06-(0,06*0,006) = 0,1*1+0,09*1+0,06*1 0,08*1+0,05*1+0,01*1=0,08*1+0,05*1+0,01*1	0,6376 →	10,13 →	t+1
0,09*1+0,1*1+0,06*1= 0,09*1+0,1*1+0,06*1 0,0996-(0,996*0,004)+ 0,089-(0,089*0,001)+0,059- (0,059*0,006) = 0,1- (0,1*0,004)+0,09-(0,09*0,001)+0,06-(0,06*0,006) 0,08*1+0,05*1+0,01*1=0,08*1+0,05*1+0,01*1	0,6367 →	10,12 →	t+2
0,09*1+0,1*1+0,06*1= 0,09*1+0,1*1+0,06*1 0,0992-(0,0992*0,004)+0,0889-(0,0889*0,001)+0,0586- (0,0586*0,006)= 0,0996-(0,996*0,004)+ 0,089-(0,089*0,001)+0,059- (0,059*0,006) 0,08*1+0,05*1+0,01*1=0,08*1+0,05*1+0,01*1	0,6358 →	9,93 →	t+3
0,09*1+0,1*1+0,06*1= 0,09*1+0,1*1+0,06*1 0,0988-(0,0988*0,004)+0,0888-(0,0888-0,001)+0,0582- (0,0582*0,006)= 0,0992-(0,0992*0,004)+0,0889-(0,0889*0,001)+0,0586- (0,0586*0,006)	0,6346 →	9,92 →	t+4
0,08*1+0,05*1+0,01*1=0,08*1+0,05*1+0,01*1 0,09*1+0,1*1+0,06*1= 0,09*1+0,1*1+0,06*1 0,0984-(0,0984*0,004)+0,0887-(0,0887*0,001)+0,0578- (0,0578*0,006)= 0,0988-(0,0988*0,004)+0,0888-(0,0888-0,001)+0,0582- (0,0582*0,006) 0,08*1+0,05*1+0,01*1=0,08*1+0,05*1+0,01*1	0,6335 →	9,91 →	t+5

Fig. 2. **The mathematical equations system which evaluates the changing of state factors for the scenario 1**

Note: Changing of $e_1 ... e_n$ is uniform over 5 years.

On the basis of the results, let us work out a mathematical equation system which evaluates the changing factors of state for the 2-nd scenario.

From the results of modelling the material intensity and of the general technological design of ACURA remote starting devices (for scenario 2, *Fig. 3*), we can conclude that, from the planned reduction of chips technology design cost (in case of mechanized production precision lines acquisition), the planned reduction in retail prices (4.7%) per ACURA unit sales can be achieved. Thus, the enterprise will reach the planned increase of ACURA remote starting device technological competitiveness in the national market.

Changing of *e*	Changing R_{total}	Changing of $e_{к}$ total per unit	Period
0,09*1+0,1*1+0,06*1= 0,09*1+0,1*1+0,06*1 0,1- (0,1*0,016)+0,09-(0,09*0,0002)+0,06-(0,06*0,008) = 0,1*1+0,09*1+0,06*1 0,08*1+0,05*1+0,01*1=0,08*1+0,05*1+0,01*1	0,638	10,15 10,02	t t+1
0,09*1+0,1*1+0,06*1= 0,09*1+0,1*1+0,06*1 0,0984 – (0,0984*-0,016)+ 0,0899-(0,0899-0,0002)+0,0595-(0,0595-0,008) = 0,1- (0,1*0,016)+0,09-(0,09*0,0002)+0,06-(0,06*0,008) 0,08*1+0,05*1+0,01*1=0,08*1+0,05*1+0,01*1	0,635	9,92	t+2
0,09*1+0,1*1+0,06*1= 0,09*1+0,1*1+0,06*1 0,0968-(0,0968*0,016)+ 0,0898-(0,0898*0,0002)+0,059-(0,059*0,008) = 0,0984 – (0,0984*-0,016)+ 0,0899-(0,0899-0,0002)+0,0595-(0,0595-0,008) 0,08*1+0,05*1+0,01*1=0,08*1+0,05*1+0,01*1	0,633	9,83	t+3
0,09*1+0,1*1+0,06*1= 0,09*1+0,1*1+0,06*1 0,0952-(0,0952*0,016)+0,0897-(0,0897-0,0002)+0,0585-(0,0585-0,008) = 0,0968-(0,0968*0,016)+ 0,0898-(0,0898*0,0002)+0,059-(0,059*0,008) 0,08*1+0,05*1+0,01*1=0,08*1+0,05*1+0,01*1	0,631	9,75	t+4
0,09*1+0,1*1+0,06*1= 0,09*1+0,1*1+0,06*1 0,0936 –(0,0936-0,0-16)+0,0896-(0,0896-0,0002)+0,058-(0,058*0,008)= 0,0952-(0,0952*0,016)+0,0897-(0,0897-0,0002)+0,0585-(0,0585-0,008) 0,08*1+0,05*1+0,01*1=0,08*1+0,05*1+0,01*1	0,628	9,67	t+5

