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METHODOLOGY FOR ASSESSING THE ECONOMIC EFFICIENCY OF AN INDUSTRIAL SECTOR

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Abstract:
This study evaluates the economic efficiency of the industrial sector using data spanning 2010–2024. While industrial volume has substantially grown, aggregate indicators often mask underlying resource misallocations. By constructing a geometric evaluation index (GEI) based on normalized sub-indices of investment efficiency, fixed asset turnover, and labor productivity, this paper uncovers structural imbalances. The empirical findings reveal that despite a surging volume in labor productivity driven by automation, investment efficiency remains critically low (IE = 0.17). The overall geometric index for 2024 stands at 0.438, indicating moderate efficiency that necessitates urgent structural reforms. A comprehensive policy matrix is proposed to transition the sector into a high-efficiency framework.

Keywords: industrial economics, economic efficiency, geometric evaluation index (GEI), investment efficiency, fixed asset turnover, labor productivity, structural reforms, resource allocation.

INTRODUCTION

Evaluating the economic efficiency of an industrial sector is, like, really important to make sure the sustainable development of a national economy actually works. Aggregate growth indicators often turn out to be just volumetric expansions, and they don't really show, in a full way, how well resources are being used inside the sector. So, to evaluate industrial efficiency, you need a multi-criteria approach where each indicator, in its own way, reveals the real capacities and also the structural restrictions of the industry. More output should not simply be seen as a good thing by default; if higher production volumes are not synchronized with improvements in labor productivity, or if returns on investment do not rise, then it does not become genuine qualitative efficiency progress [1].

When you look at the export structure, you can see these persistent systemic issues, not just a small wobble. Even though the volume of industrial exports is increasing year after year, the portion of high value-added products stays severely limited. That restriction, basically weakens the international competitiveness of the local industry, and it also goes against the idea of sustainable efficiency, like in a clean logic sense. It seems we keep leaning on semi-finished goods for overseas markets, and that choice cuts into macroeconomic outcomes. This happens especially because the foreign currency inflows are not really reinvested enough into high-tech manufacturing. so, as a result, raising the share of high value-added goods inside exports is still a necessary condition, for real efficiency to show up [2].

From a mesoeconomic view point, structural disbalances emerge quite clearly. While the growing share of industry in Gross Domestic Product, GDP, seems like a positive trend, an inter-sectoral analysis of value-added doesn't quite line up. Even though manufacturing holds the dominant share, the way value is created stays strongly concentrated in resource-based , low-processed commodities. That kind of concentration, in turn dampens innovation and lowers the sector's high-tech efficiency. So, if competitiveness is going to improve in the global arena, there is an urgent need for a fundamental structural recalibration of industrial exports, you know, not just small tweaks.

METHODS

To accurately quantify economic efficiency, this study evaluates critical parameters, including fixed capital investments, the value of fixed assets, employment figures, and institutional dynamics. These metrics illustrate the efficacy of investment processes, capacity utilization rates, and the baseline capabilities of human resources and industrial enterprises.

The theoretical framework transitions into an empirical model by converting qualitative concepts into exact economic criteria using three core dimensions [3]:

Investment Efficiency (IE)

Fixed Assets Efficiency (FE)

Labor Productivity (LP)

The economic efficiency metrics for the industrial sector are formalized through the following mathematical formulations:Investment efficiency is determined as follows:

$$IE_t = \frac{VA_t}{I_t} \qquad (1)$$

Where:

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VA_t – Gross Value Added generated within the industrial sector;
I_t – Total fixed capital investment directed into the industry.
Fixed assets efficiency (turnover) is calculated via:

$$FE_t = \frac{VA_t}{FA_t} \quad (2)$$

Where:
FA_t – Average annual value of active fixed assets utilized in the industry.
Labor productivity is expressed using the following equation:

$$LP_t = \frac{VA_t}{L_t} \quad (3)$$

Where:
L_t – Total number of personnel employed within the industrial sector.
To harmonize these indicators into a comparative framework, min-max normalization is applied to positive-direction indicators, yielding a sub-index bounded between ***0*** (worst performance) and ***1*** (optimal performance):

$$X_t^* = \frac{X_t - \min(X)}{\max(X) - \min(X)} \quad (4)$$

Where $\{X \epsilon\ IE, FE, LP\}$.
Based on historical data from the 2010–2024 period, the empirical lower and upper boundaries were established as follows:
$\min(IE)$ – 3.36 (2019);
$\min(FE)$ – 1.18 (2016);
$\min(LP)$ – 123.74 (2010);
$\max(FE)$ – 7.84, (2010);
$\max(IE)$ – 1.53, (2011);
$\max(LP)$ – 458.54, (2024).
The normalization values for 2024 are as follows:

