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**THE IMPACT OF ENVIRONMENTAL RISKS ON THE
MANAGEMENT OF INDUSTRIAL ENTERPRISES**

I.V. Kosyakova (a), D.A. Sviridenko (a)*, N.Yu. Zhilyunov (a), Yu.V. Astashev (a)

*Corresponding author

(a) Samara State Technical University, ulitsa Molodogvardeyskaya, 244, Samara, 443090, Russia, iv-kos@mail.ru

Abstract

The study raises the actual problem of environmental pollution by industrial enterprises in the modern world. A brief historical excursion on the problem of environmental pollution by human activities is given. Environmental risks are a direct characteristic of economic activities; therefore, it is necessary to organize a system for managing these risks at the industrial enterprise. The study shows the need to implement an environmental risk strategy at the industrial enterprise. The features determining the external and internal factors for the formation of the environmental strategy of the industrial enterprise are indicated. The study presents a new classification of environmental risk factors, taking into account the nature of the impact of risk on the industrial enterprise, the level of risk occurrence and the possibility of managing it. It reveals the need to create such a risk management system that would minimize and reduce environmental damage and economic costs caused by them. The authors propose an algorithm for the development of the industrial enterprise's strategy that takes into account the impact of environmental risks on the formation of the industrial enterprise's strategy. The proposed algorithm contains five main stages: setting goals, identifying risks, assessing the level of risks, managing risks, determining efficiency. The algorithm reflects the development of the environmental strategy and management.

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Keywords: Industrial enterprise, environmental risks, environmental management, strategic management, environmental strategy.



1. Introduction

Risks have always been inherent in human activity. Various risks in the form of epidemics, crop failures, etc., have always complicated people's economic activities. However, the risk was studied in more detail only at the end of the XIX - beginning of the XX centuries. But precisely in the 20th century the consequences of risks became particularly difficult, which prompted scientists to begin to study various aspects of risks. It is believed that the risk is organically inherent in any activity, including the economic one. In the XX-XXI century, environmental risks and their impact on economic activities of industrial enterprises are of importance.

The retrospective shows that the scientific community has come to the need for greening economic activity quite recently. Starting from the XVIII century, the turnover of international trade sharply increases (almost 800 times). Since the beginning of the 20th century, the rate of fuel consumption has increased 50 times. However, the aggravating ecological catastrophe became noticeable only by the 60s of the 20th century. Later, the importance of ecology for the development of mankind was reflected in global models of the world MIR-1, MIR-2, MIR-3. These are the models that first showed the importance of environmental protection for the future of humanity.

According to the Federal Law of the Russian Federation of January 10, 2002 No. 7 "On Environmental Protection", Chapter 1, Article 1, the environmental risk is the possibility of an event having an adverse effect on the environment and caused by the negative impact of economic and other activities, natural and man-made emergency situations. In other words, the environmental risk is the probability of a change in the environmental object due to changes in the environment. This concept will be used in the future.

Agenda 21, adopted in Rio de Janeiro in 1992, stresses that environmental management should be attributed to the key dominant of sustainable development and at the same time to the highest priorities of industrial activity and entrepreneurship.

In practice, most often environmental protection at the industrial enterprise is expressed in the adoption and implementation of the environmental management system. A lot of attention was paid to the issues of strategic management and the overall performance of the industry, as well as the problems of implementing environmental management to industrial enterprises in domestic and foreign literature. Environmental management includes the environmental risk management system, which shows how the industrial enterprise is able to withstand adverse situations that may arise in a business environment.

2. Problem Statement

A feature of industrial enterprises is their constant dependence on emerging environmental risks. Environmental risks can both cause significant damage to the environment, as well as entail a high amount of material losses. Therefore, industrial enterprises must develop effective management systems that are able to consider these risks.

The implementation of such a strategy would have had a positive effect on both the individual enterprise and the economy of the region and the country. Modern industrial enterprises aimed at the external market are under some pressure from foreign customers and partners, therefore they are forced to introduce the environmental management system and develop the environmental strategy (Earnhart,

Khanna, & Lyon, 2014). Providing competitive advantages is also associated with the formation of a positive environmental image of the industrial enterprise (Gunkov & Kholopov, 2017).

The industrial complex of Russia forms up to 40% of the country's GDP and is one of the main sources in budgets of all levels (Data from the Federal State Statistics Service of the Russian Federation). About 30% of the economically active population is employed in industry. It turns out that sustainable development of industry is an important task of the domestic economy. However, industry is also the main source of environmental pollution. Thus, only the share of the extractive sector accounts for about 30% of emissions from stationary sources that pollute the atmosphere (Popov & Semyachkov, 2014). At the moment, pollution charges paid by industrial enterprises do not cover all damage to the environment. This requires fundamental changes in approaches to environmental protection.

