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Leveraging Digital Tools For Enhanced ESG Supplier Assessments

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Abstract: *In the context of the transformation of the global economic paradigm and the growing demands for transparency in corporate behaviour, the integration of non-financial criteria-particularly Environmental, Social, and Governance (ESG) factors-into the strategic procurement planning process has become not only a marker of an enterprise's ethical maturity but also a determinant of its long-term competitiveness. The article substantiates a methodological approach to integrating ESG criteria into supplier selection and evaluation processes for both corporate and public supply chains. It underscores the increasing importance of non-financial indicators for business resilience and compliance with evolving regulatory demands. Crucially, the study emphasizes leveraging advanced digital technologies, including artificial intelligence, machine learning algorithms, and natural language processing (NLP). These tools are vital for automating the assessment of supplier ESG profiles, thereby enhancing objectivity and reducing human error. The article outlines a comprehensive, multi-level ESG integration architecture, detailing its application across tender documentation, contracts, and dynamic supplier rating systems. This approach transforms traditional procurement into a strategically sustainable process, enabling proactive risk management and fostering greater transparency throughout the supply chain.*
Keywords: *Artificial Intelligence; Digital Transformation; ESG; Sustainable Sourcing; Scoring*

1. INTRODUCTION

In the current context of global transformation of economic models and increasing demands for corporate responsibility, the integration of sustainable development principles into enterprise management processes has become not only a conceptual but also a practical necessity. One of the key vectors of this transformation is the institutionalization of ESG (Environmental, Social, and Governance) criteria, which are increasingly serving as determinants of strategic planning, crisis management, and operational activities of companies. The application of ESG approaches is gaining particular relevance in supply chain management, where decisions related to the selection and evaluation of suppliers directly influence both the risk profile of an organization and its compliance with international standards of transparency and accountability.

Given the growing complexity of global supply chains operating amid multifaceted environmental, social, and ethical challenges, new demands are emerging for transparency, traceability, data verification, and risk management at all stages of the procurement process. Institutional and regulatory pressure from international regulators-particularly within the framework of the EU's mandatory ESG disclosure initiatives (CSRD, SFDR) – necessitates the integration of relevant criteria into supplier selection procedures, taking into account ecological footprint, social impact, and ethical compliance of counterparties.

Special attention should be given to the role of digital technologies, particularly artificial intelligence tools, which enable scalable collection, processing, and real-time analysis of ESG data. The use of algorithmic scoring, predictive analytics, and natural language processing (NLP) paves the way for automation of supplier sustainability assessments, reduction of human error, and enhancement of the objectivity of managerial decision-making. Most studies in the field of ESG focus on the general principles of corporate responsibility or on macro-level analyses of the impact of non-financial factors on business. In contrast, the issue of systematic integration of ESG criteria into supplier selection and evaluation procedures remains underexplored, particularly due to the lack of unified models that combine regulatory requirements, digital tools, and industry-specific features. This research gap defines the relevance of our work, which aims to develop a methodologically grounded and practically applicable approach to ESG integration in supplier management.

Thus, in light of the current challenges of digital transformation and regulatory evolution in public and corporate procurement systems, there is a pressing need to develop a comprehensive, methodologically sound approach to integrating ESG criteria into supplier selection and evaluation systems. Such an approach should

not only ensure compliance with modern sustainability standards but also remain adaptable to dynamic technological and regulatory changes.

2. LITERATURE REVIEW

In the context of ESG integration into supply chain management, international standards and regulatory frameworks play a central role, establishing both methodological and operational parameters for the formalization of sustainability principles in procurement. In particular, *ISO 20400: Sustainable Procurement* provides a systematic approach to integrating environmental, social, and governance considerations across all stages of the procurement process, while *ISO 26000* offers conceptual guidance on corporate social responsibility. Universal ESG reporting tools such as the *GRI Standards* structure the disclosure of non-financial indicators, and the *UN Global Compact* provides an ethical framework for sustainable business based on ten core principles (Aroonsrimorakot, Laiphrakpam, 2024).

Practical ESG-based supplier assessments are increasingly conducted by independent rating platforms such as *Sustainalytics*, *MSCI ESG Ratings*, and *EcoVadis*, which build their scoring models on both open and proprietary data. A comprehensive regulatory infrastructure is further supported by frameworks such as *TCFD*, *SASB*, and *CDP*, as well as EU initiatives like *SFDR* and *CSRD*. The latter, in particular, mandates companies to report not only on their own ESG metrics but also to assess the sustainability of their suppliers, thereby creating a new regulatory paradigm for transnational supply chain management.

