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Framework for Quantitative Evaluation of ESG Adoption within SME Supply Chains in Emerging Economies

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Abstract
Small and medium enterprises constitute the backbone of supply chains in emerging economies, yet their environmental, social, and governance practices remain inadequately measured and understood. This study develops a comprehensive quantitative framework for evaluating ESG adoption among SMEs operating within supply chains of emerging markets. The framework integrates multi-dimensional assessment metrics that account for resource constraints, institutional voids, and contextual factors unique to developing economies. Through systematic analysis of existing measurement approaches and their limitations in SME contexts, this research proposes a weighted scoring mechanism that balances standardization with contextual sensitivity. The framework incorporates both leading and lagging indicators across environmental impact, social responsibility, and governance structures, while acknowledging the heterogeneity of SME capabilities and developmental stages. Validation through application to supply chain networks in three emerging economies demonstrates the framework's utility in identifying improvement opportunities and facilitating targeted interventions. This research contributes to closing the measurement gap in sustainable supply chain management by providing practitioners and policymakers with actionable tools for assessing and enhancing ESG performance among SME suppliers. The proposed framework addresses the critical need for scalable evaluation methods that can drive meaningful sustainability outcomes without imposing prohibitive compliance burdens on resource-constrained enterprises.

Keywords: Small and Medium Enterprises (SMEs), Environmental, Social, and Governance (ESG), Sustainable Supply Chain Management, Emerging Economies, Quantitative Framework, ESG Measurement, Resource Constraints, Institutional Voids, Weighted Scoring Mechanism, Sustainability Assessment, Contextual Sensitivity, Policy and Practice Integration

1. Introduction

The integration of environmental, social, and governance principles into business operations has emerged as a defining imperative for contemporary enterprises navigating increasingly interconnected global markets. While large multinational corporations have made substantial progress in embedding ESG considerations into their strategic frameworks, the vast network of small and medium enterprises that form the operational backbone of global supply chains remains significantly underexplored in sustainability discourse (Kot *et al*., 2020). This gap is particularly pronounced in emerging economies, where SMEs constitute upwards of ninety percent of all business entities and employ the majority of the workforce, yet operate under conditions of resource scarcity, institutional ambiguity, and market volatility that fundamentally differ from their counterparts in developed nations (Ayyagari *et al*., 2007).

The criticality of addressing ESG adoption among SMEs in emerging market supply chains stems from several converging factors that have gained prominence over the past decade. First, multinational buyers increasingly face stakeholder pressure to ensure sustainability throughout their value chains, creating cascading demands for ESG compliance that extend deep into supplier networks dominated by SMEs (Agan *et al*., 2013). Second, the concentration of manufacturing and production activities in emerging economies means that environmental and social impacts are disproportionately generated within these contexts, making SME engagement essential for achieving meaningful sustainability outcomes at scale (Shalhoob and Hussainey, 2022). Third, evidence suggests that ESG adoption can yield operational efficiencies, risk mitigation, and market

access benefits even for smaller enterprises, yet the absence of appropriate measurement frameworks prevents systematic evaluation of these relationships and inhibits targeted improvement efforts (Battaglia *et al*., 2014; Hu and Kee, 2022).

Despite the recognized importance of SME sustainability in emerging economy contexts, existing approaches to ESG evaluation remain predominantly designed for and by large corporations operating in mature institutional environments (Kotsantonis and Serafeim, 2019). Standard frameworks such as the Global Reporting Initiative, CDP disclosures, and various ESG rating methodologies impose reporting requirements and assume organizational capabilities that are misaligned with SME realities in developing markets (D'Angiò *et al*., 2022). These enterprises typically lack dedicated sustainability personnel, sophisticated data management systems, and the financial resources to engage external consultants or certification bodies (Madiwal and Dulange, 2016). Moreover, the institutional environment in emerging economies is characterized by weak regulatory enforcement, limited access to sustainability knowledge and training, and market structures that do not consistently reward ESG investments, creating contextual challenges that conventional frameworks fail to address (Jamali *et al*., 2017) (Sommer, 2017).

The measurement challenge is further compounded by the heterogeneity within the SME category itself. Enterprises ranging from family-owned workshops employing fewer than ten workers to more formalized medium-sized manufacturers with several hundred employees exhibit vastly different capabilities, resources, and developmental stages (Hemilä and Vilko, 2015). Additionally, sector-specific considerations mean that relevant ESG dimensions vary considerably between, for example, textile manufacturers, electronics assemblers, and agricultural processors. Any viable quantitative evaluation framework must therefore balance the need for standardization and comparability with sufficient flexibility to accommodate this diversity without losing analytical rigor or practical utility (Banomyong and Supatn, 2011).

This research addresses these challenges by developing a comprehensive quantitative framework specifically designed for evaluating ESG adoption among SMEs operating within supply chains in emerging economies. The framework is grounded in systematic review of existing measurement approaches, empirical investigation of SME sustainability practices in developing market contexts, and synthesis of insights from supply chain management, institutional theory, and sustainable development literatures (Singh, 2011). The proposed approach employs a weighted scoring mechanism that captures performance across key ESG dimensions while incorporating contextual factors that influence both the feasibility and impact of sustainability practices in resource-constrained settings (Howarth and Fredericks, 2012).

The framework's development is guided by several key design principles that differentiate it from existing approaches. First, it prioritizes materiality by focusing measurement on ESG dimensions that have the greatest operational relevance and impact potential within SME supply chain contexts, rather than attempting comprehensive coverage of all possible sustainability indicators (Ahi and Searcy, 2015). Second, it incorporates progression pathways that recognize enterprises at different stages of ESG maturity, allowing for meaningful evaluation across the spectrum from nascent awareness to advanced implementation (Saviano and Berardi, 2009). Third, it maintains practicality by limiting data requirements to information that SMEs can reasonably be expected to collect and report without prohibitive resource investments (Molin, 2021). Fourth, it embeds contextual sensitivity through adjustment mechanisms that account for differences in regulatory environments, market conditions, and sectoral characteristics across emerging economies (Ferrazzi and Tueske, 2022).

