

Controlling the Innovative Supply Chain Activities for Improving the Competitive Ability of Companies

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Abstract- As part of the supposed approach to strengthen the competitive capacity of industrial companies based on the implementation of the control of innovative activities in the supply chain, the flexible evaluation system was developed, differentiated according to the strategic and tactical objectives of the existing growth of competitive capacity. The strategic management of innovation process supposes achievement of competitive advantages based upon maximal usage of the experience of innovative supply chain activity organization and accounting of new factors, which influence on their change. To solve this problem have been analyzed conditions that determine the appearance and replace the six models of innovative process, allocated based on the modern world scientific experience. The logic of their development allows us to see the important characteristics of their changes, explain the effectiveness of the change process models, through the manifestation of the cumulative and complementary effects. The authors proposed a system of indicators to monitor the degree of manifestation of these effects in the study. In the course of the calculations have been identified changes in the patterns of the innovation process in the Russian mining and metallurgical complex and at the same time as there was a cumulative and complementary effect in changing patterns, and thus the efficiency of controlling innovation. The results suggest that the implementation of controlling innovation in mining and metallurgical enterprises cannot be called successful. Sustained growth was observed on single indicators. In mass production, they have a high degree of variability, or a downward trend. Nowadays, there are a few number of Innovative companies.

Keywords- companies, innovation processes, supply chain activity, indicators, competitive ability.

1. Introduction

The processes of globalization of economy, growth of internal and especially international competition, acceleration of the processes of knowledge innovation requires a fundamental increase of innovative supply chain activity of the domestic industrial enterprises for growing of the competitive advantages. In connection to it, one of the main priorities of management of large industrial enterprises is detection and maximal usage of existing possibilities for improvement of their competitive positions. Correspondingly, the search, development of innovations and the creation of conditions for their implementation become a necessary factor of competitive ability growth of separately taken enterprise and state economy overall.

In the opinion of the acknowledged authority in this region, Porter, the internal resources of the enterprise and terms of their implementation are important factors of its competitive ability, especially in a production sphere [1]. The aggregate of the applied factors in different industries is distinguished. Firms achieve the competitive advantage, if cheap or high-quality resources and factors which are important for competition in the concrete industry are at their disposal.

The consideration of enterprise competitive ability as "a system of relations between subjects in concern to formation, retention and implementation of their economic advantages" [2] can be used not only for analysis of the external environment, but the internal too. It is the essence of one of the directions of systematic study of competitive ability. In such approach the enterprise internal environment can be considered as the aggregate of subjects, ensuring the

competitive abilities, and their relations with each other, as a subsystem of competitive ability management.

For provision of enterprise high competitive ability it is necessary to provide reliability of the processes, and purposeful advancement of the growth and diversification that predetermines the long-term development of economic system. The achievement of above-mentioned aims must satisfy the interests of all “partner groups”, which participate in the process of management and functioning of the organization: owners, managers, staff, suppliers of raw materials, stuff and means of production, and also clients, insurance, auditing organizations and stock exchanges [3], [2]. As we can see, in such full list the factors of the internal environment and elements of enterprise infrastructure take the essential place in the system of its competitive ability.

The provision of competitive ability of industrial enterprises is impossible without systematization and improvement of methodological management personnel of innovative supply chain activity. Namely, the innovative enterprise activity becomes the most effective form of intensification of the reproduction processes. It, in its turn, leads to the renovation of the market, expansion of goods and services assortment, the creation of new production methods, supply and selling, effectiveness increase of the enterprise economic development management.

Within the supposed approach to enhancement of competitive ability of industrial enterprise based upon implementation of controlling of innovative supply chain activity the flexible evaluation system, differentiated in dependence on the existing strategic and tactic aims of competitive ability growth, was developed.

Thus, the methodic system for monitoring of enterprise readiness to increase of its competitive ability is created. The usage of the developed system of indicators at innovative supply chain activity evaluation of the

enterprise allows evaluating the level of its competitive ability based on the generalization of information according to key areas of activity, which has the decisive meaning for its development and competitive ability growth.

