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## Preventive Management of Industrial Enterprise Environmental Risks

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### Abstract

The current ecological state of the environment is characterized by serious concerns on the part of civil society. Positioning of the nature-conformity and overall Greening requires a fundamental change of approaches to the implementation of industrial enterprises' activities— responsible behavior in the field of environmental protection. The purpose of the study is to identify the environmental risks of the industrial enterprise and the development of new management mechanisms that can prevent the threat of their occurrence. The authors based on the concept of modern risk management and the current quality management standard identified possible sources of environmental risks, including those related to the knowledge of the organization. An algorithm for identification of environmental risks, based on its probabilistic assessment, qualitative and quantitative methods and taking into account the human factor and the social responsibility of business in the environment of industrial areas. The pain points of the industrial enterprise conditions' control that determine the adoption of preventive management decisions are revealed. The article is intended for managers and employees of industrial enterprises' environmental management systems.

**Keywords:** industrial enterprise, environmental risks, environmental management, environmental threats, preventive management, knowledge of the organization, social responsibility

Vodolazhskaya EL, Kiseleva OV, Kharisova RR, Sutyagin SA, Kurbanov RA, Lushchik IV, Ostanina SSH, Zhandarova LF (2019) Preventive Management of Industrial Enterprise Environmental Risks. Ekoloji 28(107): 317-324.

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### INTRODUCTION

The state of the environment in the modern world is followed by serious concerns due to the high saturation of industrial production with the risk of man-made threats, long-term irrational use of natural resources and the resulting environmental pollution. At the same time, environmental issues are often perceived by society as serious, as long as there is no real natural disaster (Aksenova 2011, Reznik and Malyshev 2011, Tikhomirov and Kistkina 2017, Valčo and Šturák, 2018).

For example, a survey of Russian citizens in the study of public opinion in 2018 (data of the all-Russian center for the study of public opinion) shows that despite the high level of man-made threats, half of the

respondents believe that they live in a *normal* state of the environment, 21% of all respondents believe that there are no environmental problems today. At the same time, the importance of ordinary citizens' role in the conservation of nature is taken by only 15% of respondents, considering local (29%) and regional (23%) authorities responsible for the state of the environment; 61% of our fellow citizens believe that they cannot independently affect the environment in the locality of their residence. That is, the non-obvious nature of environmental threats, their apparent *delay* in time is significantly reflected in the social and economic practices of today, ignoring the dangerous factors of human activity's significant impact on the environment.

Meanwhile, foreign and domestic studies emphasize that one of the sources of risks are increasingly environmental threats that can have a negative impact on the operation efficiency of financial market participants and, ultimately, on the stability of the financial systems of countries and regions (Aliyeva, Platonov 2016, Smetanina et al. 2014, Tumanova and Shevchenko 2012). From the standpoint of obtaining financial profit, the stability of the three subsystems (ecological, economic and social) that make up a single socio-ecological and economic system is not the same. The greatest variation happens in the economic system, which is usually chosen as a priority for development, leaving outside the society and the environment. The ecological system, which was previously considered the most stable, began to fail, obviously unable to withstand the man-made conquest and accumulated a plurality of deviations in various natural areas, and now, around the world, it significantly affects the human activity conditions and leads to sensitive losses for country economies. Understanding and acceptance of the fact that environmental threats are increasing, and in critical situations are characterized by large scale and global irreparable losses lead to an inevitable increase in attention to the environmental needs of the environment.

Environmental priorities of development and subordination of economic goals to social interests are an urgent problem of industrial enterprises with the main purpose of making a profit (Buletova 2013, Dosmagambetova et al. 2014, Kabantseva 2012). However, the conscious need to maintain the ecological balance of the territories, the avoidance of emissions dangerous to nature and the prevention of man-made disasters now require environmentally oriented actions from each industrial enterprise.

