Oleh Gavrysh
D.Sc. (Technical Sciences), Professor, Dean,
Faculty of Management and Marketing,
National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute»
37 Peremohy Ave., Kyiv, 03056, Ukraine
dekan_fmm@kpi.ua
ORCID ID: http://orcid.org/0000-0002-1961-3267

UDC 65.012.12

Kateryna Boiarynova
PhD (Economics), Associate Professor, Department of Management,
National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute»
37 Peremohy Ave., Kyiv, 03056, Ukraine
boyarinovaea@ukr.net
ORCID ID: http://orcid.org/0000-0001-5879-2213

The methodological approach to monitoring of the economic and functional state of innovation-oriented machinery engineering enterprises at the modern technological modes

Abstract. The article is dedicated to the development of the methodological approach to monitoring of the economic and functional state of innovation-oriented machine engineering enterprises in the context of selected indices in alignment with the range of recommended (desired) values. The authors suggest the following stages of performing the monitoring: structuring of the indices which determine results of performing economic functions; formation of the composition of machine engineering enterprises in accordance with the fourth and the fifth techno-economic paradigms (technological modes); calculation of economic indices, determination of respective indices of dynamics; elimination of the influence on the values of the indices of non-systemic events; indication of the range of a recommended (desired) rate of knowledge and analysis of indices of a particular enterprise. The authors applied the proposed approach to research 20 enterprises of Ukraine which by the types of activities belong either to the fourth or the fifth technological paradigm. The ranges of recommended (desired) values for the indices of dynamics in figures relevant to the results of performing economic functions of innovation-oriented machine engineering enterprises were calculated for the fourth and the fifth technological paradigm enterprises. The difficulties in turning to the fifth technological paradigm in Ukraine in comparison with Poland, Germany, France and The United Kingdom were detected due to a complex of internal and external factors; nevertheless, a possibility for positive dynamics in 2017 has been outlined.
Keywords: Innovation-oriented Engineering Enterprise; Indices of Dynamics of Economic Figures; Economic and Functional State; Innovation-oriented Development; Technological Mode; Techno-Economic Paradigm; Industry 4.0
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Гавриш О. А.
доктор технічних наук, професор, декан, факультет менеджменту та маркетингу,
Національний технічний університет України «Київський політехнічний інститут імені Ігоря Сікорського», Київ, Україна
Бояринова К. О.
кандидат економічних наук, доцент, кафедра менеджменту, Національний технічний університет України
«Київський політехнічний інститут імені Ігоря Сікорського», Київ, Україна
Методологічний підхід до діагностики економіко-функціонального стану інноваційно орієнтованих підприємств машинобудування новітніх технологічних укладів
Анотація. Статтю присвячено розробленню методологічного підходу до діагностики економіко-функціонального стану інноваційно орієнтованого підприємства машинобудування в розрізі окремих показників відповідно до діапазону рекомендованих (бажаних) значень. Запропоновано послідовність реалізації діагностики за етапами: структурування показників, що визначають результати виконання економічних функцій; формування складу підприємств машинобудування відповідно до IV-го та V-го технологічних укладів; розрахунок економічних показників; визначення відповідних їм показників динаміки; нівелювання впливу на значення показників несистемних подій; встановлення діапазону рекомендованого (бажаного) рівня значень; аналіз показників за окремим підприємством.
Ключові слова: інноваційно орієнтоване підприємство машинобудування; показники динаміки економічних показників; економіко-функціональний стан; інноваційно орієнтований розвиток; технологічний уклад.

Гавриш О. А.
доктор технических наук, профессор, декан, факультет менеджмента и маркетинга, Национальный технический университет Украины «Киевский политехнический институт имени Игоря Сикорского», Киев, Украина
Бояринова Е. А.
кандидат экономических наук, доцент, кафедра менеджмента, Национальный технический университет Украины
«Киевский политехнический институт имени Игоря Сикорского», Киев, Украина
Методологический подход к диагностике экономико-функционального состояния инновационно ориентированных предприятий машиностроения новых технологических укладов
Аннотация. Статья посвящена разработке методологического подхода к диагностике экономико-функционального состояния инновационно ориентированных предприятий машиностроения в разрезе отдельных показателей соответствующего диапазона рекомендованных (желаемых) значений. Предложены этапы последовательности реализации диагностики: структурирование показателей, определяющих результаты выполнения экономических функций; формирование состава предприятий машиностроения в соответствии с IV-м и V-м технологическим укладами; расчет экономических показателей; определение соответствующих им показателей динамики; нивелирование влияния на значения показателей несистемных событий; установление диапазона рекомендованного (желаемого) уровня значений; анализ показателей отдельно взятого предприятия.
Ключевые слова: инновационно ориентированное предприятие машиностроения; показатели динамики экономических показателей; экономико-функциональное состояние; инновационно ориентированное развитие; технологический уклад.

