Management of innovative growth and sustainable development of petrochemical enterprises in digitization

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Abstract. To improve efficiency of innovative processes management across petrochemical companies, it would be necessary to arrange for systematic and continuous analysis of innovative approaches implementation effectiveness. The proposed by the authors model of Integrated Innovation Sustainability Index calculation could be used for both assessment of the significance of a particular innovative solution or project, and assessment of innovative growth of a company as a whole. The innovative solution sustainability index is supposed to be calculated using the multidimensional average formula as an integrated index of a set of indicators, including generalizing indicator of economic sustainability, generalizing indicator of social sustainability, generalized indicator of environmental sustainability. Each generalizing indicator of innovative solution sustainability includes a number of particular indicators. It should be noted that the indicators above listed may vary depending on the nature of the industry, specific features of the enterprise, as well as market trends. Given that the model of calculation of the said Index takes into account not only economic effect indicators, but also the social and environmental spheres, the approach would be conducive to broader understanding of how effective, useful, successful and environmentally safe are the innovative approaches or innovative activities carried out by a petrochemical business.

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1 Introduction

In the context of modern economy digitalization, an increasingly significant role is given to the innovative growth of petrochemical businesses, as well as the issues related to innovation process effective organization and management. This is due to the fact that enterprises are faced with certain challenges when it comes to implementation of upgrading projects and innovative development programs necessitated by obsolescence of products and production technologies, and other process related areas, as well as changes in the market conditions, and the competition becoming tougher.

A ready-for-sale product can only be considered competitive if and when it best meets the technical and economic requirements of the end user. Consequently, there is a question of development and application of any additional special measures for the enterprise to improve

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its innovative growth status. The market today calls for continuously improving quality of products, which means that R&D, organization of production flow, and management of these areas of activity becomes far more complicated.

The concept development, design and manufacturing of a breakthrough innovative product is a complex process calling for day-to-day efforts involving continuous research, active and effective participation of design, engineering and technological departments, in line with continuous upgrading of the knowledge and skills of the personnel.

For now, the overriding priority in terms of innovative economy development would be to ensure improvement of competitive strength and efficiency of the production sector, due to which the conventional sources and economic growth drivers become required to be actuated along with looking for new ones. The global economic science is currently giving a particular significance to various aspects of industrial enterprises promotion, inclusive of creation of competitive advantages [1, 2, 3]; interaction between the enterprises, as well as cooperation [4, 5, 6]; methodology for petrochemical companies performance assessment [7, 8]; mechanisms and tools applicable to stimulate innovative growth [9, 10, 11, 12] etc.

To make it possible for a petrochemical enterprise to bid for steady innovative growth on the back of economy digitalization, there is a serious need for working out integrated approaches to organizing and managing innovative processes, as well as assessing their effectiveness, which is what determines the relevance of this study.

2 Materials and Methods

At the level of a petrochemical enterprise, the so-called corporate innovation system is formed in order to facilitate effective implementation of innovative solutions, and follow the effective innovative growth principles. Each enterprise on an independent basis sets up the elements of the system, as well as determines the feature set and participants of it. The said innovation system, which is considered to be a platform for the search, sorting out, development, and implementation of innovations, serves as a basis for the activities related to innovative processes organization and management in order to upgrade the innovative growth status of the petrochemical enterprise as a whole.

Innovative approach effectiveness assurance is the key to ensuring competitive strength of any company amid the rapidly changing market conditions of the modern economy. Continuous assessment of the corporate innovation system performance and achieved innovative development level is an indispensable element of the entire company management system. Therefore, it would be advisable for each enterprise to develop its own system for innovative solutions efficiency assessment based on relevant indicators, in order to paint the true picture while taking into account all the special features of a particular petrochemical enterprise.

Within the framework of the innovative solutions and projects efficiency assessment system, it is common that one considers key quantitative and qualitative indicators [7, 8], the main of which are profit and profitability.

After having investigated and analyzed various concepts for enterprise innovative growth assessment, we propose the following criterion that could be used to assess innovative solution efficiency – the Integrated Innovation Sustainability Index (*IISI*). The innovative solution sustainability index is supposed to be calculated using the multidimensional average formula as an integrated index of a set of particular indicators, in particular:

$$IISI = \frac{\sum_{i=1}^{n} \frac{S_i}{\overline{S_i}}}{n}, \quad (1)$$

where S_i – actual value of the particular indicator of the innovative solution sustainability;

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$\overline{S}_i$ *– normative value of the particular indicator of the innovative solution sustainability;*
n – number of generalizing indicators to assess the level of sustainability of an innovative solution.

