Integrated risk management of petroleum engineering enterprises

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Abstract. This article discusses the current problems of the functioning of oil engineering enterprises. The emergence of new risks inherent in oil engineering is shown, which is due to the intensified transformation of the external and internal environment, the complexity of production systems, competition among machine-building enterprises, their various levels of development, which ultimately determine material consumption, energy consumption of gross domestic product, labor productivity, industrial safety and defense of the state. The results of a study on the management of specific integration risks are presented. At the same time, the classification of risks inherent in integration structures was carried out, their assessment was based on the use of expert assessment method, hierarchy analysis method, ALARA risk ranking matrix. A program has also been proposed in order to increase the effectiveness of managing the identified specific risks of integrated oil engineering enterprises by developing measures to minimize such risks.

1. Introduction

In the modern world of a market economy, the processes of intensive globalization, as well as restructuring, usually take place. Transformation of external and internal environment and complex production systems activates the interaction of enterprises and, thereby, contributes to the manifestation of the factor which allows the increase of the engineering enterprises competitiveness.

The petroleum engineering industry in its composition has many sub-sectors serving all stages of oil production and refining – for geological and geophysical work, well repair; well drilling; transportation and processing of raw materials. Petroleum engineering provides production equipment for key sectors of the economy, primarily mining and manufacturing industries. Material consumption, energy intensity of gross domestic product, labor productivity, industrial safety and state defense depend on the level of development of mechanical engineering. Thus, to achieve high financial results, a clearly structured, justified, and effective strategy is needed, which leads to numerous attempts by business entities with different levels of production and innovative technological potential.

Mergers and acquisitions, both abroad and in Russia, provide an opportunity to adapt to a progressive system of the economy and gain additional privileges in the competition. At the same time, the company daily faces a wide variety of risks related to absolutely all business processes of the manufacturing enterprise – from a failure in production, logistics, to finances (credit conditions and debt obligations) and so on [1]. Any risk affecting the value chain can negatively affect the financial results of the enterprise, the achievement of strategic goals, and, ultimately, the bankruptcy of the company [2, 3, 4].
2. Problem Statement
The economic sanctions put forward by the countries of Europe and the United States against Russia and being in force for quite a long time had a significant impact both negative and positive on the enterprises of oil engineering. The negative impact is manifested in the restriction or complete abolition of imports of high technology and components, access to “cheap” land resources in comparison with high interest rates on loans from the Russian banks, as well as the outflow of foreign capital for any innovative projects. The positive impact of the introduced sanctions appears to be an increase in demand for domestic equipment for servicing oil and gas industry concerning the implementation of initiated field development projects.

There are a number of other significant problems that impede the increase in the efficiency of the functioning of oil engineering enterprises. First of all, this is a morally obsolete infrastructure of production facilities related to industrial communications and internal logistics; the presence of excess production capacity during progressive fall in demand; inefficient enterprise management system, a critical level of equipment and imperfect technology deterioration, an outflow of qualified personnel, non-transparent quality management system, a lack of financial resources, a lack of experience and resources to form an effective sales policy, an underdeveloped service and technical support system for products [5].

In this situation, the development of business planning of engineering enterprises on the basis of integration is a rational decision to implement an import substitution policy, which will allow the Russian innovative companies to supplement existing Western products or create new ones, including those ones in the field of oil engineering. It should be understood that integration processes are accompanied by specific risks that need to be identified in a timely manner and their effect on the resulting indicators of the synergetic effect of integration should be leveled.

On this basis, enterprises strive to manage identified risks by developing a system of indicators for assessing the risk of a strategy. Opinions made by S. Kaplan and D.P. Norton, who believe that risk management as a whole is an additional indicator that is taken into account when developing any business strategy [6], confirm this statement. In the broad sense of the word, the risk should be understood as a characteristic of a situation with an uncertainty in the outcome, with the obligatory presence of adverse consequences. Moreover, F.H. Nait believes that the most important thing is the ambiguity of risk compared to uncertainty. If uncertainty can be measured, then it is a measurable uncertainty, or actually “risk”. Therefore, measurable risk is not an uncertainty at all [7].