1. Introduction

The focus of mechanical engineering enterprises on innovative development requires methodological approaches to the indication of economic performance results which provide, decelerate or eliminate an enterprise's capacity to develop. The imbalance between the rate of development of various enterprises and opportunities permitting the achievement of higher results determines the need to identify recommended (desired) approximate values for each of the economic figures as reference points. Increasing or decreasing economic indices relevant to a recommended rate conduce to achievement of the appropriate economic and functional state in the process of innovation-oriented development.

2. Brief Literature Review

Development of methodological approaches to the monitoring and analysis of the effectiveness of development, the state of innovative development, the potential of development and innovativeness are considered in the scientific papers by the following domestic and foreign scientists: K. S. Boichenko (2014) [1]; S. Yu. Aloshyn (2014) [2]; I. O. Liakh (2013) [3]; O. H. Parfentieva (2015) [4]; J. Kádárová, M. Durkáčová, K. Teplická, G. Kádár (2015) [6]; E. G. Carayannis & M. Provance (2008) [7].

In particular, K. S. Boichenko suggests evaluating the enterprise development rate with the use of competitiveness indices, the enterprise development phase with the use of an integral figure and in accordance with the potential implementation degree [1].

S. Yu. Aloshyn considers an improved approach to the formation of a system of indices for monitoring of the innovative development state of an industrial enterprise, which takes into account components (catalysts) such as a market component, an organisational and managerial component, as well as innovative culture [2].

I. O. Liakh researches methodical recommendations for the evaluation of the financial and economic activity of engineering enterprises by applying the adaptive renovation approach with regard to the following stages:

a) determination of the objectives and the main goal of the framework;
b) selection of adaptive renovation indicators from the system of indices of the financial and economic activity of enterprises;
c) preliminary determination of a set of factors, which can influence the rate of the financial and economic activity of enterprises;
d) selection or calculation of the threshold values of adaptive renovate indicators related to the financial and economic activity of enterprises;
e) ascertainment of information on the state of the financial and economic activity of enterprises;
f) collection and transmission of data for their subsequent analytical processing;
g) analytical processing of indicators of the financial and economic activity of enterprises, evaluation of the rate of the factor influence on its state and selection of the most influential ones from these factors for subsequent consideration in the process of making corresponding managerial decisions;
h) collection of special information in order to analysing certain threats to the financial and economic activity of enterprises, as well as indication of adaptive renovation factors and assessment of the rate of their influence on the state of the financial and economic activity of enterprises [3].

Scientists propose different approaches to the assessment of the development potential.

O. H. Parfentieva proposes steps a diagnostic instrument for the assessment of the development potential, which includes: a) selection of a system of indices for the monitoring; b) a comparative analysis of the indices; c) formation of a vector of significance for the selected indices aimed at evaluation of the degree of their interrelation with activity results of the enterprise; d) calculation of an integrated figure of the enterprise development potential [4].

V. I. Kariuk discloses a methodical approach to the assessment of the investment potential of industrial enterprises, which includes a complex methodical instrument for the assessment of the enterprise innovation potential based on the determination of indices of its personnel, facilities and equipment, as well as its financial, economic, scientific, marketing, infrastructural, organisational, managerial, market and information potential [5].

J. Kádárová, M. Durkáčová, K. Teplická and G. Kádárhave suggest an integrated BSC-DEA model to monitor the efficiency of industrial enterprises and the relevant processes [6].

E. G. Carayannis and M. Provancehave developed an approach to the evaluation of innovativeness of the enterprise on the basis of the «3P» construction of innovation measurement which simultaneously considers *the Posture, the Propensity* and *the Performance* related to the firm's innovation capabilities with the use of the Composite Innovation Index (CII) [7].

Despite the fact that all the abovementioned scientists have considerably contributed to the research of the stated problem, there is a need to develop the methodological approach to the monitoring of the economic and functional state of innovation-oriented enterprises to determine their ability to enhance.