The innovative solution sustainability index is supposed to be calculated on the basis of three generalizing indicators, namely:

– generalizing indicator of economic sustainability (S_1);
– generalizing indicator of social sustainability (S_2);
– generalized indicator of environmental sustainability (S_3).

A system of particular indicators (criteria) has been developed for each of the generalizing indicators (S_1, S_2, S_3).

The generalizing indicator of economic sustainability (S_1) reflects the degree of economic effect achieved as a result of specific innovative solution implementation [1, 5]. In our opinion, the economic efficiency can be characterized using the following criteria:

– proportion of innovative petrochemical products (works, services) in the total amount of sold products (works, services);
– profit growth rate due to sales of all or certain types of petrochemical products based on innovative solutions, inventions, and rationalization proposals;
– production growth rate due to increased output of all or certain types of petrochemical products based on innovative solutions, inventions, and rationalization proposals;
– profit growth rate due to implementation of the very results of innovation, inventive and rationalization activities (in the form of intangible assets).

It would be advisable to determine the specific weight of each criterion related to the generalizing indicators.

The generalizing indicator of social sustainability (S_2) characterizes the degree of specific innovative solution impact on the social sphere of the petrochemical enterprise [2, 11]. In our opinion, the social sustainability can be characterized using the following criteria:

– proportion of the staff involved in the innovative solutions R&D, creation of highly effective inventions, and development of rationalization proposals;
– proportion of the staff who study and improve their qualification under the specialized programs aimed at development and promotion of the innovation-related activities of petrochemical enterprises;
– proportion of new jobs created as a result of implementation of an innovative solution (solutions, projects).

Likewise the previous indicator, specific weight of each particular criterion is to be determined.

The generalizing indicator of environmental sustainability (S_3) reflects the innovative solution efficiency from the environmental protection point of view [3, 9]. The indicator relates to the innovative solutions which, if and when implemented, are supposed to significantly reduce a negative impact on the environment. As such, the indicator is characterized using the following criteria:

– rate of decrease in the quantity of production and consumption wastes;
– proportion of the operating expenses related to environmental protection in the total cost of a specific innovative solution;
– proportion of expenses related to implementation of energy- and resource-saving measures aimed at petrochemical products energy intensity reduction and use of secondary resources in the total cost of a specific innovative solution;
– rate of decrease in the volume of environmental protection related payments.

Here, specific weight of each particular criterion is also to be determined using the expert assessment method.

As such, the innovative solution sustainability index should be calculated based on

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obtained final values of all the three generalizing indicators.

3 Results

For practical evaluation, by way of experimental testing, of the developed methodological approach, an assessment of innovative solution implementation efficiency was carried out based on the case studies related to the business activities of the two largest petrochemical companies − Nizhnekamskneftekhim PJSC and Kazanorgsintez PJSC. The calculation results based on the three generalizing indicators, namely the economic, social and environmental sustainability indices (S_1, S_2, S_3) are shown in Tables 1 – 3 below.

Table 1. Calculation of the generalizing indicator of economic sustainability of petrochemical enterprises.

Indicators	Specific weight	Nizhnekamsk-neftekhim PJSC	Kazanorgsintez PJSC
Proportion of innovative petrochemical products in the total amount of sold products	0.4	19.47	15.58
Profit growth rate due to sales of petrochemical products based on innovative solutions, inventions, and rationalization proposals	0.2	74.08	65.43
Production growth rate due to increased output of petrochemical products based on innovative solutions, inventions, and rationalization proposals	0.2	84.95	86.68
Profit growth rate due to implementation of the very results of innovation, inventive and rationalization activities	0.2	0	0
Generalizing indicator of economic sustainability (S_1)	–	39.59	36.65

Source: compiled by the authors

Table 2. Calculation of the generalizing indicator of social sustainability of petrochemical enterprises.