If we consider the origin history of the risk management system, we can highlight the following key points. Bowman in 1980 raised the need to develop a theory of risk within the discipline of strategic management and took the risk beyond performance analysis to improve the quality of managerial decision-making. McNamara and Bromiley in 1999 called for a better understanding of managerial definitions of risk and profitability and for a better understanding of risky decisions in an organizational and market environment. Palmer and Wiseman also expressed their opinion in the discussion in 1999 and showed that both managerial and organizational factors contribute to the adoption of risk, and the impact on risk is mainly directed through managerial choice. Fahlenbrach et al. in 2012 showed how the adoption of financial risks is determined by the “risk culture” and that this culture is present in all managerial decisions. Nevertheless, the accumulated knowledge is always insufficient when deciding to take greater (or lesser) risks while optimizing performance [8].

In general, risk management can be considered as a set of methods, techniques, and measures that allow to predict the onset of risky events and take measures to eliminate or reduce any negative consequences of such events. Therefore, the risk management system at the enterprise is an element of the internal control and risk management mechanism, which is a part of corporate governance, a technological means and a set of tools that ensure the effectiveness of risk management. The risk management system provides organizational prerequisites, principles and structures for the design, implementation and improvement of the organization risk management, creates an infrastructure for risk management on an ongoing basis [9, 10, 11].
The main goal of the risk management system is to reduce the level of uncertainty regarding the achievability of the tasks set for management, the development and practical expansion of risk management processes. The risk management system contributes to any regulated risk management, as well as maintaining the company's integral risk at the level of acceptable risk.

3. Research Questions
The purpose of this study was to get an idea of the types of risks inherent in integration processes, a general approach how to reduce a risk, to suggest control actions that help optimize risk/reward opportunities, and to reflect a particular vision of the risk of the integration process. Sizing risks in terms of potential losses requires companies to take into account any possible uncertainties that limit their future results. Deviations from expectations can potentially arise from many sources – from obligations on strategic resources, total investments, from poor strategic positioning or, as Starbuck and Hedberg (1977) have shown, from managerial inertia or organizational stagnation. This may also be due to the inability to timely see and respond to signals of environmental changes (Reeves and Deimler, 2011) or due to the moral hazard posed by institutions that have become “too large to fail”, as emphasized by the financial crisis (Maguire, 2009). Risk can also arise from partnership issues between management and shareholders and ownership structure (Saunders et al., 1990), as well as risk preferences and regulatory actions (Buser et al., 1981), decision making (Adner and Levinthal, 2004), strategic change (Greve, 1998), strategic diversification (Montgomery and Singh, 1984), implementation of innovation (Bowman, 1980; Cyert and March, 1963) and reduction of negative impacts (Meulbroek, 2002), etc. As a direct result of the wide spreading of risks, the challenge facing management is to consider what risks prevail and to reduce their negative consequences [8].

The strategic priority of most petroleum engineering enterprises seems to be the need to increase the competitiveness of enterprises, achieve synergies from integration [12], increase the effectiveness of integration development of enterprises, which will allow domestic companies to master innovative technologies, increase the efficiency of capital functioning and their competitiveness in world markets.

In this regard, risk management, assessment, and control of risks of the integration development of enterprises are taking on particular significance.

4. Purpose of the Study
Based on the research question posed, it is possible to define the purpose of the study as the identification and classification of risks inherent in integration processes, their assessment, as well as improving the risk management efficiency of integrated oil engineering enterprises by developing measures to minimize them.

5. Research Methods
When identifying and classifying risks, the facet method was applied, that is the parallel division of the set of risks into separate components in accordance with one of the attributes in each of them [9].

Risk diagnostics is aimed at determining the compliance of the current operating activities of the company with the goals and objectives of the business, identifying weaknesses of the company, as well as preventing possible threats and losses. Typically, risk diagnostics are carried out in the following areas: analysis of risk factors, analysis of the consequences of a risk event, analysis of cause-and-effect links [3, 6, 9].

To identify the risks of the enterprise, a risk profile was constructed, which is a collection of information about the risk area, risk indicators, as well as instructions on the application of the necessary measures to prevent or minimize risk. Its construction provides a unified point of view on the risks of the integration system, and hence the definition of the features of its risk management policy. For this purpose, the following items were selected and formed – a basic set of risk factors, a scale for expert assessments, and evaluation criteria.

