“Systemic-structural analysis of the machine-building enterprises economic sustainability formation mechanism”

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SYSTEMIC-STRUCTURAL ANALYSIS OF THE MACHINE-BUILDING ENTERPRISES ECONOMIC SUSTAINABILITY FORMATION MECHANISM

Abstract

Machine-building complex is a system-forming element of Ukrainian economy. Functioning of other industries in many respects depends on the results of its activity. Harsh conditions of globalized economic environment and geopolitical changes taking place in the country have negatively affected the state of machine-building enterprises and determined the need for increasing the level of their economic sustainability. As a result of using the systemic-structural approach, which is being developed in the context of the provisions of systemic economic theory, systemic-structural analysis of economic sustainability of several machine-building enterprises was performed. The study was conducted based on a sample of 16 machine-building enterprises and covered the 2015–2016 period. Economic sustainability was analyzed by way of defining in the structure of enterprises, econometric modeling and assessing the state of four subsystems with different space and time localization and further defining the level of mutual balance. The set of individual parameters for modeling every subsystem was determined mainly by way of regrouping of baseline statistical indicators, as well as expert assessments. Using such an approach enabled to determine structural peculiarities of machine-building enterprises development during the analyzed period and their effect on formation of volatility and stability properties, which ensure their sustainability in space and time. During the analyzed period, the determined disproportions of the subsystems in the structure of enterprises had systemic nature. The identification of economic manifestations of the determined disproportions enabled to formally define non-trivial dependencies between the economic phenomena, which took place in machine building, and to define the nature of their influence on the mechanism of economic sustainability formation. The risks affecting every subsystem under study had volatile nature, that's why the issue of systemic risk management remains relevant.

Keywords economic system, economic sustainability, systemic economic theory, systemic-structural approach, structural balance

JEL Classification B59, C12, C59, D92, L69, O12, P51

INTRODUCTION

Machine building has always played a key role in the Ukrainian industry structure. Today the effectiveness of machine-building enterprises activity has significantly decreased, the majority of them appeared not to be ready to function in the volatile conditions of open market, complicated by geoeconomic transformation of the country and change of production technological paradigm.

The complex nature of systemic economic phenomena, to which economic sustainability belongs, brings about the search for new scientific approaches to perceiving them. Till now there was no holistic paradigm that, according to practice needs, would ensure the consistency of researches in economic science. Systemic economic theory, formed

through integration of economy with other sciences that study complex objects as dynamic systems, became the first, which is being developed based on the principles of systemic economy. It harmoniously combines the fundamental provisions of other basic economic theories, ensures the complexity of researches of economic phenomena through clear identification of system-forming factor of economic systems and development of corresponding holistic systemic-structural approach. Besides, the notion of sustainability is one determining, which forms basic SET provisions, and using the systemic-structural approach – for analyzing the economic sustainability of machine-building enterprises.

1. LITERATURE REVIEW

Broad range of the problems of enterprises economic sustainability formation was studied in the works of many economists. Among them it is reasonable to define Adams, Jeanrenaud, Bessant, Overy, and Denyer (2012), Schaltegger and Wagner (2011), Seebode, Bessant, and Jeanrenaud (2012), Lototska (2011), Marchenko (2011) and others.

Kleiner (2007, 2009), Kornai (1998), Libman (2007) and others pointed in their works to the need for updating the theoretical-methodological paradigm of economic studies.

Systemic economic theory began to develop as self-dependent economic paradigm in the works of Kornai (1998, 2016). In its modern view, the theory was formed mainly in the works of the group of researchers of the Central Economic Mathematical Institute of the Russian Academy of Sciences (CEMI RAS) under the guidance of Kleiner (2007–2016).

Based on the fact that the system is interpreted as relatively sustainable in space and time integrity of interacting elements, SET considers the limitations in space and time as determining features of all economic systems, irrespective of their level. The full group is created by four types of economic systems with different spatial and time localization: a) project systems, limited (localized) both in space and time; b) process systems, not limited in space, but limited in time; c) subject-object systems, limited in space, but not limited in time; d) environment systems, not limited either in space or in time. The systems of certain type according to features of spatial and time localization are isomorphic at all levels. The sets of similar elements and subsystems are closed for unification operations – the set of elements and subsystems of certain given type is considered an economic system of this type (Kleiner, 2009, 2016).

Space and time are also considered as continuity of economic systems existence and measurement of economic phenomena, including sustainability (Kleiner, 2007–2016; Rybachuk, 2014). A priori localized in time the process and project systems are active. As a result of such activity, the state of systems changes with time, they are volatile. Consequently, the state of non-localized in time subject-object and environment subsystems that are passive changes slowly in an evolutionary way, they are consistent. A priori localized in spatial subject-object and project systems (subsystems) are intensive. As a result of such intensiveness, the spatial structure of the systems changes from one area to another, they are spatially heterogeneous. Correspondingly, the structure of non-localized in spatial environment and process subsystems, which are extensive, remains almost unchanged, they are homogeneous.

The economic system sustainability is ensured at the account of keeping the balance of properties of volatility and stability in space and time. None of the economic systems of one certain type is able to function continuously, sustainably and autonomously in space-time continuum, as it is limited in space and (or) time and therefore does not possess full set of properties, which can ensure its sustainability.

The systems complement each other concerning the exchange of space-time resources and properties, as a result of which so-called symbiotic pairs are formed. When forming the pairs necessary for ensuring its normal functioning, the systems link up into four-component higher level formations, which can be considered natural form of their sustainable existence. Kleiner (2007–2016) called this formation "tetrad" (from Greek Τετράδα – group

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of four). He notes that such tetrad can be defined in the structure of any economic system, which is sustainable in the long term, and the level of balance of four types of subsystems in its composition determines the level of system sustainability as a whole.