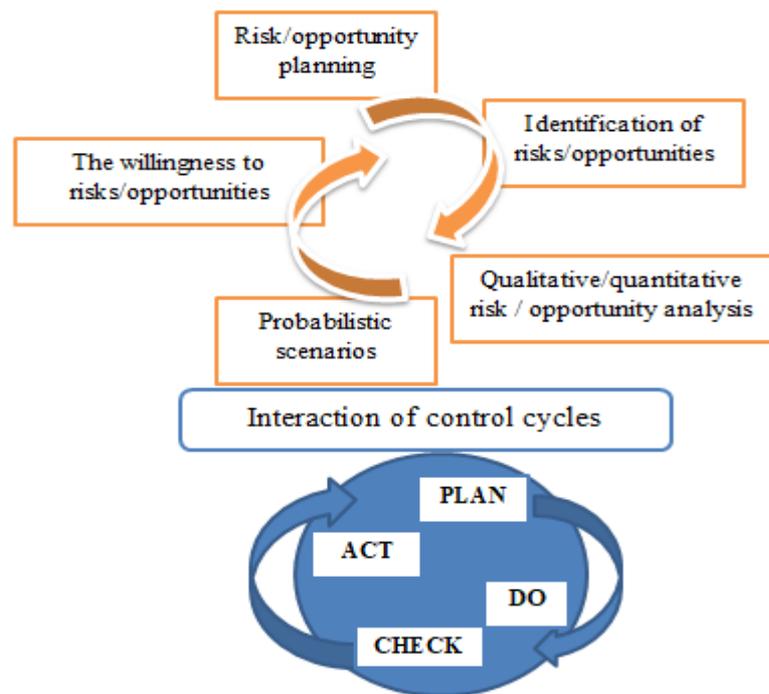
One of these areas is the environmental management of industrial enterprises, carrying out the solution of environmentally oriented tasks and control of environmental threats. Work with environmental risks, the inclusion of risk thinking in the planning and implementation of production activities of enterprises—these are the requirements of modern standards of production activity (Behmann 2010, Busygin 2015, Orlov and Pugach 2012). This vector of development allows for preventive management, which plays an important role in the decision-making process, scanning the external environment and analyzing potential environmental risk factors (Dudin et al. 2013, Vasilenko 2018, Yanitsky 2014).

## MATERIALS AND METHODS

### Integration of Quality Management System and Environmental Management of Industrial Enterprise: Interaction of Management Principles

The new version of ISO 9001: 2015 (transition to it in the certification system is planned until 2018) is less prescriptive than its previous versions. Its developers focused on achieving productivity and efficiency of processes, achieving this by combining the process approach with the *risk-based thinking* of the organization. Based on the adopted normative documents and studies, we consider the following understanding to be justified: risk-oriented thinking is the ability to determine the situation from a risk position, to identify, analyze and assess the risk, to have a willingness to influence the risk in order to obtain a positive result of the process, including life safety (Diev 2010, Dolinina and Kushnareva 2016, Kamdina 2013, Shestak 2015).

The essence of the management cycle **Plan-Do-Check-Act** at all levels of the organization in this case, at the planning stage is supplemented by an analysis of possible actions or their absence and the assessment of the occurrence of losses' or profits' various kinds in the event of possible events. The result of this analysis is a set of planned outcomes of events (scenarios) that correspond to possible factors that disrupt the process and pose a threat to its security.



**Fig. 1.** Introduction of risk-based approach into the quality management system of an industrial enterprise

Thus, the risk-oriented thinking of the organization currently is an imperative and indicates the need for the development and implementation of a range of agreed methods and measures for management and control of risks that could impede the organization activity in achieving the goal. Important here is the context of risk thinking as a tool for the development and achievement of continuous improvement of the enterprise activity in all areas – production, financial, socio-cultural. Its peculiarity lies in a new kind of risk – *missing opportunities* for development (positive increment of process indicators, when it goes beyond its borders that means not only the improvement of the process, but also the potential for intensification). In this case, another cycle is formed – risk analysis of new proposals for existing opportunities.

Implementation of environmental management of the enterprise is standardized through the international environmental initiative – ISO14000 standards, which includes in addition to the obvious environmental facilities (air and water environment, soil, natural ecosystems and landscapes) socio-economic situation and cultural and historical heritage. The essence of these positions is extremely important for the environmental audit and is aimed at updating the environmental culture of each person and the enterprise as a whole, the search for the anthropocentric balance of the enterprise and society, the emergence of not declared, but the real social responsibility of enterprises (Kirillov and Egorova

2011, Mozgovaya and Shlykova 2016, Reznik and Khazova 2017).

