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Improving the Performance Evaluation System of Industrial Enterprises: Indicator Architecture and Composite Index Methodology

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Abstract: The article develops an improved system for evaluating the efficiency of industrial enterprises, comprising an indicator architecture, an enhanced integral-index methodology and a monitoring framework. A critical analysis of current practice identifies its four systemic shortcomings and substantiates the theoretical requirements for the improved system multi-level coverage, balance, practical applicability and linkage to management decisions. A three-layer architecture covering about 20 particular indicators across five blocks (labour, capital, finance, institutional environment and foreign-economic activity) is proposed. A methodology based on linear min-max normalisation and a differentially weighted geometric mean of the integral index is designed, and its performance is confirmed retrospectively using 2018–2025 data.

Citation: Djurayevna, Y. N. Improving the Performance Evaluation System of Industrial Enterprises: Indicator Architecture and Composite Index Methodology. American Journal of Economics and Business Management 2026, 9(7), 562-569.

Received: 10th Apr 2026
Revised: 11th May 2026
Accepted: 11th Jun 2026
Published: 27th Jul 2026



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Keywords: *industrial enterprise, efficiency, evaluation system, integral index, indicator architecture, normalisation, geometric mean, monitoring, regional industry.*

1. Introduction

The quality of regional industrial development management largely depends on the accuracy and comprehensiveness of the performance evaluation system. In current practice, the performance of regional industry is predominantly assessed using only two or three quantitative indicators, such as production volume, growth rate, and, in some cases, export performance [1]. However, such an approach fails to capture the qualitative and sustainability dimensions that are essential for informed managerial decision-making. Against this background, the primary objective of this study is to develop an improved performance evaluation framework comprising a comprehensive indicator architecture, an enhanced methodology for constructing an integral performance index, and a systematic monitoring framework [2]. A critical review of the existing evaluation practices reveals four fundamental systemic shortcomings that justify the need for methodological improvement. First, volume-based indicators are highly sensitive to price fluctuations. Under conditions of high inflation, nominal growth may obscure actual performance dynamics, while changes in the prices of products manufactured by large enterprises can significantly distort the overall performance assessment of an entire region. Second, an excessive focus on production volume reinforces the misconception that "larger output necessarily indicates better performance [3]." In reality, high production volumes generated at a financial loss do not create economic value; rather, they erode it. Third, the

current evaluation framework is incapable of identifying underlying structural problems. For example, a deterioration in financial performance may remain undetected despite continuous growth in production volumes, as the existing system lacks indicators capable of capturing such discrepancies [4]. Finally, evaluation outcomes are not systematically linked to management decision-making processes. The existing framework does not specify which corrective actions should be initiated in response to unsatisfactory performance, thereby limiting the practical usefulness of evaluation results for evidence-based governance [5].

2. Materials And Methods

The proposed performance evaluation system is designed to satisfy four fundamental theoretical requirements.

The first requirement is multi-level integration. The evaluation framework should encompass enterprise, industry, district, and regional levels within a unified methodological framework, enabling indicators measured at lower levels to be systematically aggregated into higher-level assessments.

The second requirement is balance. Quantitative performance indicators should be complemented by qualitative measures reflecting efficiency, sustainability, and social outcomes, thereby avoiding an excessive emphasis on production volume alone and eliminating the incentive to pursue "growth for the sake of growth."

The third requirement is practical applicability. The proposed indicators should rely on existing statistical information or data that can be collected at a reasonable cost. Furthermore, the calculation procedures must be transparent, replicable, and suitable for regular application in performance monitoring.

The fourth requirement is decision orientation. For each indicator, the corresponding decision-making mechanism should be specified in advance by clearly defining who is responsible for taking action, under what circumstances, and which managerial decisions should be implemented. Otherwise, performance evaluation risks becoming merely a statistical exercise with limited practical value for management.

Based on these theoretical principles, a three-layer architecture of the performance evaluation system is proposed (Figure 1).

The first layer comprises the basic indicator system, including approximately twenty individual indicators grouped into five analytical dimensions: labour, capital, finance, institutional environment, and foreign economic activity.

The second layer represents the integrated evaluation stage, where normalized sub-indices are calculated for each dimension and subsequently aggregated into a weighted composite performance index.

The third layer consists of managerial applications, including performance ranking and benchmarking, a systematic monitoring framework, and a decision-support matrix for policy implementation.

The principal advantage of the proposed architecture lies in its ability to institutionalize a practically validated evaluation algorithm, transforming it from a standalone analytical tool into a continuously operating performance management system capable of supporting evidence-based managerial decision-making.