As a result of our own studies, we confirmed the hypothesis that the economic sustainability of the system was caused by the structural balance of its subsystems with different space-time localization on the example of economic systems of macro- and microlevels. Besides, according to its results, some provisions of systemic economic theory were checked and partially refined (Kravchenko, 2016, Dergachova et al., 2017). According to the hypothesis, the level of economic system sustainability can be determined through assessing the level of mutual balance of its four subsystems. The methods and results of assessing the level of sustainability of social and economic system of Ukraine as a system of macrolevel according to such approach are presented in Dergachova et al. (2017), the methods and results of assessing the sustainability of enterprises as systems of microlevel – in Kravchenko (2016). This research focuses on more deep economic analysis of the defined structural peculiarities of the enterprises.

2. AIMS

The aims of the paper are to perform systemic-structural analysis of the mechanism of machine-building enterprises economic sustainability formation in the context of provisions of systemic economic theory and to defined the economic manifestations of the disproportions, defined in the structure of the enterprises.

3. METHODS

The methodology of the systemic economic theory induces a need for using the systemic-structural approach to analyzing the economic sustainability of the enterprises. Based on its logic, the analysis of system formation of the enterprise as a system in the composition of four types of subsystems was defined as basic structure of the research.

Table 1. Division of structural-functional elements of the enterprise by the subsystems

Presence of time limits	Presence of spatial limits	
	Present	**Undefined**
Undefined	*So* – subsystem of the subject-object elements of the enterprise:	*En* – subsystem of the environment elements of the enterprise:
	organizational elements of the enterprise (subdivisions, employees, managers, owners, etc.)	socio-cultural elements of the enterprise (standards, regulations, organizational climate, corporate culture, etc.))
Present	*Pj* – subsystem of the project elements of the enterprise:	*Pc* – subsystem of the process elements of the enterprise:
	organizational elements of the enterprise (subdivisions, employees, managers, owners, etc.)	economic elements of the processes at the enterprise (technological, financial, management, logistic, informational, etc.)

Note: * The presented location of systems corresponds with the structure of its interrelationship in the tetrad: the systems having one common systemic feature directly interact with each other; the systems having the opposite features do not directly interact with each other.

The analysis of economic sustainability was performed according to the data from 16 machine-building enterprises for the 2005–2016 period. Thus, total sample of the data was 192 cases. Notwithstanding the fact that the sample intentionally contained the enterprises of different form of ownership, the research did not show its influence on the level of enterprises economic sustainability.

Economic sustainability was defined and checked by way of econometric modeling, assessment and analysis of mutual balance of four mentioned subsystems of enterprises according to proprietary methodology, which is in more detail presented in Kravchenko (2016). Then, the individual components were simplified using the Principal Component Analysis (PCA) and the set of factors (main components) for every subsystem was defined. The index value of certain subsystem of the enterprise I_{sys} was calculated using the method of defining the distance to the gauge according to formula (1).

$$I_{sys} = \frac{\sqrt{\sum_{a=1}^{A}\left[\lambda_{a_n}\left(t_{a_n} - \min_n t_{a_n}\right)\right]^2}}{\sum_{n=1}^{N}\lambda_a}, \quad (1)$$

where t_{a_n} – a-th coordinate of π-th of the analyzed enterprise in the factor space (space of the defined main components for every subsystem), $\min_n t_{a_n}$ – minimum value of the corresponding factor evaluation for the subsystem, λ_a – own values (own numbers) of the main components for the subsystem, A – number of main components, defined for the subsystem modeling, N – number of enterprises.

The level of the enterprise economic sustainability was defined by measuring the mutual balance of four pairs of subsystems based on the methodology proposed by Rybachuk (2014) and refined and complemented by the authors. The methodology is in more detail described in Kravchenko (2016), Dergachova et al. (2017). It is based on building the enterprise model, which reflects the proportions of its subsystems, in the Cartesian coordinate system. Based on the model, the set of parameters

$$D = \{a = bal(So - En), bal(En - Pc), bal(Pc - Pj), bal(Pj - So)\},$$

which reflects the balance of four pairs of its subsystems between each other, was defined for every case using the calculation-graphical method. As can be seen from Figure 1, the subsystems, which have the same index values, are absolutely balanced between each other.

The enterprise economic sustainability index E was calculated using the formula of Euclidean metric in four-dimensional space of parameters a, b, c, d using the method of defining the distance to the gauge, based on the fact that in the case of absolute sustainability, $a = b = c = d = 0.5$.

$$E = f_{norm}(a,b,c,d) = \frac{r(a,b,c,d)_{\max} - r(a,b,c,d)}{r(a,b,c,d)_{\max}} = 1 - \sqrt{\frac{(a-0.5)^2 + (b-0.5)^2 + (c-0.5)^2 + (d-0.5)^2}{2.1716}}. \quad (2)$$

In order to check the methodology consistency, the correlation between the calculated enterprise economic sustainability index and financial coefficients, which are the commonly accepted indicators of the enterprises sustainable functioning, was defined with their prior con-