3. The purpose of the article is to develop a methodological approach to the monitoring of the economic and functional state of innovation-oriented engineering enterprises in the context of selected indices in order to detect inconsistency and make managerial decisions aimed at its elimination.

4. Results

Monitoring of the economic and functional state of innovation-oriented engineering enterprises, the development of which is innovation-oriented, should be based on the indication of dynamic figure values for each economic index or ratio, along with comparing them to a particular recommended value.

The monitoring includes the following stages: a) establishment of object affiliation with a particular class or a group (the quality identification stage); b) indication of differences between the selected object and other objects of the same class (group) based on the comparison of a quantitative figure which describes its state, along with the threshold value (the quantity identification stage) [8]. Figure 1 shows a consequence of the monitoring of the economic and functional state of an innovation-oriented engineering enterprise in the context of selected indices. The first (preparatory and analytical) stage consists in substantiation of the research purpose and structuring of indices as indicators of the performance of economic functions by defining components of the enterprise's internal environment and the phases of economic functioning in promoting innovation-oriented development. The database of the engineering enterprise under analysis should be formed in compliance with the techno-economic paradigm, within which the enterprise functions. It is justified to divide enterprises of the domestic engineering industry into groups by the fourth and the fifth techno-economic paradigms. This division stipulates the specificity and the innovation rate of the activity. Such a group should comprise enterprises with traditional production, as well as leading enterprises with high indices of innovation development. Keeping to the mentioned requirements will validate the objectiveness of the research.

Researchers highlight the need to aggregate indicators defining the state and the dynamics, i.e. the dynamics indices should be included in the system of indicators [9]. The second (calculation and analytical) stage encompasses steps to determine a range of recommended values for the indices based on results of performing economic functions (economic indices and ratios) according to the components of the enterprise's internal environment. The second stage includes the following steps:

- Calculation of economic indices, which determines results of performing economic functions according to the components of the innovation-oriented engineering enterprise's internal environment.
- Determination of the chain absolute increase for linear normalised values of the figures related to the result of performing economic functions (both for the range of values and for each enterprise):

$$\left[d_{K_l,E_m,T_h}\right]_{ent}=\frac{\left[f^{K_l,E_m,T_h}\right]_{ent}-\left[f^{K_l,E_m,T_{h-1}}\right]_{ent}}{\max\limits_{E_m,\mathbf{T}}\left[f^{K_l,E_m,T_h}\right]_{ent}-\min\limits_{E_m,\mathbf{T}}\left[f^{K_l,E_m,T_h}\right]_{ent}}, \quad (1)$$

where $\left[d_{K_l,E_m,T_h}\right]_{ent}$ - the values of the chain absolute increase for linear normalised values of figures (both for the range of values and for each enterprise separately) in the context of each economic index;

K_l - the selected economic index of assessment, which is a figure related to the results of performing economic functions