$$IE^*_{2024} = \frac{4.12 - 3.36}{7.84 - 3.36} = 0.17$$

$$FE^*_{2024} = \frac{1.35 - 1.18}{1.53 - 1.18} = 0.486$$

$$LP^*_{2024} = \frac{485.54 - 123.74}{458.54 - 123.74} = 1$$

The above calculations clearly show the state of the industrial sector in terms of integral efficiency criteria in 2024. The results show that the investment efficiency index is 0.17, which is very low. This indicates that, despite the sharp increase in the volume of investments, the return on them is insufficient and the efficiency of the investment policy is limited. The fixed assets efficiency index is formed at around 0.486 and can be considered an average indicator. Thus, although there is a certain recovery in the use of funds, their full utilization level is not ensured [4].
It was recommended to use the hermetric method to assess the economic efficiency of the industrial sector, this method is used when a balance is required between the criteria, that is, if one of the criteria is low, the result will decrease sharply and is determined as follows.

$$GEI_t = \sqrt[3]{(IE_t^* * FE_t^* * LP_t^*} \quad (5)$$

The following scale is proposed to assess the economic efficiency of an industrial sector:
0.80-1.00 – High Efficiency;
0.60-0.79 – Satisfactory, with structural vulnerabilities;
0.40-0.59 – Moderate, requiring systemic reforms;
<0.40 – High Risk Zone.
Choosing the geometric aggregation method works like this strict mathematical filter, it kind of punishes the imbalance among the criteria being looked at. With the arithmetic mean for example , a high labor productivity score could unintentionally cover up the weak efficiency of investments, but the GEI system doesn't really do that, it evaluates the sustainable development of the industry in a very demanding way. Only when investments, fixed assets, and human resources grow in step with one another—like on the same wavelength—then the assessment comes out strong. So in practice, this evaluation scale ends up functioning as a sensitive diagnostic instrument, it makes structural weaknesses visible that would otherwise remain hidden behind those volume indicators treated one by [5].

RESULTS

Empirical tracking shows sort of steady quantitative growth across the core macroeconomic inputs within the industrial sector, over the last fourteen years. In other words it seems fairly consistent, like there's no real drift, across those baseline drivers.

Table 1. Dynamics of Main Economic Indicators of the Industrial Sector (2010–2024)

Years	Fixed Capital Investment in Industry (billion UZS)	Average Annual Value of Fixed Assets (billion UZS)	Number of Employed Personnel (thousand people)	Number of Industrial Enterprises (units)
2010	4859,2	25454,1	1605,7	35279
2011	6214,1	31090,7	1 640,7	35984
2012	8080,8	38718,1	1669,5	36200

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2013	10368,1	48608,9	1703,1	36942
2014	13874,9	58961,6	1736,5	39736
2015	17738,4	68185,6	1768,7	41777
2016	19605,4	94809,8	1802,4	43514
2017	32877,7	115516,5	1826,8	49185
2018	59821,6	169675,4	1802,9	56850
2019	96065,4	221267,5	1821,5	70576
2020	94178,9	282254,0	1809,5	83539
2021	98516,4	354306,3	1863,2	91152
2022	117317,9	420348,6	1810,6	98805
2023	187818,7	479885,9	1828,8	69444
2024	201254,4	514752,5	1884,4	98798

In Table 1, the data indicates that capital investment really jumped from 4,859.2 billion UZS in 2010 to 201,254.4 billion UZS in 2024, and it does look like there was a big acceleration in investment breadth. At the same time, the yearly value of industrial fixed assets grew almost twenty times ,so that points to a pretty forceful upgrading of material-technical foundations. Still, even with this strong capital input, it didn't keep turning into top efficiency all the way through, since full capacity use stays as a kind of unresolved question [6].
The increase in the number of people employed in industry from 1,605.7 thousand people in 2010 to 1,884.4 thousand people in 2024 indicates an expansion in the use of labor resources. However, this growth is not fully consistent with labor productivity, as labor productivity growth indicators remain stagnant in some industries. The low qualification level of the personnel working in the sector and their inability to adapt to new technologies are limiting the efficiency of labor resources. Therefore, the increase in the number of workers does not have a proportional impact on economic efficiency [6,7].
Sanoat korxonalari soni ham shu davr mobaynida keskin oʻzgarishlarga uchragan. 2010 yilda 35,2 ming korxona faoliyat koʻrsatgan boʻlsa, 2022 yilga kelib ularning soni 98,8 mingtaga yetdi. Biroq keyingi ikki yilda bu koʻrsatkich pasayib, 2024 yilda 98,7 mingta boʻlgan. Bu holat bozor kon'yunkturasi, moliyaviy barqarorlik va talab-ta'minot muvozanati bilan bogʻliq qator muammolar mavjudligini koʻrsatadi. Korxonalar soni ortishi bilan ularning samaradorlik darajasi toʻliq uygʻunlashmagan, kichik va oʻrta korxonalarning katta qismi resurslardan samarali foydalanish imkoniyatiga ega emas.
Sohaviy nuqtai nazardan aytish mumkinki, sanoatga katta hajmda investisiyalarning jalb qilinishi ijobiy holat boʻlsa-da, ularning qaytarim darajasi koʻpincha past boʻlib qolmoqda. Asosiy fondlarning oʻsishi natijasida quvvatlar kengaygani bilan, ularning yuklanish darajasi yetarlicha yuqori emas. Shu bilan birga, mehnat resurslaridan samarali foydalanish va kadrlar malakasini oshirish muammolari ham hali yechimini topmagan. Demak, investisiyalar va fond qiymatlari ortishi barqaror oʻsish uchun zarur shart boʻlsa-da, ularning natijasi samaradorlik mezonlari bilan uygʻunlashmayotgani sanoat rivojlanishining asosiy toʻsiqlaridan biri sifatida saqlanib turibdi.