Minimizing and preventing environmental damage can also solve social problems, such as reducing morbidity and improving the quality of life of the population. Environmental responsibility is becoming a necessary characteristic of actively developing industrial enterprises, including those that are aimed at successful operations in the international market.

Despite the fact that strategic management was developed as early as the 20th century, it should be recognized that today Russian industrial enterprises are weakly using models, methods and tools of strategic and environmental management (Gunkov, Kholopov, & Purygin, 2018). This is largely due to the fact that there is no unified approach to the issues of strategic management in the domestic school, which would be adapted to specific regional and sectoral features and be applicable in practice.

It requires developing such an algorithm for the strategy development, which would take into account possible risk factors and describe the decision-making process when choosing a strategy.

The basis of a risk management algorithm at the industrial enterprise is the identification of risk factors. The variety of risks is due to a variety of factors, which are usually denoted as risk-forming. These factors determine the occurrence of risk and its features. It was noted that the existing classifications of risk factors do not meet the requirements necessary to develop the industrial enterprise's strategy.

Thus, the problem of improving the methods for assessing the impact of environmental risks on the industrial enterprise's strategy is relevant not only from a theoretical point of view, but also of practical importance for industrial enterprises in Russia. All of the above influenced the formulation of the purposes of this study.

3. Research Questions

To carry out the study, the following research questions should be considered:

- What factors influence the development of the industrial enterprise's strategy?
- What is an algorithm for the development of the industrial enterprise's strategy?

4. Purpose of the Study

1. Determine environmental risk factors affecting the industrial enterprise's strategy.
2. Develop an algorithm that takes into account environmental risk factors of industrial enterprises.

5. Research Methods

5.1. New hypothesis

According to Rosen and Kishawy (2012), the key to sustainable development of the economy and society is the interaction of three areas: society, economy and ecology. In the future, environmental management will play an increasingly important role in industrial production. Activities to address environmental issues constitute a significant area of functioning of the modern state. However, the activities of state bodies are not enough; therefore, they should encourage industrial enterprises to implement environmental protection measures (Courtney, Kimmel, & Hull, 2012). Corporate environmental responsibility as an important part of social responsibility affects stakeholder relations and business results (Stuebs & Sun, 2015).

At the same time, effective environmental management of industrial enterprises should be systemic, manageable in nature (Testa, Rizzi, Daddi, Gusmerotti, & Frey, 2014). Alonso-Pauli and Andre (2015) show the need for the development of the enterprise's environmental management system as a necessary internal management tool. It is required to study the functions and methods of management in various management areas (Sahin, Koksal, & Garbus, 2014).

All enterprises, especially industrial ones, face environmental problems and are forced to operate in the conditions of environmental risks and non-renewable resources (Fesselmeyer & Santugini, 2013; Martynov, 2014). A study conducted by Shvarts (2015) showed that the highest percentage of introducing voluntary environmental standards is observed in the oil and gas industry, while in other sectors with high environmental risks, for example, in the energy industry, this percentage does not exceed 35%. The existing groundwork in improving environmental management and production can lead to such benefits as: improving resource efficiency, reducing losses and costs, reducing waste, reducing disposal costs, using recycled materials (Mayorova & Ponomareva, 2015).

Thus, the study is based on a hypothesis, which is to take environmental risks into account when developing the management algorithm of industrial enterprises.

5.2. Data collection procedure

Environmental monitoring to identify the factors influencing the strategy development should include the collection of the following information: the administrative and geographical position of the industrial enterprise, the state of the environment in the area where the enterprise is located, a description of the industrial enterprise, a system for monitoring environmental pollution, raw materials and energy used, air pollution, water bodies pollution, land and underwater pollution, treatment, storage and disposal of hazardous substances, waste management. The sources of information are data from the state statistical service and its territorial bodies, information posted on official websites of government bodies, regulatory and legal documents regulating environmental management, reports on economic activities of industrial enterprises of the region, materials collected directly by experts, as well as scientific publications according to the stated research problems.

5.3. Population and sample

The study considers the ecological situation in the Samara region. It was revealed that the main pollutants in the region are industrial enterprises of the fuel and energy complex, and data from the oil company Samaraneftgaz were considered.