The significance of this research extends across multiple stakeholder groups with vested interests in sustainable supply chain development. For multinational buyers, the framework provides a systematic basis for assessing supplier ESG performance, identifying capacity-building priorities, and tracking improvement over time, thereby supporting more effective supply chain sustainability programs (Park *et al*., 2022). For SME suppliers, it offers a clear roadmap of expectations and improvement opportunities that is scaled to their capabilities and resources, potentially reducing the confusion and compliance burden associated with multiple buyer-specific requirements (Palomero and Chalmeta, 2014). For policymakers and development organizations in emerging economies, the framework enables evidence-based design of interventions and incentive structures that can accelerate ESG adoption among critical segments of the business population (Le and Behl, 2022). For researchers, it contributes methodological advancement in the measurement of sustainability in contexts that have been historically underserved by existing frameworks (Kufile *et al*., 2022).

The structure of this article proceeds as follows. Section two presents a comprehensive literature review that examines the current state of knowledge regarding ESG in SME contexts, sustainability in emerging economy supply chains, and existing measurement frameworks. Section three details the methodological approach employed in developing the quantitative evaluation framework, including the selection of indicators, weighting mechanisms, and validation procedures. Section four discusses the framework's application and implications for various stakeholder groups, while also acknowledging limitations and areas requiring further research. Section five concludes by synthesizing key findings and outlining directions for future investigation and practical implementation.

2. Literature Review

The scholarly discourse on environmental, social, and governance practices has evolved considerably over the past three decades, transitioning from peripheral concern to central strategic consideration in contemporary business research. However, this evolution has been characterized by significant imbalances in focus, with the preponderance of empirical and theoretical work concentrating on large corporations in developed market contexts. The intersection of ESG considerations with small and medium enterprises operating in emerging economy supply chains represents a relatively nascent but rapidly growing area of inquiry that draws upon multiple theoretical traditions and empirical domains (Eyinade *et al*., 2022).

The foundational concepts underlying ESG evaluation trace their intellectual heritage to stakeholder theory, which posits that organizations must account for the interests of multiple constituencies beyond shareholders alone (Freeman, 1984).

This perspective gained empirical traction through research demonstrating positive associations between social responsibility and financial performance, though much of this early work focused exclusively on publicly traded firms in North America and Europe (Barney, 1991). The subsequent development of the triple bottom line framework provided a more structured approach to conceptualizing organizational performance across economic, environmental, and social dimensions, though its operationalization remained challenging particularly for smaller enterprises (Elkington, 1997). More recently, the consolidation of diverse sustainability considerations under the ESG rubric has been driven largely by the investment community's need for standardized metrics to incorporate non-financial factors into capital allocation decisions (Buallay, 2019).

Research specifically examining sustainability practices among small and medium enterprises has identified several distinctive characteristics that differentiate these organizations from their larger counterparts. Studies have documented that SME owner-managers often possess strong personal values regarding environmental protection and social responsibility, yet face substantial barriers to translating these values into systematic practices due to resource constraints, competing operational priorities, and limited access to relevant knowledge (Jenkins, 2006) (Musso and Francioni, 2012). The personalized nature of leadership in smaller firms means that individual attitudes and capabilities of key decision-makers exert disproportionate influence on sustainability outcomes, creating both opportunities for rapid change when leadership is committed and vulnerabilities when priorities shift (Huang, 2009). Furthermore, SMEs typically operate with shorter planning horizons and face greater resource scarcity, leading to preference for sustainability initiatives that promise rapid payback periods and tangible operational benefits rather than longer-term strategic positioning (Williamson *et al*., 2006) (Tounsi *et al*., 2009).

The supply chain context introduces additional layers of complexity to ESG considerations for SMEs. Research in supply chain sustainability has established that focal firms with strong market positions increasingly impose sustainability requirements on their supplier networks, creating what some scholars have termed "enforced self-regulation" whereby SME suppliers must adopt certain practices to maintain market access (Lund-Thomsen and Lindgreen, 2014) (Ritchie and Brindley, 2000). However, the effectiveness of such approaches depends critically on how requirements are communicated, the support provided for implementation, and the extent to which improved performance is recognized through preferential treatment or other incentives (Tan *et al*., 2006). Studies examining buyer-supplier relationships in sustainability contexts have revealed tension between collaborative approaches that invest in supplier development and more transactional approaches that simply screen out non-compliant suppliers, with implications for both sustainability outcomes and supply chain stability (Sancha *et al*., 2016) (Thakkar *et al*., 2008).

The emerging economy context introduces yet another dimension of complexity that fundamentally shapes how ESG principles are understood and implemented. Institutional theory provides valuable insights into these contextual influences, highlighting how formal regulations, informal norms, and cognitive frameworks vary systematically between developed and developing markets in ways that influence organizational behavior (Scott, 1995). Research on corporate social responsibility in emerging economies has documented that weaker regulatory enforcement, different cultural values regarding environmental and social issues, and distinct stakeholder expectations create institutional environments that diverge substantially from those in which dominant ESG frameworks were developed (Jamali and Karam, 2018) (Aray *et al*., 2021). Some scholars have argued that imposing Western-centric sustainability standards on enterprises in developing countries can represent a form of neo-colonialism that fails to account for legitimate developmental priorities and resource constraints (Teplova *et al*., 2022).

Empirical studies examining SME sustainability in specific emerging economy contexts have yielded important insights into both drivers and barriers. Research in Asian manufacturing contexts has found that buyer pressure represents the primary motivation for ESG adoption among supplier SMEs, though the effectiveness of this pressure depends on the credibility of enforcement and the provision of technical assistance (Jiang, 2009). Studies in Latin American settings have highlighted the importance of industry associations and collective action mechanisms in helping SMEs overcome resource constraints and knowledge gaps related to sustainability implementation (Vives, 2006) (Bunclark and Barcellos-Paula, 2021). Work in African contexts has emphasized the prevalence of informal business practices and weak institutional infrastructure as fundamental challenges to standardized ESG measurement and reporting (Otokiti *et al*., 2022). These context-specific findings underscore the need for frameworks that can accommodate institutional diversity while maintaining sufficient standardization to enable meaningful evaluation and comparison (Attah-Boakye *et al*., 2022).

The measurement of ESG performance has generated substantial scholarly and practitioner attention, resulting in proliferation of frameworks, rating systems, and disclosure standards. The Global Reporting Initiative has emerged as perhaps the most widely adopted voluntary reporting framework, providing detailed guidance on indicators across multiple sustainability dimensions organized according to the triple bottom line structure (GRI, 2016). However, research evaluating GRI adoption has found that uptake remains concentrated among large corporations with dedicated sustainability resources, while SMEs face substantial implementation challenges related to data collection, report preparation, and assurance processes (Sardanelli *et al*., 2022). Alternative approaches such as industry-specific sustainability standards, lifecycle assessment methodologies, and various ESG rating systems each offer particular advantages but also exhibit limitations when applied to SME contexts in emerging economies (Fiaschi *et al*., 2020).

