

SYNERGY FORMATION MANAGEMENT FOR INNOVATIONS AT AN ENTERPRISE

GALKINA N. V.¹

¹ Research Institute of Mining Industry Efficiency and Safety
(30, Entuziastov Str., Chelyabinsk, Russia)

Research relevance is conditioned on the need to improve the efficiency of personnel interaction within innovations aimed at competitive growth of an enterprise.

Research aims to substantiate the need to use the synergetic approach in order to improve the efficiency of personnel interaction within innovations.

Research methodology. Synergetic approach has been used, where the expected synergetic effect from the interaction of enterprise subjects within innovations is reached through their capability of self-organization.

Results. It has been stated, that the efficiency of synergy formation management for innovations at an enterprise can be reached through self-organization of enterprise subjects in workflow and innovative processes. In order to reduce the risk of negative synergetic effect, the elements of synergy formation management for innovations with regard to a mining enterprise have been distinguished, including the subjects capability of self-organization being an advantage allowing to achieve synergetic effects in all types of activities. Dependence between the subjects capability of self-organization and their innovative abilities and opportunities has been shown. A model of synergy formation management for innovations at an enterprise has been developed.

Results application. An example of synergy formation management for technological innovation at a drilling site of a mining enterprise has been given.

Key words: enterprise; enterprise subjects; innovation; interaction; synergy; synergetic effect; self-organization; capability of self-organization; resources; innovative abilities; management model.

Research relevance is conditioned on the fact, that one of the conditions of an enterprise's survival in the external environment is its competitiveness; it is achieved by innovations ensured by the corresponding synergy.

Innovations. Innovation at an enterprise is a special purposeful change in the spheres of technology, production, organization of manufacture and labour, control over the relations and connections of enterprise subjects (ES), which contributes to the development, growth, and efficiency improvement of the manufacture and occupational safety; it is characterized by the growth of knowledge, possesses the features of novelty, and manifests itself in significant positive social-economic effects.

Innovation is a means of moving to a brand new level, new condition.

Classification of innovations [1, 2]:

- according to the sphere of application at an enterprise the innovations are subdivided into technical, technological, social, and institutional;
- according to the range of changes – integrated and local;
- according to the coverage of manufacture – fulfilled at all the stages of manufacture, at particular production sites, in unit operations.

The implementation of the innovation is connected to the formation of social-economic systems consisting of a wide range of elements which interact in a complicated

way to achieve the goal of the innovation. The coordination between the elements of the system is reflected in the behavior of the system as a whole. Therefore, the appearance of a synergetic effect is possible as an excess of components collective interaction results over the amount of their individual actions [3].

Synergy. The word synergy (from the Greek word *sinergeia*) denotes collaboration, interaction, participation, and mutual action [4]. Synergy in economics means performance enhancement as a result of combination, connection, integration, and fusion of separate parts into a single system by means of so-called emergence and new properties that the acquired system gets [5, 6].

Synergism (synergy) is a strategic advantage of an enterprise as a social-economic system, which occurs in case all the enterprise subjects are capable of self-organization. Self-organization is a process of elements ordering by means of some internal factors, without any external impact [6, 7].

It is the most general definition of the notion of *self-organization* which can be applied to synergy formation management for innovations at an enterprise. In management, self-organization is considered as a method of coordinated vision of the components of managerial decisions-making (MD) process providing particular order within structural (decision tree) and functional (management functions and manufacturing functions) self-organization [7, 8].

Table 1. The elements of synergy formation management for innovations at a mining enterprise

Таблица 1. Элементы управления формированием синергии для инноваций на горнодобывающем предприятии

Field	Enterprise subjects (ES)	The object of interaction	The subject of interaction	Synergy criteria	Synergetic effect
manufacturing	Workshop supervisors, production floor supervisors, technicians, foremen, workers	Local innovations	Development and realization of resources provision plans for local innovations	ES capability of self-organization to realize local innovations	The efficiency growth of equipment utilization, production, revenue and profit
Innovative	State, proprietors, management, workshop supervisors, production floor supervisors, technicians, foremen, workers	Integrated Innovations	Development and realization of resources provision plans for integrated innovations	ES capability of self-organization to realize integrated innovations	The efficiency growth of an investment project, revenue and profit, business value

Synergy in management is to yield some competitive advantages by means of self-organization of two or more ES making MD. At that, synergetic effect obtained from their interaction can be either positive or negative. Synergism strategy in management provides for efficiency enhancement of various fields by means of mutual use of the resources [8–10].