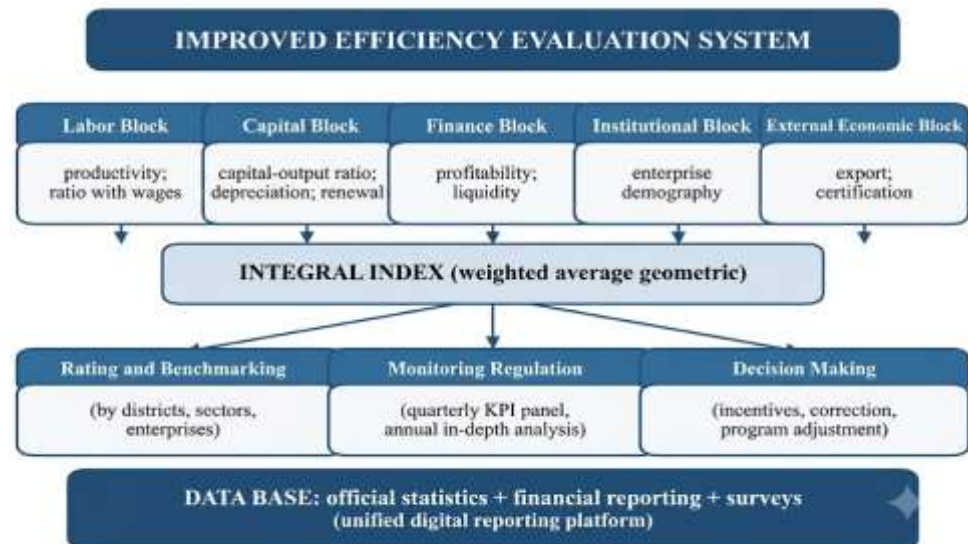


Figure 1. Architecture of the proposed performance evaluation system for industrial enterprises

Source: *Compiled by the author*

3. Results and Discussion

The proposed system of performance indicators is presented in Table 1. The development of this framework was guided by three key principles. First, each indicator should measure a specific performance issue or development potential. Second, the indicators should be mutually complementary, avoiding duplication and overlap [6]. Third, the data source and the frequency of data collection should be clearly specified to ensure transparency and practical applicability.

The labour dimension includes not only labour productivity but also the productivity-to-wage ratio, which serves as an indicator of sustainability, and employment dynamics, reflecting the social dimension of enterprise performance [7].

The capital dimension incorporates capital productivity together with asset depreciation and asset renewal rates, which represent the most critical challenges affecting industrial development, as well as energy intensity, which reflects the efficiency of resource utilization [8].

Within the financial dimension, profitability indicators are complemented by measures of liquidity and the share of loss-making enterprises, providing a more comprehensive assessment of financial sustainability [9].

The institutional dimension evaluates the net entry of enterprises and the three-year enterprise survival rate, thereby capturing the dynamism and resilience of the business environment [10].

Finally, the foreign economic dimension measures the number of exporting enterprises and the degree of export diversification, thereby assessing the international competitiveness and external market integration of industrial enterprises [11].

Table 1. Proposed system of efficiency indicators

Block	Key Indicators	Data Source	Periodicity
Labor	Labor productivity; productivity/wage ratio; employment dynamics; average wage	Statistics, enterprise reports	Quarterly/Annual
Capital	Capital productivity; depreciation rate; renewal coefficient; investment/output ratio; energy intensity	Financial report, survey	Annual
Finance	Return on sales; share of loss-making enterprises; current liquidity; autonomy coefficient	Financial report	Annual
Institutional	Net entry; 3-year survival rate; share of large/medium enterprises; administrative burden index	Registries, surveys	Annual
External Economic	Export volume and share; number of exporters; nomenclature and geography; certified enterprises	Customs, statistics	Quarterly/Annual

Source: Developed by the author.

Within the labour dimension, the inclusion of the productivity-to-wage ratio alongside the absolute level of labour productivity enables the simultaneous monitoring of two critical issues. An excessively high ratio indicates that labour compensation constitutes an insufficient share of productivity gains, thereby signalling a potential social concern. Conversely, a sharp decline in the ratio reflects the erosion of cost competitiveness, representing an economic challenge [12]. Consequently, this indicator functions as a two-sided signalling mechanism with both upper and lower threshold values. Furthermore, the inclusion of employment dynamics as a separate indicator allows the evaluation system to explicitly identify the "productivity at the expense of employment" scenario. If productivity improvements are accompanied by declining employment, the system automatically flags this situation as requiring additional analytical assessment [13].

The methodology for constructing the equally weighted geometric composite performance index was further refined in two principal directions.

The first direction concerns the improvement of the normalization procedure. Since the individual indicators are measured in different units, they are first transformed onto a common scale using linear min–max normalization:

$$Z_i = \frac{X_i - X_{\min}}{X_{\max} - X_{\min}} \quad \text{for benefit (stimulant) indicators, (1)}$$

$$Z_i = \frac{X_{\max} - X_i}{X_{\max} - X_{\min}} \quad \text{for cost (destimulant) indicators. (2)}$$