Critical analysis of existing ESG measurement frameworks has revealed several systematic gaps and limitations that motivate the development of alternative approaches. First, most frameworks prioritize disclosure and transparency, assuming that stakeholders can interpret reported information to assess performance, yet SMEs in emerging economies often lack the capacity to produce sophisticated

disclosures even when underlying performance may be reasonable (Aksoy *et al*., 2022). Second, existing frameworks tend to be comprehensive in scope, covering numerous indicators across all ESG dimensions, yet this comprehensiveness imposes data collection burdens that are prohibitive for resource-constrained enterprises (Lanza *et al*., 2020). Third, many frameworks apply uniform standards without adequate consideration of contextual factors that influence both the relevance of specific indicators and the feasibility of particular practices in different settings (Keeley *et al*., 2022). Fourth, existing approaches often conflate disclosure with performance, potentially advantaging enterprises that excel at reporting over those that deliver substantive sustainability outcomes but lack sophisticated communication capabilities (Chatterji *et al*., 2016) (Whitelock, 2015).

Recent scholarly work has begun to address these limitations through development of tailored measurement approaches for specific contexts. Research on sustainable supply chain management in emerging economies has proposed simplified assessment tools that focus on a limited set of high-impact indicators while incorporating local contextual factors (Busse *et al*., 2016). Studies examining SME environmental management have developed progression models that recognize different stages of implementation maturity rather than applying binary compliance criteria. Work on social sustainability in global value chains has highlighted the need to balance standardized core metrics with contextual indicators that capture locally relevant concerns (Baid and Jayaraman, 2022). However, these emerging approaches remain fragmented across different research streams and have not yet been synthesized into comprehensive frameworks that simultaneously address environmental, social, and governance dimensions while accounting for SME resource constraints and emerging economy contexts (Soni *et al*., 2022).

Theoretical perspectives from organizational learning and capability development offer additional insights relevant to ESG evaluation framework design. Research in this tradition emphasizes that sustainability represents an organizational capability that develops progressively through accumulation of knowledge, skills, and routines rather than emerging fully formed through one-time implementation efforts (Sharma and Vredenburg, 1998). This perspective suggests that effective measurement frameworks should capture not only current performance levels but also the presence of systems and processes that enable continuous improvement. Furthermore, capability-based approaches recognize that the trajectory of development may differ across organizations based on their starting positions, available resources, and strategic priorities, implying that evaluation frameworks should accommodate multiple pathways to improved performance rather than prescribing uniform approaches (Gunasekaran *et al*., 2017).

The concept of materiality, drawn from accounting and reporting contexts, provides another important lens for framework design. Materiality analysis focuses attention on ESG issues that are most significant for a particular enterprise given its industry, operations, and stakeholder context, rather than attempting to address all possible sustainability concerns equally (Khan *et al*., 2016). Research applying materiality concepts to sustainability measurement has demonstrated that focusing on material issues yields stronger correlations with financial performance and stakeholder satisfaction compared to comprehensive approaches that treat all issues as equally important. For SMEs in emerging economy supply chains, materiality analysis suggests concentrating measurement on issues that have the greatest operational impact and align with buyer priorities, thereby maximizing the efficiency of limited measurement and management resources (Didi *et al*., 2021).

The literature on supply chain sustainability governance reveals important insights into mechanisms through which focal firms influence supplier ESG practices. Research has distinguished between compliance-based approaches that establish minimum standards and screen out non-conforming suppliers, and collaboration-based approaches that invest in supplier development and work jointly toward improvement (Gimenez and Tachizawa, 2012). Evidence suggests that collaborative approaches tend to yield more sustainable and substantial improvements in supplier practices, particularly for SMEs that lack internal expertise and resources. However, collaboration requires significant investment from buying firms and functions most effectively when supplier bases are relatively concentrated. These findings have implications for evaluation framework design, suggesting the need for diagnostic capabilities that can identify specific improvement opportunities and capacity-building priorities rather than simply generating summary scores (Hao *et al*., 2022).

Cross-sector partnerships and multi-stakeholder initiatives represent another stream of relevant literature, examining how diverse actors collaborate to advance sustainability in contexts where individual organizations face limitations. Research on industry associations, certification schemes, and collective action mechanisms in emerging economies has shown that these intermediary institutions can play crucial roles in translating global sustainability expectations into locally appropriate practices while also aggregating SME voices in sustainability governance processes (Mena and Palazzo, 2012). For measurement frameworks, these findings suggest potential value in designing tools that can be administered through intermediary organizations that possess deeper contextual knowledge and established relationships with SME populations, rather than requiring direct buyer-supplier assessment interactions that may be constrained by power dynamics and limited trust (Machado *et al*., 2021).

3. Methodology

The development of a quantitative evaluation framework for assessing ESG adoption among SMEs in emerging economy supply chains required a multi-phase methodological approach that integrated systematic literature analysis, empirical investigation of current practices, expert consultation, and iterative validation procedures. This methodology was designed to ensure that the resulting framework achieves appropriate balance between scientific rigor and practical applicability while remaining grounded in the realities of resource-constrained enterprises operating in institutionally complex environments (Carbonneau *et al*., 2008).

The initial phase involved comprehensive systematic review of existing ESG measurement frameworks, assessment tools, and reporting standards to identify relevant indicators, methodological approaches, and design principles that could inform framework development. This review examined both

academic literature and practitioner-oriented resources, including global frameworks such as GRI Standards, industry-specific initiatives such as the Sustainable Apparel Coalition's Higg Index, and emerging economy-focused tools developed by international development organizations. The review process employed structured protocols for literature search, selection, and analysis to ensure systematic coverage of relevant work. Search terms combined concepts related to ESG, sustainability measurement, SMEs, supply chains, and emerging economies across multiple academic databases and grey literature sources. The resulting corpus of over two hundred relevant documents was analyzed to extract information on indicator categories, measurement scales, weighting approaches, and contextual adaptation mechanisms (Jasti and Kodali, 2015).

