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Technology Audit: Assessment of Innovative Portfolio

Viktoria Kurushina[1] , *Elena* Kurushina [1,*] and *Alexander* Shabarov[2]

[1]Industrial University of Tyumen, 625001 Volodarskogo str. 38, Tyumen, Russia
[2]Tyumen State University, 625000 Semakova str. 10, Tyumen, Russia

Abstract. The article discusses the features of the technological audit performing in the companies of oil and gas sector of Russian economy. To measure the innovations quality level the scale was developed based on the Theory of Inventive Problem Solving and the theory of technological structures. Figures of the innovations quantity by levels, volume and quality of the innovative portfolio are offered for assessment the innovative portfolio quality. The method was tested on an example of oil and gas transporting enterprises. The results of the comparative analysis of innovative portfolio are shown.

1 Introduction

Modern trends in the world energy consumption growth [1], as well as cooperation developing between China and Russia in this area require accelerated introduction of innovative technologies in the oil and gas transportation industry. The innovation development pace depends not only on the duration of the innovation cycle, but also on the quality of implemented innovations. For successful innovative management in the world technology audit procedures are applied. Technological audit (hereinafter referred to as TA) in accordance with the procedure of the IRE (Innovative Regions of Europe) methodology is conducted in order to "evaluate the ability of the company / organization to integrate new technologies and to work with technology partners, as well as to create an understanding of what is necessary in order to integration or, on the contrary, the technology transfer were carried out most successful" [2, p. 9]. Following the procedure of OSEO anvar (National Innovation Agency, which coordinates the work of the French Innovation Relay Centres – IRC) during the technological audit process the company innovativeness as well as its ability to innovate is assessed. Also, analysis of a specific innovation project can be carried out [same, p. 10]. The data array formation and the choice of assessment criteria depend on the audit objectives.

In Russian practice technology audit is focused on the company competitiveness assessment in the area of innovation. As noted in the Methodological materials on the creating of innovative development programs (hereinafter referred to as IDP), TA is "comprehensive and documented analysis containing an adequate assessment of the existing technological level of the company in comparison with comparable companies in Russia and abroad" [3, p. 4].

* Corresponding author: kurushina.tsogu@yandex.ru

2 Research object (model, process, unit, synthesis, experimental procedure, etc.)

The research object is the oil and gas sector enterprises of Russian economy. The research tasks include:

1. Investigation of the features of technological audit procedures in the Russian oil and gas companies sector.
2. The development of scale for innovation quality assessment.
3. Assessment of the innovation quality level on example of enterprises of oil and gas transportation sector.
4. Formation of an innovative methodology for corporate portfolio assessment.
5. Comparative analysis of the innovative portfolio.

3 Research methods

As the main research method the content analysis of methodological materials and innovative development programs was used. Development of the innovations quality scale was made based on the analogies method, and assessment was carried out according to comparison method. Approbation of techniques was carried out using computational and analytical methods as well as comparative analysis methods.

4 Results and Discussion

Carrying out of TA in accordance with IDP of OJC "Gazprom" provides: 1) choice of foreign companies for comparison; 2) analysis of open information sources; 3) analysis of foreign companies figures that are suitable for assessment of the technological level; 4) the figures calculation at OJC "Gazprom" and those at foreign companies; 5) technological level comparison; 6) the development of KPI (key performance indicators) list for the technological level [4, p. 25]. In the ranking of technological level figures of OJC "Gazprom" take in comparison with foreign companies:

- 2nd place in terms of reliability and safety;
- 5th place in terms of energy efficiency and perspective technologies;
- 7th place in terms of ecological compatibility;
- 10th place in terms of investment in research and development.

The rating data make it possible to assess the technological leadership relative to its competitors in which quality the largest by market capitalization energy companies are used such as Exxon Mobil, BP, Shell, Statoil, PetroChina and other. There are total 19 companies. Accordingly, changes in introduction pace of innovations (e.g. their slowing) in the industry have an impact on the objectivity of innovation development assessments.

