

ESTIMATION OF LEVEL OF SUSTAINABLE DEVELOPMENT OF INDUSTRIAL ENTERPRISES OF UKRAINE

Statement of the problem. In the period of globalization of economic processes into sustainable development of industrial enterprises one of the significant roles is played of their ecological component and the choice of strategic aims of management of sustainable development and coordination of a business – processes to envisage the processes of integration of the national economy into the united international economic system.

For the estimation of current level of providing of steady development of enterprises it is expedient to apply a mathematical design that assists the further decision of question of determination of existing to possibility of increase of constancy of enterprise.

Analysis of the latest researches and publications. The algorithm of management “space” modeling for enterprises to control of cost is shown in the works [2, 3] of Kalinina Ye.F. (Kalinina, 2007, p. 119-120) and Kuznetsova A.S. (Kuznetsova, 2007, p.131). The model of formation of competitive-price space for functioning of international business entity is presented in the works [4] of Ilyenko O.V. (Ilyenko, 2013, p. 140-145). However, the problem of sustainable development and of competitiveness control modeling for machine-building enterprises taking into account the ecological factor leaves much to be solved. The algorithm of economic systems modeling and problems of sustainable development has been researched by the following foreign and Ukrainian scientists [1-10]: Sovetov B.J. (Sovetov, 2001, p. 140-143), Yakovlev S.A., Rosen V.V. (Rosen, 2002, p. 196), Gracheva M.V. (Gracheva, 2005, p. 18-27), Minyk S.A. (Minyk, 2002, p. 5-13) and others.

The purpose of the article is modeling of parameters of sustainable development for directed influence of component on sustainable development of enterprises.

Main results of the research. The use of economic-mathematical instruments for profile presentation of the enterprise in three-dimensional space would be chosen as modeling of area of sustainable development for enterprise.

From mathematical point of view three-dimension space is presented in the form of pyramid (Sovetov, 2001; Rosen, 2002; Gracheva, 2005; Minyk, 2002; Itzkov, 2009; Pickover, 1999; Rucker, 1984), the algorithm of systems modeling “Three dimension space” [1-10] has been researched by the following foreign and Ukrainian scientists and on the basis of this mathematical approach it offered by us [11-14] to make the model of competitive environment (Fig. 1) for enterprise NKMZ (Novokramatorsky mashinostroitelny zavod /

Novokramatorsky mashine-building plant). NKMZ is an enterprise with a wealth of experience in participation in the large-scale national and international projects.

The parameters of “space of sustainable development” NKMZ (Fig.1) are defined:

$$\begin{aligned} S_{\min} \leq S \leq S_{\max}, E_{\min} \leq E \leq E_{\max}, \\ E_{C_{\min}} \leq E_C \leq E_{C_{\max}}. \end{aligned} \quad (1)$$

If this requirement is not fulfilled, the enterprise is outside the “space of sustainable development” (Fig. 1). So, it is necessary to carry out the analysis of external and internal environment, elicit “gaps” in the activity and define lines of further development. If the enterprise moves to the “perspective” area, space parameters move to optimal level of enterprise competitiveness and its innovation for all low scale of negative influence on the environment. The plant NKMZ is in the “space of sustainable development”. It is necessary to form development strategy of the enterprise (according to estimation results).

Maximum and minimum parameters for “space of sustainable development” were defined by the experts and equation for NKMZ passing through three points:

$$\begin{aligned} f(S, E, E_c) = (S - S_{\max}) * (E_{\max} - E_{\min}) * (E_{c_{\min}} - E_{c_{\max}}) - \\ - (E_c - E_{c_{\max}}) * (E_{\max} - E_{\min}) * (S_{\max} - S_{\min}) - (E - E_{\min}) * \\ * (S_{\max} - S_{\min}) * (E_{c_{\min}} - E_{c_{\max}}). \end{aligned} \quad (2)$$

In the model (Fig.1) the maximal and minimum values of parameters of space were set on the basis of the got results of estimations of experts - specialists of aggregate of the rating estimations (on a 100 ball scale) got from the leading specialists of economic and ecological services of enterprises. “The best” index was set on soil of possible maximum that can be attained at the modern state of national economy, and “worst” on the basis of indexes of enterprises of industry. The value of social constituent of S_{\max} for industrial enterprises was certain 70 balls, S_{\min} is 15, E_{\max} equals 70, E_{\min} is 2 (on the framework of ecolaw), $E_{C_{\max}}$ is 90, $E_{C_{\min}}$ is 30 (on a 100 ball scale).