Analysis of existing frameworks revealed several consistent categories of ESG indicators that appeared across multiple tools with varying levels of specificity and emphasis. Environmental indicators typically addressed resource consumption, waste generation, emissions, and pollution control, though the specific metrics and boundaries varied considerably. Social indicators commonly covered labor practices, health and safety, community impacts, and diversity considerations, though the operationalization of these concepts showed substantial variation. Governance indicators encompassed management systems, ethical practices, stakeholder engagement, and transparency mechanisms, though this domain exhibited the greatest inconsistency across frameworks. This analysis informed the selection of indicator domains for the proposed framework while also highlighting gaps and limitations in existing approaches that needed to be addressed (Büyüközkan and Göçer, 2018).

The second phase involved empirical investigation of current ESG practices and measurement approaches among SME suppliers in emerging economy contexts. This investigation was conducted through multiple methods including semi-structured interviews with SME managers, buyer representatives, and industry experts; review of existing supplier assessment data provided by multinational corporations; and site visits to manufacturing facilities in three emerging economy regions. Interview protocols were designed to elicit information about current sustainability practices, measurement and reporting processes, barriers encountered in ESG implementation, and perspectives on existing assessment approaches. A purposive sampling strategy was employed to ensure representation across different sectors, enterprise sizes within the SME category, and stages of ESG maturity (Hofmann and Rüsch, 2017).

Interviews were conducted with sixty-five SME representatives across textile manufacturing, electronics assembly, and food processing sectors in three emerging economy regions selected to represent different institutional contexts and levels of supply chain integration. Additionally, interviews were conducted with twenty-two representatives from multinational buying firms representing various industries, and eighteen experts from consulting organizations, certification bodies, and development agencies working on supply chain sustainability in emerging economies. All interviews were recorded with participant consent, transcribed, and analyzed using thematic coding procedures to identify recurring patterns, challenges, and insights relevant to framework design (Ivanov *et al*., 2019).

Analysis of interview data revealed several critical insights that shaped framework development. First, SME managers expressed frustration with the proliferation of buyer-specific assessment requirements that demanded similar information in different formats, creating redundant effort without corresponding benefits. Second, respondents emphasized the importance of clarity regarding expectations and concrete guidance on implementation pathways, noting that many existing frameworks provided lists of indicators without sufficient context about relative priorities or improvement strategies. Third, SME representatives indicated that resource constraints limited their ability to collect certain types of data or implement particular practices, suggesting the need for frameworks that account for capability differences across enterprises at different developmental stages. Fourth, both SME and buyer representatives emphasized the value of frameworks that could support constructive dialogue and collaborative improvement planning rather than simply generating pass-fail assessments (Souza, 2014).

The third phase focused on indicator selection and operationalization through an iterative process that balanced comprehensiveness, materiality, and feasibility considerations. Initial indicator selection drew from the literature review and empirical investigation to identify ESG dimensions that were both substantively important for sustainability outcomes and practically relevant within SME supply chain contexts. This selection process employed explicit criteria including impact magnitude, stakeholder relevance, measurement feasibility, and controllability by enterprise management. Impact magnitude assessed the potential environmental and social significance of each indicator domain. Stakeholder relevance evaluated the extent to which each dimension aligned with documented concerns of workers, communities, buyers, and regulators. Measurement feasibility examined whether SMEs could reasonably be expected to collect necessary data without prohibitive resource requirements. Controllability assessed whether enterprises had meaningful ability to influence outcomes in each domain through management actions (Hazen *et al*., 2014).

Application of these criteria resulted in selection of fifteen indicator domains organized across the three ESG pillars. Environmental indicators included energy consumption intensity, water use efficiency, waste generation and management, hazardous material handling, and environmental management systems. Social indicators encompassed occupational health and safety performance, working hours and rest periods, wage and benefit adequacy, worker training and development, and grievance mechanisms. Governance indicators covered business ethics and anti-corruption measures, supply chain transparency, stakeholder engagement processes, legal compliance, and management accountability systems. This set of indicators was intentionally more focused than comprehensive frameworks such as GRI, reflecting the design principle of prioritizing material issues and feasibility for resource-constrained enterprises (Tiwari *et al*., 2018).

Each indicator domain was operationalized through development of measurement scales that could capture both absolute performance levels and relative progress given enterprise capabilities and context. Rather than employing simple binary assessment of presence or absence, the framework utilizes a four-level maturity scale adapted from organizational learning and capability development

literature. The scale distinguishes between basic awareness and intention, initial implementation of practices, systematic integration of practices into operations, and advanced performance with continuous improvement mechanisms. This approach recognizes that ESG adoption represents a developmental process rather than a binary state, allowing for meaningful evaluation of enterprises at different stages while also providing clear progression pathways that can guide improvement efforts (Om *et al*., 2007).

Detailed scoring rubrics were developed for each indicator domain to ensure consistent application of the maturity scale across different assessors and contexts. These rubrics specify observable evidence and documentation requirements for each maturity level, reducing subjectivity in assessment while maintaining sufficient flexibility to accommodate contextual variations. For example, the occupational health and safety indicator rubric defines basic level as presence of basic safety equipment and documented emergency procedures, intermediate level as systematic hazard identification and regular safety training, systematic level as formalized safety management system with performance monitoring, and advanced level as integration of safety culture with proactive risk management and worker participation in continuous improvement (Sanusi *et al*., 2019; Lubrano and Volynets, 2022).

The fourth phase addressed weighting of indicators within the framework through a multi-criteria decision analysis approach that incorporated both empirical data and expert judgment. The weighting process recognized that not all indicator domains should contribute equally to overall ESG scores, as they differ in their relative importance for sustainability outcomes, stakeholder priorities, and potential for enterprise impact. Three primary factors informed weight assignment: documented stakeholder priorities based on analysis of buyer requirements and regulatory frameworks across multiple emerging economies; assessed impact significance based on lifecycle and sectoral analyses of environmental and social footprints; and empirical variation in performance levels observed during the investigation phase, with greater weight assigned to domains where enterprises exhibited substantial performance differences (Sarrico and Rosa, 2016).

Expert consultations were conducted with a panel of fifteen specialists in sustainable supply chain management, ESG assessment, and emerging economy business practices to validate and refine the proposed weighting scheme. The expert panel included academics with relevant research expertise, practitioners from multinational corporations managing supplier sustainability programs, representatives from standard-setting organizations, and consultants working directly with SMEs on sustainability implementation. Experts reviewed the proposed weights through a modified Delphi process involving two rounds of anonymous feedback and revision. This process resulted in consensus on a weighting scheme that assigns thirty-five percent of overall score to environmental indicators, forty percent to social indicators, and twenty-five percent to governance indicators, reflecting the particular salience of labor practices and working conditions in emerging economy supply chain contexts (Pathik *et al*., 2012).