2. Models of the innovation process

The strategic management of innovation process supposes achievement of competitive advantages based upon maximal usage of the past experience of innovative supply chain activity organization and accounting of new factors, which influence on their change. For the solution of these tasks, it is necessary to define conditions, which determine the appearance and change of models of innovation process management.

As a result of analysis of modern foreign and native experience six basic models of innovation processes were separated [4], [5], [6], [7], [8], [9]. Their characteristics and key influential factors are represented in Table 1.

Generally, approaches to innovation process changed in dependence on the market requirements, economic surrounding, and appearance of new information technologies. This determined three important transitions in the economic activity of enterprises:

- Firstly, from innovation processes on the basis of internal possibilities of enterprises of R&D area to their organization, on assumption of market requirements;
- Secondly, from linear-consecutive innovation processes to processes on the bases of parallel activity of integrated groups on innovation development;
- Thirdly, from the unfolded, stage-by-stage processes of analysis, generalization, and change of information to compressed, system and simultaneously more scale processes, which allow quicker finding and integrating of the necessary knowledge and solutions.

Table 1. Evolution of innovation process model

Model of innovation process	Key (competitive) factor	Brief characteristics of model
1	2	3
I generation of models - «Stimulated by technologies» («linear», «neoclassical») (mid of 1950-s – end of 1960-s)	R&D.	The innovation process is the process of openings and creation of new knowledge, which are transformed into new products. For the obtainment of new products and services it is necessary to concentrate efforts on the first stages of the innovation process, namely on R&D. The increased attention to the creation of scientific laboratories became the result of this approach.
II generation of models - «Pulled by demand»	Demand.	Innovations appear as a result of detection of buyer's demand, distinctly focused researches and developments, which are finished by

(mid of 1960-s – beginning of 1970)		<p>the appearance of the corresponding new products on the market. R&D keeps the meaning, however they are subjected to market demands.</p> <p>The development of innovation conception on the basis of marketing researches enhances the effectiveness of enterprise innovative supply chain activity, reducing the risks and expenditures for innovation implementation.</p>
<p>III generation of models - «Interactive models» (beginning of 1970-s – mid of 1980-s)</p>	<p>Combination of new or old knowledge.</p>	<p>The model supplements the previous sources of innovations (market demands and scientific researches), specifying the reserve of innovation sources (innovation ideas and knowledge) inside subdivisions, which take part in the creation of new products and services. The previous sources of innovations are added by:</p> <ul style="list-style-type: none"> — Existing knowledge (internal for company); — Knowledge, obtained in the process of accumulation and development of own experience. <p>In this model, the necessity of interrelation between different enterprise subdivisions was emphasized. The new ideas could appear in any subdivision, and interrelation between them provided their development and activation of the innovation process.</p>
<p>IV generation of models - «Integrated models» (mid of 1980-s – beginning of 1990-s)</p>	<p>Integration of researches and developments with production. More close cooperation with suppliers and buyers.</p>	<p>The development of the innovation process through integration of all its participants that allowed reduction of the product development term at the simultaneous reduction of expenditures.</p> <p>The important signs of this model are R&D integration with production (for example, joint systems of automated projecting and flexible production systems), more close cooperation with suppliers and leading buyers, horizontal cooperation (creation of joint enterprises, strategic alliances), and also creation of interfunctional working groups, uniting marketers, production engineers, designers and economists.</p>
<p>V generation of models - «Innovation networks» (beginning of 1990-s – mid of 1990-s)</p>	<p>Big volumes of data and information.</p>	<p>In accordance to this model owing to the appearance of information systems and networks in the innovation cycle all processes accelerated, the effectiveness of interaction between participants of innovative creation and implementation, strategic connections of innovators with suppliers, partners, and consumers increased.</p> <p>The importance of information and data in the models of such type led to the appearance of the bigger quantity of IT-solutions, which facilitate the storage and exchange of information.</p>
<p>VI generation of models - «Knowledge management models» (author's name) (mid of 1990-s – presently)</p>	<p>Implicit, concealed knowledge.</p> <p>Strategic training.</p>	<p>According to this model, more innovative enterprises are those ones, which are able to create and use effectively the available knowledge. The enterprises are distinguished by the knowledge they have and the way they are used.</p> <p>One of the ways of knowledge accumulation is training. So, at the end of 1990-s the interest to a quick training as to main source of competitive advantage began to increase. The quicker the enterprise is able to study, the bigger its innovation potential is, the quicker it is able to respond on market changes.</p>