Recent academic research in the field of ESG integration into supply processes highlights growing interest in the impact of environmental, social, and governance factors on long-term business resilience. For instance, studies by *Ahmad et al.* (2023) and *de Souza Barbosa et al.* (2023) emphasize the systemic influence of ESG factors on a company's investment attractiveness, while *Lou et al.* (2024) and *Lahodienko et al.* (2024) focus on the need to update supplier evaluation models in light of modern challenges. The works of *Sul & Lee* (2020), *Maaloul et al.* (2023), and *Shkvarchuk & Haidyn* (2022) deepen understanding of the link between ESG disclosure and company valuation indicators. Research by *Makarenko* (2023) and *Aroonsrimorakot & Laiphrakpam* (2024) demonstrates efforts to standardize ESG integration through ISO 20400, while *Zhu & Zhang* (2024) highlight the potential of digital tools and digitization in improving ESG assessment. Arpita Paul (2025) provides a comprehensive bibliometric analysis of ESG barriers in the field of ethical supply chain management, offering systemic approaches to overcoming them. In this study, it is used to substantiate the scientific basis of ESG integration. Chopra et al. (2024) focus on current issues of ESG reporting, particularly the lack of interdisciplinary expertise, which reduces the effectiveness of disclosures. Cruz (2023) proposes a software framework to address the problems of ESG reporting, including non-standardization and data fragmentation. In the context of our research, this approach is valuable from the perspective of digital solutions to ensure data quality. Yuan, Dai, and Ma (2025) demonstrate an empirical link between strong ESG performance and enhanced supply chain resilience, confirming the strategic value of ESG as a factor of long-term competitiveness.

Overall, the academic discourse converges on the necessity of a multi-level approach to ESG integration, which includes not only regulatory compliance but also the adoption of AI technologies, data analytics, and the transformation of management practices in procurement.

Thus, the current regulatory, analytical, and academic framework creates a comprehensive environment for ESG adoption in procurement, offering companies both regulatory support and tools for evaluating, monitoring, and developing sustainable supplier relationships

3. METHODOLOGY

The integration of ESG criteria into supplier selection systems is based on the implementation of an ESG scoring model that encompasses three core components: Environmental, Social, and Governance. For each component, key indicators are identified: emissions levels, energy efficiency, and eco-certifications (E); working conditions, occupational safety, and inclusiveness (S); transparency in governance, anti-corruption policy, and compliance (G). Sector-specific factors are accounted for by flexibly adjusting the weighting coefficients of each component.

To enhance assessment effectiveness, artificial intelligence tools are incorporated into the model. NLP is applied for analyzing textual ESG reports, while machine learning algorithms are used to predict risks based

on historical and open-source data. Digital platforms such as *SAP Ariba*, *Coupa*, and *OpenESG* facilitate automated collection, processing, and scoring of supplier data.

Additionally, ESG criteria are embedded into tender documentation, contracts, and evaluation systems. A standardized checklist is developed, containing baseline environmental and social responsibility requirements, verification conditions, and a system of penalties for non-compliance. This approach allows for the integration of sustainability principles across all stages of the supply process, ensuring both transparency and strategic flexibility.

Particular attention should be given to the system of criteria, which serves as the core of the ESG assessment model. It is structured into three blocks – Environmental, Social, Governance – each containing a set of indicators relevant to the industry specifics and scale of the supplier's operations. Environmental indicators reflect climate and resource impacts, social indicators characterize working conditions and inclusiveness, while governance indicators focus on transparency and anti-corruption mechanisms. Through adaptive weighting, the model ensures a balance between sectorial differences and universal sustainability standards. This system of criteria not only provides an objective basis for scoring but also allows ESG approaches to be integrated directly into tender documentation and contractual relations, making the methodology practically applicable.

To visualize the process of integrating ESG criteria into the supplier evaluation system, it is advisable to construct a sequential diagram in Fig. 1.