Within each ESG pillar, individual indicator domains received differentiated weights based on the multi-criteria analysis. Among environmental indicators, energy consumption and waste management received higher weights given their operational significance and alignment with climate change mitigation priorities. Among social indicators, occupational health and safety and wage adequacy received highest weights reflecting both impact significance and consistent prioritization in buyer requirements and regulatory frameworks. Among governance indicators, business ethics and supply chain transparency received emphasis given their foundational role in enabling verification of performance across other domains (Ogunyankinnu *et al*., 2022).

The fifth phase involved contextual adaptation mechanisms to address the challenge of applying standardized indicators across diverse institutional environments and enterprise types without losing analytical rigor. Three primary adaptation mechanisms were incorporated into the framework design. First, sector-specific adjustment factors were developed for major industry categories based on analysis of sectoral characteristics, relevant environmental and social impacts, and typical operational configurations. These factors modify scoring thresholds for specific indicators to account for systematic differences in feasibility and impact across sectors. Second, enterprise size adjustment factors were introduced to recognize that smaller enterprises within the SME category face different resource constraints than larger SMEs, allowing for appropriate scaling of expectations while maintaining meaningful differentiation of performance. Third, institutional context factors were developed to account for variations in regulatory environments, infrastructure availability, and market conditions across different emerging economy regions (Adesanya *et al*., 2020).

Implementation of contextual adaptation was designed to preserve comparability of scores while avoiding inappropriate penalization of enterprises facing systematic constraints. The adjustment mechanisms modify scoring thresholds rather than changing indicator content or weighting, ensuring that the fundamental ESG dimensions being assessed remain consistent. For example, the energy consumption intensity indicator maintains the same measurement approach across contexts but adjusts performance expectations based on sector energy intensity norms and local grid carbon intensity. This approach allows for fair evaluation of enterprises in different contexts while maintaining the ability to aggregate and compare results across larger populations (Saxena and Gupta, [n.d.]).

The sixth phase focused on validation of the framework through application to actual SME suppliers in three emerging economy regions representing different institutional contexts and levels of supply chain development. Validation sites were selected in Southeast Asia, Sub-Saharan Africa, and South America to ensure representation of diverse conditions. Within each region, the framework was applied to assess between fifteen and twenty SME suppliers across multiple sectors, generating a total validation sample of fifty enterprises. Assessments were conducted through combination of document review, management interviews, and facility observation following standardized protocols. Multiple assessors independently evaluated a subset of enterprises to assess inter-rater reliability.

Validation analysis examined several dimensions of framework performance. First, feasibility was assessed through documentation of data availability, time requirements for assessment completion, and SME feedback

regarding the burden imposed by the evaluation process. Results indicated that assessments could be completed within four to six hours per enterprise using data that SMEs could reasonably provide, though enterprises at lower maturity levels required more extensive assessor observation to compensate for limited documentation. Second, discriminatory power was evaluated by examining the distribution of scores and the framework's ability to differentiate among enterprises with varying ESG performance levels. Analysis confirmed that the framework generated meaningful variation in scores across enterprises and successfully distinguished between different maturity levels rather than concentrating all assessments in narrow ranges. Third, diagnostic value was assessed through qualitative feedback from both assessors and assessed enterprises regarding the framework's utility in identifying specific improvement opportunities. Results indicated that the detailed indicator rubrics and maturity scale approach provided clear guidance on priorities for advancement while avoiding overwhelming enterprises with undifferentiated lists of deficiencies.

Stakeholder consultation was conducted throughout the validation phase to gather feedback on framework utility and implementation considerations from multiple perspectives. SME representatives provided insights on the clarity of expectations, feasibility of requested data provision, and perceived fairness of assessment approaches. Buyer representatives evaluated the framework's alignment with their supply chain sustainability objectives and its potential to support supplier development programs. Development agencies and industry associations assessed the tool's suitability for application in capacity-building initiatives and policy design. This multi-stakeholder input informed final refinements to indicator specifications, scoring rubrics, and guidance materials.

The final phase involved development of supporting materials and implementation guidance to facilitate framework adoption by different user groups. This included detailed assessment protocols and scoring guidance for evaluators, self-assessment tools and improvement planning resources for SMEs, and interpretation guides for buyers and policymakers. Digital tools were developed to streamline data collection and score calculation while also enabling aggregation and analysis across multiple assessments. Training materials were prepared to support capacity building for assessors and to help SME managers understand framework requirements and improvement pathways.

3.1 Framework Structure and Indicator Specification

The quantitative evaluation framework developed through this research comprises three primary components that work in concert to provide comprehensive yet practical assessment of ESG adoption in SME supply chains. The structural architecture balances the need for standardized measurement with recognition of contextual diversity, while the indicator specifications operationalize abstract ESG concepts into concrete, observable practices and outcomes that can be reliably assessed in resource-constrained settings (Thakkar *et al*., 2008).

The environmental pillar encompasses five indicator domains selected based on materiality analysis and feasibility considerations for SME contexts. Energy consumption intensity measures the enterprise's energy use relative to production output, normalized by sector-specific benchmarks to enable meaningful comparison across diverse manufacturing activities. This indicator captures both the absolute energy demand and the efficiency of utilization, providing insight into carbon footprint and operational efficiency (Carbonneau *et al*., 2008). The measurement approach requires enterprises to document total energy consumption across all sources including electricity, fossil fuels, and renewable energy over a defined assessment period, along with corresponding production volumes measured in appropriate units. The maturity scale distinguishes between enterprises that lack systematic energy tracking, those that monitor consumption but have not implemented efficiency measures, those that have adopted specific efficiency technologies and practices, and those that have integrated energy management systems with regular performance review and continuous improvement processes.

Water use efficiency addresses the increasingly critical issue of water resource management, particularly relevant for enterprises operating in water-stressed regions or water-intensive sectors such as textile dyeing and food processing. The indicator assesses both the volume of water consumption relative to production and the implementation of water conservation and treatment practices. Measurement requires documentation of water intake from all sources and wastewater generation, along with evidence of treatment systems and recycling mechanisms where applicable. The maturity scale progresses from absence of water monitoring, through basic measurement and conservation awareness, to systematic water management with treatment and recycling, and ultimately to comprehensive water stewardship programs that engage with watershed-level considerations.