The significance of synergy in innovation management consists in the fact, that it allows an enterprise to achieve competitiveness by means of implementing both local and integrated innovations; increase production capacities and profitability. Local innovations are directed at the fullest use of manufacturing capacities and expenses reduction; integrated innovations are aimed at workflow rearrangement, structural transformation, as well as the modification of manufacturing functions and relations [11].

It is clear, that ES capability of self-organization reduces the risks of a negative synergetic effect in economy. This competitive advantage appears in case every manager of every hierarchical level possesses innovative potential and innovative capacities, which allow them to cooperate within tough requirements to the quality of MD connected to the development and implementation of local and integrated innovations resources provision plans.

The elements of synergy formation management for innovations at an enterprise are developed with regard to a mining enterprise (table 1).

Innovative abilities and innovative opportunities of ES determine the subjects capability to self-organization to fulfill both local and integrated innovations. Innovative abilities are viewed as knowledge and skills allowing the subjects to efficiently develop and realize the plans of innovations resources provision. Innovative opportunities are viewed as the conditions for personnel innovative abilities realization, created through corresponding management resources [11, 12].

The following can be referred to management resources [13, 14]:

- behavioral strategy of the owners directed at the improvement of labour conditions of workers and management;
- the system of education and advanced training aimed at new knowledge, experience, and skills;
- corporate culture based on the coordinated values of ES, formal and informal standards and rules of conduct;
- information system providing ES with full and reliable information;
- systems of incentives and control directed at the growth of interaction efficiency between ES;
- financial system supplying the enterprise with funds to realize the investment program;
- innovative environment creating conditions for professional growth and ES promotion;
- social-domestic infrastructure providing ES with comfort conditions of work and housing.

ES ability for self-organization in order to implement local and integrated innovations should be assessed with the indicators reflecting the concordance of viewpoints of the subjects W and the efficiency of resources utilization.

The indicators of ES ability for self-organization to implement innovations are the coefficient of ES viewpoints concordance and the coefficient of industrial resources utilization efficiency.

The coefficient of ES viewpoints concordance [15]:

$$W = \frac{S_{12}}{\max(S_1, S_2)} \left(1 - \frac{\sum_{i=1}^n |x_i - y_i|}{n(k - m)} \right),$$

where S_{12} – the amount of concurrent factors of efficiency and safety chosen by the 1st and 2nd subject; S_1, S_2 – the amount of factors chosen by the 1st and 2nd subject; x_i, y_i – the amount of grades reflecting the importance of the i -factor as estimated by the 1st and 2nd subject; n – the total amount of factors chosen by both subjects; k – maximum assigned value of grades; m – minimum assigned value of grades.

Depending on the value of the concordance coefficient which varies from 0 to 1, the following levels of viewpoints concordance are distinguished: high – $W \geq 0.7$; normal – $W \in [0.5; 0.7]$; low – $W \in [0.2; 0.5]$; very low – $W < 0.2$.

Table 2. Synergy formation management for technological innovation at a drilling site of a mining enterprise
Таблица 2. Управление формированием синергии для технологической инновации на буровом участке горнодобывающего предприятия

