

The background features a low-angle shot of several modern skyscrapers with glass facades, set against a clear blue sky. The image is overlaid with large, semi-transparent geometric shapes in shades of blue and white, creating a dynamic, architectural composition. The text is centered within a white, angular shape at the bottom of the page.

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ASSESSMENT OF THE EFFICIENCY OF THE OPERATION OF PAINT AND COATING INDUSTRY ENTERPRISES: DEA-METHOD

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Abstract. Today, in the context of the Russian Federation's full-scale military invasion, annexation, and temporary occupation of part of Ukraine's territory, it is important to increase the efficiency of all types of resources at the national and regional levels, as well as at the level of individual economic entities.

The goal of efficient use of national resources is to decouple economic growth from resource consumption. Decoupling these two factors not only promotes sustainable economic growth, but also helps to conserve resources.

Based on this, the issue of reviewing and adapting the Data Envelopment Analysis methodology in the system of assessing the efficiency of resource use by enterprises in the paint and varnish industry, taking into account the specifics of their functioning, becomes relevant.

There are a number of econometric and mathematical methods used in international practice to analyze and evaluate the performance of companies and the use of resources. One such method is Data Envelopment Analysis (DEA). Modern DEA models were largely developed by researchers Charnes, Cooper, and Rhodes (1978), refined in 1984 (Banker, Charnes, Cooper) and are a continuation of the research of Debreu (1951) and Farrell (1957).

Today, the DEA method has become widespread in the system of assessing the efficiency of resource use of business entities, taking into account the specifics of

their functioning (industries of the national economy, types of economic activity).

The DEA method is all about setting up efficiency boundaries (limits) that let you check how well each thing you're looking at does compared to a certain limit. These boundaries, or limits, are set up based on certain conditions and restrictions that the system (activity) works under.

The frontier consists of the most efficient objects of analysis of the activity under study, which, compared to other units, give the best result. The objects of analysis that provide the maximum possible efficiency within the calculated DEA model are called the "system lying on the Pareto efficiency frontier" or "efficient objects."

An analysis of the literature has made it possible to formulate the stages of applying the DEA method in the methodology for assessing the efficiency of companies' use of resources.

The first stage involves selecting a group of resource subtypes for comparative analysis. The reference group includes the types and composition of relevant resources of economic entities.

The second stage involves selecting indicators for comparison. The indicators should reflect economic, environmental, and social spheres of activity. The number of economic indicators should be limited in order to avoid overloading the weighted average of efficiency assessments based on qualitative and quantitative criteria. This second stage is important given the peculiarities of the DEA method, where

absolute indicators are required at the input and output stages, rather than pre-calculated coefficients. Further, in the process of calculating the DEA method, all possible relationships between absolute indicators and coefficients are formed independently.

Taking into account the specifics of the functioning of paint and varnish industry enterprises, the final set of indicators included the following, formed according to the characteristics of "economics", "environmental friendliness", "sociality" and their assignment to the numerator and denominator in the ratios of invested resources and obtained results:

1) Return (result) from invested or used resources and positive effects (numerator):

1. Net income from sales of products.
2. Net profit.
3. Average number of employees.
4. Charity (spending on social programs, donations and assistance to the Armed Forces of Ukraine, etc.).

2) The volume of resources used or consumed and the negative effect (denominator):

1. Equity (corresponds to net sales revenue, net profit, and affects charity expenses).
2. Payroll fund (corresponds to the average number of employees and charity expenses).
3. The presence and volume of defects or accidents in production (corresponds to the average number of employees).
4. The volume of emissions of pollutants into the atmosphere (corresponds to net sales revenue).
5. Water consumption (water consumption) for production needs (corresponds to net sales revenue).
6. The volume of production waste, except for those reused in the manufacture of products (corresponds to sales revenue).

When relating the numerator and denominator, we used the following designations: "adequate", "permissible", "possible" and "significant".

In the third stage, weighting

coefficients are selected for each type of resource to maximize the cost-output function.

There is specialized software for building DEA models that facilitates the process of analysis and calculation. The most popular DEA modelling software includes DEAP, R DEA, Saaty DEA, DEA Solver Pro, and others. These programs have a convenient interface for defining input parameters, calculating the DEA model, and performing optimization to evaluate each type of resource analyzed.

It should be noted that we have considered the simplest, basic version of DEA, which provides the basis for various modifications and extensions that allow for the consideration of various aspects of assessing the efficiency of companies' resource use. The choice of the optimal approach to building a DEA model depends on the specifics of the relevant resource, the available data, and the requirements for the results.

The DEA method allows each resource to occupy its "niche" on the efficient frontier, optimally combining inputs and outputs to achieve the best efficiency. This makes the DEA method an effective tool for evaluating and comparing the efficiency of using different types of enterprise resources, taking into account their unique combination. And if the selection of indicators is limited by the number of types of resources being evaluated, the composition of the output variables will also change within the efficient frontier, reducing the model.

Proper reduction of the DEA model is an important step in preserving the most significant relationships and ensuring the accuracy of assessing the efficiency of companies' resource use. When reducing the model, the importance of each variable and its contribution to overall efficiency should be taken into account. It is necessary to analyze the significance of variables, considering their impact on results and their ability to reflect the efficiency of each

resource.

In this case, it can be seen that the DEA model for assessing the efficiency of all types of resources will be one of the most promising methods for measuring efficiency, combining economic, environmental, and social aspects of the use of the resource potential of economic entities.

Thus:

- The DEA method allows assessing the efficiency of all types of resources used by companies of virtually any level and field of activity that can be formalized. The study demonstrates the potential of the DEA

method's best practices for assessing the efficiency of resource use by economic entities.

- The DEA-based approach allows identifying potential areas for improvement and optimization of processes, which contributes to the creation of more sustainable and competitive operating models. The application of the method allows identifying the most effective ways and best practices for using companies' resources in order to achieve sustainable development of business and the economy as a whole.

Keywords: resources; efficiency; DEA-analysis; DEA Solver Pro; cost-effectiveness; environmental friendliness; sociality.

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