Fig. 3. **The mathematical equations system which evaluates the changing of state factors for the scenario 2**

Note: Changing of $e_1..e_n$ is uniform over 5 years.

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The modelling results show the scheme elements state changing process, but the function changing at the input — approximately, as there are interim results, and, therefore, there exists a statistical risk of failure within the iteration. Therefore, in the process of enterprise and cluster technological competitiveness modelling, it is reasonable to use methods of simultaneous nature (for example, economic researchers used Seidel method [20—23]). According to this modelling method, it is appropriate to use the mathematical equations shown in *Fig. 4*.

To the left, the value of state element at the time t is substituted, according to the topological numbering scheme	e1(t) = f1(x1(t), ... , xn(t), e1(t-1));
	e2(t) = f2(x1(t), ... , xn(t), e1(t), e2(t-1));
	. . .= . . .
	ek(t) = fk(x1(t), ... , xn(t), e1(t), ... , ek-1(t), ek(t-1)).
		To the right, the input values of state elements obtained in the same iteration and only for the element that is calculated are substituted

Fig. 4. **The mathematical equations system of the determining of state of elements which characterize elements during iteration *t***

Note. To get the most accurate state of the scheme before the modelling, it is reasonable to arrange the equation, namely to record the exact order of its valuation because the state of *i*-th element can be calculated only if all states of the elements, which are included into the equation and can affect the value of this element, will be estimated.

Topological numbering of input for the equation variables is based on rank assigning. If the variable will affect the output element (e_k), it can be assigned rank 1; if value has the probability of changing (which can affect e_k), it is assigned rank 2. Thus, we receive several equations systems for the same sequence of input data sets. However, one of them will use the simple iteration method (asynchronous modelling), and the other one will provide alternative calculations that characterize the state e_k in cases of statistical and other disruptions and changes within the iteration.

However, in the process of the synchronous modelling, in one iteration, combinational equations (which show the final result) can be obtained. This, inevitably, leads to the impossibility of intermediate states of element and its impact on e_k researching (although it reduces the amount of calculations). In this regard, it is appropriate to add the asynchronous modelling to each iteration phase through alternative calculations, which describe the e_k state in cases of the statistical failures within iteration. For example, on the basis of data calculations for scenario 2 (see *Fig. 3*), we assume that at the 3rd stage, there is a possibility of statistical and other disruptions and changes; due to this, the cost can be additionally reduced by reducing the labour-intensity of the repair TPC by 7% and at the 5-th stage by 3%. Thus, the system of mathematical equations that calculate the state factors changing for scenario 2 and the possibility of statistical failures are shown in *Fig. 5*.