Waste generation and management evaluates the enterprise's approach to solid and liquid waste streams, encompassing both the quantity of waste produced and the methods employed for handling and disposal. This indicator recognizes that waste reduction at source represents the highest priority, followed by recycling and recovery, with disposal as the least preferred option consistent with waste hierarchy principles. Assessment examines waste segregation practices, documentation of waste streams, arrangements with licensed disposal contractors, and implementation of reduction initiatives. The maturity scale differentiates between enterprises with minimal waste awareness and uncontrolled disposal, those with basic segregation and licensed disposal arrangements, those with systematic waste management programs including quantified reduction targets, and those achieving advanced circular economy practices with minimal residual waste requiring disposal.

Hazardous material handling addresses the specialized considerations associated with substances that pose environmental or health risks, including chemicals, batteries, electronic components, and other materials requiring special management protocols. The indicator evaluates storage conditions, handling procedures, worker protection measures, and disposal arrangements for hazardous materials relevant to each enterprise's operations. Assessment requires documentation of hazardous material inventories, safety data sheets, worker training records, storage facility specifications, and disposal contractor certifications. The maturity framework ranges from inadequate awareness and uncontrolled handling, through

basic compliance with storage and disposal regulations, to systematic hazardous material management systems with regular risk assessment and monitoring, advancing to proactive substitution strategies that minimize hazardous material use where technically and economically feasible.

Environmental management systems constitute the fifth domain within the environmental pillar, assessing the presence and functionality of organizational structures, processes, and documentation that enable systematic environmental performance management. Rather than requiring formal certification to international standards such as ISO 14001, which may be prohibitively expensive for many SMEs, this indicator evaluates the substantive elements of environmental management including policy commitments, responsibility assignments, operational procedures, monitoring mechanisms, and review processes. The maturity scale recognizes that effective environmental management can be achieved through approaches scaled to enterprise size and complexity, progressing from absence of formal systems through documented procedures for key environmental aspects, to comprehensive management systems with regular internal review, and ultimately to externally verified systems integrated with business strategy and continuous improvement culture (Howarth and Fredericks, 2012).

The social pillar contains five indicator domains reflecting the critical importance of labor practices and human rights considerations within emerging economy supply chains where concerns about working conditions have historically been most acute. Occupational health and safety performance represents the foundational social indicator, given both the direct impact on worker wellbeing and the documented correlation between safety management and broader operational excellence. This indicator assesses multiple dimensions including physical workplace conditions, provision of personal protective equipment, incident rates and response procedures, worker training on safety protocols, and management systems for hazard identification and risk mitigation. Measurement combines lagging indicators such as injury and illness rates with leading indicators including safety training hours, hazard assessments conducted, and near-miss reporting rates. The maturity scale spans from basic compliance with minimal safety equipment provision through systematic safety management with regular training and monitoring, to advanced safety cultures characterized by worker participation in continuous improvement and proactive risk management (Hemilä and Vilko, 2015).

Working hours and rest periods address the frequently documented issue of excessive overtime and inadequate rest in manufacturing supply chains, with implications for both worker wellbeing and operational quality. The indicator evaluates compliance with legal limits on working hours where such regulations exist, provision of rest breaks during shifts, allocation of rest days, and overtime practices including compensation rates and voluntariness. Assessment examines time and attendance records, overtime authorization procedures, and worker testimony regarding actual practices which may diverge from documented policies. The maturity scale differentiates between situations of systematic overtime excess and inadequate rest, moderate compliance with occasional violations, consistent compliance with legal requirements, and best practice policies that provide working hour flexibility while ensuring adequate rest and work-life balance.

Wage and benefit adequacy evaluates whether compensation meets legal minimum requirements where such standards exist, and more importantly whether remuneration enables workers to meet basic needs and achieve decent living standards. This indicator recognizes that legal minimum wages in many emerging economies fall short of living wage thresholds required for basic needs fulfillment, necessitating assessment against multiple benchmarks. Measurement examines base wage levels, payment regularity and methods, deductions and fees, overtime compensation rates, and provision of benefits including social insurance, paid leave, and other non-wage compensation. The maturity scale progresses from sub-minimum wage payment or significant wage theft issues, through legal minimum wage compliance, to compensation approaching living wage levels for the relevant geographic context, and ultimately to comprehensive compensation packages that provide economic security and enable savings and investment (Baid and Jayaraman, 2022).

Worker training and development assesses enterprise investment in building worker capabilities through formal and informal learning opportunities, recognizing both the operational benefits of skilled workforces and the dignity and development dimensions of capacity building. The indicator evaluates availability and accessibility of training programs, coverage across workforce levels, content relevance to both operational needs and career development, and effectiveness monitoring. Assessment examines training records, program descriptions, resource allocations, and worker perspectives on learning opportunities. The maturity scale ranges from absence of structured training beyond basic operational instruction, through periodic technical skills training responsive to operational needs, to systematic training programs covering multiple competency areas with career development pathways, advancing to comprehensive learning organizations that integrate continuous capability building with strategic workforce development and worker advancement opportunities.

Grievance mechanisms constitute the final domain within the social pillar, addressing the critical importance of voice and procedural justice for workers facing concerns or disputes. This indicator evaluates the availability of confidential channels through which workers can raise issues, the quality of investigation and resolution processes, protection against retaliation, and effectiveness as perceived by workers themselves. Assessment examines documented procedures, records of grievances received and resolved, worker awareness and trust in mechanisms, and presence of independent elements such as worker representatives or external ombudsman arrangements. The maturity scale distinguishes between absence of formal grievance channels or presence of mechanisms that workers fear to use due to retaliation risk, basic complaint systems with limited independence and transparency, functional grievance procedures with documented resolution processes and some worker trust, and advanced mechanisms that include worker representation, external validation elements, and demonstrable influence on management decisions (Singh, 2011).