The collected data for the Samara region show that the main environmental pollutant is industry. About 90% of waste is produced by industry. More than 40% of emissions into the atmosphere are accounted for mining. The share of the Samara region in reserves and oil production onshore in Russia is about 1.5% and 3.0%, respectively (Data from the territorial body of the Federal State Statistics Service of the Samara region). At the same time it is planned to increase the pace of industrial production in the region and the volume of oil production. The situation in the region in the field of environmental management corresponds to the situation in the country as a whole and requires measures to improve.

5.4. Method of expert assessments

Most environmental risk factors are qualitative, i.e. immeasurable quantitatively. The probability of the environmental risk is often determined by qualitative factors, for example, by personnel actions or management decisions. Based on this, in order to analyze the collected data and identify the most powerful risk factors, it seems appropriate to use the method of expert assessments (Tulupov, 2014). Experts who are competent in the field of environmental protection, scientists and specialists of industrial enterprises can be involved as experts. To this end, it is proposed to develop a questionnaire in which it is necessary to include all risk factors inherent to the enterprise under study by category: legislative, administrative-geographical, managerial, personnel, financial and economic, production, marketing, environmental and organizational factors. After that, all factors are reduced to a unified measurement system, and a point system is used for this. The scores are arranged in decreasing order of danger from 4 to 1. Such a method allows identifying the most important risk factors, assessing the qualitative factors and comparing them with the quantitative environmental risk factors.

5.5. Algorithm for the strategy development

Most theories reduce the risk management algorithm to three stages: determining the type of risk, measuring the impact of risk on the industrial enterprise, the impact on risk. The authors of the study believe that this approach is overly integrated. Therefore, they suggest a risk management system that includes five stages reflecting the essence of risk management at the industrial enterprise:

1. Setting goals. At this stage, the main goals of the enterprise are determined for the long term.
2. Identification of risk. At this stage, an analysis of the current state of the enterprise is carried out in order to identify current and potential risk situations. The risk management process is a cyclical process, so after a while the work done to identify risks will be irrelevant due to the changed internal and external factors. It is necessary to develop a program for the timely detection of new risks.
3. Assessment of the current level of risk. Risk assessment is a risk analysis procedure whereby the most influential risk factors are selected for further analysis. Effective risk assessment assesses the consequences of risks for the industrial enterprise, correlates them with the enterprise's goals and strategy.

4. Risk management. Risk management includes various methods of influencing risk and specific measures to implement the chosen strategy.

5. Activities assessment. The final stage is the monitoring of results and the subsequent improvement of a risk management system. Ongoing activities should be constantly monitored for deviations from the planned results. Ongoing monitoring allows the company to quickly adapt to changing conditions.

The listed stages are presented graphically in the form of an algorithm.

5.6. Research results

The following classification of environmental risk factors was obtained (Table 01). The division of environmental factors into levels is of fundamental importance. The industrial enterprise is not able to manage risks from the mega level at the meso level. In this case, the industrial enterprise develops a strategy in response to risks, so the enterprise's behavior in relation to these factors is adaptable. The enterprise is able to directly manage risks of the micro level and internal risks. Managing the risks of mega and macro levels is in the competence of the state, the risks of the meso level are in the competence of regional authorities.

Table 01. Classification of environmental risk factors

| | | Content |
|--|-------------|---|
| Factors indirectly affecting the industrial enterprise | Mega level | <ul style="list-style-type: none"> • Globalization and integration; • Influence of transnational corporations; • International standardization; • Scientific and technical progress; • International division of labor, etc. |
| | Macro level | <ul style="list-style-type: none"> • Political and legal; • Economic conditions of the environment at the state level; • Environmental priorities of the state; • Social, demographic and cultural; • Technological, etc. |
| | Meso level | <ul style="list-style-type: none"> • Infrastructure; • Science and education; • Environmental risks of the economic sector; • Environmental tensions in the region; • Standards of living; • Financial and economic, etc. |
| Factors directly affecting the industrial enterprise | Micro level | <ul style="list-style-type: none"> • Suppliers; • Consumers; • Competitors; • Contact audiences; • Level of environmental safety of the industrial enterprise; • Level of environmental responsibility of the industrial enterprise; • Intermediaries. |

The algorithm for taking environmental risks into account when choosing the industrial enterprise's strategy is presented in Figure 01.

The algorithm for implementing the industrial enterprise's environmental strategy is proposed to begin with the formulation of strategic management goals considering the environmental factor. Selected goals should have specific criteria, after which you can talk about achieving or not achieving the goal. There are unlimited risk situations. Management must be aware of exactly what events may have an impact on the industrial enterprise's activity. Of course, when setting goals, the specifics of the industrial enterprise should be considered. The goals should be brought to the lower levels of management.