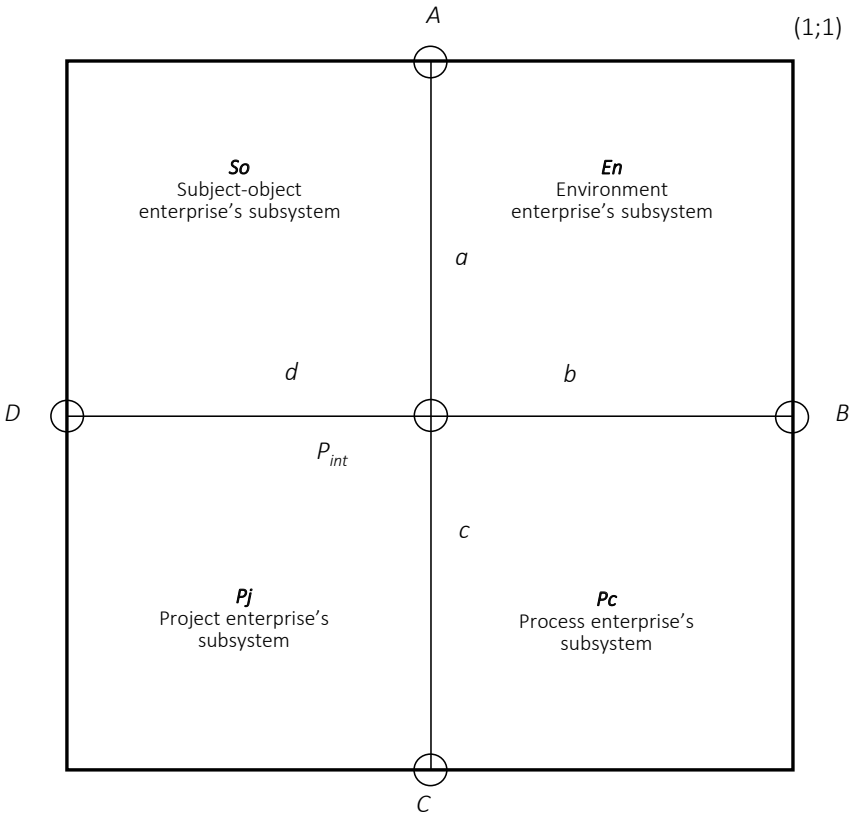

Figure 1. Graphical model of the ideal configuration of the enterprise system balanced structure

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Table 2. Determination of peculiarities, which ensure the sustainability of the enterprise economic system

Source: Specified based on Kleiner (2016).

Reflection of properties	Properties	
	Stability	Volatility
In space dimension	Spatial homogeneity (SH) – homogeneity of internal structure in the space	Spatial diversity (SD) – volatility of the structure when economic space changes or when movement is made in it
In time dimension	Time stability (TS) – homogeneity of internal structure in the time	Time differentiation (TD) – volatility of the structure when moving from one moment of time to another

volution. The presence of direct close relationship between these indicators showed that the methodology used is to a sufficient extent consistent and simultaneously enables to confirm at the microlevel of machine-building enterprises the hypothesis about the causality of the system economic sustainability by the structural balance of its subsystems with different spatial-time localization.

It was substantiated above that the spatial time localization of every subsystem determines the set of its properties of volatility and stability in space and time. In the system, there are two subsystems with the same properties (Table 2). Thus, if all four subsystems are balanced, i.e. similarly expressed in the system, together they ensure its sustainability as a whole. The violation of mutual balance in the pairs of subsystems of the enterprise leads to the disparity of properties, which ensure its sustainability – time stability, spatial homogeneity, time differentiation or spatial diversity.

Based on such thoughts, when defining the indicators of the level of expression at the enterprise of each of four properties of sustainability – time stability, spatial homogeneity, time differentiation and spatial diversity – we used the index values and indicators of mutual balance, averaged according to pairs of subsystems.

4. RESULTS

The modeling results showed that the correlation between the values of their generalized index values during the 2005–2016 period as a whole kept the same proportionality. As can be seen from Table 3, the values of subject-object I_{So} and project I_{Pj} subsystems, averaged according to groups of enterprises, were relatively higher, and those of process I_{Pc} and environment I_{En} subsystems – relatively lower. Provided that the maximum index value based on the methodology is 1.00, the subsystems values were 0.85 ± 0.06, 0.68 ± 0.03, 0.41 ± 0.08 and 0.43 ± 0.05, respectively. It means that the systemic nature of the revealed internal structural disproportions of machine-building enterprises determines the peculiarities of their economic sustainability formation during the analyzed period.

The most expressed enterprise subsystem was the subject-object, the second one – the project, the next after it are the environment and process with approximately the same level of expressiveness. Based on the methodology, in the situation of absolute balance of enterprise economic system, the level of expressiveness of each of the subsystems equals 25.0%. At the same time, their averaged values were 35.8%, 28.5%, 18.1%, 17.6%, respectively. Further, the indicators of mutual balance of the subsystems were calculated and generalized (Table 4).

Table 3. Index values of machine-building enterprises subsystems for the 2005–2016 period (generalized by the group of enterprises)

Type of subsystem	Generalized index value of the systems by year											
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Subject-object (I_{So})	0.91	0.91	0.90	0.89	0.89	0.86	0.83	0.86	0.87	0.79	0.79	0.81
Environment (I_{En})	0.44	0.44	0.41	0.45	0.47	0.48	0.46	0.47	0.47	0.41	0.33	0.40
Process (I_{Pc})	0.48	0.47	0.46	0.46	0.43	0.40	0.37	0.37	0.44	0.43	0.43	0.39
Project (I_{Pj})	0.71	0.68	0.68	0.68	0.65	0.67	0.69	0.70	0.66	0.71	0.69	0.71

Table 4. Indicators of mutual balance of enterprise subsystems for the 2005–2016 period (generalized by the group of enterprises)

Indicator	Value of the indicator by year											
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
a = bal (So – En)	0.51	0.52	0.51	0.52	0.54	0.55	0.55	0.56	0.54	0.50	0.47	0.52
b = bal (En – Pc)	0.37	0.37	0.36	0.37	0.37	0.37	0.35	0.35	0.37	0.36	0.34	0.34
c = bal (Pc – Pj)	0.49	0.49	0.50	0.48	0.46	0.45	0.45	0.44	0.46	0.50	0.54	0.48
d = bal (Pj – So)	0.64	0.63	0.65	0.63	0.63	0.63	0.65	0.65	0.63	0.64	0.67	0.66

Graphical models, which reflect the generalized four-component structure of enterprises by year, are presented in Figure 2.