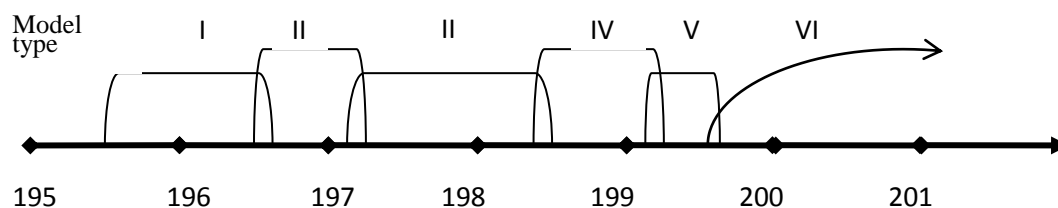


Fig 1. The common periodicity of innovation process models (according to R. Rothwell).

3. Cumulative and complementary effects in controlling system.

The proper analysis of the models and logics of their development allows seeing the important characteristics of their changes, which explain the effectiveness of the model change process. At transition from one model to another, not the change of previous one takes place, but its addition to new possibilities. The new model is established not “instead of”, but “together with” the previous one. In that transition to the next stage of transformation happens when the previous model finally established itself in the management systems. In this the cumulative character of the change process of innovation process model is expressed. However, together with it, the other effect exists. Because of appearance and implementation of the new model, the possibilities of previous models are implemented much completer. The new model isn't simply adds and expands the functions of innovation management owing to usage of the new factor, but at the same time is the certain mechanism of possibility development of all previous models for improvement of innovation processes. The new model not only bears the new ideas and approaches, but the creation of the new mechanisms for more effective usage of factors of already implemented models. Such an effect, of the new model on the operating mechanism of the previous one in its essence creates the certain complementary effect (complementarity – lat. «complementum» - «addition»).

In the modern science, the term “complementarity” is applied sufficiently wide. Primarily the term was used in natural-scientific disciplines (in mathematics – “complementary angles”, in physics – “complementary spectrum colour”, in biochemistry – “complementarity of macromolecules” etc.). Later its usage was met in humanitarian and social-economic sciences.

In the economic science, the term “complementarity” was first used by K. Menger (Austrian school of economy) [10]. In his fundamental work “The bases for political economy” Menger divides the economic goods for orders and substantiate the principle of

complementarity (augmentability) of the productive goods, and indirect satisfaction of humans demands provides the disposal of first order good, while the goods of higher order serve as the means of production for lower order goods. Thus, for example, for production of bread (first order well), it is necessary to have second (third...) order well.

Wieser in “The Theory of Public Economy” developed these ideas. “The production means are complementary and no one of them – neither capital, nor land and labour creates profit, being let on its own <...>. In order to run production in a regular way, the producer must be able in each separate case to make opinion about in what extent each of the numbers of interrelated production means take part in profit creation, he must be able to define, what part of the whole product is bound to the corresponding production devices” [11]. In innovation management, the complementarity is displayed in interaction of innovation processes, which take place in the internal and external environment of the company. For example, the fiber-optic cable, developed by Nippon Sheet Glass Company in 70-s years, did not owned mechanical solidity and had a low quality of a signal that was transmitted on big distances. However, the Sumitomo Electric Industries Company developed the technology of imposition of covering material that strengthened the cable. Then Sumitomo Electric Industries and Nippon Telephone and Telegraph companies, having conducted the joint researches, solved the problem of signal loss owing to usage of bigger length of signal wave in the cable [12]. In this case, the complementarity displayed itself owing to the interaction of company's internal subdivisions and external institutes, i.e. the highest effect was achieved owing to the increasing number of interactions with each further innovation process model.

Thus, complementary effect, which is undoubtedly present at change of innovation process models, allows looking on the process of evolution under another angle (Fig. 2). At that this effect can be differently displayed in dependence on the historical peculiarities of economy development in that or other country and in dependence on the branch specificity, within which the innovation processes are analyzed.