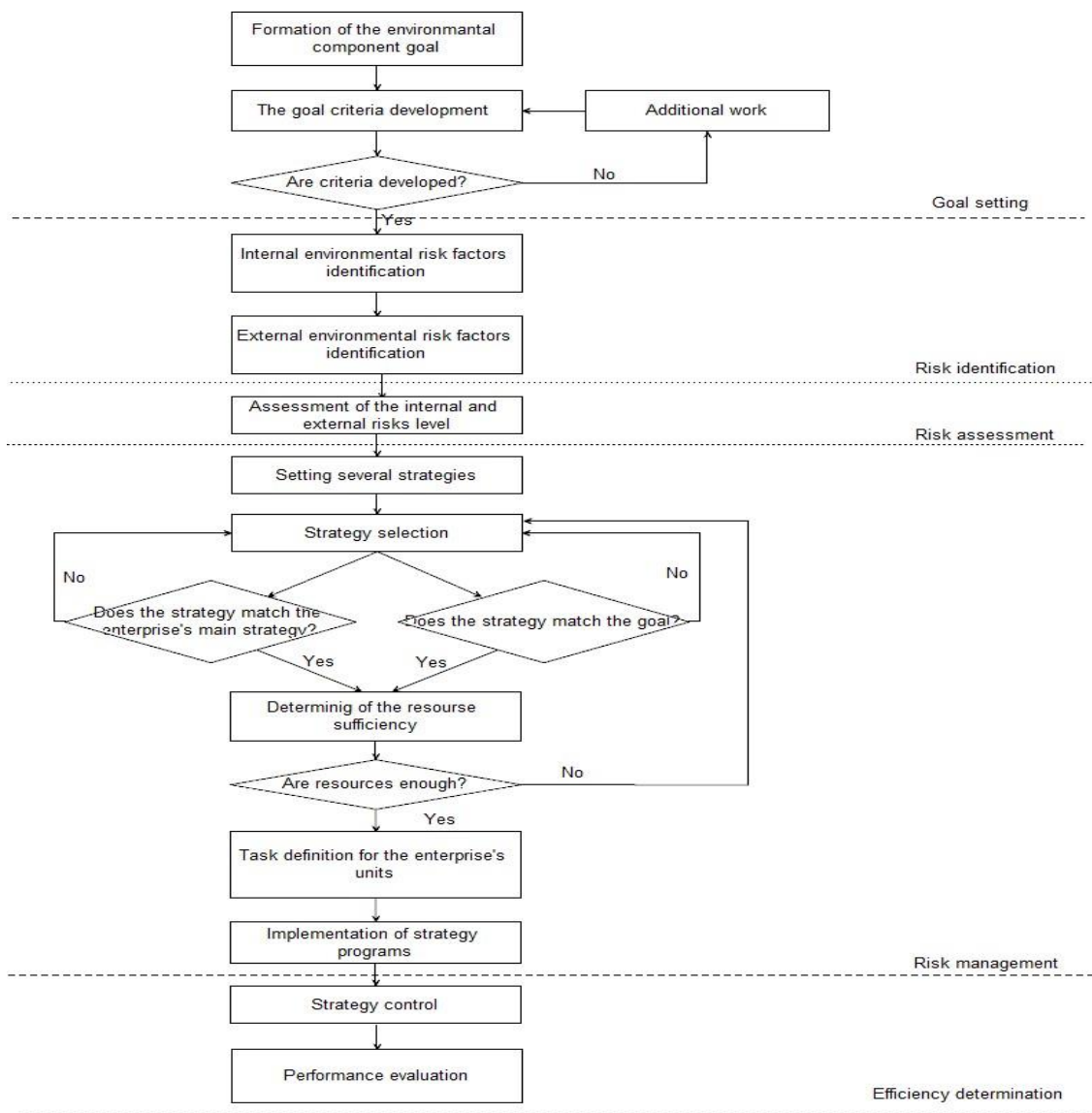


Figure 01. Algorithm for the development and implementation of the industrial enterprise's environmental strategy

The stage of criteria development for assessing the achievement of the goal involves the definition of indicators, through which both the determination of the efficiency at the final stage and the formation of a set of measures of the industrial enterprise's environmental strategies will take place. A strategy can

be considered effective only when waste reduction is accompanied by cost reduction (Kosyakova & Kudryashov, 2015).

