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Article

Assessing the Efficiency of Resource Provision in Business Entities Based on Multi-Criteria Matrix Algorithms

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Abstract: The article addresses the evaluation of resource provision efficiency and the determination of intensive development trajectories in industrial enterprises. Unlike traditional approaches, the study utilizes a two-row vector matrix evaluation model that distinguishes between the shares of extensive and intensive factors in economic growth. The analysis highlights systemic differences between resource expansion (extensive growth) and achieving high output through modernization and labor productivity enhancement (intensive growth). Concurrently, the study formulates practical recommendations focused on transitioning enterprises toward an intensive growth strategy, implementing industrial digitalization (ERP systems), and improving cost center control systems.

Keywords: industrial enterprises, resource provision, two-row matrix, L.T.Snitko model, intensive development, extensive factors, labor productivity, modernization, ERP systems

1. Introduction

In the context of modern global economic transformations and the digital revolution, the sustainable operation and competitiveness of business entities directly depend on their resource potential and the efficiency of its utilization. High volatility in market conditions, tightening constraints on raw materials and financial resources, alongside qualitative shifts in the labor market, necessitate a fundamental reform in how business structures manage their existing resources. Consequently, as complex economic systems, business entities require an optimization of their resource provision policies and continuous performance evaluation.

In conventional economic analysis, enterprise resource provision has traditionally been evaluated based on isolated primary indicators (such as financial profitability, capital intensity, or labor productivity alone). However, such a unilateral approach fails to reflect the synergetic interaction among resource factors, their systemic proportionality, and their integrated contribution to the overall production process. In economic theory, intensive development factors are considered the primary criterion ensuring the qualitative growth of national wealth [1].

Problem Statement: In enterprise operations, human, material, and financial resources constitute an interconnected chain. For instance, high-tech equipment (a material resource) fails to deliver the expected economic yield unless it is supported by appropriately qualified personnel (a human resource) and timely investments (a financial resource). Therefore, achieving a competitive advantage at the firm level through the

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efficient utilization of resource provision holds strategic significance [2]. This necessitates the development of multi-criteria and systemic mechanisms for the comprehensive assessment of resource provision in business entities.

In recent years, the demand for mathematical modeling and algorithmic approaches in economic research has been steadily increasing. In particular, multi-criteria evaluation techniques and matrix models enable an all-encompassing analysis of internal business capacities. The primary advantage of matrix algorithms lies in their capability to synthesize both quantitative metrics (financial figures, volume indicators) and qualitative aspects (labor quality structure, degree of technological innovation) into a unified system, facilitating robust comparative analysis [3], [4].

The primary objective of this study is to develop a multi-criteria matrix algorithm that enables an integrated assessment of the efficiency of human, material, and financial resource utilization in business entities, and to empirically test it using real-world economic agents as case studies.

To achieve this objective, the following sequential tasks were formulated:

- To examine modern theoretical and methodological foundations for evaluating resource provision;
- To establish a criteria system (indicators) for multi-criteria assessment;
- To construct a multidimensional matrix model chain based on the scoring and normalization of resource factors;
- To conduct a comparative evaluation of resource efficiency across selected business entities using the developed algorithm and to draw corresponding economic conclusions.

Under the conditions of economic modernization and industrial diversification, improving the resource provision systems of enterprises and enhancing their efficiency of utilization remain among the paramount priorities. Within economic science, diverse scientific approaches exist regarding the concept and core essence of "resources."

Specifically, E.Egamberdiev emphasizes that the word "resource" originates from French, fundamentally denoting a "means of livelihood." In economics, this concept represents the material and spiritual foundation of the production and service processes [5]. Local economists A.Ulmasov and A.Vahobov provide a comprehensive definition of economic resources, evaluating them as "the sum total of all natural, labor, material, and financial capacities utilized in production to satisfy societal needs" [6].