During the study, a ten-point scale was used. The expert group consisted of eleven experts who are the specialists from various departments of the integration system (including company executives).
The experts were faced with the task of determining what, in their opinion, is the influence of each factor on this integration association. In case of discrepancies between the experts’ opinions, they were discussed at the meetings with the experts. The score was determined according to the data posted on the website of the Rosstat Federal State Statistics Service and the reporting of the New Technologies of Oil Industry Association of Equipment Manufacturers depending on the degree of probability of risk occurrence, as follows: "1" - low probability of risk occurrence; "3" - probability of risk occurrence below average; "5" - average degree of probability of risk occurrence; "7" - degree of probability of risk occurrence above average; "9" - high degree of probability of risk occurrence. Weight was determined by the hierarchy analysis method by pairwise risk comparison: “1” - equal importance; “3” - moderate superiority; “5” - significant superiority; “7” - significant superiority; “9” - maximum superiority. In intermediate cases, even scores were used – 2, 4, 6, 8, 10.

To assess the degree of consistency of expert opinions, an index and a coefficient of consistency were determined, which, according to the results of the study, did not exceed the limit level of 0.1. The final risk level was calculated as the product of the probability of occurrence of risk in points and the gravity of this risk, determined by the method of hierarchy analysis [3, 9].

The ALARA matrix (Target Mitigated Event Likelihood (TMEL) & ALARP (or ALARA) was used as a way of risks ranking, where the probability points of occurrence of risk were plotted horizontally and the weight of the corresponding risk – vertically. When two indicators intersect, the matrix is divided into the following zones:

- green - area of acceptable risk - insignificant risk, having a low probability of occurrence and low significance for the activities of the integration structure;
- yellow - area of negligible risk - risks that have both negative and positive impact on the activities of the structure under consideration;
- red - area of excessive risk - it includes the risks that are likely to occur to a great extent and have a significant impact on the financial activities of the integration structure [11, 13].

6. Findings
Like any business, integration associations are accompanied by various risks. Table 1 presents the types of integration risks identified in the studied integration structures of oil engineering enterprises, including specific ones that are inherent only to integration structures.

Table 1. Suggested Supplement for Integration Risk Classification [14, 15, 16, 17, 18, 19, 20].

| Integration Risks       | Operational                                                                 |
|-------------------------|-----------------------------------------------------------------------------|
|                         | - Risk of improper handling of operations                                    |
|                         | - Risk of technological changes in the industry, which will lead to the fact that one of the links of the integrated structure will be redundant * |
|                         | - Loss of customer base *                                                   |
| Financial               | - Increase in the cost of borrowing                                          |
|                         | - Increase in total tax payments                                            |
|                         | - Foreign exchange risk                                                      |
|                         | - Credit risk                                                               |
|                         | - Underpayment risk                                                         |
|                         | - Risk of disruption of concluded agreements *                              |
|                         | - High costs associated with acquisition of companies or innovations *      |
| Strategic               | - Uneven development of regions                                             |
|                         | - Wrong choice of form of interaction *                                     |
|                         | - Wrong choice of development strategy *                                    |
|                         | - Wrong choice of strategic partners *                                      |
|                         | - Incorrect assessment of the economic potential of a partner *             |
|                         | - Underestimation of the amount of investment needed for integration *     |
|                         | - Redistribution of corporate control towards people not interested in the strategic development of the company * |
|                         | - Reduced capitalization of an integrated company compared to the individual functioning of firms * |

*specific risks that have been identified

Below you can find a summary table indicating the scores for each risk group and the total score reflecting the level of risk inherent in the integration structure of oil engineering enterprises (Table 2).
Table 2. Calculation of the Total Risk Score.