After this, an analysis of the current internal and external factors affecting environmental problems of the industrial enterprise takes place. Identification of risk factors is one of the most important and difficult stages. The conditions, under which the industrial enterprise operates, are constantly changing, so the list of identified factors will be constantly changing. Moreover, some arising situations may not be a direct, but an indirect threat with a significant impact on the industrial enterprise, and therefore must also be considered. After determining all external and internal factors, the most significant ones should be selected, which will be considered when further developing the environmental strategy. The choice of influencing factors determines how adequate the selected environmental strategy will be to the current situation. The number of factors should be fixed.

In the next step, goals are developed for each structural unit. The goal is approved if there are enough available resources for its implementation (material, technical, human, etc.). Otherwise it is revised.

The strategy implementation takes place through the development and implementation of a set of measures. The measures considered depend on the chosen strategy of environmental risk management and accompanying risk management methods. The choice of measures should be based on both environmental and economic components. In other words, maximum effect should be achieved at minimum cost.

After identifying alternative strategies, the strategy is selected based on its efficiency. To do this, it is necessary to calculate a number of indicators - criteria for assessing the efficiency set by the industrial enterprise in the first step.

The above classification of risk factors and the algorithm for implementing the environmental strategy were used for the analysis of Samaraneftegaz JSC. The data collected during the monitoring served as a basis for identifying the main environmental risk factors. The analysis was conducted on all major environmental risk factors.

Table 02 presents an assessment of management and production factors.

Table 02. Assessment of management and operational factors of environmental risks

| Influence factor | Possible states of risk factor | | | | | Points |
|-------------------------|---------------------------------------|---------------|--------------------------------|-----------------------|---------------------|---------------|
| Factor number | Name | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Management factors | | | | | | |
| 1 | Executive authority | Low | Average | Very high | High | 1 |
| 2 | Environmental change abilities | Low | Average | Very high | High | 2 |
| 3 | Environmental management program | Not developed | Developed, but not implemented | Not fully implemented | Implemented in full | 2 |
| 4 | Sustainable development | Low | Average | Very high | High | 2 |

| Influence factor | Possible states of risk factor | | | | | Points |
|--------------------|---|---|--|--|-----------------------|--------|
| Factor number | Name | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 5 | Environmental management system | As part of the environmental department (service) | Developed, but not implemented | Not fully implemented | Implemented in full | 2 |
| 6 | Environmental strategy | Not developed | Developed, but not implemented | Not fully implemented | Implemented in full | 2 |
| Production factors | | | | | | |
| 1 | Implemented technology | No sewage treatment plant | Partial cleaning of emissions / discharges | Complete cleaning | Closed process cycle | 3 |
| 2 | Technological, technical know-how | Not available | Under development | Available, but not implemented in practice | Available | 1-2 |
| 3 | Use of resource-saving technologies | Low | Average | Above average | High | 3 |
| 4 | Pricing policy for environmental products | Not available | Under development | | Available | 3 |
| 5 | Disposal of recyclable waste | Disposal | Other methods of disposal | Recycling into materials | Recycling into energy | 3 |

The following options are possible for minimizing environmental risks at the industrial enterprise: installing filters that can reduce environmental pollution (to maintain standards), paying for exceeding standards, installing fine and coarse filters.

As criteria for assessing the efficiency of suitable indicators of the UNIDO system are the following: NPV (net present value); IRR (internal rate of return), BCR (benefit-cost ratio); PBP (payback period).

6. Findings

It is necessary to implement an effective risk management system at the industrial enterprise. Avoiding risks can lead to emergencies, loss of stability and loss of profit. Risk management should be considered as an element of the management system and as an object of management. The risk management system should be combined with the general management system of the industrial enterprise.

Any strategy is a set of measures and is determined by their efficiency. Alternative measures should include not only the replacement of old equipment, but, above all, possible ways to change the use of the old one. It is recommended to make a choice in favor of measures that eliminate the causes of

environmental risks. The selected measures must meet the enterprise's goals. Any measure should be verified according to the condition of feasibility. The final choice of the strategy should take into account the performance indicators, which should take into account the economic component of measures.

7. Conclusion

It can be argued that the implementation of the industrial enterprise's strategy with regard to environmental risks is an important component of the overall industrial enterprise's strategy and can significantly improve the competitive position of the industrial enterprise as a whole. Currently, environmental protection is becoming an important task facing the state and individual industrial enterprises. The study showed that there are provisions that require additional development when developing a risk management system at the industrial enterprise, such as an analysis of risk factors and an algorithm for the development of the environmental strategy taking into account these factors.

The findings can be used as a methodological support and practical recommendations for industrial enterprises when developing a strategy, taking into account the impact of environmental risks on the industrial enterprise. This issue involves several paths of development. Further study of this issue should be related to a detailed review of risk management methods, criteria for selecting measures, and determining the efficiency of these measures.

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