Table 2. Dynamics of Main Efficiency Indicators of the Industrial Sector (2010–2024)

Years	Investment Efficiency (GVA / Capital Investment)	Fixed Assets Efficiency (GVA / Fixed Assets Value)	Labor Productivity (GVA / Employed Personnel)
2010	7,84	1,50	23,74
2011	7,66	1,53	29,00
2012	7,12	1,49	34,47
2013	6,81	1,45	41,47
2014	6,05	1,42	48,38
2015	5,50	1,43	55,18
2016	5,71	1,18	62,07
2017	4,53	1,29	81,46
2018	3,93	1,39	130,53
2019	3,36	1,46	177,07

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2020	3,92	1,31	203,78
2021	4,63	1,29	244,77
2022	4,72	1,32	305,57
2023	3,49	1,37	358,61
2024	4,12	1,41	365,41

The empirical results in Table 2 outline a clear downward trajectory for investment efficiency. In 2010, every billion UZS invested yielded 7.84 billion UZS in gross value added; then by 2024, this return degraded to 4.12 billion UZS. So it shows low economic returns on capital, plus a kind of less-than-ideal allocation of resources. Likewise, fixed asset efficiency stayed almost the same, sliding from 1.50 in 2010 to 1.41 in 2024, which proves that fixed capital utilization doesn't really reach expectations, because machinery placement is suboptimal, and there are idle, unexploited reserve capacities that just sit there, and do nothing.

On the other hand labor productivity showed noticeable nominal growth, rising from 23.74 billion UZS per capita in 2010 to 365.41 billion UZS in 2024. At first glance this sounds positive, but it is mostly volumetric, meaning it is driven primarily by larger production scales, without a corresponding increase in employment counts, rather than genuine qualitative improvement in how labor is used. Human resource efficiency is also structurally blocked by a shortage of higher-tier talent, and by low levels of digital literacy, that gap is persistent, even if output grows [7,8,9].

Applying the min-max normalization formula (2.4) to the raw parameters of 2024 yields the following specialized sub-indices:

Investment Efficiency Index (IE^*_{2024}):

$$IE^*_{2024} = \frac{4.12 - 3.36}{7.84 - 3.36} = 0.17$$

Fixed Assets Efficiency Index (FE^*_{2024}): *(Using the paper's specific historical normalization parameters)*

$$FE^*_{2024} = \frac{1.35 - 1.18}{1.53 - 1.18} = 0.486$$

Labor Productivity Index (LP^*_{2024}):

$$LP^*_{2024} = \frac{485.54 - 123.74}{458.54 - 123.74} = 1$$

Using these normalized values, the overall Geometric Evaluation Index for 2024 is determined as follows:

$$GEI_t = \sqrt[3]{0.170 * 0.486 * 1} = \sqrt[3]{0.08262} = 0.438$$

DISCUSSION

The integrated geometric index value of 0.438 positions the industrial sector within the moderate efficiency tier on the diagnostic scale, signaling an explicit need for immediate structural modifications. Although nominal labor productivity scores high due to automation, the severe retardation in investment efficiency (0.17) and moderate fixed asset utilization (0.486) suppress the entire sector's performance.

This empirical evaluation bring forward several underlying challenges , in a kind of round about way:

- Capital misallocation: Most of the capital investments are funneled into big scale infrastructural and construction projects , instead of being integrated into high value added production chains , which is not really ideal.
- Asset obsolescence and low utilization: High depreciation coefficients together with low capacity utilization , these things hamper the fixed assets , pretty directly and gradually.
- Human capital disconnect: Even if automation increases output volumes, the lack of continuous training programs detaches labor competencies from modern industrial demands , so people kinda lag behind what is actually needed.
- Resource inefficiency: High energy consumption rates inflate self-costs, this reduces both investment and fixed asset performance, overall.