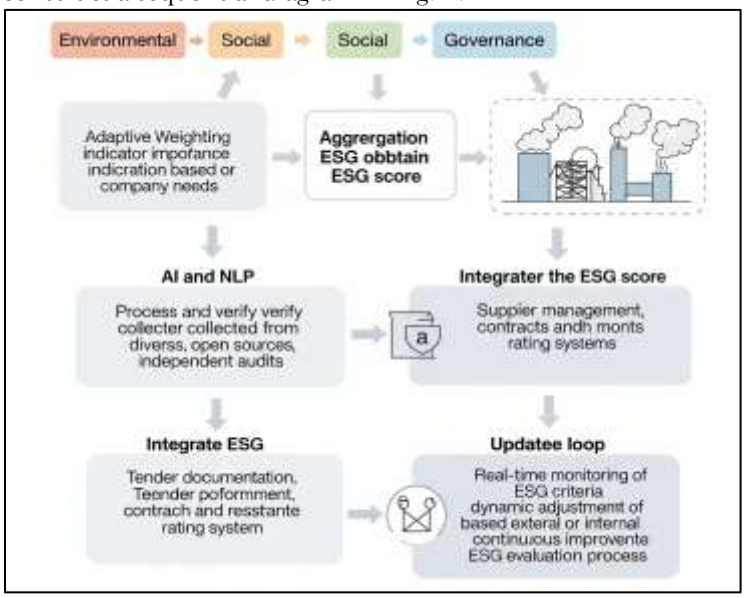

Fig. 1. Integration of ESG criteria integration into the supplier evaluation system.

4. RESULTS/DISCUSSION

A conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

In the context of formalizing decision-making processes in supplier management, the integration of ESG factors requires the development of a multifactor evaluation model based on the principles of Multi-Criteria Decision Analysis (MCDA). From a systemic supply chain risk management perspective, ESG scoring is viewed as an integral indicator of sustainability that aggregates both quantitative and qualitative assessments across three core dimensions: Environmental (E), Social (S), and Governance (G).

Each component of the ESG model consolidates a set of indicators relevant to the supplier's industry, geographical context, and operational scale:

Environmental (E): CO_2e emission levels; share of renewable energy in total consumption; water use efficiency; presence of waste management policies; environmental certification of production (e. g., ISO 14001).

Social (S): Compliance of working conditions with national and international standards (ILO); frequency of labor law violations; diversity and inclusion index; percentage of employees involved in professional development programs; existence of socially oriented initiatives.
Governance (G): Corporate governance structure; transparency of reporting; level of anti-corruption practices; participation in independent audits; existence of ESG policies in statutory documents (Matos, 2020).
An ESG score for a supplier is calculated using a model that adjusts the importance of different environmental, social, and governance (ESG) factors based on the supplier's industry. The model uses "adaptive weighting coefficients" to change how much each factor contributes to the total score. For example, in manufacturing, which uses a lot of materials, environmental factors might make up half of the total score. In contrast, for IT or consulting companies, governance issues might be considered more important and thus be given more weight. The final score is a total of these weighted and normalized values.
To avoid dominance of any single ESG dimension, a triadic constraint is proposed, whereby no individual block (E, S, or G) may account for more than 60% of the total ESG score in any sector. This ensures model balance and prevents systemic bias.
This approach can be practically implemented via *ESG modules* within Supplier Relationship Management (SRM) systems, which enable:
Automated processing of supplier ESG questionnaires;
Comparative analysis of counterparties' ESG profiles;
Real-time generation of supplier risk scoring maps.
The key element ensuring the validity of this model is the quality and reliability of data sources, which necessitates the use of verified ESG analytics aggregators (e. g., *EcoVadis*, *Refinitiv*, *Arabesque S-Ray*) and machine learning components to dynamically adjust weighting coefficients in response to market fluctuations (de Souza Barbosa, da Silva, & da Silva, 2023).
Given the growing complexity of ESG data processing and the need for timely decision-making within supply chains, the next logical step involves analyzing the potential of Artificial Intelligence (AI) as a critical tool for automated interpretation, aggregation, and dynamic assessment of supplier ESG indicators within high-dimensional information ecosystems.
In the context of digital transformation of supply chains, AI plays an increasingly significant role as a multidimensional analytics instrument capable of cognitively processing large volumes of ESG data from heterogeneous, structured, and unstructured sources. The application of machine learning (ML) models-including classification, clustering, and regression techniques-enables not only retrospective assessment of supplier ESG profiles but also the development of predictive sustainability risk scenarios.
Of particular note are natural language processing (NLP) technologies, which facilitate the automated semantic analysis of open-source documents-non-financial reports, tender documentation, media releases, court records, etc. – to detect latent indicators of social or ethical violations by suppliers. When combined with sentiment analysis algorithms, this allows for the construction of dynamic ESG risk profiles in near-real time.
It is advisable to analytically compare the key technologies-machine learning (ML) and natural language processing (NLP) – in the context of their application to supplier ESG analysis (see Table 1). This comparison helps not only to systematize the functional capabilities of each approach but also to delineate their effectiveness and appropriate use cases within the digital ecosystem of supplier management.

