ANALYSIS OF INNOVATIVE SUSTAINABILITY OF SOCIO-ECONOMIC SYSTEMS

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1. Introduction

In conditions of uncertainty and extreme variability of socio-economic processes taking place nowadays in Ukraine, considerable attention should be given to the evaluation strategy for the development and management of innovative sustainability.

“The problem of the domestic economy recovering from the state of socio-economic stagnation towards sustainable economic development is of vital importance. It is the solution to this problem that ensures the overcoming of backwardness in socio-economic development of the society...” [1, p.4–21]. Research of the sustainability of socio-economic system as a component of the development strategy has a number of features and is characterized by interconnectedness and diversity of the processes that occur in the system.

Stability is a property of the system to save values of all the parameters that characterize the ability to perform required functions in specified regimes and conditions of use within the established limits [2]. Such understanding of the stability is based on the theory of complex systems management.

In the applied value in relation to the socio-economic system it is bound with the properties of the elements of the socio-economic system that determine its economic ability to perform specified functions within the specified limits in the changing internal and external environment.

“The stability of the socio-economic system” is the ability to perform specified production and economic functions and preserve their basic characteristics in certain temporal boundaries in conditions of the environmental instability.

Innovative activities have a twofold effect on the system which creates a new quality in the process of innovation and has a disturbing effect on its functioning. The main system elements of innovation sphere of science are: “sector of high technologies and science-intensive products, the education system in combination with the labour market, the business sector, various sources of innovation financing, infrastructure (innovation and technology centers, technology transfer centers, technology parks, business incubators, venture funds, special economic zones of technical innovation type, etc.)” [3, p.333–338].

The concept of “innovative sustainability” of socio-economic system characterizes the ability of the system to serve as a positive innovative effect for it while maintaining sensitivity to innovation and innovative activity in the conditions of occurrence of disturbing actions. Innovative resistance is directly linked with the vitality of the system. Until recently the concept of viability was used mainly in relation to the technical system.

With regard to productive enterprises the vitality is interpreted as the ability of socio-economic systems to perform their basic functions despite the damage caused by

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disturbing actions (even with an allowable loss of quality of their performance) and further to implement the optimal recovery strategy taking into account emerging restriction [4]. Thus, it is necessary to bear in mind the following ideas of the sustainability of socio-economic systems.

First, the vitality should be considered as an intrinsic property of the system, which it has, regardless of operating conditions, that is shown at the revolting action, but under normal circumstances it remains "invisible".

Second, the vitality is manifested in the fact that the system keeps not all the functions it must perform during normal operation, but only the basic functions followed by possible decline in the quality of their performance and reduces resistance.

Third, the system must have the property of gradual degradation with increasing severity of adverse effects, and this process can be suspended by administrative influence.

Fourth, in complex integrated systems the vitality displays the ability of the system to prevent cascade development of the revolting influence in it using control system tools. Thus, the change in the state of vitality is determined by innovation activity risk management effectiveness.

The concept of sustainability can be divided into structural and functional components. If the study of the structural component of sustainability is largely reduced to the identification of vulnerabilities in the system topology and determination of their impact on the integrity of the system (largely inherent in the study of technical systems), the study of functional component of sustainability is reduced to determining the system's ability to solve its tasks in terms of varying possibilities of its elements (it is mainly related to systems that have behavioral, depending on a variety of external and internal factors).

The level of sustainability greatly affects the quality of introduced innovative projects, their respective capacities of socio-economic system, especially in the management of innovation risks. This level in its turn is the basis for changes of innovation stability of economic systems.

The risk analysis of the project which is the cornerstone of management of vitality of social economic system identifies the main sources of change of innovation stability [5, p.126]. The persistence of the socio-economic system that determines the effective management of innovative industrial risks, is the main tool to enhance its innovative sustainability. In such a case innovative sustainability of socio-economic systems is complex characteristic of its ability to innovate through the selection and implementation of safe innovative projects to improve the sustainability of the system in an unstable environment.