Based on the calculated values of the indicators of mutual balance of the subsystems, the level of systemic balance and the enterprises economic sustainability indexes were defined, then they were generalized by the group. The value of the enterprises economic sustainability index *E*, generalized by the group, was within the range of 0.73-0.85. The analyzed period witnesses the decline – till 2016 the value decreased by 12.6% to 0.73, average chain increment rate was 1.3%. The analysis of the coherence of the index with complex indicator of financial sustainability, defined using the method of fuzzy logic based on convolution of commonly accepted financial coefficients, showed direct close linear relationship between them. It testifies the consistency of the methodology and confirms the proposed hypothesis at the microlevel of enterprises.

The revealed structural disproportions of machine-building enterprises determine the specificity of the mechanism of their economic sustainability formation. In order to ensure the sustainability, it is important to maintain the structural balance and functional parity of the subsystems, which formally, according to the proposed methodology, is reflected in the equality of their index values. The sustainability can be violated as a result of both decreased and increased level of the subsystem expressiveness. The decreased level of the expressiveness of certain subsystem, when it is peripheral in relation to others, reflects its decreased functionality, relative ill-being (such situation will be conditionally named the "deficit" of the subsystem). The increased level of expressivity of certain subsystem, when it dominates over others, reflects its increased functionality, relative hyperfunctionality (such situation will be conditionally named the "proficit" of the subsystem). The characteristics of formal features of possible structural violations, caused by relative deficit or proficit of the subsystems in the enterprises structure, as well as their functional manifestations, is given in Table 5.

From Figure 2 and Table 3, it is seen that in the majority of cases, the least expressed system was the process one – when generalizing the indicator by year, such situation was observed during 9 years from 12, involved in the observation. As a whole, in all the sample, the deficit of process subsystems was observed in 51.0% of cases. During 3 years from 12, the least expressed was the environment subsystem. As a whole, in the sample, the deficit of environment subsystems was observed in 43.8% of cases. The most expressed subsystem was subject-object – when generalizing the indicators by year such situation is observed during all the years. When analyzing each certain case, the dominance of subject-object subsystems was observed in 90.0% of cases. The project subsystem became the second by the level of expression. The balanced structural configuration of the machine-building enterprises was observed in 10.0% of analyzed cases.

Such patterns of machine-building enterprises functioning do not comply with the requirements of economic surroundings, decreasing the sustainability of enterprises, which is confirmed by the modeling results. Structural disproportions lead to decreased sustainability of enterprises in space and (or) time due to corresponding violation of volatility and stability balance. So, the simultaneous proficit of subject-object and project subsystems and deficit of environment and process subsystems, which was observed in 2005–2016, shows the increased relative level of the system spatial diversity over the level of spatial homogeneity. It leads to decreased level of the enterprise spatial sustainability.

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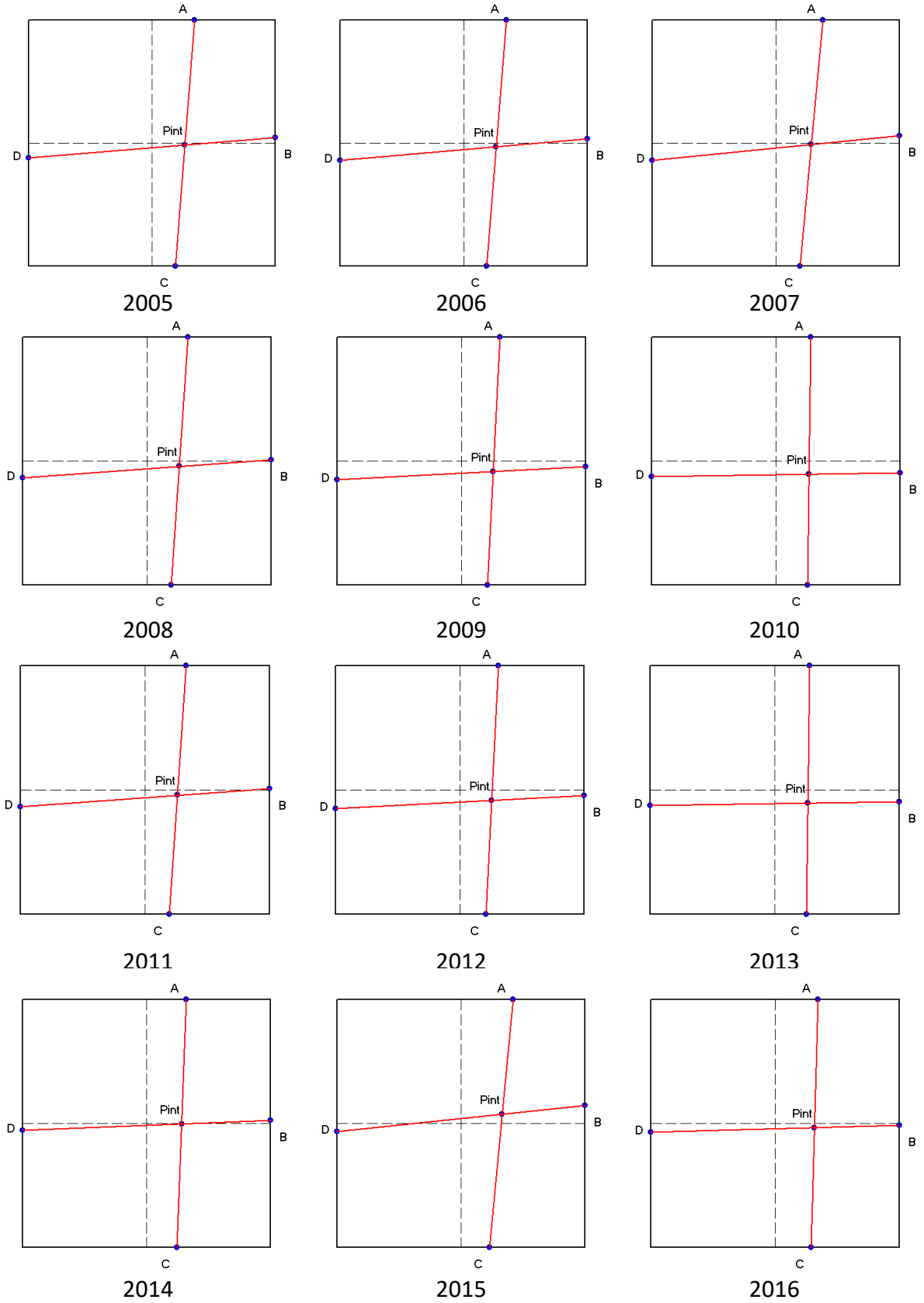