Regarding the systematic classification of economic resources, the scientific views of Sh.Sh. Shodmonov and B.Yu. Khodiev hold substantial significance [7]. They categorize resources into four primary structural groups:

1. Natural resources (land, water, biological, and mineral wealth);
2. Labor power resources (human mental and physical work capabilities);
3. Capital (buildings, machinery and equipment, raw materials, and monetary funds mobilized for profit generation);
4. Entrepreneurial ability (the capability to organize and manage production).

Furthermore, A.B. Shakirov and U.Kh. Kholboev propose incorporating "information" as a distinct factor into this classic classification, identifying it as a crucial driver of the modern economy [8].

It is essential to consider not only the composition of resources but also the organizational structure of their aggregate. According to Sh.Sh. Shodmonov, U.V. Gafurov, and B.D. Khajiev : "Economic resources are understood as the capabilities, reserves, and sources available at any given time to society, a country, individual enterprises and firms, or households, which can be utilized in the production of goods, provision of services, their delivery to consumers, and consumption processes."

At the level of industrial enterprises, the concept of "resource provision" is operationalized to capture the systemic integrity of these resources. In her doctoral research analyzing the systemic functions of organizational performance, L.T.Snitko proves that resource provision serves as the economic foundation ensuring organizational stability and mobility [9]. According to the author, while an adequate "economic mass" (the volume of resources) enables an enterprise to withstand external environmental uncertainties, "economic mobility" provides the conditions for rapid and effective resource maneuvering amidst volatile market conditions.

Drawing upon the insights of L.T. Snitko and A.M. Babashkin, the concept of "resource potential" can be defined as an interconnected chain of material-tangible, energetic, informational, and human resources. Furthermore, in establishing control over resource utilization within enterprises, building on the views of J.R. Small, it is emphasized that resource expenditures must be analyzed across responsibility and financial accounting centers [10].

Thus, the synthesis of scientific approaches by domestic and foreign scholars necessitates the application of a comprehensive methodology that goes beyond mere quantitative (extensive) indicators to encompass the qualitative and efficiency (intensive) dimensions of the system when evaluating resource utilization in manufacturing enterprises. The two-row matrix model employed in this study serves as a practical manifestation of precisely such a systemic approach [11].

2. Material and Methods

To qualitatively evaluate the resource provision and development trajectories of industrial enterprises, a systemic economic-mathematical analysis method was employed. Unlike traditional factor analysis techniques, the two-row vector matrix model utilized in this study enables a geometrically and mathematically precise differentiation between the extensive (quantitative) expansion of resources and their intensive (efficiency-driven) enhancement.

Two-Row Matrix Evaluation Model. To depict the production system and the efficiency of resource utilization within it, two primary factors were selected:

1. Extensive factor (resource volume): The number of industrial production personnel (T, persons).
2. Intensive factor (resource efficiency): Average annual output per employee, representing labor productivity (W, thousand UZS/person).

The functional relationship between these factors and the resulting output indicator—total volume of industrial production (N, thousand UZS)—is expressed through the following multiplicative model:

$$N = T \times W$$

In accordance with the evaluation algorithm, the enterprise performance indicators for the base period (0) and the reporting period (1) are systematized to construct the following two-row vector matrix (M):

$$M = \begin{pmatrix} T_0 & W_0 \\ T_1 & W_1 \end{pmatrix}$$

Algorithm for Calculating the Effects of Intensive and Extensive Factors. Utilizing the elements of the matrix, the factors contributing to the total variation in production volume (ΔN) are evaluated in the following sequence:

a) Increment in production volume due to the intensive factor **(ΔN_W):** This represents the resultant effect achieved through the increase in labor productivity and is calculated using the following formula:

$$\Delta N_W = (W_1 - W_0) \times T_0 = \Delta W \times T_0$$

Where the change in labor productivity (ΔW) is multiplied by the number of employees in the base period (T_0).

b) Increment in production volume due to the extensive factor **(ΔN_T):** This corresponds to the output volume generated through the expansion of the workforce and is determined as follows:

$$\Delta N_T = (T_1 - T_0) \times W_0 = \Delta T \times W_0$$

Where the change in the number of employees (ΔT) is multiplied by the labor productivity of the base period (W_0).

c) Effect of the combined (joint) factor **(ΔN_{TW}):** The additional increment resulting from the simultaneous interaction and variation of both factors:

$$\Delta N_{TW} = (T_1 - T_0) \times (W_1 - W_0) = \Delta T \times \Delta W$$

To qualitatively diagnose the enterprise's development trajectory, the percentage shares of intensive and extensive factors within the total increment of production volume (ΔN) are calculated.