TABLE 1. Comparative characteristics of ML and NLP applications in supplier ESG analysis

Evaluation Criterion	Machine Learning (ML)	Natural Language Processing (NLP)
Core Function	Pattern recognition, ESG risk prediction	Text analysis, semantic pattern detection
Data Type	Structured and numerical data (indicators, metrics, historical profiles)	Unstructured text data (reports, press releases, tenders, social media)
Key Algorithms	Classification, clustering, regression, decision trees, random forest	NLP models, BERT, sentiment analysis, topic modeling

Application Scenarios	Supplier ESG scoring, anomaly and trend detection	Detection of latent risks, social violations, reputational impact
Risk Prediction	Yes	Indirectly (through contextual analysis)
Limitations	Requires large volumes of high-quality labeled data	Needs deep contextual learning, sensitive to linguistic and cultural nuances
System Integration	Easily integrated into ERP / SRM analytics modules	Often requires a dedicated NLP module or API integration

Source: author's development based on (Shkvarchuk, & Haidyn, 2022).

Thus, machine learning and natural language processing (NLP) play complementary roles in ESG analytics: the former provides structural forecasting based on historical trends, while the latter enables semantic risk recognition within textual content. The integration of both approaches creates a synergistic effect, allowing for the formation of dynamic, multidimensional supplier profiles and real-time ESG risk management with a high degree of reliability and relevance.

AI models with adaptive learning capabilities-such as reinforcement learning-can be applied to develop self-correcting ESG scoring systems that automatically update evaluation weights based on new data, changes in the regulatory environment, or contextual supplier behavior. These approaches help to reduce information asymmetry between the purchasing organization and the supplier and to enhance the credibility of sustainability assessments (Shkvarchuk & Haidyn, 2022).

In addition, the use of neural networks, particularly deep multilayer models (Deep Neural Networks, DNNs), enables integrated ESG analysis that considers complex correlations among macroeconomic, sectoral, and environmental variables-relationships often beyond the reach of traditional heuristic methods.

Thus, the intellectualization of ESG evaluation through AI implementation not only automates processes that previously required significant human effort but also lays the foundation for self-learning ethical frameworks in supply chain management (Matos, 2020).

In practical terms, the realization of these approaches is reflected in the use of comprehensive SRM and ERP systems integrated with AI-powered ESG analytics modules. One leading example is the SAP Ariba Sustainability Module, which enables automated processing of ESG declarations, supplier scoring based on industry-specific criteria, and verification of ESG indicators through integration with external databases.

A similar functionality is offered by the EcoVadis API, which allows for the automated import of supplier ESG ratings via multifactor analysis across more than 200 indicators. The system uses NLP algorithms to analyze non-financial reports, policies, and press releases, and applies machine learning models to construct sector-adaptive ESG profiles.

Other platforms-such as Refinitiv ESG, SupplyShift, and Intelex ESG Management-also employ advanced AI modules to detect patterns in both declarative and behavioral ESG parameters of suppliers. These solutions support the automated, dynamic updating of ESG metrics through connections to regulatory filings, financial news, and corporate disclosures, significantly reducing latency in the analytical process.

In industries with elevated regulatory requirements (e. g., pharmaceuticals or extractives), AI ESG Risk Engines are increasingly being adopted. These systems combine reputational, environmental, and compliance risk assessment models into a unified platform interface for supplier evaluation (Lou, You, & Xu, 2024).

To construct a functionally integrated and legally valid model for ESG implementation in supplier selection processes, a three-tier integration architecture is recommended:

Tender documentation.

Contractual provisions.

Scoring / rating system.

This architecture ensures both formal compliance with regulatory standards and the creation of mechanisms for dynamic ESG compliance throughout the supplier relationship lifecycle.

Tender documentation acts as a primary screening filter, determining supplier eligibility and serving as the entry point for ESG criteria into the contractual cycle. It is advisable to include a structured ESG annex questionnaire, in which the supplier must provide:

Documented evidence of environmental management (e. g., ISO 14001, GHG inventory certificates).

Social responsibility policies (anti-discrimination clauses, adherence to ILO standards).