| Risk Group | Risk Type                                                | Score | Cumulative Score | Total Score |
|------------|----------------------------------------------------------|-------|------------------|-------------|
| 1.         | Macroeconomic                                            |       |                  |             |
|            | 1.1 Inflation risk                                       | 6     | 0.034            | 0.206       | 0.474       |
|            | 1.2 Currency exchange risk                               | 5     | 0.015            | 0.073       |             |
|            | 1.3 Inconvertibility risk                                | 4     | 0.009            | 0.034       |             |
|            | 1.4 Risk of default                                      | 2     | 0.005            | 0.005       |             |
|            | 1.5 Interest risk                                        | 6     | 0.026            | 0.154       |             |
| 2.         | Production                                               |       |                  |             |
|            | 2.1 Product liquidity risk                               | 3     | 0.007            | 0.021       | 0.364       |
|            | 2.2 Lack of raw materials                                | 5     | 0.015            | 0.075       |             |
|            | 2.3 Pricing risk                                         | 7     | 0.036            | 0.255       |             |
|            | 2.4 Risk of buyer’s refusal of received or paid products | 3     | 0.004            | 0.013       |             |
| 3.         | Strategic                                                |       |                  |             |
|            | 3.1 Uneven development of regions                        | 4     | 0.043            | 0.172       | 0.172       |
| 4.         | Financial                                                |       |                  |             |
|            | 4.1 Credit risk                                          | 7     | 0.076            | 0.535       | 0.813       |
|            | 4.2 Possibility of additional tax liabilities            | 5     | 0.015            | 0.075       |             |
|            | 4.3 Increase in the cost of borrowing                    | 6     | 0.034            | 0.203       |             |
| 5.         | Social                                                   |       |                  |             |
|            | 5.1 Risk of death of the main partner or the main shareholder of the enterprise, risk of loss of a qualified employee and intellectual property | 2 | 0.004 | 0.009 | 0.027 |
|            | 5.2 Risk of illness (disability) and death of the owner of the enterprise | 2 | 0.009 | 0.018 |
| 6.         | Property                                                 |       |                  |             |
|            | 6.1 Physical damage to property (fixed assets)           | 6     | 0.015            | 0.090       | 0.115       |
|            | 6.2 Equipment failure                                    | 5     | 0.005            | 0.025       |             |
| 7.         | Production                                               |       |                  |             |
|            | 7.1 Risk of equipment shutdown                           | 5     | 0.040            | 0.198       | 0.308       |
|            | 7.2 Risk of full or partial non-implementation           | 4     | 0.011            | 0.043       |             |
|            | 7.3 Risk of damage to material resources (current assets) | 4 | 0.017 | 0.067 |
| 8.         | Financial                                                |       |                  |             |
|            | 8.1 Risk of disruption of concluded agreements *          | 2     | 0.009            | 0.018       | 0.045       |
|            | 8.2 Underpayment risk                                    | 6     | 0.064            | 0.386       |             |
|            | 8.3 High costs of integration and entry into new markets * | 5 | 0.027 | 0.136 |
| 9.         | Operational                                              |       |                  |             |
|            | 9.1 Incorrect processing of operations                   | 3     | 0.010            | 0.029       | 0.216       |
|            | 9.2 Loss of customer base *                              | 3     | 0.015            | 0.045       |             |
|            | 9.3 Technological incompatibility of integrated production * | 4 | 0.036 | 0.142 |
| 10.        | Social                                                   |       |                  |             |
|            | 10.1 Employees turnover risk                             | 3     | 0.079            | 0.238       |             |
|            | 10.2 Risks associated with the safety, health and disability of employees | 4 | 0.139 | 0.555 | 0.852 |
|            | 10.3 Risk of illness (disability) and death of the owner of the enterprise | 2 | 0.030 | 0.059 |
| 11.        | Strategic                                                |       |                  |             |
|            | 11.1 Wrong choice of form of interaction *               | 4     | 0.027            | 0.107       | 0.528       |
|            | 11.2 Wrong choice of development strategy *             | 4     | 0.045            | 0.180       |             |
|            | 11.3 Wrong choice of strategic partners *                | 3     | 0.013            | 0.038       |             |
|            | 11.4 Incorrect assessment of partner’s economic potential | 4 | 0.034 | 0.155 |
|            | 11.5 Redistribution of corporate control for those people who are uninterested in the strategic development of the company * | 3 | 0.010 | 0.030 |
|            | 11.6 Reduced capitalization of an integrated company compared to the individual functioning of firms * | 3 | 0.013 | 0.038 |
| 12.        | Infrastructure                                           |       |                  |             |
|            | 12.1 Reduced labor efficiency due to negative perceptions of change | 4 | 0.022 | 0.090 | 0.134 |
|            | 12.2 Decrease in the level of manageability and quality of business processes while expanding the company | 4 | 0.011 | 0.044 |
| TOTAL      |                                                         |       |                  | 1.00        | 4.54        |

* specific risks that have been identified
Thus, the final score is 4.54 out of 10 possible, and, respectively, the total risk of the integration structure in question makes 45%. To reduce the calculated risk level, it is necessary to propose a number of measures. For this, the ALARA risk ranking matrix was used (Figure 1, the numbering of risks is taken from Table 2).

