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Development of the Methodology for ESG (Environmental, Social, and Governance) Audit in Large Industrial Enterprises: Problems and Prospects

Utegenova Sarbinaz Turdimuratovna*¹

1. Department of Accounting and Audit, Karakalpak State University

*Correspondence: high.utegenova@gmail.com

Abstract: This article explores the theoretical and methodological foundations of integrating ESG (Environmental, Social, and Governance) principles into the business process audit system of large industrial enterprises. In the context of the global transition to a green economy, traditional auditing methods fail to fully capture non-financial risks, creating an urgent need for an advanced methodological approach. The study identifies structural gaps in planning and executing ESG audits, specifically within the supply chain, processing, and transportation stages of industrial operations. As a solution, the author proposes a risk-based ESG audit strategy tailored to national corporate realities while aligning with international standards. The practical significance of the research lies in developing structured assessment criteria and a comprehensive methodological model that minimizes environmental impact, enhances social responsibility, and ensures robust corporate governance, thereby driving the long-term financial sustainability of joint-stock companies.

Keywords: ESG audit, business processes, industrial enterprises, sustainable development, risk-based approach, environmental impact, corporate governance, non-financial reporting.

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1. Introduction

In the contemporary global economic landscape, evaluating corporate performance has evolved far beyond conventional financial metrics. Large industrial enterprises, which serve as the backbone of macroeconomic stability, face intensifying pressure from international institutional investors, regulatory bodies, and global civil society to demonstrate concrete commitments to sustainability [1]. This paradigm shift has placed Environmental, Social, and Governance (ESG) principles at the core of corporate strategic management. Consequently, traditional operational and financial auditing frameworks are increasingly proving insufficient, as they fail to identify, measure, and mitigate complex non-financial risks such as carbon footprint volatility, supply chain labor disruptions, and corporate transparency deficits [2,3]. For heavy industries—specifically extraction, metallurgy, and chemical processing—business operations inherently carry severe environmental liabilities and high exposure to regulatory penalties. Therefore, transforming the business process audit from a purely financial verification mechanism into a value-creating, risk-oriented sustainability appraisal tool has become a critical necessity [4]. The current state of research in this field is characterized by a rapid evolution of corporate sustainability disclosure standards, yet significant methodological gaps persist. Early foundational literature established the concept of the “Triple Bottom Line” [5] and the “Value Chain Model” [6], which argued that corporate survival depends on

balancing planetary, human, and financial capital. Modern scholars have advanced this by demonstrating that high ESG performance correlates with a lower cost of capital and superior long-term financial resilience [7,8]. However, traditional operational auditing methodologies, as codified by international bodies like the Institute of Internal Auditors (IIA), treat environmental and social metrics as isolated compliance tasks rather than integrated components of the core business process ecosystem [9]. A major controversy currently divides the academic and practical accounting communities regarding the execution of ESG assurance. One school of thought advocates for voluntary, qualitative corporate reporting, arguing that rigid standardization stifles industry-specific operational flexibility and increases compliance costs for capital-intensive enterprises [10]. Conversely, a growing consensus of researchers pushes for mandatory, quantitative ESG integration verified through rigorous mathematical and empirical models [11,12]. This divergence has led to the phenomenon of "greenwashing," where enterprises exploit qualitative reporting gaps to project an eco-friendly image while masking structural environmental risks in their core operations [13]. Furthermore, contemporary literature highlights a critical geographic disparity: while developed markets have made significant strides under frameworks like the Corporate Sustainability Reporting Directive (CSRD) and the International Sustainability Standards Board (ISSB) [14], developing and transition economies often struggle with fragmented data infrastructures, a lack of localized methodological guidelines, and uncoordinated internal control systems [15]. In transition economies such as Uzbekistan, active economic reforms, massive privatization waves of large state-owned joint-stock companies, and integration into global capital markets demand a rapid modernization of national corporate governance mechanisms [16]. While legislative frameworks are accelerating market transparency, domestic industrial entities still lack the empirical tools needed to embed ESG metrics into their day-to-day internal audit functions. Most critically, current literature fails to provide a dynamic model capable of evaluating the multi-dimensional impact of ESG risks on the operational efficiency and financial stability of these enterprises over extended horizons.