Confirmation of anti-corruption practices and the existence of corporate oversight mechanisms (Maaloul, Zéghal, Ben Amar, & Mansour, 2023).

Additionally, the overall tender evaluation framework should incorporate a qualitative ESG block with a verified scoring scale and clearly defined indicators and threshold values, such as: «No environmental violations within the last three years», «Annual non-financial reporting in accordance with GRI Standards».

To ensure transitional transfer of ESG obligations from the tendering phase into binding contractual obligations, the model requires the integration of dedicated ESG clauses into the main body of contracts. Key recommended provisions include:

A declaration of ESG compliance, wherein the supplier affirms adherence to environmental, social, and governance standards at the time of contract signing.

A dynamic ESG compliance clause, obliging the supplier to maintain ESG standards throughout the contract duration.

A monitoring and audit clause, granting the buyer the right to verify ESG compliance.

A liability clause, allowing for sanctions or unilateral contract termination in cases of significant violations or undisclosed ESG risks.

These clauses serve as institutional compliance mechanisms, moving ESG factors from declarative to enforceable legal territory, with real consequences for non-compliance (Lahodienko, Rudenko & Lahodienko, 2024).

The integration of ESG criteria into supplier rating systems involves building a multi-criteria scoring model, functioning as an aggregated matrix of risks and strengths. The model consists of:

1. **Weighting coefficients is used to adjust the importance of each ESG factor based on the supplier's industry.**

The model uses a series of normalized scores for each individual ESG parameter to create a consistent rating.

Penalty modifier is applied if the supplier is found to have ESG violations or a lack of transparency.

Self-learning module is included to allow for continuous improvement and to make adjustments after audits are completed.

Suppliers receive an integrated ESG rating, which can be directly linked to their eligibility status, contract size, prepayment conditions, or access to strategic procurement categories.

To ensure model reliability, it is recommended to establish a triangulated ESG data validation system, consisting of:

2. **Supplier self-reporting.**

Third-party audits or verifications.

Automated open-source scanning using AI tools.

Such a system mitigates the risk of ESG data falsification and helps to build trust within the sustainable procurement ecosystem (Ahmad, Yaqub, & Lee, 2023).

In response to identified barriers, integrating ESG criteria demands a rethinking of the traditional supplier assessment paradigm toward a multidimensional sustainable development approach.

To highlight the core differences between the classical and ESG-oriented supplier selection models, a comparative table is presented below (Table 2).

TABLE 2. Comparative characteristics of traditional and ESG oriented supplier evaluation models

Criterion	Traditional model	ESG-oriented model
Primary aim of evaluation	Cost minimization, quality maximization	Ensuring sustainability, transparency, and reducing ESG risks
Data sources	Commercial offers, technical specifications	ESG reporting, audits, compliance certificates, integrated data
Scope of coverage	Cost and technical parameters	Environmental, social, governance, ethical, regional context
Tools	Excel, ERP systems	ESG analytics, AI platforms, blockchain, automated risk modules
Risk management approach	Reactive, post-hoc	Proactive, preventive, scenario-analytical

Institutional integration	Partial (mainly within procurement department)	Cross-functional (engaging ESG officers, compliance professionals, legal experts)
Information validation	Formal, irregular	Verification via third-party sources, ISO 26000, GRI, SA8000
Flexibility to industry specifics	Limited adaptation	ESG metrics differentiated by industry, geography, and scale

Source: author's adaptation based on (Zhu & Zhang, 2024).

The ESG-oriented supplier evaluation model not only broadens analytical scope to include non-financial risks but also transforms procurement logic from transactional to strategically sustainable. Its implementation requires deeper cross-functional collaboration, adoption of advanced digital tools, and the establishment of new standards of corporate ethical responsibility (Zhu & Zhang, 2024).

Let us analyze the critical aspects and practical limitations of ESG integration. Despite the obvious progress in the direction of sustainable procurement and the formation of a regulatory framework, the integration of ESG criteria into supplier selection and evaluation processes is accompanied by a number of methodological and practical challenges (Arpita, 2025). Unlike traditional selection models, which focus on TCO (total cost of ownership), quality, supply reliability, and technical compliance, the ESG-oriented approach adds a multidimensional layer of risks and responsibilities that are more difficult to measure, verify, and maintain in a stable dynamic. We will conduct a critical analysis of key limitations and trade-offs, comparing them with classical models and practical ways to mitigate them (Chopra, 2024).

1. Cost constraints and implementation economics.

ESG integration generates both direct and indirect costs for buyers and suppliers.