Indicators	Specific weight	Nizhnekamsk-neftekhim PJSC	Kazanorgsintez PJSC
Proportion of the staff involved in the innovative solutions R&D, creation of highly effective inventions, and development of rationalization proposals	0.4	17.56	12.23
Proportion of the staff who study and improve their qualification under the specialized programs aimed at development and promotion of the innovation-related activities of petrochemical enterprises	0.3	6.84	3.97
Proportion of new jobs created as a result of implementation of an innovative solution (solutions, projects)	0.3	1.37	0.84
Generalizing indicator of social sustainability (S_2)	–	9.49	6.34

Source: compiled by the authors

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Table 3. Calculation of the generalizing indicator of environmental sustainability of petrochemical enterprises.

Indicators	Specific weight	Nizhnekamsk-neftekhim PJSC	Kazanorgsintez PJSC
Rate of decrease in the quantity of production and consumption wastes	0.25	20.98	14.17
Proportion of the operating expenses related to environmental protection	0.25	2.32	1.87
Proportion of expenses related to implementation of energy- and resource-saving measures aimed at petrochemical products energy intensity reduction and use of secondary resources	0.25	1.13	2.1
Rate of decrease in the volume of environmental protection related payments	0.25	4.27	3.74
Generalizing indicator of environmental sustainability (S_3)	–	7.18	5.47

Source: compiled by the authors

The results of the innovative solution sustainability index (*IISI*) calculations, in other words the innovative activity efficiency of Nizhnekamskneftekhim PJSC and Kazanorgsintez PJSC as a whole are shown in Table 4.

Table 4. Calculation of Innovative Solution Sustainability Index (Innovation Efficiency) of petrochemical enterprises.

Indicators	Nizhnekamskneftekhim PJSC	Kazanorgsintez PJSC
Generalizing indicator of economic sustainability (S_1)	39.59	36.65
Generalizing indicator of social sustainability (S_2)	9.49	6.34
Generalizing indicator of environmental sustainability (S_3)	7.18	5.47
Integrated Innovation Sustainability Index (*IISI*)	1.12	0.88

Source: compiled by the authors

Analysis of the calculation results related to the innovative solutions sustainability in terms of economic, social and environmental, as well as the innovative activities efficiency index of petrochemical enterprises in general, as presented in Tables 1 – 4 above, shows that Nizhnekamskneftekhim PJSC can be considered as a company where innovative solutions are implemented in the most effective and successful way. Nonetheless, both of the petrochemical companies demonstrate middle level of economic sustainability of innovative solutions, and low level of social and environmental sustainability. This indicates that the enterprises pay insufficient attention to their innovative growth status and corporate innovation-related activities improvement issues.

It should be noted that Nizhnekamskneftekhim PJSC and Kazanorgsintez PJSC have gained quite a lot of experience in terms of working out, mastering and maintaining innovative solutions. The petrochemical sector, especially as things stand today, needs that sustained and careful efforts should be made to maintain the competitive strength [4, 6], in line with improving the quality of ready for sale petrochemical products, and enhancing the production facilities utilization efficiency [10, 12]. From this perspective, it is recommended

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that special attention be paid to the issues related to innovative development activities organization and management by the petrochemical companies.

4 Discussion

Amid the rapidly changing market environment as the things in the modern economy are going today, innovative solution implementation efficiency assurance is instrumental in keeping any company go strong from the point of view of competitiveness. Against that background, the authors, in order to identify the issues of innovative growth management and stimulation of innovation-oriented activities of petrochemical companies, within the scope of this study have developed and tested a model designed for assessment of innovative solution implementation efficiency.

The model allows carrying out an analysis of economic, social and environmental sustainability of particular innovative solutions, or evaluating the company's innovative activities effectiveness as a whole.

Each generalizing indicator of innovative solution sustainability includes a number of particular indicators. It should be noted that the indicators above listed may vary depending on the nature of the industry, specific features of the enterprise, as well as market trends.

Since the model described in this study takes into account the aspects relating to various areas of the enterprise's activities (economic, social and environmental), the sustainability index turns out to be an indicator of a wide range of applicability.

5 Conclusion

The proposed by the authors model of integrated innovation sustainability Index calculation could be used for both assessment of the significance of a particular innovative solution or project, and assessment of innovative growth of a company.

The materials of the article can be used in the development of strategies and programs to improve the efficiency of energy and resource saving systems at petrochemical enterprises in the context of industrial digitalization.

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