As a result of the modelling, it was found that the implementation of the scenario 2, in case of failures due to which there is a possibility of additional cost reducing by reducing the labour-intensity of the repair TPC at the 3-rd stage (by 7%) and the 5-th stage (by 3%), the enterprise can get additional opportunity to reduce retail prices by 5.8%.

t+1

0,09*1+0,1*1+0,06*1= 0,09*1+0,1*1+0,06*1
0,1- (0,1*0,016)+0,09-(0,09*0,0002)+0,06-
(0,06*0,008) =
0,1*1+0,09*1+0,06*1
0,08*1+0,05*1+0,01*1=0,08*1+0,05*1+ 0,01*1

ek – 10.02

t+2

0,09*1+0,1*1+0,06*1= 0,09*1+0,1*1+0,06*1
0,0984 – (0,0984*-0,016)+ 0,0899-(0,0899-
0,0002)+0,0595-
(0,0595-0,008)
= 0,1- (0,1*0,016)+0,09-(0,09*0,0002)+0,06-
(0,06*0,008)
0,08*1+0,05*1+0,01*1=0,08*1+0,05*1+0,01*1

ek – 9.92

t+3

0,09*1+0,1*1+0,06*1= 0,09*1+0,1*1+0,06*1
0,0968-(0,0968*0,016)+ 0,0898-
(0,0898*0,0002)+
0,059-(0,059*0,008) =
0,0984 – (0,0984*-0,016)+ 0,0899-(0,0899-
0,0002)+
0,0595-(0,0595-0,008)

ek - 9.83

0,09*1+0,1*1+0,06*1= 0,09*1+0,1*1+0,06*1
0,0968-(0,0968*0,016)+ 0,0898-
(0,0898*0,0002)+
0,059-(0,059*0,008) =
0,0984 – (0,0984*-0,016)+ 0,0899-(0,0899-
0,0002)+0,0595-(0,0595-0,008)
0,08-
(0,08*0,07)+0,05*1+0,01*1=0,08*1+0,05*1+0,0
1*1

ek - 9.73

t+4

0,09*1+0,1*1+0,06*1= 0,09*1+0,1*1+0,06*1
0,0952-(0,0952*0,016)+0,0897-(0,0897-0,0002)+
0,0585-(0,0585-0,008)
= 0,0968-(0,0968*0,016)+ 0,0898-
(0,0898*0,0002)+
0,059-(0,059*0,008)
0,08*1+0,05*1+0,01*1=0,08*1+0,05*1+0,01*

ek – 9.75

0,09*1+0,1*1+0,06*1= 0,09*1+0,1*1+0,06*1
0,0952-(0,0952*0,016)+0,0897-(0,0897-0,0002)+
0,0585-(0,0585-0,008)
= 0,0968-(0,0968*0,016)+ 0,0898-
(0,0898*0,0002)+
0,059-(0,059*0,008)
0,0744*1+0,05*1+0,06*1= 0,09*1+0,1*1+0,06*1

ek – 9.65

t+5

0,09*1+0,1*1+0,06*1=
0,09*1+0,1*1+0,06*1
0,0936 –(0,0936-0,0-
16)+0,0896-(0,0896-
0,0002)+0,058-
(0,058*0,008)=
0,0952-
(0,0952*0,016)+0,0897-
(0,0897-0,0002)+0,0585-
(0,0585-0,008)
0,08*1+0,05*1+0,01*1=0,08
*1+0,05*1+0,01*1

ek - 9.67

0,09*1+0,1*1+0,06*1=
0,09*1+0,1*1+0,06*1
0,0936 –(0,0936-0,0-
16)+0,0896-(0,0896-
0,0002)+0,058-
(0,058*0,008)=
0,0952-
(0,0952*0,016)+0,0897-
(0,0897-0,0002)+0,0585-
(0,0585-0,008)
0,0744*1+0,1*1+0,06*1=
0,09*1+0,1*1+0,06*1

ek - 9.58

0,09*1+0,1*1+0,06*1=
0,09*1+0,1*1+0,06*1
0,0936 –(0,0936-0,0-
16)+0,0896-(0,0896-
0,0002)+0,058-
(0,058*0,008)=
0,0952-
(0,0952*0,016)+0,0897-
(0,0897-0,0002)+0,0585-
(0,0585-0,008)
0,0744-(0,0744*
0,03)+0,1*1+0,06*1=
0,09*1+0,1*1+0,06*1

ek - 9.56

Fig. 5. **The system of mathematical equations that calculate state factors changing for scenario 2 and the possibility of statistical failures**

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Thus, the proposed combination of situational asynchronous modelling elements and Seidel method features (used in modelling of a synchronous nature) is the most effective way for modelling the technological competitiveness of products, companies and clusters in the national competitiveness system as a complex system. Due to the outlined combination, combinational equations at all stages of iteration could be obtained, and the alternative calculations that describe the state of finite elements of state in cases of statistical and other disruptions and changes during the implementation of a specific scenario could be formed.