Direct costs include: implementation of IT modules for collecting and analyzing non-financial data, licensing external platforms and APIs; certification/audits (environmental, social, ethical), regular verifications and post-audit checks; development of ESG questionnaires, contract templates, staff training, and compliance consulting.

Indirect costs cover: lengthening of the procurement cycle due to additional qualification requirements, which delays contract signing and may reduce speed-to-market; costs of supplier development (capacity building), especially SMEs that lack resources for rapid compliance; potential narrowing of the supplier pool due to the "compliance threshold," which increases concentration risk and reduces competition.

In traditional models, these costs are either absent or minimal and fall under general quality management. ESG adds a kind of "compliance premium": in the short term, it increases TCO, while the benefits of reducing strategic/reputational risks appear only in the medium- to long-term horizon. For SMEs, this may represent an actual entry barrier and a diversification of relationships in favor of large, "paper-strong" contractors (Yuan, 2025).

Practical mitigation approaches: proportionality of requirements ("risk-based proportionality"): differentiation of assessment depth depending on procurement category and risk profile (criticality, geography, material intensity, customer-facing impact); phased implementation: pilots in the riskiest categories, followed by scaling as processes mature; joint financing/cooperation: audit pools, shared certification registries within industries, pre-competitive data exchange initiatives; integration with existing quality (ISO 9001/14001) and SRM systems to avoid duplication of procedures; economic validation: modeling NPV/IRR of initiatives through avoided incidents, fines, downtime, or market loss; separation of "mandatory" and "optional" ESG requirements with a transparent map of benefits.

2. Lack of reliable data and methodological heterogeneity.

ESG evaluation critically depends on the quality, comparability, and timeliness of data. In practice, we face:

- Incomparability of metrics: different interpretations of indicators (e.g., boundaries of emission calculations or coverage of staff social policies);
- Reporting gaps: incomplete time series, lags, differing periodicity and data collection methods;
- Self-reporting and biases: temptation to present a "better picture" without proper independent verification;
- Geographic variability: in regions with weak institutional capacity, there is a lack of official registers and independent verifiers;

– Scope 3 complexity: assessing "embedded" impacts further down the chain (tier-2/3) is costly and methodologically ambiguous, with a high risk of double counting or, conversely, data gaps.

By contrast, traditional models rely on relatively stable, objective, "operationally close" KPIs (OTD, PPM, defects per million, cycle time), which are easily verified through ERP transactional data (Yuan, 2025).

Practical mitigation approaches: clear data governance: attribute catalog, source descriptions, update rules, quality control, and data lineage; assurance levels: introduction of self-report, second-level confirmation, independent audit, each weighted in scoring; use of proxy indicators where primary data are unavailable (industry benchmarks, regional factors, certifications), with uncertainty levels indicated; careful imputation and conservative aggregation rules to avoid skewing ratings; explainable AI instead of "black boxes": transparent contribution of each variable, control for biases in language models and media sources; contractual "comply or explain" clauses requiring suppliers to justify missing indicators and provide an improvement plan with milestones.

3. Risk of formalization and "green washing."

ESG risks devolving into a formal "checklist" approach when:

– Excessive documentation is created without linkage to measurable results ("document-rich, outcome-poor");
– Suppliers showcase policies on paper without changing operational practices (diffusion of responsibility, fragmented initiatives);
– Ratings overvalue declarative aspects and undervalue actual outcomes (emissions, accident rates, disciplinary cases);
– The use of NLP/media signals in scoring creates reputational noise: algorithms "punish" negative news regardless of factual accuracy or, conversely, "reward" PR activity (Yuan, 2025).

Traditional models, based on quality and logistics, are less vulnerable to such formalization because result verification (delivery, defects, timing) is more straightforward.

Practical mitigation approaches: shift to outcome indicators: accident frequency, emission intensity per unit of production, share of confirmed violations – as the "hard" part of assessment; contractual mechanisms: performance-based clauses, ESG result-linked bonuses/penalties, right to audit and corrective action; triangulation of sources: policies + operational data + external registries/complaints/hotlines; grievance mechanisms with whistleblower protection; dynamic monitoring: regular "light" checks (pulse checks), unannounced reviews, remote monitoring for high-risk locations; independent verification of AI outputs and periodic decontamination of training datasets from "PR bias."

