EVALUATION OF ECONOMIC AND ENVIRONMENTAL EFFICIENCY OF IRON ORE ENTERPRISES IN UKRAINE

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Abstract: The author's vision of the key role of the metallurgical complex in the economic system and significant systemic anthropogenic impact on the environment underlies the mining processing production monitoring and ecologization. The purpose of this paper is to develop the integrated index of economic and environmental performance as the information basis of analysis and decision-making of mining processing production in the context of environmental activities. The review of scientific sources for defining the essence of the ecological efficiency of iron ore mining production was considered. The structure of informational basis for the economic analysis of mining production economic efficiency of iron ore mining plants was given. The means for improving the information basis for analysis and evaluation of mining processing and production in the context economic-ecological monitoring is suggested. Keywords: efficiency of environmental activities, information basis, mining production, management, economic analysis, index of economic and environmental performance.

Keywords: iron ore, economic efficiency, environmental efficiency, enterprise, Ukraine, metallurgy.

Introduction
Iron ore industry is the basis of the metallurgical complex of Ukraine and one of the most important systems of domestic economy, which depends on the efficiency of the economy and welfare of the general population. It is structurally complex branch of Ukraine's economy. So today the question of increasing economic and environmental efficiency of the iron ore industry arises acutely.

To make informed management decisions it is necessary to understand and trace the trajectory of the dynamics not only of key indicators of financial reporting and management accounting but also the dynamics of indicators that reflect the complex state of enterprise efficiency and allow comparison with the results of other industry. For this purpose the generalized complex integrated indicators are developed, the use of which will meet the objectives outlined above.

Method
The issues of the development of integrated index of economic performance in statistical aspect are developed in the works of the following local and foreign scientists: Yerina A. (2003) and Tsaruk O. (2007). However, the result of these studies did not form the effective methods of environmental impact monitoring of industrial activity and its influence on the environment.

In the domestic and foreign literature there are also approaches to building an integrated assessment through the performance, and for each element of the environment: atmosphere, water resources etc. Without going into the analysis of the proposed approach, we can notice that the estimates of the economic and environmental performance directly at the enterprise level were carried out and published infrequently. Most commonly the assessment of this nature were used at the level of sectors or regions, and only recently such interest can be seen in the assessment at the enterprise level.

The aim of our research is to develop the integrated index of economic and environmental performance as the information basis of analysis and decision-making of mining processing production in the context of environmental activities.

Results
There are different approaches to the development of integrated and general indicators of economic and environmental efficiency of enterprises. This assessment is carried out either on the basis of one of the indicators that reflects the greatest impacts on the environment, either through an aggregated indicator based
on several indicators. Procedures of expression of the economic and environmental efficiency through one integrated index are quite difficult and time consuming. All of this makes to use the integral as a universal indicator that can display the main features of the enterprises' efficiency. Indicators of economic losses, environmental efficiency measures, waste volume production, rate of weight reduction, resource-intensive, aggregates, indicators of pollution charges, etc. may be used as one of universal indicators. Environmental Law outlines the nature of environmental monitoring as a tool for environmental regulation that allows creation of an information base necessary to perform the tasks of environmental management and control. Therefore, the study of structure formation and the economic-ecological monitoring should start from the second component.

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In these circumstances, the assessment produced on the basis of comprehensive, universal and generalized indicators, cannot fully characterize the level of economic and environmental development of the company, as it becomes necessary to shift the relationship of environmental activities with industrial, financial, organizational processes that occur in a particular company.

Many estimates of anthropogenic impact on the environment, which are applied in practice, does not take into account the current trends in the market economy and mechanism of paid nature use. The methods for ranking and classification of enterprises according to their environmental and economic development are very poorly developed. The work, which is carried out at the enterprises by assessing their environmental performance, is systemless in nature. In addition, the majority of calculation methods for the integral indicator of economic and environmental efficiency of enterprises is very difficult to realize in practice.

Thus, the need to improve existing approaches to the integral index of economic and environmental efficiency for mining businesses is an obvious and urgent demand for today.

![Integrated assessment of economic and environmental performance](image)

**Fig. 1.** Integrated assessment of economic and environmental performance

According to the author's opinion the integral indicator of ecological and economic efficiency of mining enterprises should include 2 groups and 4 sub-groups of indicators that will more fully describe the economic and environmental performance of the enterprise. (See Fig. 1). These indicators are part of two major groups of economic and environmental efficiency indicators, respectively. In the early stages the number of parameters was significantly higher, but only those values, which were available for analysis and there is no doubt in their accuracy and objectivity, were selected.