The conducted analysis of the innovation process model in the theory and practice of management proves actuality and necessity of introduction of this term. Presently semantically close definitions are used as “integral”, “synergetic”, “system” effects of innovations, not reflecting the specificity of implementation of innovation models. The appearance of integral effect is frequently connected with the economic effectiveness of innovations [13].

The display of synergetic effect is connected with mutual intensification separate innovations (however, not models of innovation process!). Owing to synergetic effect, the innovation interactions, for example, inside cluster or business-incubator explain the cumulative growth of economical well-being of these associations [14], [15]. The system effect is connected with interaction of different factors on the process of

innovation implementation, and their potential effect on the environment [16], [17]. Thus, the display of complementary effect in enclosure to innovation process management was studied a little and requires additional specifications.

According to the logics of innovation process model evolution and on the basis of hypothesis about cumulative and complementary effects of innovation models, it is possible to suppose that at the transition from one model to another innovative supply chain activity of Russian business must grow up. This can evidence that the experience of realization of the previous innovation process models was taken over successfully, i.e. the system of accounting, planning, control, and analysis of qualitative and attributive information about an innovative supply chain activity that was spoken above.

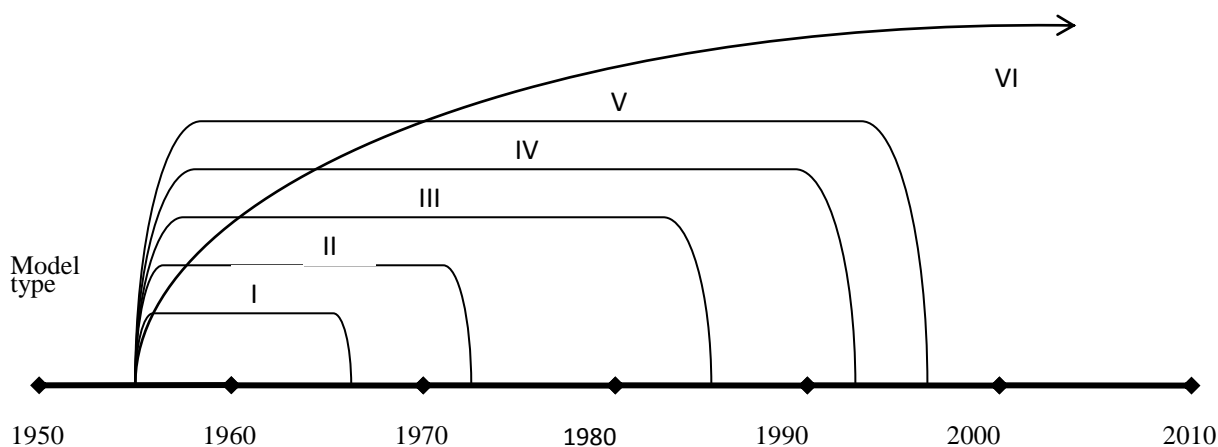


Fig 2. The principal scheme of implementation of complementary effect of innovation process models

Thus, according to the degree of displaying of the complementary and cumulative effect of innovation models, we can judge about success, building

4. Analysis of the innovation process' models of mining and metallurgical complex in Russia

In the frameworks of study, conducted by the authors, the change of innovation process models in the domestic mining and metal sector industry (hereinafter referred to MMSI) was detected, and the extent at which cumulative and complementary effect took place in the course of the model change, and correspondingly effectiveness of innovative supply chain activity controlling.

Generally, the change of innovation development priorities of a metallurgic complex of Russia took place

effectiveness of innovative supply chain activity controlling on the enterprise.

in the following way: from growth of metal production (up to mid of 70-s years) to the provision of economic metal usage in the country (up to the end of 80-s years), then to establish as a basic priority of economic indicators of production functioning (in 90-s years) and, finally, to energy saving (the beginning of 2000-s years). As it is seen, the dynamics of changes in mining and metal sector industry already did not correspond to the general tempos of innovation process model renovations. Undoubtedly, it could not help but effecting on the character of the changes. The dynamics of innovation process models in MMSI are represented in Fig. 3.