Synergy planning	Synergy organization	motivating the personnel	Synergy control
<ol style="list-style-type: none"> The analysis of the previous performance indicators of a drilling rig Goal setting by the management of an enterprise – to achieve labour productivity exceeding 1000 m per shift* The development of drilling technology to achieve the required parameters of a block being drilled Technology negotiation with the managers of the enterprise and the site Introducing the drilling technology to the personnel of the drilling site Planning the realization of a drilling technology: <ul style="list-style-type: none"> – determining the parameters of a drilling area; – determining the technological characteristics of a drilling rig and drilling bits, and the number of spare parts Planning the schedule of a working shift/shift changeover 	<ol style="list-style-type: none"> Forming the composition of a drilling rig crew Accepting the new rules of the crew interaction Forming the composition of a repair crew for immediate repairs Accepting the new rules of shift changeover between different crews Accepting the new rules of the drilling rig accelerated refueling by a refueling tanker with a higher capacity The coordination of the drilling rig refueling with a dispatcher Setting the new rules of oil refueling with the help of a new discharge system PRELUBE 	<ol style="list-style-type: none"> Forming a friendly attitude and mutual support Holding trainings increasing the concordance of the crew interaction Naming the prestige value and the recognition of previous performance indicators mutual search for the possibilities to achieve the goal Sizing the reward for the results achieved The reward guarantee at the management level of the enterprise and company 	<ol style="list-style-type: none"> Appointing people responsible for the control function Control over the state of a block for drilling according to the schedule Control over the number of the drilled meters according to the schedule Control over the technical state of equipment according to the schedule monitoring the critical level of fuel in a tank, informing the dispatcher monthly control and results analysis Informing the management of the enterprise on the pace of achieving the goal

The coefficient of industrial resources utilization efficiency [16]:

$$K_{и.р} = \frac{Y_{p.ф}}{Y_{p.э}}$$

where $Y_{p.ф}$ – the actual level of resources utilization; $Y_{p.э}$ – the reference level of resources utilization, in the capacity of which the world’s (branch’s or enterprise’s) best level or the theoretically possible one is accepted.

The results estimation of synergy formation management for innovations at an enterprise includes the total of methods and procedures allowing to determine the value of synergetic effects (SE) in manufacturing and innovative activity. It is known, that the value of SE in the manufacturing activity is limited by the production capacity of an item of equipment or a workshop; in the innovative activity – by the planned efficiency of investment projects.

Fig. 1 presents the model of synergy formation management for innovations at an enterprise [17–21].

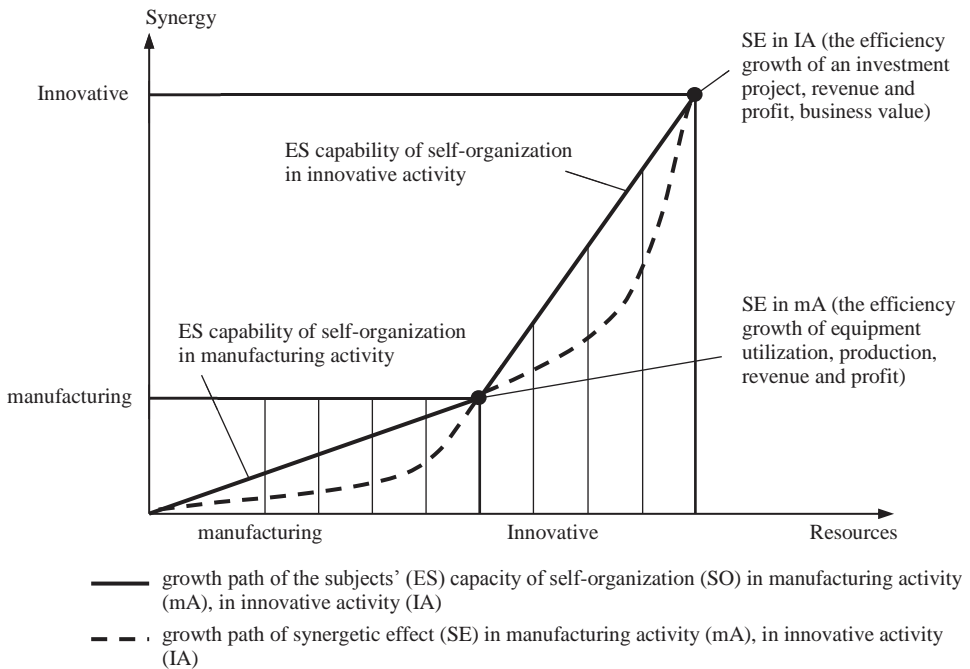


Fig. 1. The model of synergy formation management for innovations at an enterprise
 Рис. 1. Модель управления формированием синергии для инноваций на предприятии

Results application. By way of example of applying separate methodological theses, work practice presents an experience of synergy formation management for technological innovation at a drilling site of a mining enterprise. Management purpose is the formation of a synergetic effect measured with the drilling rig capacity index (table 2, data specified with * have been obtained by A. S. Dovzhenok and A. G. Zhilkin (*Investigation report for 2017. Scientific and methodological maintenance of work space and dangerous workplace situations dynamics and condition monitoring system development in AO Razrez Tugnuisky. Chelyabinsk, 2017. 46 p.*)).

