Analysis of the environmental and economic indicators of the industrial enterprise

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Abstract. In the paper the features of the analysis of the environmental and economic indicators of the industrial enterprise are considered. The purpose of the study is to improve the system of environmental and economic analysis at the enterprise for more accurate forecasting of its main environmental and economic indicators. The study of the main approaches to the implementation of environmental and economic analysis based on the corresponding systems of indicators with identification of the most significant factors was carried out. The main result of the study is the choice of a system for analyzing the environmental and economic indicators, maximally oriented to a specific enterprise, taking into account its production specific features. The practical significance of the study consists in the selection of an adequate system of indicators at enterprises to improve the effectiveness from preparation of an environmentally safe management decision.

1. Introduction

One of the modern trends in the effective operation of an enterprise is the consideration of the environmental factor in the implementation of management decisions [1 - 3] in the conditions of a multi-level management system – from the workplace of the production unit to the Director General. Figure 1 presents a simplified scheme for the development of an effective environmental-friendly management decision.

The first block, presented in figure 1, includes the choice of the system of environmental and economic indicators, which depends on many factors, including the size of the enterprise and its negative environmental impact, industry, availability of reliable data, etc.

In the second block, the analysis of the environmental and economic indicators is performed, in which its purpose is determined, the tasks and the procedure are formed.

The third block is directly linked to the forecasting of environmental and economic indicators, the results of which are used to justify and support the adoption of an effective environment friendly management decision.

The result of the fourth block includes the entire range of control actions aimed at the internal and external environment of the enterprise, including:

- formation of a production program taking into account environmental constraints;
- improvement of the organizational structure of the environmental service;
- implementation of technological solutions aimed at minimizing the negative impact on the environment;
• organization of procurement of raw materials and materials based on environmental safety requirements, etc.

![Figure 1. Scheme for the development of an effective environment friendly management decision.](image)

In this regard, for the adequate analysis and forecasting, the choice of a system of environmental and economic indicators is of great importance.

2. Material and methods

The object of the study is the environmental and economic analysis of large industrial enterprises, differentiated according to the areas of environmental policy implementation.

The subject of the study is a system of environmental and economic indicators that is maximally adapted to the specific functioning enterprise.

The study is based on the analysis of domestic and foreign literature devoted to the problems of environmental and economic analysis of enterprises and other territorially distributed environmental and economic systems. Particular attention is paid to approbation of the chosen system of environmental and economic indicators on these large industrial enterprises.

To approbate the proposed methodology, statistical processing of environmental data of an industrial enterprise was carried out on the basis of official environmental reporting forms. The elements of system analysis and results obtained by specialists in the field of environmental and economic analysis of objects of different levels were also used in the work.

3. Results and discussion

There are various approaches to solving this problem, for example, a number of researchers note that in calculating environmental and economic indicators, the methodology used to calculate the economic damage from environmental pollution is of great importance [4, 5]. In the article [6] the authors considered the existing approaches to the assessment of environmental and economic damage, including in the context of economic losses in the sphere of forest use.

In work [7] the technique for calculation of the efficiency of complex use of material resources, based on the system of indicators reflecting social-economic and environmental efficiency, is offered. The group of indicators of economic efficiency includes the following elements:

- volume of sold products produced using wastes [8];
- the amount of profit from the sale of waste and products produced with their use;
- economic efficiency of waste utilization.

Direct analysis of environmental and economic indicators is also a key stage in the making of an effective management decision [9], for example, a number of authors note that the environmental and economic analysis of production is an important part of the environmental management system at macro and micro levels [10]. In work [11] the improved technique of the environmental and economic analysis of environment protection activity of the enterprise for a substantiation of increase of its efficiency is considered. At the same time, the author supplemented the traditional system of principles of economic analysis of the enterprise with specific indicators:

- capital productivity of the main production assets of environment protection purposes, taking into account the amount of prevented environmental damage per one ruble of the cost of environmental protection equipment;
resource intensity of products – through the specific weight of their consumption in value terms in the cost of production.

In study [12], the calculated indicators were developed for carrying out environmental and economic analysis at the facilities of housing and communal services and incorporated into the following blocks:

- indicators of the state and efficiency of the use of fixed assets, including those involved in environmental protection measures;
- environmental and economic indicators that characterize the impact on the production process, the performance of work, the provision of services;
- environmental and economic indicators that reflect the impact of environmental and economic processes on the financial performance of economic entities;
- coefficients of return on equity, adjusted for the environmental factor;
- turnover indicators.

Based on the study of approaches to the problem of effective environmental and economic analysis, a system of environmental and economic indicators was developed [13], which was tested at the enterprises of “Azot” KJSC and “Koks” PJSC, which have a significant negative environmental impact (NEI). The most important are the statistical dependencies of the level of risk [14], charges for the NEI and the compensation coefficient of economic losses from the current costs of environmental protection. The information base for determining these indicators is the statistical reporting form No. 4-OS “Information on current costs for environmental protection and environmental payments”.