2. System-synergetic approach to the research of innovative sustainability of socio-economic system

Innovative sustainability of socio-economic system, being a complex property has a double nature: the element of sustainability of socio-economic systems; the subsystem innovation management.

The quality characteristic of these systems is the ability to perform specified functions of household production (as a result of effective innovation implementation) and preserve their basic characteristics (sensitivity of innovation and innovation activity). The significance of the quality of socio-economic systems is increasing in terms of uneven development and innovation and requires the development of new approaches to methodology of innovation stability management.

The analysis of methodological approaches to the study of management (systemic, structural, synergistic) showed that each of them discloses only some aspects of the problem, so it seems necessary to use the synthesis of these approaches. The principles of the proposed methodology for managing innovative sustainability of socio-economic systems are based on systematic, integration, dynamics, continuity, adaptability, constructiveness, synergism.

The duality of the system features of innovative sustainability of socio-economic systems has led to the need for a systematic approach in the formation of integrated management in conditions of revolving influences. As a result, it was determined that the management should be focused not only on the periods of innovative sustainability change in the implementation of innovations.

Not less important is the use of administrative measures at the stage of development and/or selection of the innovative project, the beginning of its implementation. Such measures increase the adaptive control system, because they allow to determine in advance the possible sources of decrease in stability and to develop mechanisms of adaptation through the creation of additional reserves. It increases the effectiveness of the implemented measures and makes management system integrated.

Analysis of the system of innovative sustainability management of socio-economic systems from the view point of a synergistic approach perspective showed that the control system is affected by the external environment and therefore need continuous change of the innovation stability management system. For this purpose the system should contain elements of self-development, which using administrative complex increases the flexibility of the system.

These elements are put in the system due to its belonging to an innovative activity management system, but their implementation is possible only in the case of an effective, integrated management of economic systems sustainability. Therefore the formation of innovative management of socio-economic systems sustainability is based on the development of alternatives which meet the requirements of the overall impact on innovative industrial risk at various environmental changes in the management of functional and structural sustainability.

3. Methods of socio-economic stability and sustainability assessment and a set of sustainability indicators

This methodology contains elements of assessment not only the current level of stability, but also the instruments to determine the quality of the changes to correct the direction of management. It is based on the definition of indicators in three areas: financial vitality; stability level; the willingness of staff to liquidate emergencies and their consequences. Financial ability (willingness) of the object to eliminate the consequences (financial vitality of the object) and to recover economic activity at the expense of their own and borrowed funds. It is defined with the help of a set of indicators which are calculated using the following formulas:

$$Vfo = Fo / Dfe, \tag{1}$$

where Vfo – the object financial vitality, which is realized at their own expense;

Fo – value of own funds mobilized by the enterprise in case of emergencies;

Dfe – expected maximum value of the total damage.

$$Vfl = \Sigma (Fl) / Dfe, \tag{2}$$

where Vfl – the ability of object to attract the required value of borrowed funds fast;

Fl – value of borrowed funds, which may involve the company in case of emergencies (H) with the cost of capital;

Dfe – expected maximum value of the total damage resulting from the implementation of emergency.

$$Av = Fo ' / (1- Fo'), \quad (3)$$

where Av – autonomy of organization stability (the ratio of debt to equity required for disaster management (H));

Fo '– the share of own funds which are mobilized in case of emergencies;

(1- Fo ') – share of borrowed funds which the company has to use in case of emergencies;

Level of stability characterizing the quality management system (its efficiency, preventive and developmental rate).

$$Ev = \Delta Dfe / (1-\Delta Ca), \quad (4)$$

where Ev – economic efficiency of stability changing level;

ΔCa – the amount of changing costs for the disasters management compared with the initial value;

Δ Dfe – the relative amount of expected maximum total loss changes in case of having happened emergency as a result of changes in the value of preventing accidents cost.

$$Evr = \Delta Dfre / (1-\Delta Car), \quad (5)$$

where Evr – the quality level of stability changes;

ΔCar – the relative change in the costs value in preventing emergency situations to happen as compared to the initial value;

Δ Dfre – relative change in the value of the expected total loss caused by having happened emergency situations and as a result of changes in preventing accidents costs.

$$Sa = Qv\ t / Qv\ b, \quad (6)$$

where Sa – the rate of stability level growth over time;

Qv t – value of stability quality in the reporting period;

Qv b – value of stability quality in the base period.

$$Qv = \Delta Dfp / \Delta Cp, \quad (7)$$

where Qv – quality of stability;

ΔCp – the change in the cost of emergency prevention;

Δ Dfp – the change in the expected full damage arising in cases of emergency, as a result of increasing the number of preventive measures.