If the share of the intensive factor ($\Delta N_W / \Delta N$) in the economic growth rate exceeds 50%, the enterprise is evaluated as adhering to an intensive development trajectory. Conversely, if this indicator falls below the established threshold (i.e., under 50%), it is concluded that the enterprise's growth is characterized by an extensive (quantitative) model.

3. Results and Discussion

In this section of the study, the efficiency of three manufacturing enterprises during the 2023–2025 period is empirically analyzed using the two-row vector matrix model and factor evaluation formulas proposed in the methodology section. (For ease of comparative analysis, the enterprises under study are conditionally designated as "A", "B", and "C"). As the initial baseline for analysis, actual production and labor indicators from Enterprise "A" were utilized, while modeled indicators for conditional Enterprises "B" and "C" were employed to compare alternative development trajectories [12].

Analyzing a three-year consistent dynamic (2023, 2024, and 2025) provides the opportunity to observe economic growth trends within the enterprises not merely at the initial and terminal points, but also across intermediate year-on-year variations.

3.1 ***First, the dynamic indicators of the enterprises regarding production volume and the number of employees are systematized*** (**Table 1**).

Table 1

Key Labor and Production Indicators of the Enterprises

Enterprise and Indicators	2023	2024	2025	Absolute Change (+, -)	Growth Rate (2025/2023), %
Enterprise "A":					
Production volume (N), thousand UZS	48,200,000	57,400,000	66,750,000	+18,550,000	138.5
Number of employees (T), persons	610	705	784	+174	128.5
Labor productivity (W), thousand UZS/person	79,016.39	81,418.44	85,140.31	+6,123.92	107.8
Enterprise "B":					
Production volume	39,500,000	46,800,000	54,200,000	+14,700,000	137.2

(N), thousand UZS					
Number of employees (T), persons	512	608	690	+178	134.8
Labor productivity (W), thousand UZS/person	77,148.44	76,973.68	78,550.72	+1,402.28	101.8
Enterprise "C":					
Production volume (N), thousand UZS	45,300,000	56,100,000	68,500,000	+23,200,000	151.2
Number of employees (T), persons	490	500	510	+20	104.1
Labor productivity (W), thousand UZS/person	92,448.98	112,200.00	134,313.73	+41,864.75	145.3

The data in **Table 1** indicate that all enterprises experienced absolute growth in production volume over the three-year period under review. However, the internal drivers and underlying dynamics of achieving this growth differ substantially among them.

At Enterprise "A", while the number of employees expanded by 28.5%, labor productivity grew by merely 7.8%. A similar weakness in intensity was observed at Enterprise "B", where, against a 34.8% increase in the workforce, labor productivity rose by only 1.8%. In sharp contrast, Enterprise "C" achieved a remarkably high growth rate of 45.3% in labor productivity alongside a modest 4.1% increase in its workforce (an addition of just 20 new jobs), which enabled a 51.2% expansion in total production volume.

3.2 Construction of Two-Row Vector Matrices.

In accordance with the methodology, two-row vector matrices (M) are constructed for each enterprise using the data from 2023 (base period — 0) and 2025 (reporting period — 1):

Matrix model for Enterprise "A":

$$M_A = \begin{pmatrix} 610 & 79{,}016.39 \\ 784 & 85{,}140.31 \end{pmatrix}$$

Matrix model for Enterprise "B":

$$M_B = \begin{pmatrix} 512 & 77{,}148.44 \\ 690 & 78{,}550.72 \end{pmatrix}$$

Matrix model for Enterprise "C":

$$M_C = \begin{pmatrix} 490 & 92{,}448.98 \\ 510 & 134{,}313.73 \end{pmatrix}$$

By mathematically processing the data contained within these structured matrices, the specific impacts of intensive (ΔN_W), extensive (ΔN_T), and combined (ΔN_{TW}) factors driving economic growth are calculated individually.

