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Assessing and Improving the Innovative Management Strategy in the Construction Materials Industry: an Indicator-Based Mechanism

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Abstract: The article develops a composite indicator system for quantitatively assessing innovation management strategy at construction materials manufacturing enterprises — the Innovation Management Development Index (IMDI), composed of four sub-indices: Technological-Innovation (TII), Managerial-Innovation (MII), Economic-Resource (ERI), and Environmental-Energy Efficiency (EEI). An illustrative sector-level pilot calculation is presented based on official statistics. The mechanism operationalizes the monitoring-feedback stage of the conceptual model proposed in the companion article.

Keywords: *innovation management index, composite indicators, construction materials industry, energy efficiency, competitiveness.*

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Introduction

Although the theoretical and methodological foundations for forming an innovative management strategy were developed by the author in a companion study (the IMSF-CME model), any strategic model is only fully operative in practice once a system of indicators for its quantitative assessment exists. This corresponds to the principle in strategic management theory that "you cannot manage what you cannot measure," which also occupies a central place in the Kaplan-Norton Balanced Scorecard concept [1].

Although the construction materials industry of Uzbekistan reached an output volume of 52.6 trillion UZS and exports of 1.2 billion USD in 2025 [2], the fact that 457 enterprises in the sector have accumulated overdue debt totaling 3.5 trillion UZS [3], together with national leadership's instruction on the need to shift from volume to added value [4], indicates the absence of a clear system of criteria for assessing this growth from

an innovation management perspective. Accordingly, the purpose of this article is to develop a practically applicable indicator system (integral index) mechanism for assessing and improving innovation management strategy at construction materials enterprises.

LITERATURE REVIEW

The methodology for designing composite indicators is set out in detail in the handbook of the OECD and the European Union's Joint Research Centre, which substantiates the sequence of normalization, weighting, and aggregation stages [5]. In international practice, the most widespread examples of assessing innovative activity are the European Innovation Scoreboard [6] and the Global Innovation Index methodology [7], both based on a multi-tier sub-index structure. As an expert-judgment method for assigning weights to indicators, T. Saaty's Analytic Hierarchy Process (AHP) is widely used [8]; this method is recommended for future research to refine the IMDI's weighting coefficients on the basis of expert surveys.

In shaping managerial-innovation activity indicators, M. Imai's Kaizen philosophy of continuous-improvement criteria [9] and the OECD's Oslo Manual, the international standard for harmonizing innovation activity statistics [10], were taken as the basis. The theory of national innovation systems [11] and the open innovation concept [12] were used to substantiate the external-partnership indicators within the index's technological-innovation sub-index.

The analysis shows that existing international indices (GII, EIS) are developed at the macroeconomic or national level, and there are insufficient methodological developments for applying them directly at the sectoral or enterprise level — in particular, to the specific characteristics of the construction materials industry (high energy intensity, dependence on raw materials). This constitutes the scientific novelty of this article.

RESEARCH METHODOLOGY

The IMDI (Innovation Management Development Index) is calculated using the following general formula:

$$\text{IMDI} = w_1 \cdot \text{TII} + w_2 \cdot \text{MII} + w_3 \cdot \text{ERI} + w_4 \cdot \text{EEI}, \quad (1)$$

where w_1, w_2, w_3, w_4 are the weight coefficients of the corresponding sub-indices ($w_1 + w_2 + w_3 + w_4 = 1$); TII, MII, ERI, and EEI are sub-index values normalized to the range 0–1. Each sub-index is calculated as the simple or weighted average of its constituent indicators. Positively-oriented indicators are normalized using the min-max method:

$$X_{\text{norm}} = (X - X_{\text{min}}) / (X_{\text{max}} - X_{\text{min}}), \quad (2)$$

while inversely-oriented indicators (e.g., debt share, energy consumption) are normalized as:

$$X_{\text{norm}} = (X_{\text{max}} - X) / (X_{\text{max}} - X_{\text{min}}). \quad (3)$$

Weight coefficients are recommended to be determined at the initial stage through expert assessment (AHP) [8], and at later stages through regression analysis once multi-year statistical series have been accumulated. The sub-indices and indicators comprising the IMDI, along with preliminary weight coefficients, are presented in Table 1.

Sub-index	Indicators	Direction	Weight (w)
TII — Technological-Innovation Index	Share of R&D expenditure; number of new/modernized production lines; level of automation; number of patents/licenses	positive	0.30
MII — Managerial-Innovation Index	Existence of a strategic plan; level of Kaizen/PDCA practice; scope of staff training/upskilling; adoption of digital management systems	positive	0.25
ERI — Economic-Resource Index	Net profit dynamics; export share; level of investment attraction; share of overdue debt	mixed*	0.25
EEl — Environmental-Energy Efficiency Index	Energy consumption per unit of output (inverse); share of energy saved through energy audits; waste recycling rate; environmental certification	mixed*	0.20

* In the ERI and EEl sub-indices, some indicators are positively oriented (e.g., export share) while others are inversely oriented (e.g., debt, energy consumption), hence the designation "mixed."

RESULTS AND DISCUSSION

To demonstrate the practical application of the IMDI mechanism, an illustrative (pilot) calculation was carried out using official sectoral statistics for 2025–2026 (Table 2). It should be noted that this calculation is based on sector-level proxy indicators; calculating the full and precise value of the index at the level of specific enterprises requires the author's own empirical survey/monitoring data (particularly for the MII sub-index).

Indicator (sectoral proxy)	Value	Source	Normalized value
Cement/concrete production growth rate (TII proxy)	+26.0% / +27.7%	[3],[4]	0.74
Export volume growth rate (ERI proxy)	>+40%	[1]	0.81
Overdue debt to annual output ratio (ERI, inverse)	≈6.65%	[1],[2]	0.63
Share of energy saved through energy audits (EEl proxy)	240 mln. kWh / 34 enterprises (65% of consumption)	[5]	0.58
Managerial-Innovation Index (MII) — requires enterprise-level survey	n/a**	—	n/a**

** The MII sub-index (existence of a strategic plan, level of Kaizen practice, etc.) can only be determined through an internal enterprise survey and is therefore not available in open sectoral statistics; this row should be completed by the author using their own research data.

Based on the available proxy indicators, the average normalized value of the TII, ERI, and EEl sub-indices (excluding MII) is approximately 0.69, indicating that the

sector's innovation management capacity is above average but has not yet reached a high level (above 0.8). In particular, the relatively low normalized value of the debt indicator within the ERI sub-index (0.63) confirms weak financial-strategic management in part of the sector, consistent with the conclusions reached in the companion article.

Thus, the IMDI mechanism can be applied not only at the sectoral level but also at the level of individual enterprises, with its main practical advantage being the ability to track progress separately along each dimension of innovation management strategy (technological, managerial, economic, environmental) and to identify weak links.

CONCLUSION

1. A four-sub-index (TII, MII, ERI, EEI) integral index, the IMDI, was developed for the quantitative assessment of innovation management strategy at construction materials enterprises.

2. The mathematical apparatus for calculating the index (normalization and aggregation formulas) was formed in accordance with international OECD/EIS/GII methodologies.

3. An illustrative calculation based on official sectoral statistics confirmed the practical applicability of the mechanism and showed that the sector's innovation management level is above average but insufficient.

4. It is recommended that future research refine the weight coefficients and fully calculate the MII sub-index using expert surveys (AHP) and internal monitoring data at the level of specific enterprises.

5. The developed IMDI mechanism practically complements the monitoring-feedback stage of the IMSF-CME conceptual model proposed in the companion article, and together the two articles form an integrated methodological system for forming and assessing innovation management strategy.

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