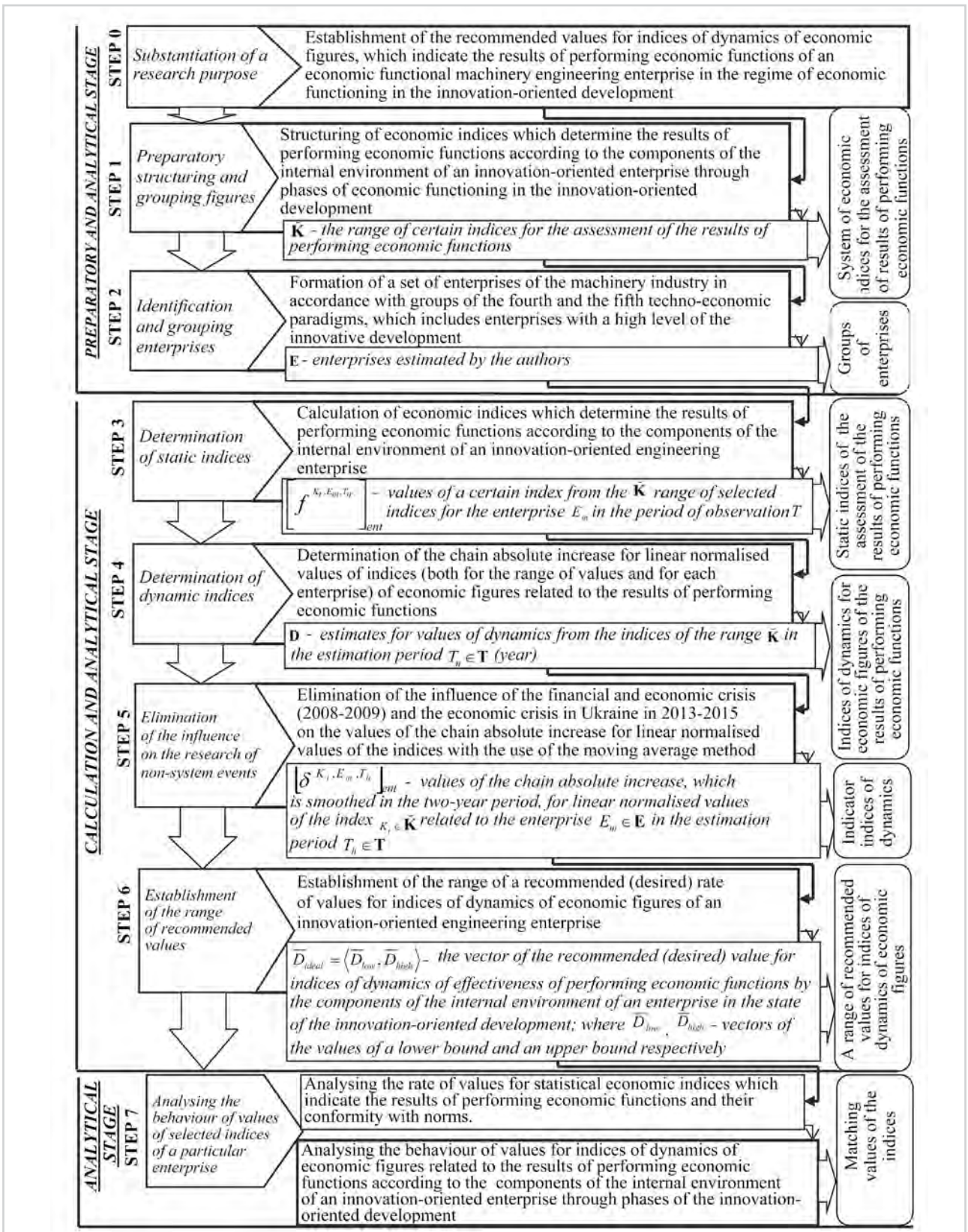

Fig. 1: **Sequence of the monitoring of the economic and functional state of innovation-oriented enterprises of the engineering industry in the context of selected indices**
Source: Compiled by the authors

according to the components of the enterprise's internal environment during a corresponding phase of economic functioning in the innovation-oriented development; $K_t \in \breve{\mathbf{K}}$; $\breve{\mathbf{K}}$- a set of estimation indices, which are figures of the results of performing economic functions;

T_n - the year of assessment, in the period of assessment (T), $T_n \in \mathbf{T}$;

E_m - a number of the engineering enterprise, $E_m \in \mathbf{E}$; E - a set of enterprises in the researched group representing the fourth and the fifth techno-economic paradigms, respectively;

$\left[f^{K_t, E_m, T_n}\right]_{ent}$ - the value of the selected economic index of assessment, which is a figure related to the result of performing economic functions for a certain enterprise in the estimated period.

- Elimination of the influence of the 2008-2009 financial and economic crisis and the 2013-2015 economic crisis in Ukraine. To eliminate the influence of the 2008-2009 financial and economic crisis and the 2013-2015 economic crisis in Ukraine on the relevant indices, it is expedient to smooth the values with the use of the moving average method regarding a two-year interval.
- Establishment of the range of a recommended (desired) rate of values for indices of dynamics of economic figures related to the results of performing economic functions according to the components of the internal environment of the innovation-oriented engineering enterprise. Taking into account the differences between the values of indices of dynamics for various enterprises, which is stipulated by the scale of the activity, the rate and the reserve of the development, it is expedient to use the range of values that forms the zone of the desired (optimal) rate as the desired rate of values in the state of innovation-oriented development. To determine the upper and lower bounds of the zone, which correspond to the economic status of the enterprise in the state of innovation-oriented development, the authors have applied the minimax (or maximin) method to determine the optimal values with concomitant estimates [10].