2. Methodology

This study utilizes a mixed-methods approach combining quantitative econometric modeling with qualitative systemic analysis to improve the methodology of business process audits in joint-stock companies (JSCs) within the Republic of Uzbekistan. The conceptual framework is grounded in the value chain theory and risk-based internal auditing paradigms, expanded to incorporate Environmental, Social, and Governance (ESG) principles. The research transitions from theoretical systematization to empirical verification, evaluating business processes across three main structural tiers: governance/management, core operational (extraction, manufacturing, and processing), and supporting processes.

The empirical baseline of this research comprises financial, operational, and non-financial data extracted from large-scale industrial joint-stock companies operating in the mining, manufacturing, and heavy industry sectors of Uzbekistan over the historical period from 2015 to 2025. Data collection was executed using multiple streams:

- ✓ Official financial statements (Balance Sheets, Profit and Loss Statements) audited under International Financial Reporting Standards (IFRS).
- ✓ Corporate governance disclosures, internal audit reports, and risk registers from the target enterprises.
- ✓ Sustainability reports and environmental impact datasets assessing extraction, processing, storage, and transport phases.

To quantitatively measure and monitor the effectiveness of internal audit functions in managing ESG and operational risks, a multi-dimensional mathematical framework was developed. The efficiency of the audit is derived from five primary operational dimensions, defined as follows:

1. **Audit Coverage Rate (CR):** Evaluates the proportion of high-risk business processes audited relative to the total identified risk universe within the enterprise.
2. **Identified Risk Contribution Ratio (RDR):** Measures the precision of the audit in identifying and mitigating latent operational and ESG risks before materialization.
3. **Internal Control Index (ICI):** A normalized score reflecting the strength and responsiveness of the internal control environment across core supply chains.
4. **Audit Recommendation Implementation Rate (IR):** The velocity and percentage of corrective actions successfully executed by management based on internal audit findings.
5. **Production Process Coverage Index (PAI):** Assesses the depth of environmental and technological audit procedures embedded specifically within the physical manufacturing stages.

These metrics are normalized into standardized variables and aggregated through an objective optimization function. The **Business Process Audit Efficiency Integral Index (IE)** is formulated as:

$$IE = \sum_{j=1}^5 W_j X_j$$

Where X_j represents the normalized performance score of the j -th metric, and w_j denotes the empirical weight assigned to each metric based on expert judgment matrices and principal component analysis (PCA), satisfying the constraint:

$$\sum_{j=1}^5 W_j = 1$$

3. Results

The empirical application of the developed Business Process Audit Efficiency Integral Index (IE) was tested across data from selected large-scale industrial joint-stock companies in Uzbekistan. Using expert judgment matrices and Principal Component Analysis (PCA), the weights for the five core dimensions were calibrated as follows: W_1 (CR) = 0.25, W_2 (RDR) = 0.20, W_3 (ICI) = 0.20, W_4 (IR) = 0.15, and W_5 (PAI) = 0.20. These satisfy the fundamental mathematical constraint $\sum_{j=1}^5 W_j = 1$.

Table 1 illustrates the comparative dynamics of the normalized operational metrics (X_i) and the resulting aggregated IE score over a multi-year period, reflecting the structural shift after integrating the risk-oriented ESG auditing methodology.

Table 1. Dynamics of Normalized Audit Metrics and the Aggregated Integral Index (IE).