It can be seen from the table 2 that synergy formation management for technological innovation is carried out with the help of universal management functions: goal setting, planning the stages of development and technological innovation realization; organizing

the complex of special activities creating the conditions for technological innovation realization; motivating the personnel for conscious and voluntary participation in innovation; control over the efficiency of synergy formation management based on the analysis of the economic effect obtained.

Conclusions. For an enterprise, innovation is a means of moving to a brand new level, new condition. Innovation efficiency is ensured by coordinated interaction between ES – synergy being a strategic advantage of an enterprise as a social-economic system. The coordinated interaction between ES occurs in case ES are capable of self-organization. ES capability of self-organization is a criterion of synergy, the value of which depends on the innovative potential of the subjects and their innovative opportunities, which are formed at an enterprise with the help of the corresponding management resources. Thus, the essence of synergy formation management for innovations at an enterprise consists in the formation management of ES capability of self-organization to implement innovations directed at the acquirement of the economic effect at the enterprise.

REFERENCES

1. Galkina N. V. [A coal producer's social-economic adaptation to the innovative model of technological development]. Moscow, Ekonomika Publ., 2007, pp. 15–34.
2. Gamidov G. S., Tepsaev A. N., Gadzhimuradova D. Z. [Innovations and competitiveness are the main factors of industrial enterprises sustainable development]. *Innovatsii – Innovations*, 2009, no. 1, pp. 85–89. (In Russ.)
3. Bulgakova I. N., Salikov Iu. A. [Improving the model of social-economic systems development]. *Sovremennaya ekonomika: problemy i resheniia – Modern Economics: Problems and Solutions*, 2010, no. 2(2), pp. 146–154. (In Russ.)
4. Ozhegov S. I. [Defining Dictionary of the Russian language]. Moscow, TEMP Publ., 2008. 736 p.
5. Raizberg B. A., Lozovskii L. Sh., Starodubtseva E. B. [Modern dictionary of economics]. Moscow, INFRA-M Publ., 2006. 495 p. (In Russ.)
6. Skiba A. N. [Resonance effects in economy: forming of system-synergetic approach]. *Trudy Instituta sistemnogo analiza rossiyskoy akademii nauk – Proceeding of the Institute for Systems Analysis of the Russian Academy of Science*, 2011, vol. 61, no. 3, pp. 65–75. (In Russ.)
7. Boldoev O. N. [Innovative dynamics and financial markets in the developed countries from the position of self-organization]. *Problemy prognozirovaniia – Studies on Russian economic Development*, 2008, no. 5. 21 p. (In Russ.)
8. Kniazeva E. N., Kurdiymov S. P. [Fundamentals of synergy. Modes with escalation, self-organization, and tempo worlds]. Moscow, Alleteya Publ., 2002. 218 p.
9. Zhemchuzhnikov S. I. [Directions of improving interaction between the enterprises based on the integration of economic processes]. *Innovatsionnyi vestnik region – Innovative Bulletin Region*, 2011, no. 1, pp. 20–26. (In Russ.)
10. Iakutin Iu. V. [Models of corporate integration: design, development, and efficiency]. Moscow, Ekonomicheskaya gazeta Publ., 2006. 7 p.
11. Gorshenin V. P., Lega K. A. [The influence of the innovative potential of the personnel on the performance of innovative transformations. Proc. Internat. Sci.-to-Pract. Conf. "Strategic Control over the Resource at the Enterprise"]. Chelyabinsk, 2005, pp. 34–40. (In Russ.)
12. Alekseev A. P. [The use of R. Stone's model to assess the synergetic effect on the process of enterprise integration]. *Nauka i obrazovanie v zhizni sovremennogo obshchestva – Science and Education in the Life of a Modern Society*, 2014, no. 11, pp. 10–11. (In Russ.)
13. Senge P. [The fifth discipline: the art and practice of learning organization. Translation from English]. Moscow, Olimp-Biznes Publ., 2003. 408 p.
14. Ivantss A. I. [Da Vinci code in business, or well-balanced management according to Fibonacci]. Moscow, KomKniga Publ., 2005. 104 p.
15. Poleshchuk M. N. [On the calculation of the concordance coefficient. Proc. Sci.-to-Pract. Conf. "The Management Problems of Regional and Municipal Development" (Chelyabinsk, 8th December, 2006)]. Chelyabinsk, Entsiklopediia Publ., 2007, pp. 142–145. (In Russ.)
16. Prakhlad K. K., Krishnan M. S. [The space of business innovation: creating the value together with the consumer. Translation from English]. Moscow, Al'pina Publisherz: Iurait, 2011. 258 p.
17. Rangus K., Slavec A. The interplay of decentralization, employee involvement and absorptive capacity on firms' innovation and business performance. *Technological Forecasting and Social Change*, 2017, vol. 120, pp. 195–203.
18. Dawit K. Mekonnen, Jeffrey H. Dorfman. Synergy and learning effects of informal labor-sharing arrangements. *World Development*, 2017, vol. 99, pp. 1–14.
19. Chen H., Qi H., Feng Q. Characteristics of direct causes and human factors in major gas explosion accidents in Chinese coal mines: case study spanning the years 1980–2010. *J. Loss Prev. Process. Ind.*, 2013, no. 26, pp. 38–44.