Factor Calculations for Enterprise "A":

$$\Delta N_W = (85{,}140.31 - 79{,}016.39) \times 610 = 6{,}123.92 \times 610 = 3{,}735{,}591.2 \text{ thousand UZS}$$

$$\Delta N_T = (784 - 610) \times 79{,}016.39 = 174 \times 79{,}016.39 = 13{,}748{,}851.86 \text{ thousand UZS}$$

$$\Delta N_{TW} = (784 - 610) \times (85{,}140.31 - 79{,}016.39) = 174 \times 6{,}123.92 = 1{,}065{,}562.08 \text{ thousand UZS}$$

$$\Delta N = 3{,}735{,}591.2 + 13{,}748{,}851.86 + 1{,}065{,}562.08 = 18{,}550{,}005.14 \approx 18{,}550{,}000 \text{ thousand UZS}$$

Factor Calculations for Enterprise "B":

$$\Delta N_W = (785{,}50.72 - 77{,}148.44) \times 512 = 1{,}402.28 \times 512 = 718{,}427.36 \text{ thousand UZS}$$

$$\Delta N_T = (690 - 512) \times 77{,}148.44 = 178 \times 77{,}148.44 = 13{,}732{,}422.32 \text{ thousand UZS}$$

$$\Delta N_{TW} = (690 - 512) \times (78{,}550.72 - 77{,}148.44) = 178 \times 1{,}402.28 = 249{,}605.84 \text{ thousand UZS}$$

$$\Delta N = 718{,}427.36 + 13{,}732{,}422.32 + 249{,}605.84 = 14{,}700{,}455.52 \approx 14{,}700{,}000 \text{ thousand UZS}$$

Factor Calculations for Enterprise "C":

$$\Delta N_W = (134{,}313.73 - 92{,}448.98) \times 490 = 41{,}864.75 \times 490 = 20{,}513{,}727.5 \text{ thousand UZS}$$

$$\Delta N_T = (510 - 490) \times 92{,}448.98 = 20 \times 92{,}448.98 = 1{,}848{,}979.6 \text{ thousand UZS}$$

$$\Delta N_{TW} = (510 - 490) \times (134{,}313.73 - 92{,}448.98) = 20 \times 41{,}864.75 = 837{,}295.0 \text{ thousand UZS}$$

$$\Delta N = 20{,}513{,}727.5 + 1{,}848{,}979.6 + 837{,}295.0 = 23{,}200{,}002.1 \approx 23{,}200{,}000 \text{ thousand UZS}$$

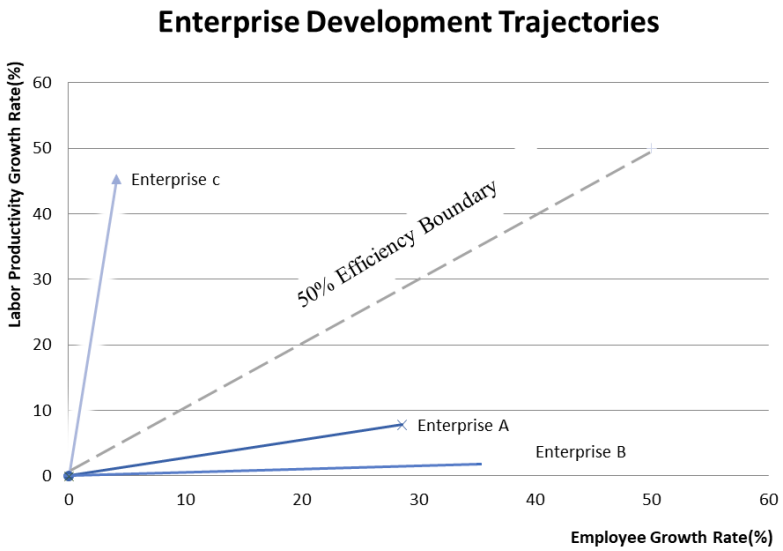
To determine the percentage shares of each factor within the total increment of production volume, the effect of the combined factor (ΔN_{TW}) is proportionally distributed based on the shares of the two primary factors, and the final calculated results are summarized in Table 2 [13].