*Human factor* can be traced in the standard of environmental management in the format of *public participation* and is disclosed in detail when it is integrated with the principles of quality management:

1. The principle of *customer orientation*. The main direction of quality management is to ensure compliance with the requirements of consumers and is an effort to exceed their expectations. Then, in the context of environmental risk analysis, one of the *expectations* should be positioned as a *minimization of environmental harm* in the operation of production facilities.

2. The principle of *leadership*. Leaders at all levels ensure the unity of goals and directions of development and create conditions in which employees are involved in activities to achieve the goals of the organization in the field of quality. The focus on the *environmental consciousness* of business leaders is closely related to social responsibility and is considered by us as “the ability to understand the existing inextricable link between the human community and nature, which is expressed in the dependence of human well-being and the efficiency of economic activity on the integrity and comparative immutability of the natural environment.” The existing ecological cataclysms and their destructive

consequences for the further existence of mankind should be the starting point for the analysis of the consequences of the enterprise's economic activity for the natural environment and be accompanied by the readiness for significant economic expenses of the enterprise (not the state) to support and develop the high quality of the ecological environment.

3. The principle of *employee engagement*. It is important for the organization that all employees are competent, have the necessary authority and are involved in the creation of the values of the goods/services produced. Leadership of the organization in the field of environmental safety leads to the need to form the environmental culture of the enterprise and each of its employees, as a set of sustainable views on the essence of life activity in the natural or urban environment. Like any kind of culture, environmental culture manifests itself in moral attitudes and declared values and is practically implemented through behavior in real conditions, capable of ensuring sustainable environmental quality, ensuring environmental safety of the nation and the rational use of natural resources in all activities.

4. Principles of *process approach implementation and continuous improvement*. Sustainable and predictable results are achieved more efficiently and effectively when activities are viewed and managed as a set of interrelated and interoperable processes that function as a coherent system, taking into account the environmental risks of production activities. Their identification should be focused on the specifics of the enterprise and its territorial location in the region, the ratio of many important environmental aspects and related impacts, as well as the interests of internal and external stakeholders.

5. The principle of *decision-making based on monitoring (evidence)*. Decisions based on the analysis and evaluation of data and information are more likely to achieve the desired results. The method used should produce consistent results and include the development and application of evaluation criteria, such as those that take into account the interaction with the environment and legislative issues.

A typical environmental audit of an enterprise consists in the implementation of a standard sequence of steps:

- Determination of compliance of a business entity's environmental documentation with environmental requirements;

- Assessment of the environmental management system's effectiveness;

- Assessment of damage to the natural (environment) environment from pollution;

- Determination of environmental management's rationality of the enterprise;

- Assessment of measures' effectiveness developed by the company to reduce emissions into the air;

- Assessment of measures' effectiveness developed by the company to reduce emissions into natural water reservoirs;

- Environmental risk assessment as a result of man-made accidents and random natural processes;

- Identification of environmental problems of the enterprise and development of measures to address them.

Taking into account the concept of *environmental culture of the enterprise*, the regulation of the audit can be significantly changed – the idea of the role and place of each employee in the formation of the environmental culture of the enterprise as a whole is expanding, therefore, the role of the content-semantic basis of environmental culture – environmental knowledge, the need for their development and implementation of this educational function by the industrial enterprise itself is increasing. An important one is the aspect of the *universality* of this training, expanding the responsibility of all employees, and not only of managers and specialists. Environmental education and training are the essence of modern knowledge of the organization, its socio-psychological climate, contributing to the resolution of the contradiction between the use of the environment and the attitude of people to the nature of its use. Therefore, the environmental knowledge of the organization and its employees, both declared and implemented in economic activities should also be undergone environmental audit and included in its program.

6. The principle of *relationship management*. Organizations to achieve sustainable success manage their relationships with stakeholders in order to optimize their impact on their activities. This principle in the context of environmental management is extremely important, and is determined by the low rate of natural benefits' growth relative to the increasing rate of their consumption's growth. Moreover, the

<b>(a) methodological changes</b>	→	a clear focus on the interests of all <i>stakeholders</i>
	→	introduction of the concept <i>risk-based decision-making</i>
	→	introduction of the concept of <i>the organization competence</i>
<b>(b) structural changes</b>	→	coordination of requirements and all sections of the management system taking into account the interests and logical relationship of the processes of the organization in the context of environmental safety
	→	freedom to documenting of the needs and objectives of the enterprise
<b>(c) procedural changes</b>	→	increasing the requirements for top management leadership in relation to the environmental culture of employees and the enterprise as a whole
	→	increasing the level of social responsibility of employees and the company as a whole for the preservation of the ecological balance
	→	implementation of risk management tools in the enterprise management system
<b>(d) result and assessment changes</b>	→	establishment of a systematic assessment of the environmental management system's effectiveness in order to identify the risks of quality violation
	→	implementation of <i>statistical thinking</i> in environmental management