The governance pillar encompasses five domains that provide the foundational transparency and accountability structures necessary to ensure credibility and verifiability of ESG commitments. Business ethics and anti-corruption

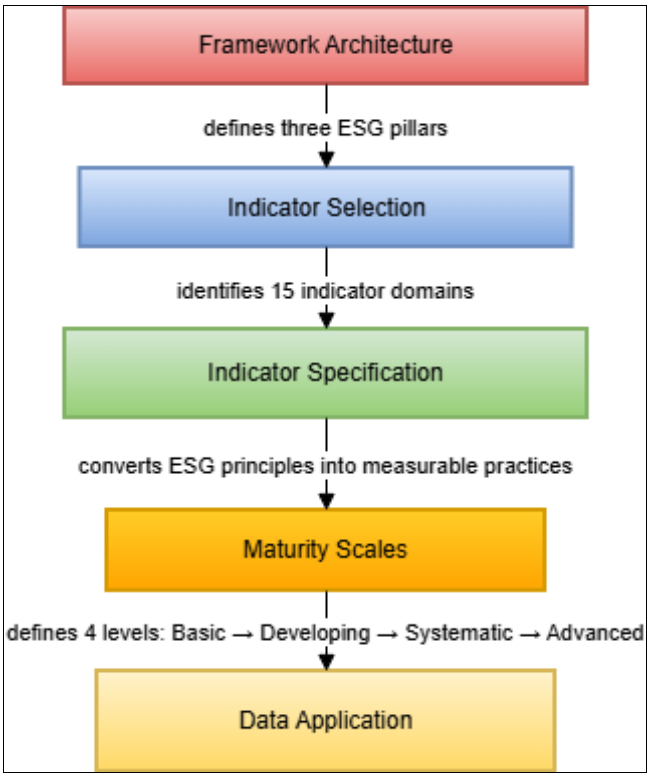
measures evaluate the enterprise's policies and practices regarding bribery, conflicts of interest, accurate record-keeping, and ethical business conduct. This indicator assesses written ethics policies, training provided to managers and workers, disciplinary procedures for violations, and actual track record regarding ethical issues. The maturity scale progresses from absence of ethics policies or presence of systematic corruption, through basic policies with limited implementation, to comprehensive ethics programs with regular training and monitoring, and ultimately to embedded ethical cultures with transparent governance and independent oversight mechanisms.

Supply chain transparency addresses the enterprise's willingness and capability to provide accurate information about its operations, suppliers, and ESG performance to buyers and other legitimate stakeholders. This indicator evaluates documentation systems, information disclosure practices, verification arrangements, and responsiveness to information requests. Assessment examines the quality and accessibility of records, track record of accurate reporting, and openness to site visits and audits. The maturity scale spans from resistance to transparency and provision of misleading information, through basic documentation with reactive disclosure, to proactive information sharing with systematic record-keeping, advancing to comprehensive transparency systems that enable traceability and third-party verification (Adesanya *et al*., 2020).

Stakeholder engagement processes evaluate the mechanisms through which the enterprise identifies and responds to concerns from workers, local communities, buyers, and other affected parties. This indicator assesses the presence of consultation processes, responsiveness to stakeholder input, documentation of engagement activities, and demonstrated influence of stakeholder perspectives on business decisions. The maturity scale differentiates between absence of engagement beyond minimum transactional interactions, ad hoc consultations on specific issues, systematic engagement processes with documented outcomes, and advanced participatory approaches that integrate stakeholder voices into governance and strategic planning.

Legal compliance encompasses adherence to applicable environmental, labor, tax, and business regulations in the relevant jurisdiction. This indicator evaluates knowledge of legal requirements, implementation of compliance systems, track record regarding violations and penalties, and corrective action processes when non-compliance is identified. Assessment examines compliance documentation, regulatory inspection records, and management systems for tracking regulatory obligations. The maturity scale ranges from systematic non-compliance and regulatory violations, through basic awareness with inconsistent compliance, to systematic compliance management with regular review and minimal violations, advancing to proactive legal risk management that anticipates regulatory changes and maintains exemplary compliance records.

Management accountability systems constitute the final governance domain, assessing the structures and processes through which leadership is held responsible for ESG performance. This indicator evaluates whether ESG responsibilities are formally assigned to specific managers, whether performance is monitored and reviewed, whether ESG considerations are integrated into decision-making processes, and whether consequences exist for performance failures. The maturity scale progresses from absence of ESG accountability with sustainability treated as peripheral concern, through informal assignment of responsibilities without systematic monitoring, to formal accountability structures with performance tracking and management review, and ultimately to comprehensive integration of ESG accountability into governance systems with board-level oversight and performance-linked consequences (Saviano and Berardi, 2009).



Source: Author

Fig 1: Structure of ESG Evaluation Framework for SME

3.2 Scoring Methodology and Aggregation Procedures

The translation of qualitative assessments across fifteen indicator domains into quantitative scores that enable comparison and aggregation required development of a systematic scoring methodology that maintains transparency while accommodating the complexities inherent in ESG evaluation. The methodology employs a multi-stage process that converts maturity-level assessments into numerical scores, applies indicator-specific weights, aggregates across ESG pillars, and incorporates contextual adjustments to generate final evaluation results (Tiwari *et al*., 2018).

Each indicator domain utilizes a four-point maturity scale that assigns numerical values corresponding to the developmental stages identified through the framework design process. The basic or nascent stage, characterized by minimal awareness or implementation of relevant practices, receives a score of one point. The developing or initial implementation stage, where enterprises have begun adopting practices but lack systematic integration, receives two points. The systematic or established practice stage, characterized by formalized processes and regular monitoring, receives three points. The advanced or excellence stage, demonstrating continuous improvement and leadership practices, receives four points. This scaling approach provides sufficient granularity to differentiate

performance levels while avoiding the false precision that would be implied by finer gradations given the inherently qualitative nature of many ESG assessments.

The raw scores from individual indicators are normalized to a common scale before aggregation to ensure comparability across domains with different measurement characteristics. Normalization converts each indicator score to a percentage of the maximum possible score for that indicator, generating values ranging from twenty-five percent for basic-level performance to one hundred percent for advanced-level performance. This normalization process accounts for situations where certain indicators may employ modified scoring scales or where contextual adjustments affect maximum achievable scores, ensuring that all indicators contribute to aggregate scores on an equivalent basis.

Aggregation across indicators within each ESG pillar applies the differentiated weights established through the expert consultation and multi-criteria analysis process described in the methodology section. Within the environmental pillar, the weighted aggregation assigns twenty-five percent to energy consumption intensity, twenty percent to water use efficiency, twenty-five percent to waste generation and management, fifteen percent to hazardous material handling, and fifteen percent to environmental management systems. These weights reflect both the relative impact significance of each domain and the priorities identified through stakeholder consultation, with emphasis on resource efficiency and waste management as areas where SME actions can generate substantial environmental benefits.