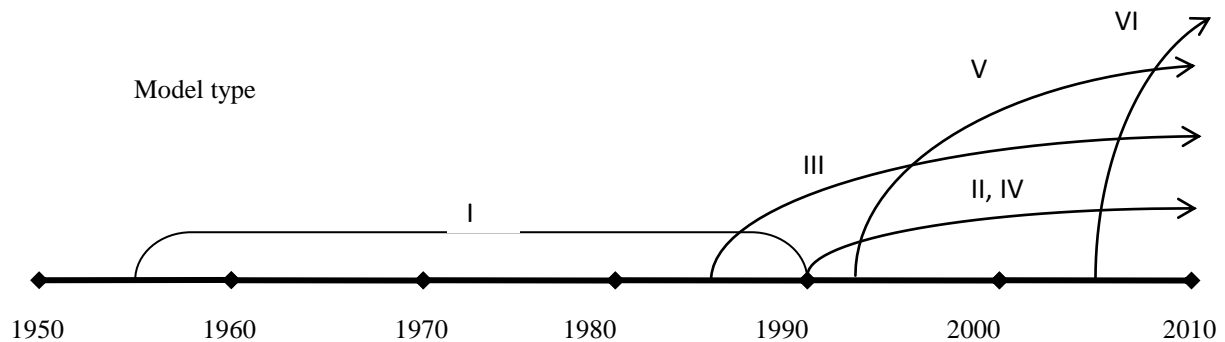


Fig 3. Evolution of innovation process model in MMSI (autom.).

Presently the results and shortages of innovation process development in the domestic MMSI can be characterized in the following way (Table 2).

Table 2. Result estimation of implementation of innovation process models on MMSI enterprise

Innovation process model	Result evaluation of model implementation	
	Cumulative effect	Complementary effect
1	2	3
I generation «Stimulated by technologies» Mid of 1950-s – the end of 1980-s.	The developed R&D system according to priority directions of development.	The developed system of branch institutes.
II generation «Pulled by demands» 1990 – presently	Almost complete break with the R-effect system in the soviet period. R&D works on the basis of old technologies in accordance with customers' demands become the sources of innovations.	The ability of metallurgic industrial complexes enough quickly adapt to the changeable demand factors develops.
III generation «Interactive models» Mid of 1980-s – presently	The active search of internal research for improvement becomes the source of innovations that in its turn requires interaction between subdivision of mining and metal sector industry enterprises.	It is displayed in formation of system approach at the development of technical projects. It was displayed in two moments: key direction of the majority of technical projects was economic consumption of resources that gave possibility to form the research funds for further production development; In the development of projects it was necessary to calculate their consequences, beginning from the ore production. For this purpose, it is necessary to support close connection with all productions and structures in the frameworks, for example, one production chain.
IV generation «Integrated models» Beginning of 1990-s – presently	The appearance of holdings and metallurgic alliances. The active integrated processes took place both in the external and internal environment. Aspiration to standardization of business-processes.	The possibility of innovation development began to depend on the ability of industrial complexes to integrate with the necessary market contracting party (mining and processing combine complexes, owners of financial capitals, supervisory bodies etc.). It was easier for large holdings to do it owing to the production scales, significance of brand and financial possibilities.
V generation «Innovation networks»	The active creation of single information space for branch	ASC (automated systems of control) were created for the provision of uninterrupted monitoring of information about

<p>Beginning of 1990-s – presently</p>	<p>enterprises. The model did not bear the independent character, but only “accompanied” the model of IV generation.</p>	<p>last technical and technological innovations on the metallurgical market, dynamics of demand factors, quality of internal and external interaction etc. However, the created information systems in great extent provide interaction inside holdings, and in lesser extent were targeted for the help in the study of demand and scientific developments.</p>
<p>VI generation «Knowledge management models» Mid of 2000-s – presently</p>	<p>The special subdivisions and employees, which activity was connected with knowledge processing, are separated on the single branch enterprises.</p>	<p>The understanding comes that the knowledge control system can become the same source of innovation ideas, similar as R&D and consumers. However, the first attempts led to the creation of separate elements, but not the system. In great extent, they provide access to the old knowledge, already available at disposal of enterprise workers. The aim of new knowledge creation is not put now in such systems.</p>