**Fig. 2.** Changes in the management system for solving environmental problems

contradiction of each person as a consumer of nature and products of production also refers to the problem of relationship management. Theoretically, this problem can be solved by compensation to the natural system through restoration work of the withdrawn natural potential's cost. However, in practice, especially in view of economic crises, the pursuit of profit increasingly reduces the rate of evolutionary processes in the biosphere. This position, in our opinion, emphasizes the importance and priority of ecological culture of the enterprise in modern conditions and sets a new task of management - identification of environmental risks and development of preventive scenarios of the industrial enterprise's economic activity.

## RESULTS

The positive effect of the integration of the environmental management standard and the new quality standard, as well as the degree of changes in management will depend on the level of development and effectiveness of the existing management system, organizational structure and practices. The reconfigurations of the existing management system in the context of solving environmental management problems are required (see **Fig. 2**).

Under the environmental risk, we mean the occurrence of negative changes with instant or delayed action in the environment under the influence of economic activity of the enterprise. The described changes lead to the expansion of the process of identification of environmental risks of the enterprise, which are embedded in its system of social interests and is formed by the awareness of the high probability of adverse events.

The standard formula for risk assessment is presented as a dependence of the damage value on the probability of occurrence of  $j$  adverse events of  $P_j$  type

and the probability of obtaining damage of size as a result of occurrence of  $I$  adverse event of  $P_i$  type when controlling the damage value  $X_i$  in accordance with the law of damage distribution  $P_i(j, Z_j)$  depending on the taken security measures  $Z_j$  and the probability of choice of the situation  $g_{ij}$  by the object

$$R = \sum_{i=1}^n \sum_{j=1}^m g_{ij}(V) P_j P_i(j, Z_j) X_i, \quad (1)$$

Meanwhile, despite the probabilistic nature, the application of this formula to the assessment of environmental risks is difficult due to the prolonged effect and unpredictability of the consequences of environmental risks' combinations (including from two or more industrial enterprises united geographically).

Regarding environmental management, in our opinion, more applicable are the qualitative and quantitative assessments of the circumstances in the identification of environmental risks, built on a multidimensional analysis-combining view of individual environmental risks of industrial enterprises with environmental assessment. Monitoring indicators corresponding to adverse processes and phenomena of social, natural, man-made nature or their combinations determine individual environmental risks.

We give a generalized example of an algorithm for identifying environmental risks of an industrial enterprise (**Fig. 3**).

Thus, the assessment of individual risks of the industrial enterprise on the given algorithm allows them to systematize and subsequently carry out their quantitative assessment based on introduction of the scaled indicators and the expert analysis of their boundary states. The application of the process approach here contributes to the formation of a system of special triggers – pointers to the high probability of

<b>Industry specific</b>							
construction materials production	agroindustrial sector	transport sector	petrochemical industry	metallurgy	energy sector		
<b>Individual industry risks</b>							
↓							
<b>Regional specificity</b>							
landscape specifics	risks of natural and man-made disasters	level of environmental pollution	climatic features	distribution of potentially hazardous industrial facilities	information on population density in the area of possible impact	data on meteorological indicators	public health
<b>Individual risks of natural emergencies</b>							
↓							
<b>Facility specifics</b>							
statistics on environmental accidents	data on hazardous substances that are produced, used, processed and stored at the facility		information on the level of technology used	information on the state of environmental protection equipment	information about the existing security system at the enterprise	data on depreciation of fixed assets	environmental compliance
<b>Individual risks of man-made emergencies</b>							
↓							
<b>Level of social responsibility of the enterprise in the environmental sphere</b>							
environmental culture of the enterprise	ecological culture of leader and leadership	environmental culture of employees	data on the qualification of production personnel				
<b>Individual social risks of the enterprise</b>							

**Fig. 3.** Changes in the management system for solving environmental problems

risk (negative changes in the environment or long-term adverse effects of these changes arising from negative environmental impact). These representations and interrelations open new opportunities for an assessment of a state and prospects of development of the enterprises' ecological management systems and implementation of preventive management.