The authors propose to calculate the upper and lower bounds according to Formulas 2 and 3:

$$\overline{D}_{low} = \begin{cases} \left\{ \max_{\mathbf{T}} \left(\frac{\sum_{\mathbf{E}} \left[\delta^{K_t, E_m, T_n}\right]_{ent}}{M} \right) \mid K_t \in \breve{\mathbf{K}}, E_m \in \mathbf{E}, T_n \in \mathbf{T} \right\}, \text{if } d^{K_t}_{nor} \to \max; \\ \left\{ \min_{\mathbf{T}} \left(\frac{\sum_{\mathbf{E}} \left[\delta^{K_t, E_m, T_n}\right]_{ent}}{M} \right) \mid K_t \in \breve{\mathbf{K}}, E_m \in \mathbf{E}, T_n \in \mathbf{T} \right\}, \text{if } d^{K_t}_{nor} \to \min, \end{cases} \quad (2)$$

$$\overline{D}_{high} = \begin{cases} \left\{ \frac{\sum_{\mathbf{T}} \max_{\mathbf{E}} \left(\left[\delta^{K_t, E_m, T_n}\right]_{ent} \right)}{M} \mid K_t \in \breve{\mathbf{K}}, E_m \in \mathbf{E}, T_n \in \mathbf{T} \right\}, \text{if } d^{K_t}_{nor} \to \max; \\ \left\{ \frac{\sum_{\mathbf{T}} \min_{\mathbf{E}} \left(\left[\delta^{K_t, E_m, T_n}\right]_{ent} \right)}{M} \mid K_t \in \breve{\mathbf{K}}, E_m \in \mathbf{E}, T_n \in \mathbf{T} \right\}, \text{if } d^{K_t}_{nor} \to \min, \end{cases} \quad (3)$$

Where $\overline{D}_{low}$, $\overline{D}_{high}$ - the values of the upper and lower bounds of the index of dynamics for a certain economic figure related to the results of performing economic functions;

$\left[\delta^{K_t, E_m, T_n}\right]_{ent}$ - the value of the chain absolute increase, which is smoothed in a two-year period for linear normalised values in the context of the selected index of dynamics for a certain economic figure related to the result of performing economic functions according to the components of the enterprise's internal environment in the estimated period $(T_h \in \mathbf{T})$;

M - a number of enterprises under research;

$d^{K_t}_{nor} \to \max, d^{K_t}_{nor} \to \min$ - the desired dynamics value of the K_t parameter.

With regard to the proposed approach, the authors researched twenty enterprises in the context of indices of each of the components and phases of economic functioning in the conditions of the innovation-oriented development.

According to scientific research, the fifth techno-economic paradigm includes electronic industry, computer industry, optical fibres, telecommunications, robot construction [12], and it is based on industries manufacturing electric appliances, machine tools, instruments, household appliances and machines, including the aviation industry producing aircraft, helicopters, unmanned aircraft and accurate weapons, as well as rocket production [13-15].

The types of economic activity, which basically belong to this paradigm, are: 26. Manufacture of computer, electronic and optical products and 30.3. Manufacture of air and spacecraft and related engineering, including classification of high-tech products [16]. However, it is appropriate to consider industries manufacturing electrical appliances, machine tools and instruments as belonging to this paradigm providing its high innovation level, in particular: 27.1. Manufacture of electric motors, generators, transformers, electricity distribution and control apparatus; 27.5. Manufacture of household appliances; 28.99. Manufacture of engineering equipment special setting and 29.31. Manufacture of electrical and electronic equipment for motor vehicles. Comparing the results of machine building enterprises by the types of economic activity, which are fully attributed to the fifth techno-economic paradigm, with the leading countries of European machine building (Table 1), it can be argued that domestic machine building has significantly lower figures both in the number of enterprises and in the volume of production, for example such a kind of production in Poland in 2015 exceeded the same domestic production 17 times (compared to 7 times in 2012).

In total, until 2015, the production activity referred to the fifth techno-economic paradigm in Ukraine decreased, however the production of computers, electronic and optical products in 2016 was characterised by an increase in the indicators (as in January 2017 in relation to December 2016), which evidences the presence of certain changes in the transition to the fifth technological paradigm (Table 2).