One of of the important stages of design electing of form of connection, that characterizes dependence of integral index (constituent of sustainable development) on factors that influence on her, became. Accessible of alternatives were additive and multiplicative models. The special literature of synonymous recommendations does not give through this question. In of our view, an empiric way of choice of connection is only possible. A select

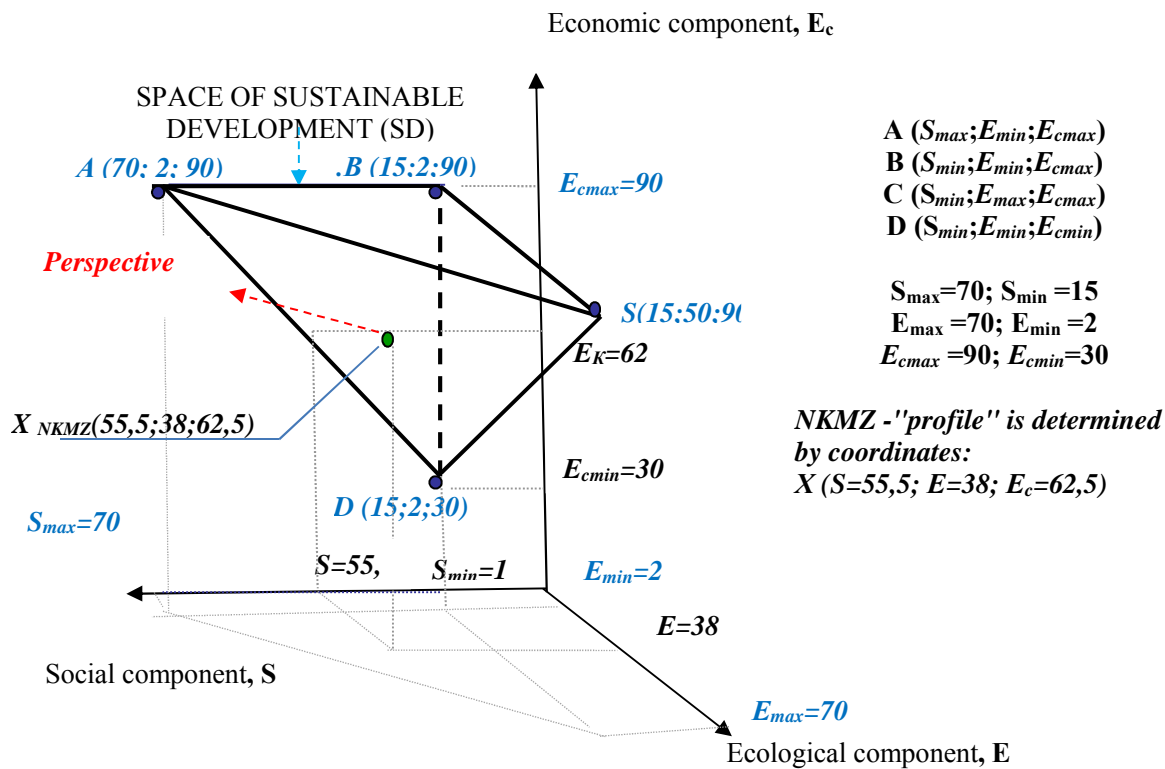


Fig. 1. Position of enterprise “Novokramatorsky mashinostroitelny zavod/ Novokramatorsky machine-building plant” (NKMZ) in “space of sustainable development”
 Source: authoring.

model must answer essence of the investigated processes (economic, ecological or social), to be will stand enough from the point of view of her mathematical treatment and economically interpreted. At of a choice the forms of connection were used such criteria: coefficient of of plural детермінації, Fisher – criterion, remaining dispersion, middle error of approximation. Electing of of additive form of model (3) became a result with the managed, not managed and weakly – adjusted factors:

$$I = a_0 + \sum_{j=1}^k a_j z_j + \sum_{i=k+1}^n a_i x_i + u, \quad (3)$$

$$f(E_c) = 22,899 + (uec) - 0,858Ec_1 + 0,568 Ec_2 - 0,285 Ec_3 + 0,309 Ec_4 - 0,628 Ec_5 - 0,724 Ec_6 - 0,742 Ec_7 + 0,182 Ec_8 - 2,665 Ec_9 + 6,345 Ec_{10} - 1,380 Ec_{11} - 1,771 Ec_{12} + 1,277 Ec_{13} + 0,441 Ec_{14} - 4,584 Ec_{15} + 1,531 Ec_{16}; \quad (4)$$