At first glance some of them may seem mutually exclusive or interrelated, such as labour productivity and labor input. Of course in classical terms, these figures are inverse to one another and eliminate the use of both in the same model for estimate technique, but provided that labour productivity is calculated based on the natural parameters of work time spent, output and labour input based on cost, their use enables to combine the effect of price and technological efficiency in the synthesis target.
Determination of integrated assessment of enterprises' economic and environmental efficiency based on our proposed sets of indicators for mining enterprises for 5 years deepened the analysis of industrial and environmental activities in the dynamics. We offer to determine the partial elements of integrated assessment of economic and environmental efficiency of mining enterprises by comparison with the average over the period:

\[ z_{ij} = \frac{-x_{ij}}{\bar{x}_i} \quad \text{for index of stimulants (+),} \tag{1} \]

\[ z_{ij} = \frac{x_{ij}}{\bar{x}_i} \quad \text{for index of deterrents (-)} \tag{2} \]

where, \( x_{ij} \) – value \( i \)-index for \( j \)-enterprise (or period); \( \bar{x}_i \) – average \( i \)-index for \( j \) enterprises (periods), stimulants/detriment – indexes, with positive/negative impact on the overall assessment, respectively.

Integral estimates for \( j \)-enterprise (or period) can be determined with the help of multidimensional medium:

\[ G_j = \sum_{i=1}^{m} z_{ij}d_i \tag{3} \]

where \( d_i \) – weighable coefficient \( i \)-index (group of indexes).

Calculation of the integrated assessment of economic and environmental efficiency of \( (G_j) \) for mining enterprises for different periods of time allows to analyze the dynamics of industrial activity and to identify the nature of their relationship with indicators of environmental activities. Comparison of integrated assessments of mining companies helps set for owner its own formal policy for volumes of production. In view of the above, the cost-effectiveness of environmental activities of iron ore companies can be defined as a comprehensive assessment of the activity of iron ore companies in the segment of environmental activities in relation to the direct and indirect results of this activity.

As indicators of economic and environmental efficiency were grouped in 2 groups and 4 groups, there was a problem determining the weighting coefficients for each of these groups. To solve this problem we used techniques of relationships analysis and the Delphi method. As a result of processing the experts' surveys we defined weight coefficient for each group (I group – 0,18, II group – 0,15, III group – 0,38, IV group – 0,29), that allows us to determine the average rating grade of economic and environmental performance of mining enterprises more accurately.

Expert method found that the greatest weight will have the indicators that characterize financial performance and environmental performance of the enterprise. Given the fact that our system of rating includes only five observations, the use of correlation and regression techniques becomes impossible, so we used expert assessment. We have made a written correspondence using anonymous individual expert survey (Delphi method) with twenty experts in the field of economic and environmental efficiency of mining enterprises of Dnipropetrovsk region with subsequent formation results based on their acceptance by a qualified majority of experts.

Conducted calculations for 2008-2012 were concerned to determine the partial and total integrated assessment of ecological and economic efficiency of 6 enterprises, producing more than 90% of production in Ukraine: The South GOK, The Central GOK, Inguletskiy GOK, The North GOK, Novokryvorizkyy GOK (part of Mittal Steel) and Poltava GOK.

The results of calculations help to assess the efficiency of companies for each of the groups of selected indicators, and to identify what factors had the greatest impact on the summary for assessment of the effectiveness. It is necessary to note the strong correlation between the values of integrated assessment for all mining enterprises.

That is, the results indicate that enterprises' activity in the dynamics is substantially interdependent on external influences, which determine the level of environmental and economic efficiency because the synthesis rate for all firms at each time interval was the same vector of development.
The calculations also show that Novokryvorizky GOK (Krivorizhstal) had the highest level of economic and environmental performance in 2008. But in 2009 all companies experienced deterioration in virtually all groups of efficiency, as a result in 2012 this company had the worst score for efficiency, and leaders were the North and Inguletskiy GOK. It should be noted that these two companies are characterized as the least variable in the average weighted group $z_{vi}$, and they took the leading positions in 2012 despite the fact that all groups of indicators they received had a mediocre efficiency importance, however, and in the absence of a significant negative impact of deterrents' performance.

Discussion

Thus, based on our adapted method using a multi-dimensional medium for the implementation of an integrated assessment of environmental and economic efficiency of the mining and processing of iron ore production in Ukraine, we have concluded that examined for the period 2008 to 2012 the Northern GOK and Inguletskiy GOK have the best dynamics performance, and low levels of variation, suggesting that they inherent a sustainable type of development. To implement an integrated assessment of environmental and economic efficiency of enterprises GOK we adapted and tested method using multidimensional medium, based on the system grouped parameters of production and eco-efficiency with regard to expert review of the impact of each group of indicators.

References