Figure 2. Graphical models of the enterprise subsystems structure by year for the 2005–2016 period (generalized by the group of enterprises)

Table 5. Characteristic of features and functional consequences of structural violations, caused by relative deficit or proficit of certain subsystems in the enterprise structure

Source: Developed by the author based on Kleiner (2008).

Type of enterprise subsystem	Deficit/dysfunctionality		Proficit/hyperfunctionality	
	Formal features	Manifestation consequences	Formal features	Manifestation consequences
Subject-object (*So*)	Peripherality of every corresponding subsystem (*So*, *En*, *Pc*, *Pj*) in the tetrad structure of the enterprise is formally reflected by relative (compared to other) decrease of the index value corresponding to them (I_{So}, I_{En}, I_{Pc}, I_{Pj})	unstable activity of enterprises; decreased labor productivity; violation of responsibility; mismatch of interests of owners and managers	Dominance of every corresponding subsystem (*So*, *En*, *Pc*, *Pj*) in the tetrad structure of the enterprise is formally reflected by relative (compared to other) increase of the index value corresponding to them (I_{So}, I_{En}, I_{Pc}, I_{Pj})	high administrative-management costs; low labor productivity; overwhelmed corporate management system; difficulties in subdivisions coordination
Environment (*En*)		inconsistency of the activity of subdivisions and employees; high level of uncertainty in the enterprise operation; low level of corporate culture		limited self-dependence of employees and subdivisions; low level of internal diversity; possible excessive bureaucratization; duplication of functions
Process (***Pc***)		autonomation of subdivisions; decreased effectiveness of economic activity; internal space fragmentation; ineffective self-regulation		ungrounded loans, credits; unreturned investments; low level of production innovativeness; overloaded personnel
Project (***Pj***)		low innovation-investment activity; technical-technological underperformance of production; management and technological stagnation at the enterprise		ineffective mechanism of selection and realization of innovative-investment projects; their non-compliance with main economic activity; financial overload

Note: ** The shaded cells show the type of structural violations, which were most often observed at the studied machine-building enterprises.

The fact that the proficit of subject-object subsystems concerning the environment subsystems was smaller than the proficit of project systems concerning the process systems shows the increased level of the system time stability over its time differentiation, which caused the slowdown of the enterprise development rates.

The gradual increase of the mutual unbalance level of all four pairs of enterprise subsystems during 2005–2016 shows that they become "exhausted" in course of time and all the properties that ensure their sustainability weaken.

The developed methodology enabled to calculate the percent level of time stability, spatial homogeneity, time differentiation and spatial diversity properties expressiveness and generalize them according to the group. Figure 3 shows the generalized by the group correlation of the properties expressiveness levels, which ensure the sustainability (according to the methodology, in the situation of absolute balance of the enterprise economic system, the level of all the properties expressiveness is the same and equals 25.0%). As a whole, the correlation of the levels of all the properties expressiveness, which ensure the sustainability of enterprises in space and time, remained almost unchanged, but the level of their expressiveness decreased. It formally confirms the exhaustion of all the subsystems of enterprises and gradual loss of sustainability (Figure 4).

As a result, the mentioned disproportions are of systemic nature and show the incompliance of the enterprise internal structure with its economic surroundings and mismatch of its dynamics with dynamics of surroundings. The enterprises are structurally unbalanced and unsynchronized in time. Further, the properties become more imbalanced – without the corresponding structural regulation, the enterprises lose its sustainability in dynamics. In modern tendencies of rapidly changing environment, the main condition of successful functioning and development of socio-economic systems is their synchronicity with the dynamics of surroundings. It is emphasized by both the theorists and practitioners of management (for ex-