It should be noted that the competition level in the industry is constrained by a high degree of the capital concentration as well as the continuing mergers and acquisitions processes. Accordingly, the motivation of accelerated innovations introduction to strengthen the competitive position declines. The technology promise is estimated at OJC "Gazprom" not by the depth of innovative transformation but by the susceptibility and development degree of new technologies. The elaboration degree is assessed by experts.

The structure of key performance indicators (KPI), assessing the technological leadership, includes quantitative and qualitative indicators in Methodological materials on the development of IDP [3]. Programs of Russian oil and gas transporting corporations provide only quantitative figures. Following figures are included in the list KPI of technological level of OJSC "Gazprom": 1) the quantity of patents and licenses obtained for the calculation period and the last 2 years, 2) the quantity of patented technologies developed within the framework of the IDP for the calculation period and the last 2 years [4]. The figure of technological leadership of OJC "AK" Transneft "," is assessed only on basis of patents quantity assigned to the company's balance [5]. The recommended by Methodological materials quality portfolio estimation based on a balance between the breakthrough projects and improving projects in IDP in the survey, is not performed.

Taking into account the given above, in this article it is offered to assess additionally the individual innovation quality and innovative portfolio as a whole on the basis of objective evaluations to enhance the validity of the TA conclusions about promising technologies and projects. As the methodological basis for measurement of the quality innovation level modern theories can serve, such as the Theory of Inventive Problem Solving of G. Altshuller and the theory of technological structures of S. Glazyev. To assess the quality of certain innovations the appropriate scale was developed by the authors of the article, providing the levels differentiation according to the inventions characteristics [6, 7]. As seen in the Table 1, the criteria for the quality level estimation of innovation on this scale, are: 1) the inventions level (by G. Alshuller), 2) the degree in changes technology, 3) the depth of the system changes, 4), the origin and the innovations incidence.

Table 1. Scale of innovation quality assessment**.**

Criterion	**Innovations quality level**				
	1	**2**	**3**	**4**	**5**
Level of inventions	**Easiest invention**	**Easy invention**	**Average invention**	**Major invention**	**Largest inventions**
Changes degree in technology	Small improvemen t in technology	Moderate improvement in technology	Major step in the development of technology	Almost fundament al one	The fundament al one
Depth of the system changes	Change in the element	Change in the element	Partial change of other elements	System changing	Creation of essentially new system
Origin and the innovations incidence	In the present system	In related systems	Within the branch of science	Outside of the branch of science	The emergence of a new branch of technology

Inventions assessment of G. Altshuller allowed to obtain the data that 32% of inventions correspond to the first (lowest) level, 45% of those – to the second one, 19% – to the third one, less than 4% – to the fourth one and 0.3% – to the fifth inventions level [6, p. 68]. The inventions of the first three levels make 96%. Correlation of this scale with the theory of technological structures of Glazyev shows that the first 3 levels are improving (or evolutionary) rather than revolutionary innovations. Therefore, it is not enough to measure the technological leadership by the patents quantity. On the developed scale the quality level estimation of innovation was performed provided by IDP of Russian oil and gas transporting corporations. Since the IDP data sheet of OJC "AK" Transneft" does not specify exactly what the company understands under the future technologies, "nanotechnologies in oil pipeline transport" as well as "systems and technical means of oil pipelines monitoring," the assessment for quality level estimation of these technologies has not been made. The estimation results are shown in Table 2.

Of the fourteen being assessed technologies of OJC "AK" Transneft" 2 of them can be referred to the revolutionary, and 12 – to the evolutionary ones. Of the five main pipeline transport technologies represented in IDP of OJSC "Gazprom" 2 are assessed as revolutionary and 3 as evolutionary ones. The research had not taken into account the company innovations in the hydrocarbon production and storage areas etc.

Table 2. Quality level estimation of innovations provided by IDP in the oil and gas transportation sector of the economy.