Conclusions. The long-term assessment of enterprise technological competitiveness method is based on the synthesis of indicators of specific and absolute technology product cost according to the areas of manifestation and involves using a scenario approach, combining situational and asynchronous modelling elements with Seidel method features. Modelling the material intensity and the technological competitiveness of ACURA remote starting devices made it possible to determine that, under scenario 1, only 2.4% reduction of the planned technological chip design cost reduction in the retail price per ACURA unit sales can be achieved, and under scenario 2, the planned technological chip design cost reduction in retail prices (4.7%) per ACURA unit sales (in case of mechanized precision production lines acquisition) can be achieved. As a result of the modelling, it was found that, in case of Scenario 2 implementation, there is probability of failures, which can result in possible additional cost reduction with the labour-intensity of the repair TPC reducing at the 3-rd stage (by 7%) and the 5-th stage (by 3%) — the enterprise can get an additional opportunity to reduce retail prices by 5.8%. Assessment of mechanical engineering enterprise technological competitiveness prospects should be based on the following determinants: cost according to type of technological competitiveness of products based on material intensity including all expenditure; along with absolute technological cost, it is advisable to use the specific technological cost according to areas of its manifestation.

Література

1. Меры и программы по поддержке конкурентоспособности национальных производителей в США и Канаде. *Внешняя торговля*. 1996. № 5. С. 34—36.
2. Andriushchenko K., Lavruk V., Uliganets S., Kovtun V., Matviienko H. Reputation Risk Management Companies Based on Competence Approach. *TEM Journal*. 2019. № 8 (2). P. 516—524.
3. Экономика предприятия / под ред. Н. А. Сафронова. Москва : Юристъ, 1998. 584 с.
4. Kravchenko O., Kucher A., Hełdak M., Kucher L., Wysmułek J. Socio-economic transformations in Ukraine towards the sustainable development of agriculture. *Sustainability*. 2020. Vol. 12 (13). P. 5441.
5. Nitsenko V., Mardani A., Streimikis J., Shkrabak I., Klopov I., Novomlynets O., Podolska O. Criteria for Evaluation of Efficiency of Energy Transformation Based on Renewable Energy Sources. *Montenegrin Journal of Economics*. 2018. Vol. 14. № 4. P. 253—263.
6. Шкардун В. Д., Ахтямов Т. М. Методика исследования конкуренции на рынке. *Маркетинг в России и за рубежом*. 2000. № 4. С. 44—54.
7. Svyrydenko D., Stovpets O. Cultural and Economic Strategies of Modern China: In Search of the Cooperation Models across the Global World. *Future Human Image*. 2020. Vol. 13. P. 102—112.
8. Шмулевич Т. В. Конкурентоспособность крупных предприятий и ее роль в развитии предпринимательства. Народы СНГ накануне третьего тысячелетия : материалы Междунар. научн. конгресса. Нижний Новгород : Университет ННТЕУ, 1999. 136 с.
9. Hryvkivska S., Salkova I., Polishchuk N., Kucher L. Human capital in the formation of efficiency of enterprises activity. *European Journal of Sustainable Development*. 2019. Vol. 8. № 3. P. 499—509.
10. Pavlova O. Politically-Technological Potential of Cultural Practices in Ukrainian Perspective. *Ukrainian Policymaker*. 2018. Vol. 2. P. 20—26.
11. Чернишевський Л. М. Економічний аналіз на підприємствах промисловості і торгівлі. Київ, 2008. 312 с.
12. Kovtun V., Andriushchenko K., Horbova N., Lavruk O., Muzychka Y. Features of the Management Process of Ambidextrous Companies. *TEM Journal*. 2020. Vol. 9 (1). P. 221—226.
13. Svyrydenko D., Stovpets O. Chinese Perspectives in the «Space Race» through the Prism of Global Scientific and Technological Leadership. *Philosophy and Cosmology*. 2020. № 25. P. 57—68.
14. Андреева О. Д. Технология бизнеса: маркетинг. Москва : Инфра-М, 1997. 224 с.
15. Краткий словарь менеджера / под ред. В. П. Грошева. Москва : Дело, 1991. 435 с.
16. Фасхиев Х. А., Костин И. М. Обеспечение конкурентоспособности грузовых автомобилей на этапе разработки. Набережные Челны : Изд-во Камского политехн. института, 2001. 349 с.
17. Антонюк Л. Міжнародна конкурентоспроможність країн: регіональний аспект. *Міжнародна економічна політика*. 2005. № 1. С. 45—68.
18. Bezzubov D. Administrative and Legal Forms of Regulation of the Modern Market of Space Services and Technologies. *Advanced Space Law*. 2020. Vol. 5. P. 14—24.