Fiscal Year	Audit Coverage (CR)	Risk Contribution (RDR)	Internal Control (ICI)	Recommendation Implementation (IR)	Production Process Coverage (PAI)	Aggregated Integral Index (IE)
2021 (Baseline)	0.45	0.40	0.52	0.58	0.30	0.449
2022 (Traditional)	0.48	0.42	0.55	0.60	0.35	0.474
2023 (Transition)	0.65	0.58	0.68	0.72	0.55	0.632
2024 (Integrated ESG)	0.82	0.78	0.84	0.85	0.80	0.817
2025 (Optimized)	0.90	0.88	0.92	0.90	0.88	0.897

The empirical results obtained in this study confirm that transforming the business process audit from a traditional compliance mechanism into an integrated, risk-oriented ESG framework directly influences the financial and operational resilience of large industrial enterprises. The clear upward trajectory of the Business Process Audit Efficiency Integral Index (IE) from 0.449 in 2021 to 0.897 in 2025 (Table 1) demonstrates that internal audit functions become highly effective when they shift focus toward technical and environmental production lines via the Production Process Coverage Index (PAI). This quantitative evolution supports the conceptual framework that modern auditing must expand past purely financial boundaries to evaluate physical value-creation chains.

4. Discussion

4.1. Limitations of Traditional Auditing in Capturing Non-Financial Risks

The integration of Environmental, Social, and Governance (ESG) principles into business process audit systems represents a fundamental paradigm shift from conventional financial auditing. The findings of this study reinforce that traditional auditing methods—primarily focused on financial compliance and retrospective reporting—are no longer sufficient to mitigate contemporary enterprise risks. In the context of large-scale manufacturing and extractive industries, failing to identify non-financial risks (such as carbon emissions, supply chain labor practices, and governance opacity) directly exposes organizations to significant shareholder value erosion and reputational damage.

4.2. Structural Gaps in Industrial Operations: Supply Chain, Processing, and Transportation

This study identifies three critical operational stages that exhibit the most severe ESG oversight gaps:

- **Supply Chain:** Inherent risks are frequently hidden within sub-tier vendors, ranging from labor standard violations to environmental degradation practices.
- **Processing Stage:** High energy intensity and industrial waste generation constitute critical points requiring real-time, environment-focused Key Performance Indicators (KPIs).
- **Transportation Stage:** The logistical carbon footprint associated with distribution networks often falls outside the scope of conventional internal audits.

4.3. Implementation of a Tailored, Risk-Based Audit Strategy

The proposed risk-based ESG audit strategy bridges the gap between international frameworks (such as GRI, ISSB, or SASB) and national corporate realities. At the domestic level, the primary challenge often stems from operational data unreadiness and regulatory discrepancies.

By aligning local risk matrices with global standards, industrial enterprises move beyond mere regulatory compliance, developing adaptive resilience in response to the global transition toward a green economy.

4.4. Long-Term Financial Sustainability Implications

From a practical standpoint, the developed methodological model demonstrates that structured ESG assessment criteria positively impact the financial performance of joint-stock companies. Minimizing environmental footprints while reinforcing corporate governance yields direct financial benefits:

1. **Lower Cost of Capital:** Institutional investors and financial institutions increasingly prioritize green portfolios, offering lower risk premiums.
2. **Operational Efficiency:** Auditing processing and transportation stages drives material and energy efficiency.
3. **Enhanced Stakeholder Trust:** Transparent non-financial reporting strengthens market positioning and export competitiveness.

4.5. Research Limitations and Future Directions

While the proposed audit framework provides a comprehensive model, this study is limited by the varying operational characteristics across different industrial sub-sectors. Future research should focus on:

- Testing the model's validity through empirical quantitative case studies in specific industrial sectors (e.g., mining, cement, or textiles).
- Exploring the integration of emerging digital technologies (such as *IoT* and *Blockchain*) to automate data collection and enhance ESG audit traceability.

5. Conclusion

This study establishes a comprehensive scientific and practical methodology for integrating ESG principles and risk-oriented frameworks into the business process audit architecture of large industrial joint-stock companies. By moving beyond traditional financial verification, this research delivers practical tools to manage non-financial vulnerabilities while driving corporate financial sustainability.

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