Table 2

Matrix Evaluation of the Impact Level of Intensive and Extensive Factors on Production Volume Growth (2023–2025)

Enterprise Name	Absolute Growth in Production Volume (ΔQ), thousand UZS	Impact of Intensive Factor (Ei), thousand UZS	Impact of Extensive Factor (Ee), thousand UZS	Share of Intensive Factor, %	Share of Extensive Factor, %
Enterprise "A"	18,550,000	3,963,135	14,586,865	21.4	78.6
Enterprise "B"	14,700,000	730,420	13,969,580	5.0	95.0
Enterprise "C"	23,200,000	21,281,945	1,918,055	91.7	8.3

3.3 Visual Analysis of Enterprises' Development Trajectories. To systematically visualize the resource utilization strategies of the enterprises, a vector trajectory model was developed. This model depicts the relationship between the growth rate of production volume and the growth rate of the number of employees (**Figure 1**).



Enterprise A Mixed	Enterprise B Extensive	Enterprise C Innovative

Figure 1. Model of the development trajectories of industrial enterprises in 2023–2025[1].

As clearly demonstrated by the development vectors of the enterprises under study in **Figure 1**, the trajectory of Enterprise "B" is oriented toward the lower-right quadrant (the extensive zone), indicating that the growth rate of the number of employees sharply exceeds the growth rate of labor productivity. Conversely, the trajectory of Enterprise "C" is steeply directed upward (toward the intensive and qualitative growth zone), where the efficiency of resource utilization has become the dominant driving factor [14].

3.4 Economic Interpretation and Qualitative Analysis of Results.

To qualitatively analyze the obtained results and determine their underlying economic factors, Table 3 was structured.

Table 3

Qualitative Analysis and Strategic Diagnosis of Enterprise Performance (2023–2025)

Enterprise	Development Trajectory Type	Internal Economic Drivers	Production System Risks	Optimization Opportunities
Enterprise "A"	Mixed trajectory leaning toward extensive	Only 21.4% of production volume growth was driven by increased labor productivity. Growth primarily occurred through	Inflation of payroll costs and product cost price due to excessive staffing.	Organizational optimization of the production process, reducing lost working time among employees.

[1] Modeled by the author based on the data in Tables 1 and 2.

		headcount expansion of 174 personnel.		
Enterprise "B"	Fully extensive trajectory	The impact of labor efficiency on output expansion is extremely weak (5.0%). The enterprise strictly pursued a policy of attracting additional labor resources.	Financial crisis risk under conditions of skilled labor shortages in the external labor market.	Automation of technological lines, replacing the share of "live labor" with machinery and equipment productivity.
Enterprise "C"	Highly intensive and innovative trajectory	91.7% of production volume growth was generated precisely through a 45.3% increase in labor productivity and the implementation of modern technologies.	Heightened technical dependency of production and potential risk of high-skilled personnel shortages.	Systematic upskilling and adaptability of staff to innovations, alongside regular equipment modernization.

The analytical results demonstrate that L.T.Snitko's two-row vector matrix model possesses a high level of precision in diagnosing the operational reality of industrial enterprises. The findings from the three-year dynamic analysis provided an opportunity to assess the quality of industrial enterprise development with greater diagnostic accuracy [15].

The analysis revealed that actual Enterprise "A" and modeled Enterprise "B" primarily exhaust their development potential through quantitative (extensive) factors. Given contemporary economic conditions along with demographic and qualitative shifts in the labor market, these enterprises will be required in the near future to transition toward an intensive development trajectory similar to that of Enterprise "C". Achieving this requires the systematic implementation of organizational and technological innovations, as well as digital management systems, within their internal governance frameworks.