$$f(E) = -8,488 + (ue) - 0,158E_1 + 0,935E_2 + 0,211E_3 + 0,479E_4 + 0,052E_5 + 0,029E_6 + 0,229E_7 + 0,302E_8 + 2,029E_9 - 1,714E_{10} - 0,255E_{11} + 1,103E_{12} - 0,204E_{13} - 0,371E_{14} - 0,235E_{15} - 1,408E_{16}; \quad (5)$$

$$f(C) = 2,951 + (us) + 0,281S_1 - 0,041S_2 + 0,079S_3 - 0,927S_4 + 0,374S_5 - 1,796S_6 + 0,0002S_7 - 0,061S_8 + 0,235S_9 + 0,170S_{10} - 0,466S_{11} + 1,058S_{12}; \quad (6)$$

$f(E_c), f(E), f(S)$ – functions of rating estimation of components (constituents) of sustainable development (economic, ecological and social accordingly); E_{ci}, E_i, S_i – coefficients of regression after the corresponding functions of rating estimation, u_{ec}, u_e, u_c – factors are conditioned by branch (cluster) features and position of enterprise in a cluster.

The got indexes of regressive statistics testified functions to the high enough level of meaningfulness and reliability of got. The got functional dependences

I – integral estimation of component of sustainable development of enterprise; z_j – weakly – adjusted factors; x_i – adjusted (managed) factors; u – factors, conditioned by branch features; a_0 – a free member; a_j – coefficients of regression at weakly – managed factors; a_i – coefficients of regression at the managed (adjusted) factors

Processing of statistical data in relation to the rating estimation of constituents of sustainable development of the investigated selection of enterprises and forming of regressive models (4 - 6) allowed getting the aggregate of equalizations:

(formula 4 – formula 6) and corresponding rating estimations of constituents of sustainable development of enterprises create informative soil of positioning of en-

terprises in space of sustainable development. Possibility of being of function (formula 2) that characterizes the terms of providing of hit in the marked space and profile of industrial enterprise (his coordinates) in space appears farther.

$$f(E_c) = 22,899 + (-0,944) - 0,858*88 + 0,568*78 - 0,285*94 + 0,309*93 - \\ - 0,628*87 - 0,724*92 - 0,742*98 + 0,182*92 - 2,665*29 + \\ + 6,345*29 - 1,380*60 - 1,771*38 + 1,277*23 + 0,441*18 - \\ - 4,584*23 + 1,531*27 = 62,5;$$

$$f(E) = -8,488 + (1,045) - 0,158*5 + 0,935*30 + 0,211*17 + 0,479*32 + 0,052*100 + \\ + 0,029*26 + 0,229*96 + 0,302*44 + 2,029*16 - 1,714*2 - 0,255*47 + \\ + 1,103*38 - 0,204*45 - 0,371*45 - 0,235*86 - 1,408*39 = 38,0;$$

$$f(S) = 2,951 + (-4,489) + 0,281*90 - 0,041*96 + 0,079*78 - 0,927*20 + \\ + 0,374*78 - 1,796*10 + 0,0002*33 - 0,061*32 + 0,235*47 + 0,170*85 - \\ - 0,466*58 + 1,058*38 = 55,5.$$

Thus, optimal function defines "space of sustainable development" of NKMZ:

$$f(S; E; E_c) = (f(S) - S_{max}) * (E_{max} - E_{min}) * (E_{Cmin} - E_{Cmax}) - (f(E_c) - E_{Cmax}) * \\ * (E_{max} - E_{min}) * (S_{max} - S_{min}) - (f(E) - E_{min}) * (S_{max} - S_{min}) * (E_{Cmin} - E_{Cmax}) = \\ = (55,5 - 70) * (70 - 2) * (30 - 90) - (62 - 90) * (70 - 2) * (70 - 15) - \\ - (38 - 2) * (70 - 15) * (30 - 90) = f(55,5; 38; 62,5) \geq 0 \\ f(0; 0; 0) \geq 0.$$

The NKMZ is in "space of sustainable development" (Fig. 1), because the following conditions are complied: S - parameters: $15 < 55,5 < 70$; E - parameters: $2 < 38 < 70$; E_c - parameters: $30 < 62,5 < 90$. Component optimization for sustainable development of NKMZ – "ecological factor" was conducted due to the implementation of the program of ecologically oriented control and measures for lowering of the harmful environmental effects.