The application of an inverse scale to destimulant indicators such as the asset depreciation rate, the share of loss-making enterprises, and energy intensity ensures that all components of the composite index follow the same interpretation, whereby higher normalized values consistently indicate better performance [14]. Several normalization techniques were compared before selecting the most appropriate approach. Although z-score standardization preserves information about the statistical distribution of variables, it may generate negative values, making it incompatible with the geometric mean and more difficult to interpret for a broader audience. The ranking method offers computational simplicity but sacrifices information regarding the relative distances between observations [15]. Consequently, linear min-max normalization (Equations 1 and 2) was selected because it provides an intuitive scale ranging from 0 to 1, is fully compatible with the geometric aggregation procedure, and preserves proportional differences among observations. Its sensitivity to extreme values is mitigated by defining boundary values based on the 3rd and 97th percentiles. In addition, the potential problem of zero-valued sub-indices eliminating the geometric mean is addressed by introducing a small positive constant into the normalization procedure. The second methodological enhancement concerns the differentiation of block weights. Although equal weighting offers methodological simplicity, it fails to reflect differences in the strategic importance of individual dimensions and the severity of existing performance constraints. In the proposed methodology, block weights are determined using an expert-analytical approach based on two criteria: (i) the contribution of each block to the target performance objectives and (ii) the current level of structural challenges associated with that block.

The initial weights were established as follows: Labour – 0.25; Capital – 0.25 (assigned the highest priority due to its critical role in industrial development); Finance – 0.20; Institutional Environment – 0.15; and Foreign Economic Activity – 0.15.

The block sub-index and the overall composite performance index are calculated as follows:

$$S_j = \frac{1}{m_j} \sum z_{ij} \quad (3) \quad I_{int} = \prod (S_j)^{w_j}, \sum w_j = 1 \quad (4)$$

The application of equal weights within each block represents a deliberate methodological choice. While differences among the five dimensions reflect strategic priorities and are therefore incorporated through differentiated block weights, the indicators within each block measure complementary aspects of the same performance dimension. Artificially assigning different weights to these indicators would create an unjustified impression of precision without sufficient theoretical or empirical justification. This two-level weighting structure—equal weighting within blocks and differentiated

weighting across blocks—is widely recognized as an appropriate approach in the construction of composite performance indices.

Moreover, the use of the geometric mean preserves the "weakest-link" principle, whereby a substantial deterioration in any single dimension exerts a disproportionately larger negative impact on the overall composite index. This property encourages balanced development across all dimensions rather than exceptional performance in only a few areas. To ensure continued relevance, the weighting scheme is subject to review and revision by the relevant expert council every three years.

Table 2. Composite performance index: equal-weight and weighted variants (year-on-year, %)

Year	Equal-Weight Index	Weighted Index (Proposed Methodology)	Remarks
2018	121.6	120.9	Rapid growth phase
2019	144.3	142.1	Year of structural transformation
2020	108.4	107.2	Resilience during the COVID-19 pandemic
2021	108.1	107.5	Gradual recovery
2022	117.2	116.4	Return to intensive growth
2023	109.6	109.1	Moderate growth
2024	119.5	118.3	Strong growth dynamics
2025	115.2	113.6	Institutional constraints

Source: *Author's calculations.*

The retrospective calculation results obtained using the proposed methodology for the period 2018–2025 are presented in Table 2 (based on the available data for four analytical dimensions). Although the weighted composite index generally follows the same trend as the equally weighted index, it reflects the problem of asset depreciation more sensitively due to the greater weight assigned to the capital dimension. The retrospective analysis confirms the validity and practical applicability of the proposed methodology while establishing a baseline for implementing the evaluation system in its complete configuration, encompassing all five dimensions together with predefined threshold (signal) values.

The practical application of the proposed methodology can be illustrated using the 2025 assessment results. Within the labour dimension, substantial growth in labour productivity maintained the block sub-index within the high-performance range; however, weaker employment dynamics partially offset this positive effect. In the capital dimension, strong investment activity contributed positively, whereas the high level of asset depreciation exerted a negative influence, resulting in an overall medium-performance ("yellow zone") assessment. The financial dimension represented the weakest

component of the evaluation system due to the increasing proportion of loss-making enterprises. Meanwhile, the institutional dimension approached the low-performance ("red zone") threshold as a consequence of the declining number of operating enterprises. By contrast, the foreign economic dimension demonstrated moderate performance, supported by the recovery of export activity. Consequently, the weighted composite performance index reached 113.6%, which was slightly lower than the equally weighted estimate (115.2%). This difference indicates that the differentiated weighting scheme places greater emphasis on the influence of the most problematic performance dimensions.

5. Conclusions

This study proposes a three-layer, multi-level, and decision-oriented framework for evaluating the performance of industrial enterprises. The proposed methodology addresses the principal limitations of the conventional volume-oriented evaluation approach by introducing a comprehensive indicator architecture structured around five analytical dimensions, together with a linear min-max normalization procedure and a differentially weighted geometric composite performance index. Retrospective calculations based on data for the 2018–2025 period confirm both the robustness and the practical applicability of the proposed methodology.

The principal contribution of the proposed evaluation system lies not merely in producing a single composite performance score, but in decomposing overall performance into its constituent dimensions, thereby enabling policymakers and managers to identify precisely where intervention is required. Consequently, the framework establishes a direct link between performance evaluation and managerial decision-making, facilitating the targeted application of institutional and economic policy instruments aimed at improving the efficiency and sustainable development of regional industrial enterprises.

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