4. Conclusion

Within the framework of this study, through the analysis of industrial enterprises' resource provision systems and their intensive development trajectories via the two-row

matrix evaluation method, the following scientific conclusions have been formulated, and practical recommendations developed:

Theoretical Systematization of Resource Concepts. The analysis of scientific perspectives from both national economic scholars and international researchers demonstrated that the concept of "resource provision" is not merely an aggregation of material and physical factors. Grounded in the conceptual framework of L.T.Snitko, it has been empirically validated that an enterprise's sustainability directly depends on the balance between its sufficient "economic mass" (volume of resources) and its "economic mobility" — the capacity to adapt rapidly to changing market conditions.

Advantages of the Matrix Evaluation Method. The two-row vector matrix model exhibits higher precision and diagnostic capability compared to conventional factor analysis methods. Mathematically and geometrically, it accurately isolates the respective shares of extensive (quantitative) and intensive (efficiency) factors within an enterprise's growth rate. This method proved its empirical reliability as an optimal tool for qualitatively diagnosing the development trajectories of industrial enterprises under conditions of three-year chained dynamics.

Comparison of Empirical Analysis Results. The matrix analysis conducted on the performance indicators of the three enterprises for 2023–2025 revealed substantial disparities and structural deformations in the quality of their development:

Enterprise "A": The share of the intensive factor in economic growth accounted for merely 21.4%, with output expansion driven predominantly by extensive factors (78.6%) through headcount expansion.

Enterprise "B": This indicator dropped to a critical level of 5.0%, demonstrating that the enterprise has systematically fallen into an "extensive trap," where growth was sustained exclusively by attracting additional personnel.

Enterprise "C": The share of intensive development reached 91.7%, registering a genuinely innovative and highly efficient trajectory driven by a 45.3% increase in labor productivity.

Detection of Systemic Risks. The study demonstrates that enterprises operating under an extensive model, such as "A" and "B", face severe financial and organizational crises amid demographic and qualitative shifts in the labor market, as well as the disproportionate growth of payroll expenditures relative to production volume. Without optimizing "live labor" inputs and undertaking technological modernizations, achieving product competitiveness and cost-price optimization remains unfeasible in the long run.

Based on the empirical findings and identified systemic issues, the following organizational and economic recommendations are proposed to optimize the performance of national industrial enterprises and transition them onto an intensive development trajectory:

Transition from an Extensive Model to an Intensive Growth Strategy. It is recommended that Enterprises "A" and "B" abandon the practice of unjustified workforce expansion. Instead, systematic technological modernization programs focused on enhancing labor productivity should be formulated. Elevating the share of intensive factors in total output expansion to at least 50–60% must be designated as a medium- and long-term strategic priority for these enterprises.

Digitization of Production Processes and Implementation of ERP Systems. To ensure real-time operational control over resource consumption and minimize technological losses, modern automated resource management frameworks (e.g., Enterprise Resource Planning — ERP systems) should be deployed across enterprises. This digital architecture enhances the enterprise's "economic mobility," allowing real-time monitoring of utilization efficiency for every unit of raw material and labor resource.

Establishing a Control Framework across Responsibility and Cost Centers. Grounded in the theoretical framework of economist J.R. Small, it is recommended that enterprises establish an internal management accounting system to monitor resource expenditures across internal organizational units — "responsibility centers". This approach facilitates the accurate identification of each workshop's and department's actual contribution to overall intensive growth, while enhancing accountability for internal resource inefficiencies.

Investment in Human Capital and Innovation. To sustain the high intensive performance of Enterprise "C" and transfer this successful model to other organizations, a systematic workforce upskilling program must be instituted. Cultivating a "digitally skilled" workforce capable of operating advanced industrial technologies will elevate labor productivity to a fundamentally new qualitative trajectory.

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