The focus was on the economic functioning of the fifth techno-economic paradigm enterprises, such as PJSC MERIDIAN named after S. P. Korolyov, PJSC MOTOR SICH, PJSC ELMIZ, PJSC ELEKTROPANEL Hlukhiv Plant, PJSC Kharkiv Electrical Engineering Plant UKRELECTROMASH, PJSC Scientific and Industrial Company «BILSHOVYK», ARTEM State Joint Stock Holding Company, PJSC Kyiv RADAR Plant, PJSC ELEKTRONPRYLAD, PJSC Ivano-Frankivsk Plant PROMPRYLAD, PJSC KVAZAR. In the aggregate, the economic activity of the mentioned enterprises is covered by the following types: 26.11. Manufacture of

Tab. 1: **The results of functioning of machine engineering enterprises by the type of economic activity in the selected countries (manufacture of computer, electronic and optical products of the fifth techno-economic paradigm)**

Name of the country		2012	2013		2014		2015	
		Indicator value	Indicator value	GR	Indicator value	GR	Indicator value	GR
Ukraine	PV	918.6	941.5	2.5	752.1	-20.1	502.9	-33.1
	NE	769	877	14.0	792	-9.7	746	-5.8
Poland	PV	8,218.1	7,516.9	-8.5	8,407.5	11.8	8,608.9	2.4
	NE	2,730	3,102	13.6	3,120	0.6	2,805	-10.1
Germany	PV	63,904.1	65,519.8	2.5	66,687.3	1.8	75,634.6	13.4
	NE	7,686	8 ,070	5.0	8,158	1.1	8,149	-0.1
France	PV	30,0151	29,143.2	-2.9	29,143.2	-8.3	30,951.3	6.2
	NE	2,823	2,919	3.4	2,832	-3.0	3,024	6.8
United Kingdom	PV	21,090.2	21,355.5	1.3	22,318.6	4.5	23,979.2	7.4
	NE	5,877	6,000	2.1	5,967	-0.6	6,078	1.9

Note: PV - production volumes, million euro; NE - number of enterprises, thousand units; GR - growth rate, %
Source: [17-18]

electronic components; 26.30. Manufacture of communication equipment; 26.51. Manufacture of instruments and equipment for measuring, testing and navigation; 27.11. Manufacture of electric motors, generators and transformers; 27.12. Manufacture of electricity distribution and control apparatus; 28.99. Manufacture of engineering equipment special setting and 30.30. Manufacture of air and spacecraft and related machinery.

Tab. 2: **Industrial Production Index by the types of economic activity referred to the fifth techno-economic paradigm in Ukraine**

By NACE code	Name	Year				
		2013	2014	2015	2016	January 2017 in relation to December 2016
26	Manufacture of computer, electronic and optical products	86.0	77.9	71.3	124.2	100.9
27	Manufacture of electrical equipment	91.1	100.9	89.8	100.9	95.8
27.11	Manufacture of electric motors, generators and transformers	107.6	114.2	85.0	108.2	95.7
27.12	Manufacture of electricity distribution and control apparatus	85.8	120.9	101.6	100.0	100.7
27.5	Manufacture of house hold appliances	91.0	84.4	77.5	92.1	89.8
28.9	Manufacture of engineering equipment special setting	84.3	86.6	76.8	109.6	141.3

Source: [18]

According to the scientific literature, the 4th techno-economic paradigm includes: automobile construction, tractor construction, shipbuilding industry, agricultural machine building, road-building and municipal machine building, manufacture of sanitary-technical and gas equipment and products, machine building for light and food industry (excluding the production of household appliances and machines) [12-15]. The study of the 4th technological paradigm was based on the example of enterprises such as PJSC Korosten Plant of Chemical Machine-Building, PJSC Sumy Machine-Building Science and Production Association, PJSC Sumy NASOSENERGOMASH Pump and Power Engineering Works, PJSC Elektropanel Hlukhiv Plant, PJSC Kharkiv Electrical Engineering Plant UKRELECTROMASH, PJSC Scientific & Industrial Company «BILSHOVYK», PJSC BUDMASHPlant, PJSC Kharkiv Machine-Building Plant «SVITLO SHAKHTARIA», JSC Novokramatorsk Machine-Building Plant, PJSC Drogobych Machine-Building, PJSC BOREKS, JSC Kyiv Motorcycle Plant, the economic activity of which covers types such as: 28.13. Manufacture of other pumps compressors; 28.22. Manufacture of lifting and handling equipment; 28.29. Manufacture of machinery and equipment for general purpose; 28.30. Manufacture of machinery and equipment for agriculture and forestry; 28.91. Manufacture of machinery and equipment for metallurgy; 28.92. Manufacture of machinery and equipment for mining and construction industry; 28.94. Manufacture of machinery and equipment for manufacturing textiles, clothing, fur and leather products; 28.92. Manufacture of machinery and equipment for mining and construction industry; 28.96. Manufacture of machinery and equipment for plastic and rubber; 30.91. Manufacture of motorcycles; 29.20. Manufacture of bodies for motor vehicles, trailers and semi-trailers.