Qualitative level of	Main oil transportation *	Main gas transportation **
Evolutionary technologies		
1	Creation of systems for productivity increasing of pumping by drag hydraulic reduction in the main oil and oil product pipelines	-
2	- The development of highly reliable pump units with an increased efficiency factor. - Development of an integrated oil-heating system with nominal capacity of 50 MW as well as integrated heating and unloading systems of oil and fuel oil from railway tanks. - Technologies for production and use of non-contact bearings using permanent magnets or electromagnetic bearings for the electric motors of main and booster pump units of various capacities. - Development of monitoring system for technical condition of pipeline. - Development of technical solutions for the manufacture and installation of the pupping stations facilities elements as well as oil pipelines when operation in permafrost conditions. - Energy saving technologies.	- Technologies of highly efficient gas compression. - The technology of energy generation through its use.
3	- Development of a unified management system (UMS) for main oil pipeline. - Creation of highly reliable import-substituting equipment. - Creation of technology, equipment and facilities for the Polar region, offshore and marine zone. - Development of variable frequency electric motor for pumping units. - New composite materials for repair performing without cutting by method of composite-coupling technology.	Technologies of energy generating due to the use of low power generating units (1-10 kW), based on alternative and renewable energy sources for electric power supply of linear part consumers of main gas pipelines
Revolutionary technologies		
4	- Development of the complex of the high-precision in-line diagnostic devices. - Development of the leak detection system and activity control for temperature and vibroacoustic operating principle.	- Gas transportation technologies in liquid and multiple-phase state - Construction and operation technologies of high-pressure pipelines.
5	-	-

* Compiled on the basis of the IDP data sheet [5]

** Compiled on the basis of the IDP data sheet [4]

For the most complete assessment of the corporation innovation portfolio it is advisable to perform calculation on the parameters system given below.

1. The innovations quantity in the portfolio (Nп), including by levels one (Ni).

The innovations quntity presented in the IDP data sheet of OJSC "AK" Transneft", makes 14 innovations, including that of the first level – 1 innovation; of the second one – 6; of the third – 5 and of the fourth – 2 innovations. In OJC "Gazprom" 2 of 5 innovations on the main transportation presented in the IDP belong to the second level; 1 of them – to the third one and 2 innovations – to the fourth level.

2. The volume of the innovative portfolio (Oip):

$$O_{ip} = \sum_{i=1}^{5} \mathrm{N}_i \cdot I, \tag{1}$$

where I – innovation significance coefficient of the ith level; Ni – the innovations quantity of ith level.

The level number can be used as the significance factor. Distribution of "weights" will be, respectively, 0.067 (1st level), 0.133 (2nd level), 0.200 (3rd level), 0.267 (4th level), 0.333 (5th level). The innovations volume coefficient at OJSC "AK" Transneft", calculated according to Table. 2 data, is 2.4 c. i. u. (conventional innovations units), given to the first quality level. At OJSC "Gazprom" this figure is only 1 c. i. u. for gas transportation innovative portfolio.

3. The quality of innovative portfolio K_{un}:

$$K_{un} = \frac{\mathrm{N_r}}{\mathrm{N_e}} \cdot 100 \tag{2}$$

where Nr – quantity of revolutionary innovations (those of the 4th and 5th levels); Ne – quantity of evolutionary innovations (those of the 1st, 2nd and 3rd level).

According to the performed above calculations (2) the innovative portfolio quality of oil transportation corporation is equal to 16.7%, and that of gas transportation one – 66.7%. The results of the comparative analysis of innovation portfolio are shown in Table 3.

Table 3. Comparative analysis of innovative portfolio of IDP of Russian oil and gas transportation sector.

Index	Unit of measure	Main oil transportation *	Main gas transportation **
1. Total number of innovations including:	qty.	14	5
1st level	qty.	1	-
2nd level	qty.	6	2
3rd level	qty.	5	1
4th level	qty.	2	2
5th level	qty.	-	-
2. The volume of innovative portfolio	c. i. u.	2.4	1.0
3. The quality of innovative portfolio	%	16.7	66.7

The obtained estimations indicate a higher quality of innovative portfolio of OJC "Gazprom". Assessment of innovation development based on introduction of the revolutionary innovations allows the identifying the patterns development of technical systems. The results of the conducted researches on the example of Russian oil pipeline system containing qualitatively new conclusions were reflected in the works [8, 9, 10].

5 Conclusion

Assessment of the innovative portfolio quality can be used as an additional criterion for the selection of promising technologies in the creation of corporation innovation development programs. Taking into account the degree of technology innovation [11-21] will accelerate the innovation development.

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