Thus, in the domestic MMSI the character of model change is considerably distinguished from the west one. It became not cumulated, by combined more probably. It means that at the transition from one model to the other, no accumulation of elements of the previous models and formation of own innovation model architecture, typical only for MMSI, took place. It is connected with the fact that simultaneously several innovation process models co-existed (see fig. 3). Especially “rich” period in the history of domestic metallurgy was time since the beginning of 1990-s to the mid of 2000-s – the sings of II, III, IV and V models are separated. This led to necessity of parallel

5. Indicator system displays cumulative and complementary effects

It is offered to evaluate the degree of display of the cumulative and complementary effect for MMSI enterprises with the help of indicator system, calculation procedure and meanings, which were stated in Table 3.

management of several competitive factors simultaneously. At that the models were implemented not in its full potential, but only in the part that allows “docking” with parallel implemented models. This made to look for possible combinations that allow passing the trajectory of innovation process development closely similar to the western one.

It is connected with the fact that simultaneously several innovation process models co-existed (see fig. 4). This led to the necessity of parallel management of several competitive factors simultaneously, that considerably complicates requirements to the organization of managerial accounting of IA.

The graphics on the Figure 4 visibly demonstrate the level of display of innovation process models on two enterprises of MMSI: PJSC “NTMK” and PJSC “VGOK”.

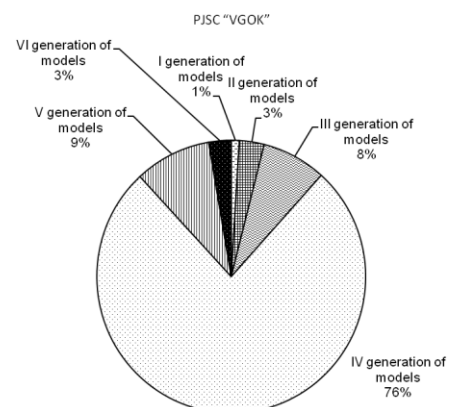
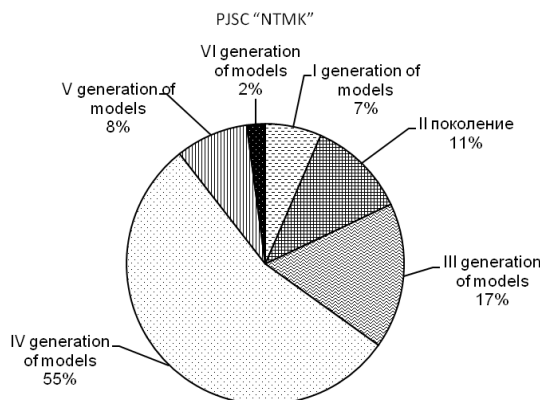


Fig 4. The structure of integrated indicator of cumulative effect of managerial accounting of MMSI enterprise innovative supply chain activity

The determination of group indicators of cumulative and complementary effect is determined by means of function calculation of φ_i , specifying the level of managerial accounting development in the direction that corresponds to the block considered:

$$\varphi_i = \sum_{j=1}^m s_j I_{ij}; \sum_{j=1}^m s_j = 1, \quad (1)$$

where y_{ij} – i- indicator j- effect constituent (according to the innovation process model); s_j – rating – i- indicator; m – number of indicators in the content of this group (can vary in dependence on the branch).

Calculation of the integral indicator of managerial accounting IA development as the amount of its group indicators:

$$\varphi = \sum_{i=1}^2 r_i \varphi_i; \sum_{i=1}^2 r_i = 1, \quad (2)$$

Where r_i – rating i- group (cumulative or complementary effects), 2 – the number of total indicators of managerial accounting IA development level.