Within the purpose of the research, we have formed ranges of recommended values for the indices of dynamics as reference points of the economic and functional state of engineering enterprises according to the proposed methodology (Table 3).

- Analysis of the dynamics indices in the context of economic figures related to the results of performing economic functions according to the components of the internal environmental system of the selected enterprise in the zone of recommended values and establishment of the desired rate of dynamics indices for the enterprise. It is expedient to take into account the statistical values, especially those being at the normative/recommended level, in

Tab. 3: **Ranges of recommended (desired) values for the indices of dynamics in figures relevant to the results of performing economic functions of innovation-oriented machine engineering enterprises**

Phase	Index	Recommended (desired) values for enterprises	
		the fourth techno-economic paradigm	the fifth techno-economic paradigm
	Subject industrial and production environment		
1	Capital intensity (in relation to labour)	0.119-0.368	0.091-0.314
	Labour intensity	(-0.126)-(-0.434)	(-0.168)-(-0.306)
	Technical equipment of labour	0.120-0.317	0.098-0.352
2	Amount of a salary fund per a unit of production	0.107-0.340	0.095-0.368
3	Ratio of the increase in the number of employees	0.055-0.247	0.099-0.288
4	Ratio of provision of employees with intangible assets	0.156-0.343	0.126-0.370
	Environment of financial turnover		
1	Inventory coverage ratio	0.113-0.377	0.064-0.283
	Ratio of self-financing	0.114-0.240	0.0232-0.256
	Ratio of provision of intangible assets with financial resources	0.0628-0.202	0.072-0.254
2	Ratio of provision of inventories with own current funds	0.086-0.304	0.068-0.226
	Equity turnover ratio	0.114-0.334	0.068-0.333
	Ratio of financial production of fixed assets	0.040-0.344	0.124-0.342
3	Ratio of financial and investment potential of the manufacturing process	0.063-0.312	0.140-0.321
	Ratio of financial and investment production of the manufacturing process	0.051-0.298	0.056-0.373
4	Ratio of accumulation of depreciation of fixed assets and intangible assets	0.068-0.325	0.064-0.309
	Ratio of financial production of fixed assets and intangible assets	0.074-0.348	0.079-0.393
	Environment of productive capacities		
1	Depreciation to fixed assets ratio	(-0.170)-(-0.384)	(-0.174)-(-0.303)
	Fixed asset output ratio	(-0.108)-(-0.349)	(-0.220)-(-0.347)
	Fixed asset immobilisation ratio	0.165-0.250	0.138-0.257
	Material expenditures per a unit of products	(-0.233)-(-0.328)	(-0.152)-(-0.359)
2	Net book value to fixed assets ratio	0.166-0.318	0.174-0.302
	Share of fixed assets in assets	(-0.137)-(-0.314)	(-0.153)-(-0.328)
	Inventory turnover ratio	0.138-0.326	0.07-0.292
3	Fixed asset replacement ratio	0.067-0.369	0.060-0.413
	Ratio of machinery and equipment turnover	0.052-0.333	0.083-0.369
	Ratio of fixed asset augmenting	0.115-0.385	0.080-0.335
4	Ratio of innovative turnover of fixed assets	0.049-0.226	0.139-0.252
	Innovative environment of tangible assets		
1	Ratio of new equipment mastering	0.042-0.163	0.045-0.222
2	Ratio of machinery and equipment modernization	(-0.104)-(-0.365)	(-0.205)-(-0.332)
3	Technical innovation ratio	0.0086-0.185	0.077-0.202
4	Ratio of innovative turnover of fixed assets and intangible assets	0.026-0.193	0.117-0.271
	Innovative environment of intangible assets		
1	Intangible asset depreciation ratio	(-0.105)-(-0.338)	(-0.135)-(-0.382)
	Expenditure to intangible assets ratio	(-0.081)-(-0.170)	(-0.117)-(-0.258)
	Intangible assets immobilisation ratio	0.125-0.332	0.0382-0.326
2	Net book value to intangible assets ratio	0.066-0.397	0.047-0.4225
	Intangible asset stagnation ratio	(-0.129)-(-0.358)	(-0.074)-(-0.343)
3	Intangible asset replacement ratio	0.131-0.349	0.0384-0.479
4	Ratio of innovative turnover of intangible assets	0.033-0.230	0.137-0.247