19. Матвійчук С. С. Аналіз шляхів підвищення конкурентоспроможності промислових виробів за рахунок підвищення технологічності конструкції. *Вісник Хмельницького національного університету*. 2009. № 5. С. 156—159.
20. Strategy 2010. Research, Technology and Innovation for Austria (analyses, proposal and recommendations of the Austrian council for researcher and technology development). Alpbach : ICIY, 2009. 39 p.
21. Bilan Yu. V., Nitsenko V. S., Samoilyk Iu. V. Conceptual modeling of agri-food market development under economy's globalization. *Scientific bulletin of Polissia*. 2017. Vol. 3 (11). P. 54—61.
22. Bazaluk O. Plato's Traditions in Modern Educational Theories. *Annals of the University of Craiova. Philosophy Series*. 2019. Vol. 43 (1). P. 5—20.
23. Baharun R., Jing Mi T., Streimikiene D., Mardani A., Shakeel J., Nitsenko V. Innovation in healthcare performance among private brand's healthcare services in small and medium-sized enterprises (SMEs). *Acta Polytechnica Hungarica*. 2019. Vol. 16. № 5. P. 151—172.

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References

1. Mery i programmy po podderzhke konkurentosposobnosti nacional'nyh proizvoditelej v SSHA i Kanade [Measures and programs to support the competitiveness of domestic producers in the United States and Canada]. (1996). *Vneshnyaya torgovlya — Foreign trade, 5*, 34—36 [in Russian].
2. Andriushchenko, K., Lavruk, V., Uliganets, S., Kovtun, V., & Matviienko, H. (2019). Reputation Risk Management Companies Based on Competence Approach. *TEM Journal, 8* (2), 516—524. http://doi.org/10/18421/TEM82-27.
3. Safronov, N. A. (Ed.). (1998). *Ekonomika predpriyatiya [Economics of the enterprise]*. Moscow: Yurist [in Russian].
4. Kravchenko, O., Kucher, A., Hełdak, M., Kucher, L., & Wysmułek, J. (2020). Socio-economic transformations in Ukraine towards the sustainable development of agriculture. *Sustainability, 12* (13), 5441. https://doi.org/10.3390/su12135441.
5. Nitsenko, V., Mardani, A., Streimikis, J., Shkrabak, I., Klopov, I., Novomlynets, O., & Podolska, O. (2018). Criteria for Evaluation of Efficiency of Energy Transformation Based on Renewable Energy Sources. *Montenegrin Journal of Economics, 14* (4), 253—263. https://doi.org/10.14254/1800-5845/2018.14-4.17.
6. Shkardun, V. D., & Ahtyamov, T. M. (2000). Metodika issledovaniya konkurencii na rynke [Methods of research of competition in the market]. *Marketing v Rossii i za rubezhom — Marketing in Russia and abroad, 4*, 44—54 [in Russian].
7. Svyrydenko, D., & Stovpets, O. (2020). Cultural and Economic Strategies of Modern China: In Search of the Cooperation Models across the Global World. *Future Human Image, 13*, 102—112. https://doi.org/10.29202/fhi/13/11.
8. Shmulevich, T. V. (1999). Konkurentosposobnost' krupnyh predpriyatij i ee rol' v razvitii predprinimatel'stva [Competitiveness of large enterprises and its role in business development]. *Narody SNG nakanune tret'ego tysyacheletiya: materialy Mezhdunar. nauchn. Kongressa — The peoples of the CIS on the eve of the third millennium: materials International scientific Congress.* Nizhniy Novgorod: Universitet NNTEU [in Russian].