The willingness of staff to liquidate emergency situations and their consequences

$$Rp = Nse / Ne, \quad (8)$$

where Rp – personnel training to liquidate the consequences;

Nse – the number of employees successfully trained in industrial safety, people;

Ns – the total number of employees that are required to pass attestation of industrial safety, people.

$$Rk = Nse / Ne, \quad (9)$$

where Rk – the ability of staff to the elimination of the consequences;

Nn – number of employees, people who are trained in disaster consequences elimination;

Na – the total number of staff, people required for dealing with emergencies at particular premises.

$$Ra = SEm / SEmr, \quad (10)$$

where Ra – the readiness of staff to emergency situations ocurrance;

SEm – the number of employees involved in the urgent liquidation of emergencies consequences;

SEmr – the total number of people involved in the disaster consequences liquidation.

Within the framework of the given technique, based on the developed expertise method limit values and the weight of each of the indicators (Tab. 1).

Tab. 1. Limit values of stability levels [6, p.342–347]

Level of stability	Value range	Description
Critical	Less 0,4	The system is not ready for an emergency, in the event of disruption of the process of life will have to restore the system using external tools and resources (state), an innovative critical resistance
Moderate	0,4–0,6	The system is ready for an emergency, but if the violation will have consequences within more than 50% of the most dangerous events, then the vital functions of the system will have to be restored using external tools and resources (state), an innovative low resistance
Normal	0,6–0,8	The system is ready for an emergency, but only if the violation will have consequences within the most dangerous predicted events, the vital functions of the system will be restored without attracting external influence, innovation average resistance
Steady	0,8–1,4	The system is ready for an emergency, and it transforms at the rate of the most dangerous scenarios changes, while maintaining the capacity for survival with changes in the external environment, innovative optimal stability

The table shows that the optimal value of innovative sustainability will match the last interval level of socio-economic systems stability (limit value corresponds to the reaching of adequate levels of all groups of indicators), further increase of stability is possible, but it leads to an increase of marginal costs, so economically it is unfeasible.

4. Conclusion

Thus, this research allows to make a conclusion that the theoretical and methodological problems of innovative sustainability management of socio-economic systems by increasing stability have practical importance for the solution of important national economic problems.

The importance of this argument is confirmed by the fact that in the beginning of XXI century an interdependence of the different parts of the world economy, dominated by innovation and knowledge-intensive activity is increasing. Innovation of production became the main factor of competitiveness [7, p.109–110].

So, through the effective management of innovation, socio-economic systems affect the level of self-sustainability, increasing it in the safe implementation of production capacities modernization in the course of innovative development. It increases the level of socio-economic system innovation sustainability through the susceptibility of the system to innovations and innovative activity. It also allows to achieve a positive growth effect from innovation implementation and to improve the competitiveness of socio-economic systems of higher level.

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Summary

The article analyses the research on innovation sustainability of the socio-economic system as a component of development strategy. When choosing a strategy for the development, the evaluation of innovative sustainability is of basic importance. One of the components of the overall sustainability of the system is an innovative sustainability. System support for the sustainable development strategy implementation should be based on achieving a combination of life cycle phases, interchangeability and intensification of system resources, the parameters of which are defined within the framework of innovative concepts. The article offers the analysis of approaches to the definition of the notion of innovation stability diagnostics and the conclusion is made about the necessity of further synthesis of enterprise development strategy and indicators of sustainability.

Keywords: innovation, management, strategy development, innovation sustainability.

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