Note:1 - the phase of functional provision; 2 - the phase of functional production;
3 - the phase of functional expanded production; 4 - the phase of functional innovative production.
Source: Compiled by the authors based on [11; 19-20]

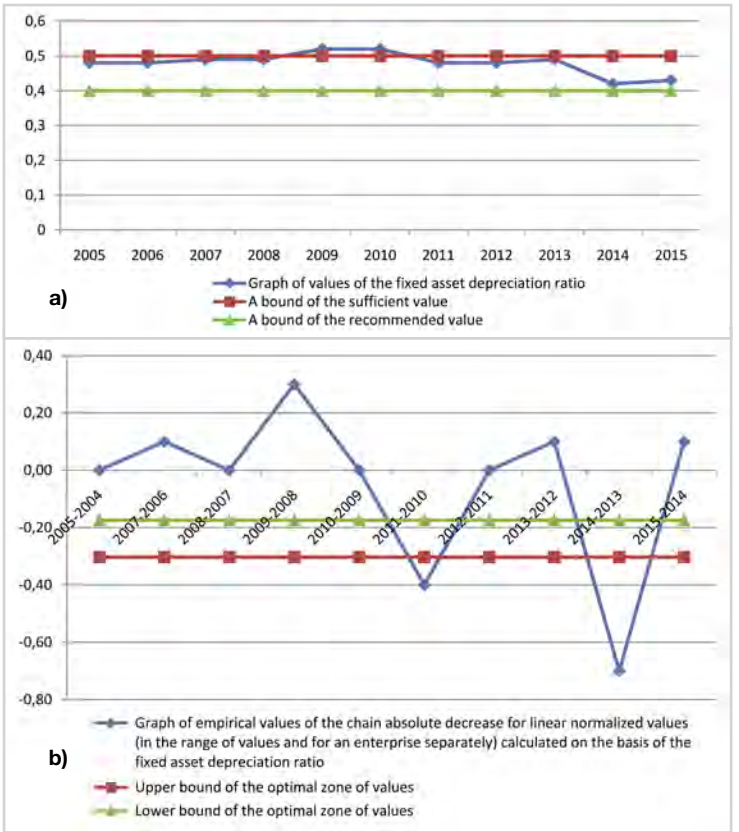

Fig. 1: **Graphs for the following values:**
a) values of the fixed asset depreciation ratio;
b) values of dynamics indices calculated on the basis of the fixed asset depreciation ratio and their indicators in the zone of recommended (desired) values for machine engineering enterprises which function within the fifth techno-economic paradigm
Source: Calculated by the authors based on [11]

the process of the dynamics indices. If the index value is within the appropriate range, it is expedient to analyse a deviation of the values of dynamics from the recommended (desired) ones in order to reveal the undesirable growth by indices focusing on the minimization and vice versa.

The authors explain the analysis process regarding the values of dynamics indices of related to a particular enterprise according to the proposed methodological approach by the example of the fixed asset depreciation ratio. As can be seen in Figure 2a, the value of the fixed asset depreciation ratio for an enterprise, which functions within the fifth techno-economic paradigm, fluctuates within limits. However, it tends to increase, which can be seen from the deviations from the recommended (desired) value of dynamics (Figure 2b).

5. Conclusions

The proposed methodological approach consists in monitoring of the economic and functional state in the context of selected dynamics indices, establishment of desired values and determination of the corresponding techno-economic paradigm due to the analysis of the indices of engineering enterprises. The approach enables the analysis of the dynamics indices by using the main indices and ratios which determine results related to performing economic functions according to the components of the enterprise's internal functional system in the zone of recommended (desired) values.

The conducted research enables innovation-oriented engineering enterprises to ascertain inconsistency of their economic functional state and make managerial decisions with the use of object management.

Further research will aim at developing measures and procedures for the enhancement of the economic functional state of innovation-oriented engineering enterprises.

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