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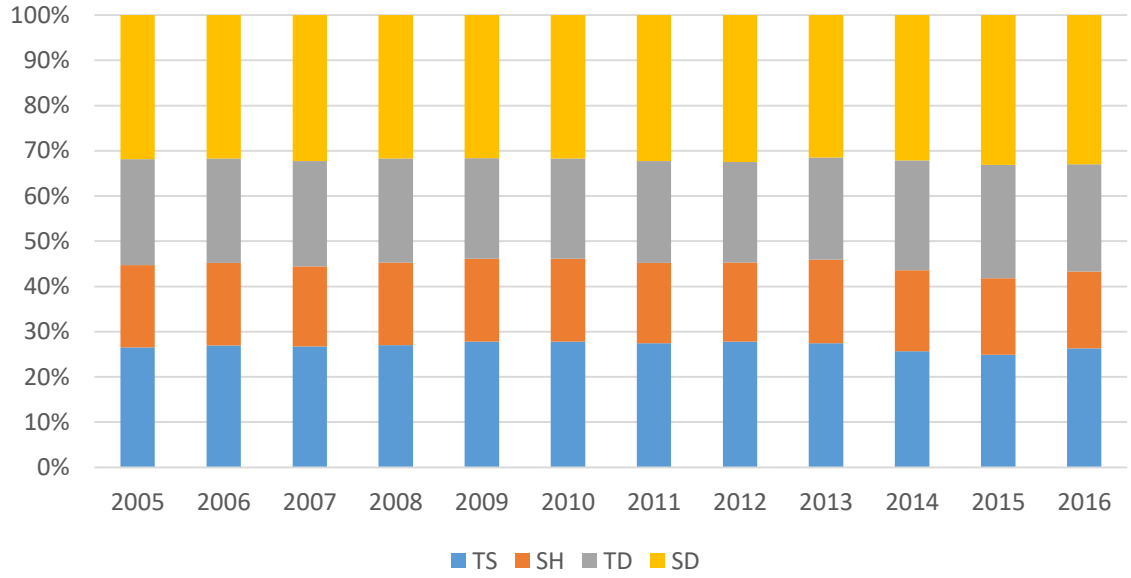

Figure 3. Correlation of the levels of the properties expressiveness, which ensure the sustainability of enterprises (generalized by groups of enterprises)

ample, Kotelnikov, 2017; Chernozatonskaya, 2017). The research confirmed that the enterprises lack this property most of all.

The obtained data gave the possibility to determine the nature of the mechanism of sustainability formation and economic manifestations of machine-building enterprises structural disproportions. Figure 5 shows the defined by the group of enterprises structural violations, their functional manifestations and influence on properties, which ensure economic sustainability of the enterprises.

Modeling results showed that the situation of relative proficit of project subsystems, which reflect the characteristics of the complex of innovative

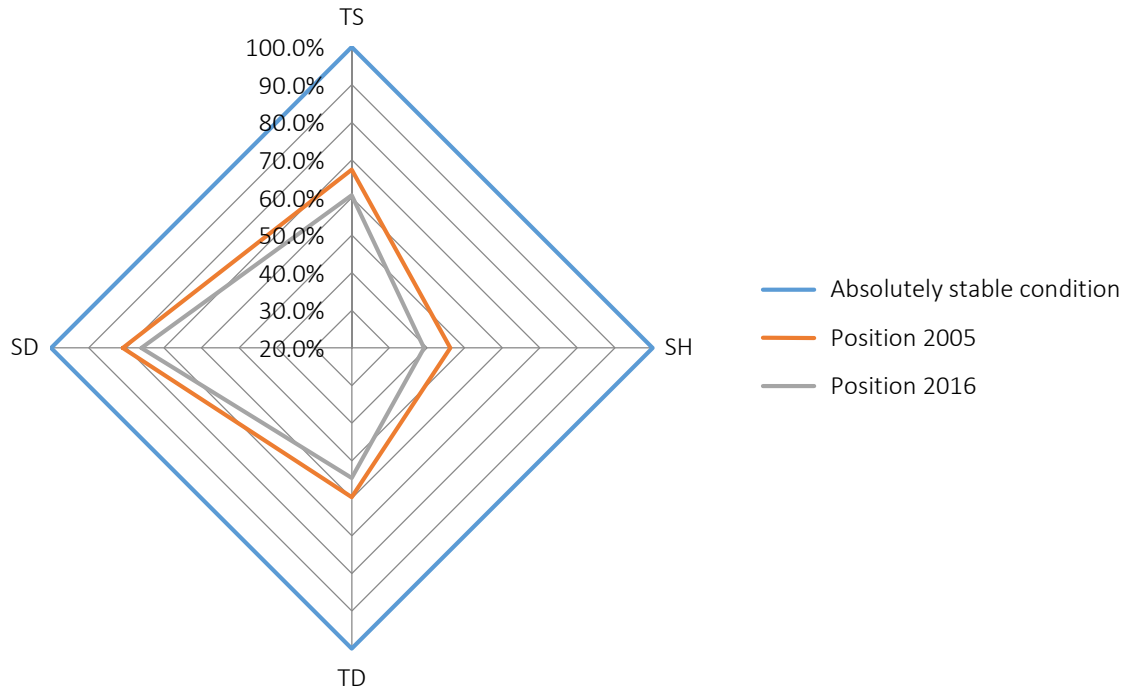

Figure 4. The diagram of the change of the levels of properties expressiveness, which ensure the sustainability of enterprises, for the 2005–2016 period (generalized by the group of enterprises)