The level of risk or the specific weight of the fee for excess NIE in the total amount of payment is determined by formula (1):

\[ RL = \frac{\sum_{k=1}^{K} \sum_{l=1}^{L} P_{l|k} \cdot P_{e|kl}}{P_{k}} \times 100 \% \]  \hspace{1cm} (1)

where \( k \) is the type of pollutant or hazard class of production and consumption waste; \( l \) is an element of the environment; \( K \) – total number of types of pollutants or hazard classes of production and consumption wastes; \( L \) is the total number of elements of the environment; \( P_{k} \), \( P_{l|k} \), \( P_{e|kl} \) – respectively, the total amount of payment and payment for the limit-exceeding NIE of the \( k \)-th type of pollutant or hazard class of production and consumption waste per \( l \)-th element of the environment, million rubles.

Figure 2 shows the correlation field between the current costs of environmental protection and the risk level at the enterprise of “Azot” KJSC. Each point on the analyzed correlation fields displays a calendar year.

Figure 2 shows that the dependence is non-linear, in particular, until 2013 (the points on the left side of the diagram) there is an inverse relationship, when the increase in current costs from 23.8 to 2187.5 million rubles leads to a decrease in RL from 39.59 to 0%. From 2013 (the right side of the diagram) the further increase in current costs is accompanied by a significant increase in RL to 92.58%, which is explained by a sharp increase in payments for limit-exceeding pollution of water sources and may be caused by large-scale technical re-equipment of treatment facilities, which is planned to be completed in 2017.

The forecast of the risk level, carried out with the help of a simple extrapolation, provided that the enterprise environmental policy did not changed during the forecast period, showed that further increase in current costs will not lead to the reduction in the risk level, the value of which will fluctuate about 100%. This situation characterizes insufficiently effective use of current costs for environmental protection and requires a search for a mechanism of their distribution to enhance the company environmental and economic security.

Figure 3 shows the correlation field between the current costs of environmental protection and the payment for NEI by the enterprise “Azot” KJSC.
Figure 2. Correlation field and empirical line of regression of the dependence of the risk level on the current costs of environmental protection at the enterprise “Azot” KJSC.

Analysis of figure 3 also shows different conditions for implementing the environmental policy of the enterprise. In the lower part of the correlation field, it can be seen that a significant increase in current costs (from 24 million rubles to about 2.5 billion rubles) led to a slight fluctuation in the payment (from 5 to 2 million rubles). The upper part of the correlation field shows that the further increase in current costs is accompanied by a sharp rise in fees (up to 31.51 million rubles) due to excess pollution of water sources. The forecast of the NEI payment is consistent with the conclusions drawn from the analysis of figure 2. In particular, the current costs intended to reduce the negative impact under these conditions do not fulfill this function and with the forecast of their increase to 3.5 billion rubles. The payment for negative impact will also increase and will amount to more than 40 million rubles.
To assess the environmental and economic efficiency of environmental protection, an indicator such as the economic loss compensation coefficient (CCel), which for a particular enterprise is calculated using formula (2), can be used:

\[
CCel = \sum_{k=1}^{K} \sum_{l=1}^{L} \frac{P_{kl}}{EL_{kl}} \times 100 \%,
\]

where \( EL_{kl} \) – economic damage from negative impact of the \( k \)-th type of pollutant or hazard class of production and consumption wastes on the \( l \)-th element of the environment, million rubles.

Figure 4 shows the correlation field of the dependence of the economic loss compensation factor on the current environmental costs of the “Koks” PJSC.

![Figure 4. Correlation field of the dependence of the economic loss compensation coefficient on the current environmental costs of “Koks” PJSC.](image)

From figure 4 it can be assumed that environmental activities at the enterprise were implemented under different conditions. The lower part of the correlation field characterizes a significant increase in current costs (from 20 to 69 million rubles), at which CCel is below 1% and almost unchanged. The upper part of the field also shows a sharp increase in current costs (from 142.6 to 213.2 million rubles), but there is a significant increase in CCel (from 2.74 to 5.8%). This situation is explained, in particular, by the commissioning of a closed water cycle, which led to a decrease in the magnitude of economic damage. The general trend of CCel is positive, and with an increase in current costs for environmental protection to 250 million rubles its predicted value, also obtained by simple extrapolation, should be more than 4%.

The analysis and forecasting [15, 16] of the considered environmental and economic indicators are necessary for the formation of effective management decisions aimed at improving the quality of current costs. The improvement of the system of their distribution for specific areas of use is of great importance here, for example, using the method of expert assessments. The projected increase in the level of risk and NEI payment also motivates enterprises to improve the efficiency of the organizational and economic mechanism for environmental management, in particular, for “Azot” KJSC it is advisable to plan a production program taking into account environmental constraints.

4. Conclusions
As a result of the study the following conclusions can be drawn:
• a simplified scheme for the development of an effective environment friendly management decision with interpretation of individual blocks was developed;
• a system of environmental and economic indicators was selected based on the analysis of literature sources;
• proposed environmental and economic indicators based on official data and adapted to the specifics of enterprises;
• correlation fields and empirical regression lines for the dependence of the main environmental and economic indicators on current costs for environmental protection are constructed;
• an attempt is made to predict the main environmental and economic indicators taking into account the “non-linearity” of the environmental policy implementation by the enterprise;
• proposals have been worked out for the system of support for making an effective environment friendly management decision.

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