9. Hryvkivska, S., Salkova, I., Polishchuk, N., & Kucher, L. (2019). Human capital in the formation of efficiency of enterprises activity. *European Journal of Sustainable Development, 8* (3), 499—509. https://doi.org/10.14207/ejsd.2019.v8n3p499.
10. Pavlova, O. (2018). Politically-Technological Potential of Cultural Practices in Ukrainian Perspective. *Ukrainian Policymaker, 2*, 20—26. https://doi.org/10.29202/up/2/3.
11. Chernyshevskyi, L. M. (2008). *Ekonomichnyi analiz na pidpryiemstvakh promyslovosti i torhivli [Economic analysis in industry and trade]*. Kyiv [in Ukrainian].
12. Kovtun, V., Andriushchenko, K., Horbova, N., Lavruk, O., & Muzychka, Y. (2020). Features of the Management Process of Ambidextrous Companies. *TEM Journal, 9* (1), 221—226. http://doi.org/10.18421/TEM91-31.
13. Svyrydenko, D., & Stovpets, O. (2020). Chinese Perspectives in the «Space Race» through the Prism of Global Scientific and Technological Leadership. *Philosophy and Cosmology, 25*, 57—68. https://doi.org/10.29202/phil-cosm/25/5.
14. Andreeva, O. D. (1997). *Tekhnologiya biznesa: marketing* [*Business technology: Marketing]*. Moscow: Infra-M [in Russian].
15. Groshev, V. P. (Ed.). (1991). *Kratkij slovar' menedzhera [Short dictionary of the manager]*. Moscow: Delo [in Russian].
16. Faskhiev, H. A., & Kostin, I. M. (2001). *Obespechenie konkurentosposobnosti gruzovyh avtomobilej na etape razrabotki [Ensuring the competitiveness of trucks at the development stage]*. Naberezhnye Chelny: Izd-vo Kamskogo politekhn. instituta, [in Russian].
17. Antoniuk, L. (2005). Mizhnarodna konkurentospromozhnist krain: rehionalnyi aspect [International competitiveness of countries: regional aspect]. *Mizhnarodna ekonomichna polityka — International economic policy, 1*, 45—68 [in Ukrainian].
18. Bezzubov, D. (2020). Administrative and Legal Forms of Regulation of the Modern Market of Space Services and Technologies. *Advanced Space Law, 5*, 14—24. https://doi.org/10.29202/asl/2020/5/2.
19. Matviichuk, S. S. (2009). Analiz shliakhiv pidvyshchennia konkurentospromozhnosti promyslovykh vyrobiv za rakhunok pidvyshchennia tekhnolohichnosti konstruktsii [Analysis of ways to increase the competitiveness of industrial products by increasing the manufacturability of the structure]. *Visnyk Khmelnytskoho natsionalnoho universytetu — Bulletin of Khmelnytsky National University, 5*, 156—159 [in Ukrainian].
20. Strategy 2010. (2009). Research, Technology and Innovation for Austria (analyses, proposal and recommendations of the Austrian council for researcher and technology development). Alpbach: ICIY.
21. Bilan, Yu. V., Nitsenko, V. S., & Samoilyk, Iu. V. (2017). Conceptual modeling of agri-food market development under economy's globalization. *Scientific bulletin of Polissia, 3* (11), 54—61. https://doi.org/10.25140/2410-9576-2017-1-3(11)-54-61.
22. Bazaluk, O. (2019). Plato's Traditions in Modern Educational Theories. *Annals of the University of Craiova. Philosophy Series, 43* (1), 5—20.
23. Baharun, R., Jing Mi, T., Streimikiene, D., Mardani, A., Shakeel, J., & Nitsenko, V. (2019). Innovation in healthcare performance among private brand's healthcare services in small and medium-sized enterprises (SMEs). *Acta Polytechnica Hungarica, 16* (5), 151—172. https://doi.org/10.12700/APH.16.5.2019.5.9.

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