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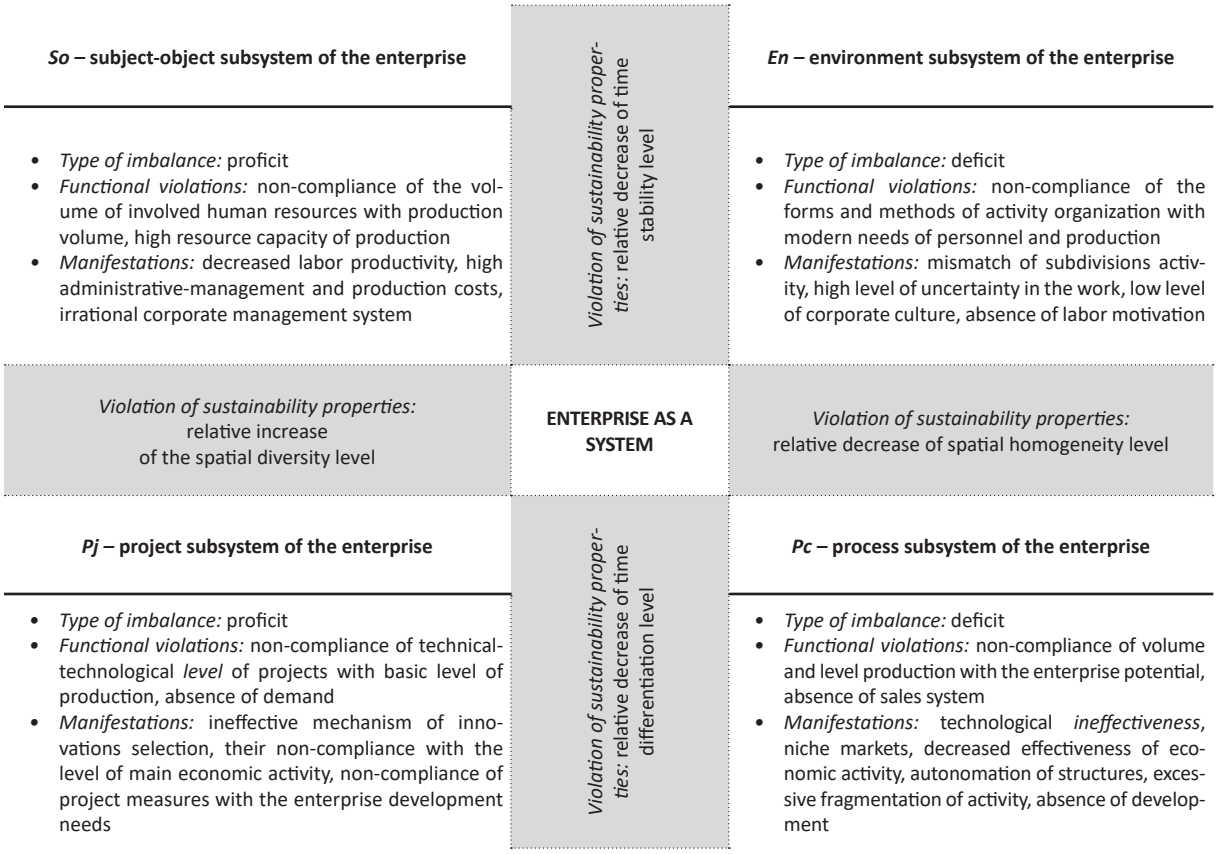

Figure 5. Generalized characteristic of the defined structural peculiarities of enterprises and their influence on functionality and sustainability formation mechanism

and investment projects that were implemented at the enterprises, against a backdrop of the process subsystems of the enterprise, which reflect the characteristics of the sphere of implementation of its main production-economic processes. It shows the incompliance of the enterprise project activity results with the needs of extended reproduction. In course of time, the imbalance depth increases – during the observation period, the subsystems imbalance level increased by 10.0%.

On the one hand, it is a feature of the phenomenon, conditionally called by the specialists "decrease in investment response, which is inherent to slumping economies, on the other hand, violation of main basic principle of formation of economic effect from innovations (Suleimenov et al., 2016; Sholomitskaya, 2017). It lies in the fact that the effect of innovative activity is determined by the possibility of capitalization of its results. The same principle in essence emerges from one of the founders of innovation theory J. Schumpeter. He studied the value of innovations in the context of the perspective of enterprise economic process transformation at the account of their creation and implementation (Schumpeter, 2000).

The situation that took place at the machine-building enterprises when against a backdrop of relatively high indicators, which characterize their innovative-investment activity, the "quality" of the invested projects is extremely low and they actually do not lead to technological changes in economic activity, contradicts the principles of formation of economic effect from innovations (Ovcharova, 2013). Not the high-risk innovative projects, which are aimed at increasing the technical-technological level of enterprises, are financed, but the simple and short-term, the clearest and easily forecasted. The extension of production in most cases is accompanied by its simplification and adjustment to secondary market niches. Technological projects are mainly based on exploiting the achievements, which comply with maximum fourth technological pattern, created in USSR. I.e. formally the intellectual products and projects that are able to

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quite rapidly and relatively easy ensure the short-term economic effect are implemented, but they do not improve the dynamics of technical-technological development and do not favor the economic growth as a whole.

The enterprises that found themselves in the conditions of the need for self-financing, in the absence of practical experience of activity in the marker conditions, operate in the mode of "surviving at any cost". So, the change of components of technical equipment at the account of working capital has become the traditional peculiarity of investment processes in machine building. Herewith the share of own capital in the investments, including the profit, is near 80% (Velykiy, 2010).

Such a phenomenon is inherent not only to machine building, but also has mass nature in industry. As noted by Yergozhin et al. (2010), "one can talk about the bluff of innovative development, connected with the sectioned sector of postindustrial economy. Fundamental discoveries, inventions and innovations of STP epoch were replaced with cheap innovations…". In order to mark these innovations in economic literature, together with the term "microinnovations" (insignificant innovations), here is also used the term "pseudoinnovations" – external modifications of products or processes, which do not lead to the change of consumer characteristics, and even "antiinnovations" – innovations that have regressive nature and lead to partial degradation in this or that sphere of activity (Shcherbakov, 2012; Yakovets, 2004).

Bu the official statistics of innovative activity, which takes place in Ukraine, in particular, the form of state statistic observation No. 1 – innovation "Study of innovative activity of industrial enterprise" does not divide the innovations of different classes. Thus, this statistic simultaneously includes the information of both the basic and micro-, pseudo- and even antiinnovations.

At the same time, the machine building has a range of specific properties, which explain and enhance the imbalance between project and process subsystems. There can be the following: relatively low level of production profitability; high level of overhead costs, energy capacity and metal capacity of technologies; long-term production process; long-term period of return on investment. Low level of return on assets, high level of specialization, increased need in costly high-technology equipment are inherent to machine-building enterprises. Besides, they are affected by ramified infrastructure and poor scales ratio, which are directly involved in main production, and general area, in particular, facilities of enterprises of military-industrial complex, the share of which in the whole sample was 56.3%, are loaded by not more than 30-40% (Velykiy, 2010).