In the course of the study, the identified risks were divided into the areas of acceptable, negligible and excessive risks, which made it possible to formulate an integrated enterprise development program that promotes the modernization and technological development of companies by significantly improving key performance indicators of production processes. The program should include risk management measures specified in Table 3 (a fragment of possible measures to manage only identified specific risks is given).

All the identified specific risks inherent in the integration processes, when ranking, fell into the acceptable risk area, which, with timely monitoring and control, as well as timely and clear organization of risk management in the integration structure, would reduce their negative impact on the financial results of oil engineering enterprises.

7. Conclusion

Thus, when managing the integrated structure of oil engineering enterprises, it is important to authenticate all kinds of risks, including specific ones; to be able to apply methods for assessing the possibility of risk formation; to apply management functions when leveling identified risks; to apply an adequate methodology for assessing the comparative effectiveness of various risk management measures and recommendations for their use in every particular case.

The used risk management tool “Risk Profile” made it possible to clearly identify the sources of risk. The example of a risk analysis of the investment project (the New Technologies of Oil Industry Association of Equipment Manufacturers) showed its functionality, efficiency and specificity. The types of risk were sorted in accordance with the purposes of the integrated structure using the risk matrix. This made it possible to identify the sources of risk, to analyze them and to develop measures to eliminate or to limit the risk. Based on the results of the analysis, the most dangerous risks for the Association were identified, such as: risk associated with pricing policy, credit risk, underpayment risk, as well as the risks related to safety, health and disability of employees, while specific integration risks that were identified, were not subject to the immediate management goals, as they fall into the area of acceptable risks.

This study showed possible options on how to minimize risks. However, the choice of a specific way to minimize the risk in the activities of the integration structure depends on the experience of the
leader and the capabilities of the association. As a rule, to achieve more effective results, it is not only one method, but a whole set of them for minimizing risks at all the stages of an enterprise economic activity, is used. Thus, we can conclude that building a risk management system is a prerequisite for the effective operation of integration structures, which should include enterprise assessment, risk analysis and selection of the most optimal ways to minimize the risk. A well-balanced and economically sound solution will undoubtedly benefit the enterprise and have a positive impact on its further development.

Table 3. Possible Measures to Manage Identified Specific Risks.

| Risk                                                                 | ACCEPTABLE RISK AREA                                                                 |
|----------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| 8.1 Risk of disruption of concluded agreements                       | Timely monitoring and control, compensation, hedging, futures method, diversification, insurance, self-insurance, reservation. Attracting a reliable company. Conclusion of a multilateral agreement governing the liability in case of a possible failure, upon the occurrence of a risk event. Advance development of the enterprise functioning system in search for alternative suppliers. Expansion of suppliers. |
| 8.3 High costs of integration and entry into new markets             | Timely monitoring and control, compensation, limitation, hedging, futures method, diversification, self-insurance. Risk distribution involves the distribution of risk among project participants. Development of recommendations to streamline the financial and economic activities of the enterprise and to bring its documentation in accordance with the current law. |
| 9.2 Loss of customer base                                            | Timely monitoring and control. Informing management and drawing up management report, covering risk from capital. Analysis of the financial statements of the client. Individual approach to the client, taking into account the opinion of the client. Well-thought-out pricing policy. Feedback support. Monitoring the mention of your own company in the media and Internet. |
| 9.3 Technological incompatibility of integrated production           | Timely monitoring and control, technology development, methods of losses recovering, covering risks from capital, risk allocation among project participants, risk insurance. Use of special technological techniques. Introduction of auxiliary processes. |
| 11.1 Wrong choice of form of interaction                             | Timely monitoring and control, insurance, limiting, hedging. Attracting third-party experts. |
| 11.2 Wrong choice of development strategy                           | Timely monitoring and control, insurance, limiting, hedging. Attracting third-party experts. |
| 11.3 Wrong choice of strategic partners                              | Timely monitoring and control, insurance, limiting, hedging. Attracting third-party experts. |
| 11.4 Incorrect assessment of the economic potential of a partner     | Timely monitoring and control, insurance, limiting, hedging. Conducting analytical studies of the activities of enterprises located in the same sector of the market. Attracting third-party experts. |
| 11.5 Redistribution of corporate control for those people who are uninterested in the strategic development of the company | Timely monitoring and control, insurance, limiting, hedging.                                  |
| 11.6 Reduced capitalization of an integrated company compared to the individual functioning of firms | Timely monitoring and control, insurance, limiting, hedging, self-insurance. Predicting market reactions, attracting third-party experts. |
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