4. Sectorial adaptation complexity and the "chain effect."

ESG requirements vary significantly across industries, technologies, and geographies. In high-risk sectors (mining, agriculture, chemicals, and textiles):

– Tracing the origin of raw materials and intermediates is technically complex (multiple mixing of flows, intermediaries, seasonality);
– A large share of the chain lies in tier-2/3 and beyond, where there are no direct contractual relationships, thus weaker compliance incentives;
– Informal labor practices are widespread (subcontracting, off-the-books workers, seasonal migrants), which are difficult to cover with tier-1 supplier policies;
– Contextual risks (deforestation, water stress, conflict zones) are geo-spatial in nature and require specialized monitoring tools (Arpita, 2025).

Traditional supplier evaluation usually focuses on tier-1 and does not require deep origin tracing. ESG forces a restructuring of the entire supply chain management architecture (Yuan, 2025).

Practical mitigation approaches: tracing strategy tailored to product model: "identity preserved," "mass balance," "book and claim" – with transparent indication of accuracy limits; product-level certifications (e.g., forestry, agricultural raw materials) as an interim solution where individual tracing is too costly; cluster audits and buyer cooperation in shared high-risk regions to lower costs and avoid duplicate checks; mixed monitoring: satellite data, geo-analytics, remote inspections, worker hotlines, local NGOs as monitoring partners; cascading contracts: tier-1 requirements include mandatory obligations for tier-2/3, subcontractor templates, escalation tools.

5. Legal and cultural barriers and regulatory fragmentation.

The ESG landscape is characterized by uneven regulatory development:

- Different jurisdictions establish incompatible requirements for reporting (Cruz, 2023), due diligence, disclosure, and audits, creating risks of double burden or, conversely, gaps that encourage regulatory arbitrage;
- Issues of confidentiality and data protection (especially concerning employees, unions, medical/social indicators) limit the depth of information collection;
- Sanctions and trade regimes may conflict with local laws (e.g., bans on "secondary sanctions"), while supply chain requirements may clash with antitrust restrictions on buyer cooperation;
- Cultural differences affect the acceptance of practices: attitudes toward unions, gender equality, working hours, local customs; direct transplantation of "Western" standards without adaptation may cause resistance and pseudo-compliance (Yuan, 2025).

Traditional models are less sensitive to these differences, as they operate with more universal technical and economic parameters.

Practical mitigation approaches: modular policy architecture: core with minimum universal requirements (human rights, prohibition of forced labor, basic environmental standards) + regional/sectorial modules; mutual recognition and harmonization where possible: acceptance of equivalent certifications, avoiding "double audits"; legal "safe harbors" in contracts: clear conditions under which suppliers' good faith actions do not entail disproportionate liability; culturally sensitive implementation: localized training, involvement of social partners, translation and explanation of requirements in local practice terms, co-creation approach with suppliers; phased prioritization: starting with high-risk issues (work safety, forced labor), gradually moving to more complex ones (emission accounting, gender equality in management).

We summarize the results of the critical analysis in Table 3. It shows the limiting factor, its manifestations compared with traditional models, and possible mitigation approaches.

TABLE 3. Key limitations of ESG integration in supplier selection and evaluation

Critical aspect	How it manifests in ESG model	Comparison with traditional models	Practical mitigation approaches
Cost constraints	High direct costs (IT modules, audits, certifications) and indirect costs (longer procurement cycle, reduced supplier pool)	In classical models, costs are minimal, focused on quality and TCO	Proportional requirements, phased implementation, joint audits, integration with ISO/SRM, economic validation of benefits
Lack of reliable data	Incomparable metrics, reporting gaps, risk of self-reporting, geographic variability, complexity of Scope 3 assessment	Traditional KPIs are stable, transaction-based (price, quality, delivery time)	Data governance, assurance levels, proxy indicators, explainable AI, contractual "comply or explain" clauses
Risk of formalization and green washing	Checklist approach, policies without practice change, overestimation of declarations, reputational noise in scoring	Classical models rely on verification of factual results	Focus on outcome indicators, performance-based clauses, triangulation of sources, grievance mechanisms, dynamic monitoring
Sectorial adaptation complexity	High-risk sectors require deep tracing, tier-2/3 control, addressing informal labor, geo-contextual risks	Traditional evaluation usually stops at tier-1 without detailed origin analysis	Flexible tracing models, product-level certifications, cluster audits, mixed monitoring, cascading contractual requirements
Legal and cultural barriers	Regulatory incompatibility, double burden, legislative conflicts, data	Traditional approaches are less sensitive, based on	Modular policy architecture, mutual recognition of certifications, safe harbors in

	confidentiality, cultural differences	universal technical and economic parameters	contracts, culturally sensitive implementation, phased prioritization

Source: compiled by the author based on the study

Thus, compared to traditional models, the main tension arises from differences in metrics, depth of evaluation, time horizon of benefits, and organizational integration. While classical KPIs can be easily verified at the tier-1 supplier level and deliver immediate results in terms of cost, quality, and lead time, ESG metrics are multidimensional, require external verification, extend to deeper supply chain levels, and provide long-term benefits, particularly in terms of risk reduction and enhanced resilience. This complicates management, as integration demands cross-functional collaboration and the involvement of additional resources.