Conclusions. This model "space of sustainable development" helps to defines directions of strategic (sustainable) development of enterprises. For authentication of influence of ecological constituent on sustainable development of industrial enterprises the design of three-dimensional space of constancy of development is offered. The economic component of sustainable (steady) development (E_c) is suggested to determine the level of economic position of industrial enterprise. A social component (S) is characterized by the level of accordance of enterprise to the modern requirements of corporate social responsibility. An ecological component (E) is determined by the degree of accordance of economic activity to the ecological norms, to the standards of safety and by the level of introduction and efficiency of the ecological programs and ecological projects. After implementation of additional measures for environmental safety for sustainable development, vector motion to the perspective of competitiveness rise of the NKMZ became the result of technique approbation. Advantage of the model is in its versatility and flexibility. It enables to use it for enterprises under any conditions of their development and state of environment. Perspectives for further research are in the preparation of optimal strategy model for sustainable development of the enterprise.

Thus, for NKMZ will get aggregate of indexes of optimal function defines "space of sustainable development":

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Латишева О. В. Оцінка рівня сталого розвитку промислових підприємств України

У статті досліджено процес еколого-економічного управління "простором сталого розвитку" підприємств, визначено параметри, управління якими дозволяє підвищити загальну сталість підприємств. У представленій моделі були вибрані параметри оцінки, які дозволяють усебічно оцінити ефективність функціонування підприємств в конкурентному середовищі і визначити напрями сталого розвитку підприємств. Для ідентифікації впливу екологічної складової на сталий розвиток промислових підприємств пропонується моделювання тривимірного простору сталості розвитку. Запропоновано економічну складову сталого розвитку підприємства визначати рівнем економічного стану промислового підприємства. Соціальна складова сталого розвитку підприємств характеризується рівнем відповідності підприємства сучасним вимогам корпоративної соціальної відповідальності. Екологічна складова сталого розвитку підприємств визначається ступенем відповідності господарської діяльності екологічним нормам, стандартам безпеки і рівнем впровадження та ефективності екологічних програм і екологічних проектів.

Ключові слова: сталий розвиток, еколого-економічне управління, підприємства, конкурентне середовище, модель "простору сталого розвитку", економічні параметри, соціальні чинники, екологічний компонент сталого розвитку.

Латышева Е. В. Оцінка рівня сталого розвитку промислових підприємств України

В статье исследован процесс еколого-экономического управления "пространством устойчивого развития" предприятий, определены параметры, управление которыми позволяет повысить общую устойчивость предприятий. В представленной модели были выбраны параметры оценки, которые

позволяют всесторонне оценить эффективность функционирования предприятий в конкурентной среде и определить направления устойчивого развития предприятий. Для идентификации влияния экологической составляющей на устойчивое развитие промышленных предприятий предлагается моделирование трехмерного пространства устойчивости развития. Предложено экономическую составляющую устойчивого развития предприятий определять уровнем экономического состояния промышленного предприятия. Социальная составляющая устойчивого развития предприятий характеризуется уровнем соответствия предприятия современным требованиям корпоративной социальной ответственности. Экологическая составляющая устойчивого развития предприятий определяется степенью соответствия хозяйственной деятельности экологическим нормам, стандартам безопасности и уровнем внедрения и эффективности экологических программ и экологических проектов.

Ключевые слова: устойчивое развитие, эколого-экономическое управление, предприятия, конкурентная среда, модель "пространство устойчивого развития", экономические параметры, социальные факторы, экологический компонент устойчивого развития.

Latysheva O. Estimation of level of sustainable development of industrial enterprises of Ukraine

The process of ecologically – economic management of "space of sustainable development" of enterprises are investigated in the article. Ecological of activity, economical component and social factors are accepted in models for the increase of total sustainability of enterprise. Control their factors makes it possible to increase the sustainability of enterprises. The parameters of estimation of sustainable development of enterprises were chosen in the presented model. This model "space of sustainable development" helps to defines directions of strategic development of enterprises. For authentication of influence of ecological constituent on sustainable development of industrial enterprises the design of three-dimensional space of constancy of development is offered. The economic component of sustainable development is suggested to determine the level of economic position of industrial enterprise. A social component of sustainable development is characterized by the level of accordance of enterprise to the modern requirements of corporate social responsibility. An ecological component of sustainable development is determined by the degree of accordance of economic activity to the ecological norms, to the standards of safety and by the level of introduction and efficiency of the ecological programs and ecological projects.

Keywords: sustainable development, ecologically – economic management, enterprises, model of of "space of sustainable development", economic parameters, social factors, ecological component of sustainable development.

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