Among other reasons that lead to violated imbalance are the imperfect formal requirements to innovative projects, poor system of technical-technological survey and actual absence of projects qualification system, absence of interest and resistance to innovations from the enterprise personnel, etc.

In turn, the subject-object, environment, project and process subsystems are prone to influence of risk factors, which include: increased rates of loss of qualified personnel and future employees; divergent thoughts in management environment concerning the decision-making; ineffective internal control of the work process from the side of corresponding managers of departments; complex and diversified of production-technological relationship; non-compliance of the equipment used with technological requirements and standards, etc. The political and economic events in the country show that the level of influence of risk factors on the subsystems of different type has volatile nature because of unstable external environment.

On the one hand, thanks to increased project activity there was being created the mechanism, which partially compensated the low level of main economic processes effectiveness, enabling to keep the economic sustainability and certain dynamics of enterprises. On the other hand, such dynamics does not comply with the external economic dynamics and leads to devastating consequences. As a result, in Ukraine during the market transformation period, there did not take place even simple transformation of technical-technological industrial potential and the innovative activity cycle was significantly violated (Fedulova, 2007).

The proficit of subject-object systems in the enterprise structure reflects the characteristics of

the total of employees, managers and owners of the enterprise. At the same time, the deficit of environment subsystems reflects the characteristics of socio-cultural sphere of the enterprise. All this shows that against a backdrop of excessive number of industrial-production personnel in relation to scales of economic activity, its qualitative characteristics (including the ones caused by irrational labor organization) are low. It in turn causes the more decreased level of socio-cultural and organizational indicators of enterprise activity – acting internal standards, regulations, communications and other indicators, which reflect the characteristics of its organizational climate and culture. Such situation, when having paraphrased Gimpelson, can be characterized as "excessive labor with deficit of qualification" (Gimpelson et al., 2007).

In order to confirm the modeling results, at the end of 2016, a survey of the representatives of machine-building enterprises was conducted, where 25 respondents (chairs of the board, directors general and their deputies) from 21 enterprises in Kyiv[1], and from 4 others, which entered the group of the studied enterprises, took part. The expressed opinions were not checked – one representative from each enterprise was involved in the survey.

The majority of respondents (18 from 25 respondents or 72.0%) noted that the number of industrial-production personnel (IPP) at the enterprises assigned to them is excessive concerning the demand for the products issued, expected in 2017. And this is taking account that according to the data obtained during the research, during 2000–2016, the number of IPP of the enterprises only in 2016 decreased by more than 8.0%. Even in the post-crisis period with positive economic dynamics of 2010–2012, when there was observed the increase of production volumes at all the enterprises, it took place with increased number of industrial-production personnel – on average by 10.8% from the number in the crisis 2009 only at 43.8% of the enterprises.

At the same time, the vast majority of respondents (19 from 25, or 76.0%) noted that their enterprises feel acute lack of qualified employees (56.0%), and specialists in the sphere of strategic planning and marketing (46.0%), information-computer technologies (44.0%), designers (40.0%), technologists (36.0%), and specialists with command of professional foreign language (28.0%). 60.0% of managers pointed to the lack of qualified employees and specialists, and before they noted that the total number of employees is excessive.

Thus, the survey confirmed that there two main problems in machine building: excessive total number of industrial-production personnel (excessive labor) and lack of qualified personnel (lack of qualification). What is more, the problem of personnel deficit for managers is more important than the problem of their excessive number. But, irrespective of it, the enterprises suffer losses both from the excessive number and the lack.

CONCLUSION

The systemic-structural analysis of the mechanism of machine-building enterprises economic sustainability formation enabled to define the economic manifestations of the disproportions, defined in the structure of the enterprises. The combination of these economic manifestations leads to the conclusion that the development of domestic machine-building enterprises during the analyzed period was characterized by two determining phenomena, which had resonant nature and devastating consequences.

The first phenomenon is formally reflected in the proficit subsystems of the enterprises against the backdrop of deficit of the process ones. It is caused by the incompliance of the results of the innovative-investment projects being implemented with the needs of extended reproduction of the machine-building enterprises potential. It shows that against a backdrop of relatively high indicators of enterprise innova-

1 The survey was conducted during the meeting of the Board of Directors of the enterprises, institutions and organizations in Kyiv at the Kyiv City State Administration. The total number of the staff of the machine-building department is 28 managers, 21 of which took place in the survey.

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tive-investment activity, quality and technical level of the invested projects were low. They actually did not lead to extended reproduction, which caused the lower investment response, violation of innovative activity cyclicality, technical-technological wear-out of productions.

The second phenomenon is reflected in the proficit of subject-object subsystems against a background of the environment ones. It is caused by non-compliance of the number of human resources involved with their quality. It shows that against a backdrop of excessive number of industrial-production personnel in relation to scales of economic activity, its qualitative qualification characteristics were low. It caused the catastrophic decrease of labor productivity and the level of all the socio-cultural and organizational indicators of the enterprise activity. With high likelihood ratio, the revealed violations, having the systemic nature in the machine building, are to some extent inherent to the majority of industrial enterprises.

As a whole, the systemic-structural approach, used for analyzing the mechanism of the enterprise economic sustainability formation, has a range of advantages when being utilized. In particular, it enables to: make a complex systemic idea on the mechanism of the economic system sustainability formation in space and time; assess the properties ensuring it; reveal the specific dependencies between the economic phenomena concerning their influence on economic sustainability formation. Also this approach can be used at any level of economic hierarchy and herewith it will ensure the possibility of comparing the results obtained. Thus, using such approach is reasonable and promising in the researches of other systemic economic phenomena.

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