To ensure that ESG does not remain merely declarative, it is essential to follow several key principles: apply requirements proportionally depending on risk, focus on actual outcomes rather than formal procedures, provide support for small and medium-sized suppliers, avoid excessive digitalization, implement clear contractual mechanisms, and build partnership-based models of cooperation. This makes it possible to combine efficiency with accountability and turn ESG into a practical management tool rather than just a formal requirement.

5. CONCLUSIONS

The integration of ESG criteria into the supply system serves not only as a tool for enhancing a company's reputational resilience but also as a critically important mechanism for minimizing strategic, regulatory, and operational risks in a highly unstable environment of the globalized economy. The ESG approach enables companies to establish a multidimensional supplier assessment model that encompasses both financial and non-financial parameters-with an emphasis on environmental responsibility, ethical business practices, transparency in management processes, and compliance with labor standards. Such transformation strengthens the sustainability of supply chains, increases their adaptability to external shocks, and enhances long-term competitiveness.

Given the complexity of ESG implementation, a phased approach is advisable. This includes: preliminary assessment of the company's internal readiness for ESG transformation; identification of relevant criteria based on industry specifics; development of ESG checklists for tender documentation; revision of contractual frameworks to include mandatory clauses on compliance with sustainability standards; and the formation of a transparent supplier rating system. Special attention should be paid to the regular validation of information through independent sources, as well as the adaptation of criteria to the local context without compromising alignment with international standards (GRI, ISO 20400, OECD Due Diligence Guidance).

We have observed that ESG integration is not merely an "extension of the checklist" used in traditional supplier evaluation – it represents a paradigm shift that shifts the focus from short-term operational metrics to long-term resilience and accountability across the entire value chain. Its main weaknesses – cost, data, and the risk of formalization, sectorial complexity, and regulatory fragmentation – are not reasons for rejection but rather requirements for a mature implementation architecture. Compared to traditional models, ESG introduces an element of uncertainty but, at the same time, provides access to managed risk scenarios and enhanced adaptability. In practice, this means choosing proportionality, effectiveness, and gradual implementation; investing in data and verification; building partnership-based supplier development mechanisms; and balancing digitalization with managerial simplicity. Only in this way can ESG move beyond being an expensive ritual to become a competitive advantage that strengthens supply efficiency and reduces strategic risks in a volatile environment.

Thus, ESG integration into supplier selection and evaluation systems requires not only strategic vision but also concrete, practice-oriented actions. For businesses, it is advisable to implement ESG criteria gradually, starting with the most high-risk procurement categories where the effects of compliance are most visible. A central task lies in investing in data management systems that ensure reliability, comparability, and timeliness, since the quality of the information base determines the objectivity of scoring and the fairness of decisions. Equally important is the creation of partnership-based development programs with suppliers, especially small and medium-sized enterprises that often lack the resources for rapid adaptation. Collaboration through training, consulting, and capacity building helps prevent the exclusion of SMEs and maintains competition

within supply chains. In practice, the use of a mixed monitoring system proves valuable, combining audits, digital analytics, and local sources of information, including geo-analytics tools and worker feedback channels. For governments and regulators, a priority task should be the harmonization of ESG reporting requirements and the elimination of regulatory overlaps that reduce efficiency and create excessive burdens on businesses. Policymakers should design incentives for SMEs in the form of tax benefits, subsidies, or access to dedicated modernization programs, thereby leveling the playing field in sustainable procurement. It is also appropriate to support sectorial and cross-sectorial ESG data-sharing platforms, which help avoid duplication of audits, reduce costs, and increase supply chain transparency.

In this way, the combination of corporate-level initiatives and state-level policies creates a synergistic effect that turns ESG integration into a genuine tool for risk management and competitive advantage, rather than a mere formal requirement of today's regulatory environment.

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