20. Christiane Prange, José Carlos Pinho. How personal and organizational drivers impact on SME international performance: the mediating role of organizational innovation. *International Business Review*, 2017, vol. 26, issue 6, pp. 1114–1123.

21. Markko Hamalainen, Babak Mohajeri, Timo Nyberg. Removing barriers to sustainability research on personal fabrication and social manufacturing. *Journal of Cleaner Production*, 2018, vol. 180, pp. 666–681.

Received 2nd July, 2018

For citation: Galkina N. V. Synergy formation management for innovations at an enterprise. *Izvestiya vysshikh uchebnykh zavedenii. Gornyi zhurnal*. 2018. No. 8. Pp. 83–90.

Information about authors:

Galkina Natal'ia Vladimirovna – Doctor of Economic Science, leading researcher, Research Institute of Mining Industry Efficiency and Safety. E-mail: galkinanv2012@mail.ru

УПРАВЛЕНИЕ ФОРМИРОВАНИЕМ СИНЕРГИИ ДЛЯ ИННОВАЦИЙ НА ПРЕДПРИЯТИИ

Галкина Н. В.¹

¹ ООО «Научно-исследовательский институт эффективности и безопасности горного производства», Челябинск, Россия.

Актуальность работы обусловлена необходимостью повышения эффективности взаимодействия персонала в инновациях, направленных на повышение конкурентоспособности предприятия.

Цель работы. Обоснование необходимости применения синергетического подхода для повышения эффективности взаимодействия персонала в инновациях.

Методология исследования. Использован синергетический подход, в котором ожидаемый синергетический эффект от взаимодействия субъектов предприятия в инновациях достигается за счет их способности к самоорганизации.

Результаты. Установлено, что эффективность управления формированием синергии для инноваций на предприятии может быть достигнута за счет самоорганизации субъектов предприятия в производственных и инновационных процессах. Для снижения риска возникновения отрицательного синергетического эффекта выделены элементы управления формированием синергии для инноваций применительно к горнодобывающему предприятию, в числе которых способность субъектов к самоорганизации – преимущество, позволяющее достигать синергетических эффектов во всех видах деятельности. Показана зависимость способности субъектов к самоорганизации от их инновационных способностей и возможностей. Разработана модель управления формированием синергии для инноваций на предприятии.

Применение результатов. Показан пример управления формированием синергии для технологической инновации на буровом участке горнодобывающего предприятия.

Ключевые слова: предприятие; субъекты предприятия; инновация; взаимодействие; синергия; синергетический эффект; самоорганизация; способность к самоорганизации; ресурсы; инновационные способности; инновационные возможности; модель управления.