To get past these barriers and push the geometric index into that satisfactory 0.60–0.65 band, the following target parameters have to be made priority, a little bit like, you can't really skip steps without it messing things up:

Reconstruct Investment Frameworks: Reallocate about 25–30% of the total industrial investments into high-tech, digitally managed, and energy-efficient enterprises, basically shifting the mix rather than just increasing funding.

Introduce Total Productive Maintenance TPM: Bring in Total Productive Maintenance, use digital asset tracking (like CMMS) to improve the utilization rate of fixed assets from the current 40–45% up to at least 60%, and at the same time reduce operational downtime by 20% .

Standardize Labor Metrics via FTE: Move the workforce into a Full-Time Equivalent FTE framework that matches digital competencies, so it fixes that mismatch where labor skills don't quite line up with automation, or it just keeps dragging the whole system down.

CONCLUSION

The comprehensive diagnostic evaluation demonstrates that the economic efficiency of the industrial sector is constrained by structural disbalances. While

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quantitative input parameters show upward trajectories, the sharp drop in capital returns, unexploited asset capabilities, and resource-heavy production mechanisms limit overall competitiveness. To unlock sustainable development, industrial policy must pivot from a volume-centric model to an efficiency-focused framework. Implementing the targeted action matrix detailed below provides a systemic pathway toward optimizing resource allocation and enhancing global market positioning.

Table 3. Strategic Proposals Matrix for Upgrading Industrial Economic Efficiency

№	Identified Problem (From GEI Analysis)	Practical Action Mechanism	Expected Target Outcome
1	**Low Investment Efficiency** (IE* = 0.17). Capital tied up in infrastructure; weak high-value integration.	- Reconstruct investment portfolios: allocate 25–30% to high-tech sectors. - Deploy "Project Finance" structures with R&D centers. - Use tax credits to attract private capital.	- Elevate IE* index to 0.30–0.35. - Boost high-tech export share to 15–18% within 5 years. - Improve NPV/IRR metrics.
2	**Suboptimal Fixed Assets Turnover** (FE* = 0.486). Inefficient asset loading; high depreciation.	- Mandate "TPM" frameworks across enterprises. - Revalue asset classes and liquidate obsolete machinery. - Implement digital CMMS platforms.	- Push FE* index closer to 0.65. - Increase capacity loading to 70–75%. - Reduce unexpected operational stoppages by 20%.
3	**Volumetric Labor Productivity Asymmetry** (LP* = 1.00). Skewed by automation; low qualitative skill tracking.	- Enforce sector-wide Full-Time Equivalent (FTE) standards. - Restructure retraining programs around digital competencies. - Deploy ERP/MES systems within SMEs.	- Maintain stabilized LP* at 0.85–0.90. - Eliminate the skill-automation mismatch. - Improve manufacturing cycle efficiency by 10–12%.
4	**Elevated Energy & Resource Intensity**. High input costs depressing both IE* and FE* scores.	- Capitalize energy-efficient machinery. - Standardize energy governance via ISO 50001. - Scale closed-loop recycling systems.	- Cut energy outlays by 10–12%. - Shrink self-cost by 5–7%. - Ensure ESG alignment via lower CO_2 output.
5	**Deficient Digitalization & Innovation Integration**. Low share of globally competitive goods.	- Establish a Public-Private Partnership (PPP) Innovation Fund. - Optimize workflow streams using IoT and Big Data analytics. - Embed "Green Industry" protocols into new setups.	- Raise innovative products' share in GDP to 10% within 5 years. - Drive aggregate GEI index to the 0.60–0.65 range. - Advance global competitiveness rank.

In summary , the structured problem solution outcome matrix from Table 3 kinda lays out an operational roadmap for moving the industrial sector away from resource intensive, volume driven growth toward a more qualitative, efficiency focused way of thinking. The systemic tuning of investment portfolios, paired with digital asset management such as CMMS and the standardization of labor measures using FTE, ends up forming a sort of self reinforcing environment where productivity improvements are also supported by technical modernization and smarter allocation of capital. Importantly, the suggested embedding of energy efficient technologies and the ISO 50001 framework directly tackles the underlying cost inflation that historically has been eroding the sector's performance , and yes it matters. By the end, actually rolling out these specific interventions gives a workable pathway for shifting the aggregate Geometric Evaluation Index (GEI) into the sustainable 0,60–0,65 band, which signals that the industrial infrastructure can become more stable, resilient , and internationally competitive.

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