Since any extreme situation is easier to prevent than to eliminate its consequences, preventive management can be an essential argument in the implementation of environmental management tasks.

In the most General case, the following steps can describe the preventive management cycle of environmental risk management:

1. Setting goals for environmental risk management. Alternatively, it may be the reduced impact of economic activities of industrial enterprises, prevention of environmentally hazardous activities. It evaluates the external and internal environmental situation, determines the target function and target values for selecting the best alternative.

2. Identification of possible actions and target costs for each alternative (price-quality) in the short and long term (collection and analysis of information, analysis of best practices, etc.).

3. Analysis of the environmental potential from the standpoint of the probability of risks - the search for uncontrolled factors in situations of uncertainty and methods of leveling risks.

4. Monitoring of environmental risk indicators according to the established scale and evaluation of the effectiveness of existing preventive measures

5. Development of management decisions on work with environmental risks based on scenario alternatives.

6. Development and implementation of corrective methods of impact on environmental risks.

The problem of situational modeling of alternative scenarios in the framework of environmental management is closely related to the availability of necessary and sufficient information: systematized source data, key indicators that identify the process; boundaries of processes with variable tolerance; established periods of indicators' control (local, operational, intermediate, total, etc.). The following factors are also important: availability of adequate information sources and detailed logging of events (states, periods, and emerging tasks) for statistical analysis.

The tasks of preventive management of environmental risks of an industrial enterprise include:

- Identification of problem ecological zones of the enterprise;
- Identification of the main man-made factors of production and their interaction with natural hazards in the local area of the enterprise;
- Identification of hazardous production areas and units, their continuous technological monitoring;
- Description of environmental safety degree of all production processes;
- Improving the environmental culture of the company's employees, their continuous training in this area;
- Creating a system of environmental regulation of the enterprise and its continuous improvement by including all employees in the achievement of environmental safety of the enterprise.

Increased attention to the full range of tasks allows preventive management of environmental risks in a comprehensive manner and at an early stage to identify potential problems.

## DISCUSSION AND CONCLUSION

Environmental safety is one of the most important types of civilization security. The ever-existing threats of random natural processes in the course of historical development have been complemented by increasing anthropogenic impacts on the natural environment, causing adverse effects both in the environment and in the economy and public health at the global, regional and local levels. This became particularly evident in the last third of the twentieth century, when environmental hazards at all levels and the need to protect against them were recognized as a priority for humanity. Meanwhile, the multiplicity of threats to human security (terrorist, economic, information) inevitably push environmental problems into the background (Shchankina 2016, Shtrikov 2010).

Environmental risks, of course, are a problem of the whole society, but they often have a territorial localization, so they suggest the need for a plurality of actors at the community level to make management decisions (Kuzmin 2012). This fact also caused the problems of environmental risk assessment:

- Lack of a unified approach to the assessment of environmental risks of an industrial enterprise;
- Lack of a unified approach to the economic assessment of natural emergency impacts and their delayed effect;
- Absence of integrated assessment of environmental risks for various facilities;
- Absence of levels of acceptable environmental risk.

The study of tools and practices for environmental risk analysis and assessment conducted by the G20 working group on green Finance showed that this area of risk management is still at an early stage of development, despite the fact that there are positive examples of identification and assessment of environmental risks and measures to eliminate or minimize them in the modern practice of organizations of various countries and industries.

Meanwhile, socially responsible industrial relations in the field of environmental safety can ensure the reduction of environmental threats through preventive management of environmental risks, implying continuous assessment and identification of risks and realizing the need for continuous monitoring of emerging and existing risks.

The solution of these problems of industrial enterprises' environmental risk assessment will be contributed by the authors developed:

- Mechanisms of integration of environmental management systems and quality management of the enterprise, contributing to the creation of universal standardized categories of environmental risks;
- Practical implementation of the principles of quality management in the environmental management system (customer orientation, leadership, employee involvement, implementation of the process approach and *continuous improvement*, decision-making based on monitoring (evidence), contributing to the growth of social attitudes regarding environmental activities;
- Formation of the organization's risk-oriented thinking in the framework of environmental management, involving the identification, analysis and assessment of life safety risks in order to make adequate management decisions regarding environmental activities.

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