DOI: 10.21440/0536-1028-2018-8-83-90

БИБЛИОГРАФИЧЕСКИЙ СПИСОК

1. Галкина Н. В. Социально-экономическая адаптация угледобывающего предприятия к инновационной модели технологического развития. М.: Экономика, 2007. С. 15–34.
2. Гамидов Г. С., Тепсаев А. Н., Гаджимурадова Д. З. Инновации и конкурентоспособность – главные факторы устойчивого развития промышленных предприятий // Инновации. 2009. № 1. С. 85–89.
3. Булгакова И. Н., Саликов Ю. А. Совершенствование модели развития социально-экономических систем // Современная экономика: проблемы и решения. 2010. № 2(2). С. 146–154.
4. Ожегов С. И. Толковый словарь русского языка. М.: ТЕМП, 2008. 736 с.
5. Райзберг Б. А., Лозовский Л. Ш., Стародубцева Е. Б. Современный экономический словарь. М.: ИНФРА-М, 2006. 495 с.
6. Скиба А. Н. Резонанс-эффекты в экономике: формирование системно-синергетического подхода // Труды ИСА РАН. 2011. Том 61. № 3. С. 65–75.
7. Болдоев О. Н. Инновационная динамика и финансовые рынки в развитых странах с позиции самоорганизации // Проблемы прогнозирования. 2008. № 5. 21 с.
8. Князева Е. Н., Курдюмов С. П. Основания синергетики. Режимы с обострением, самоорганизация, темпомеры. М.: Аллетта, 2002. 218 с.

9. Жемчужников С. И. Направления совершенствования взаимодействия предприятий на основе интеграции экономических процессов // *Инновационный вестник регион*. 2011. № 1. С. 20–26.
10. Якутин Ю. В. Модели корпоративной интеграции: проектирование, развитие, эффективность. М.: Экономическая газета, 2006. 7 с.
11. Горшенин В. П., Лега К. А. Влияние инновационного потенциала персонала на результативность инновационных преобразований // *Стратегическое управление ресурсами предприятия: сб. статей Междунар. науч.-практ. конф.* Челябинск, 2005. С. 34–40.
12. Алексеев А. П. Использование модели Р. Стоуна для оценки синергетического эффекта процесса интеграции предприятий // *Наука и образование в жизни современного общества*. 2014. № 11. С. 10–11.
13. Сенге П. Пятая дисциплина: искусство и практика самообучающейся организации / пер. с англ. М.: Олимп-Бизнес, 2003. 408 с.
14. Иванцс А. И. Код да Винчи в бизнесе, или гармоничный менеджмент по Фибоначчи. М.: Ком-Книга, 2005. 104 с.
15. Полещук М. Н. О расчете коэффициента конкордации // *Проблемы управления развитием регионов и муниципалитетов: матер. науч.-практ. конф.* (Челябинск, 8 дек. 2006 г.) Челябинск: Энциклопедия, 2007. С. 142–145.
16. Прахалад К. К., Кришнан М. С. Пространство бизнес-инноваций: создание ценности совместно с потребителем / пер. с англ. М.: Альпина Паблишерз; Юрайт, 2011. 258 с.
17. Rangus K., Slavec A. The interplay of decentralization, employee involvement and absorptive capacity on firms innovation and business performance // *Technological Forecasting and Social Change*. 2017. Vol. 120. P. 195–203.
18. Dawit K. Mekonnen, Jeffrey H. Dorfman. Synergy and learning effects of informal labor-sharing arrangements // *World Development*. 2017. Vol. 99. P. 1–14.
19. Chen H., Qi H., Feng Q. Characteristics of direct causes and human factors in major gas explosion accidents in Chinese coal mines: case study spanning the years 1980–2010 // *J. Loss Prev. Process. Ind.* 2013. No. 26. P. 38–44.
20. Christiane Prange, José Carlos Pinho. How personal and organizational drivers impact on SME international performance: the mediating role of organizational innovation // *International Business Review*. 2017. Vol. 26. Issue 6. P. 1114–1123.
21. Markko Hamalainen, Babak Mohajeri, Timo Nyberg. Removing barriers to sustainability research on personal fabrication and social manufacturing // *Journal of Cleaner Production*. 2018. Vol. 180. P. 666–681.

Сведения об авторах:

Галкина Наталья Владимировна – доктор экономических наук, ведущий научный сотрудник ООО «Научно-исследовательский институт эффективности и безопасности горного производства». E-mail: galkinanv2012@mail.ru