6. Diagnostic results of controlling innovation.

The general integral indicator of innovative supply chain activity controlling the effectiveness of PJSC “NTMK” made 0.1192 according to the data of the calculations, PJSC “VGOK” – 0.1155. According to the results of innovative supply chain activity, controlling diagnostics the conclusions were made:

The only IV model was implemented in a significant extent. It means that MMSI until now is enough successfully adapted to the changed of customers' demands. The stage of active integration of subdivisions was passed both inside and between metallurgic companies. The implementation of this model tells about some insularity and restriction of directions of innovative supply chain activity controlling development in the domestic MMSI. In the development of innovations, the customers' requirements, and those possibilities, which integration of subdivisions gives, were taken into account. At that the competitors' behavior and many other factors are not taken into account.

I, II, III, V and VI model have not been implemented completely until now. This means that the effective controlling systems of key factors of the listed models are absent in the branch. These tasks should be solved in a rapid way.

Table 3. Indicators of effectiveness of managerial accounting of mining and metal sector complex enterprises

Innovation process method	Indicator		Indicators of PJSC «NTMK» (2012)		Indicators of PJSC «VGOK» (2012)	
	Cumulative effect, un.	complementary effect, %	cum. eff., un.	complem . eff., %	cum. eff., un	complem . eff., %
I generation of models «Stimulated by technologies»	I (cum)I Share of expenditure on R&D in the enterprise earnings	I (com)I Percent of expenditure share change on R&D in the enterprise earnings for the last three years	0.0401	+2.49	0.0037	-1.23
II generation of models «Pulled by the demand»	I (cum)II Share of internal market in the enterprise earning structure	I (com)II Percent of change of internal market share in the enterprise earning structure for the last three years	0.0706	-1.52	0.0115	-2.36
III generation of models «Interactive models»	I (cum)III Share of own investment expenditures in the enterprise earnings	I (com)III Percent of changes of own investment expenditure share in the enterprise earnings for the last three years	0.1038	+0.16	0.0298	-5.31
IV generation of models «Integrated models»	I (cum)IV Share of the amount of received annual effect from the implemented projects in the enterprise earnings	I (com)IV Percent of share amount change of the received annual effect from the implemented projects in the earnings of enterprise for the last three years	0.3357	-10.15	0.2951	+8.23
V generation of models «Innovation networks»	I (cum)V Share of expenditures on IT-technologies in the enterprise earnings	I (com)V Percent of share change on IT-technology in the enterprise earnings for the last three years	0.0519	+19.64	0.0354	+0.26
VI generation of models «Knowledge management models»	I (cum)VI Share of expenditures on the training of staff in the enterprise earnings	I (com)VI Percent of expenditure share changes on training of the staff for the last three years	0.0132	+2.39	0.0104	+1.18
Integrated indicators of effectiveness of managerial effect			0,1192	+0,3068	0.1155	+0.2805

7. Conclusion

The conducted analysis allowed to make the following conclusions in relation to controlling the development of IA in MMSI:

1. The absence of sequence in the innovation process model development on MMSI enterprises can evidence that innovative supply chain activity controlling was not considered as the competitive factor in the branch. The approach to information provision organization for acceptance of managerial decisions remained purely formal and bore a spontaneous character. Therefore, in the near time it was necessary to form an active system of controlling both on MMSI level overall, and on the level of separate enterprises.

2. More full realization of models of higher-level organization (IV and partly V model) allowed the creation of visibility of the accelerated domestic MMSI development (totally 15 years (!) instead of 50 years according to western sample), and accordingly visibility of regulated innovative supply chain activity controlling. However, taking into account the absence of the prepared base in the form of processed methods of managerial accounting, which were used at the time of the first three models of innovation processes, presently there is a big gap in the demands and possibilities of managerial IA accounting on MMSI enterprises.

3. The reason of the high level of development of innovative supply chain activity controlling of the enterprise on the west is complementarity as the key principle of model development. In the Russian conditions the research of development lies in the cumulative effect usage of the applied models. All the listed evidences that implementation of innovative supply chain activity controlling on MMSI enterprises can be called successful. The stable growth was marked according to the single indicators. In the basic aggregate they have a high degree of variability or tendency to reduction. The enterprise innovative supply chain activity remains low now. It means that the existing level of controlling development does not integrate the quantity and quality of information about innovative supply chain activity for acceptance of successful solutions. In connection to this, it is necessary to develop the model of innovative supply chain activity controlling that eliminates the detected shortages [18].

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