Within the social pillar, the weighted aggregation assigns thirty percent to occupational health and safety performance, twenty percent to working hours and rest periods, twenty-five percent to wage and benefit adequacy, fifteen percent to worker training and development, and ten percent to grievance mechanisms. The substantial weight accorded to health and safety reflects both the direct impact on worker wellbeing and the consistent prioritization of this issue across buyer requirements and regulatory frameworks in emerging economies. The significant weight for wage adequacy acknowledges that compensation represents the fundamental element of decent work and the dimension where many SMEs in emerging economy supply chains face the greatest challenges in meeting stakeholder expectations.

Within the governance pillar, the weighted aggregation assigns twenty-five percent to business ethics and anti-corruption measures, thirty percent to supply chain transparency, fifteen percent to stakeholder engagement processes, twenty percent to legal compliance, and ten percent to management accountability systems. The emphasis on transparency reflects its foundational role in enabling verification of performance across all other ESG dimensions, while the substantial weight for legal compliance recognizes that regulatory adherence provides the baseline for responsible business conduct. The relatively modest weight assigned to stakeholder engagement and management accountability systems reflects their enabling function rather than direct impact, though these domains remain essential components of comprehensive ESG evaluation.

The pillar-level scores generated through weighted aggregation of constituent indicators are themselves aggregated to produce an overall ESG score using the framework-level weights of thirty-five percent for environmental performance, forty percent for social performance, and twenty-five percent for governance performance. This weighting scheme reflects the particular salience of labor and social issues within emerging economy supply chain contexts, where working conditions have historically generated the greatest stakeholder concern and where SME practices diverge most substantially from international expectations. The significant weight accorded to environmental performance acknowledges the growing urgency of climate and resource challenges, while governance receives somewhat lower weight reflecting its largely enabling function in supporting performance across the other two pillars (Keeley *et al*., 2022).

Contextual adjustment mechanisms are applied after initial score calculation to account for systematic differences in operating conditions that affect the feasibility and relevance of certain practices. The sector adjustment factor modifies scoring thresholds for specific indicators based on industry characteristics, using predetermined adjustment coefficients derived from sectoral analysis. For example, energy-intensive industries such as metal processing receive adjusted thresholds for energy consumption intensity that recognize higher baseline requirements while still differentiating between efficient and inefficient operations within the sector. Labor-intensive industries such as garment manufacturing receive adjusted thresholds for certain labor practice indicators that account for different operational models while maintaining meaningful standards.

The enterprise size adjustment factor applies a modest modification to scoring thresholds for certain indicators where documented evidence demonstrates systematic differences in feasibility between smaller and larger SMEs. This adjustment is calibrated to avoid creating perverse incentives for remaining small while recognizing legitimate constraints. The adjustment factor operates by modifying the evidence requirements and documentation expectations for achieving each maturity level rather than directly inflating scores, ensuring that actual practices remain comparable while accommodating different resource availability. Smaller enterprises demonstrating substantive implementation of practices may achieve equivalent scores to larger enterprises with more sophisticated documentation systems, provided that observational evidence confirms performance claims (Madiwal and Dulange, 2016).

The institutional context adjustment accounts for differences in regulatory environments, infrastructure availability, and market conditions across emerging economy regions. This adjustment modifies scoring thresholds for indicators where contextual factors substantially affect both the relevance of practices and the feasibility of implementation. For example, in contexts where grid electricity remains unreliable or unavailable, the energy management indicator thresholds are adjusted to recognize on-site generation requirements and alternative energy sources. In contexts where legal minimum wages are set at levels far below living wage thresholds, the wage adequacy indicator employs different benchmarks that balance local regulatory standards with international expectations regarding basic needs fulfillment (Ferrazzi and Tueske, 2022).

The scoring methodology includes explicit procedures for handling situations where indicators are not applicable to particular enterprises due to operational characteristics. For example, water use efficiency may be less material for enterprises with minimal water consumption in their

production processes, while hazardous material handling is relevant only for enterprises utilizing substances requiring special management protocols. When indicators are deemed not applicable following standardized determination procedures, those indicators are excluded from score calculations and weights are redistributed proportionally among remaining indicators within the relevant pillar. This approach avoids penalizing enterprises for issues irrelevant to their operations while maintaining the integrity of the evaluation framework (Ahi and Searcy, 2015).

Uncertainty in assessments is acknowledged and managed through confidence rating procedures that accompany numerical scores. Assessors assign confidence levels based on the quality and completeness of evidence available for each indicator, using a three-level scale encompassing high confidence where multiple sources of evidence corroborate findings, moderate confidence where evidence is adequate but limited in scope or consistency, and low confidence where significant information gaps or inconsistencies exist. These confidence ratings enable users of assessment results to interpret scores appropriately and identify priorities for additional verification or information gathering. Aggregate scores are accompanied by summary confidence assessments that reflect the confidence levels of constituent indicators.

The framework incorporates explicit minimum thresholds for certain critical indicators that function as gateway requirements regardless of performance in other domains. Enterprises that score at the basic level for occupational health and safety, indicating presence of severe safety deficiencies, cannot achieve overall scores above a defined threshold even if performance in other areas is strong. Similarly, evidence of systematic child labor, forced labor, or severe environmental violations triggers automatic scoring penalties that cannot be offset by strong performance elsewhere. These threshold mechanisms recognize that certain failures are sufficiently serious to warrant categorical concern regardless of offsetting strengths, aligning with stakeholder expectations regarding non-negotiable standards (Soni *et al*., 2022).

Table 1: Environmental, Social, and Governance Indicator Structure

ESG Pillar	Indicator Domains (5 per Pillar)	Measurement Focus
Environmental	Energy Consumption Intensity, Water Use Efficiency, Waste Generation & Management, Hazardous Material Handling, Environmental Management Systems	Resource use efficiency, pollution control, and process management
Social	Occupational Health & Safety, Working Hours & Rest, Wage & Benefit Adequacy, Worker Training & Development, Grievance Mechanisms	Labor welfare, equity, and human rights practices
Governance	Business Ethics & Anti-Corruption, Supply Chain Transparency, Stakeholder Engagement, Legal Compliance, Management Accountability	Accountability, transparency, and institutional integrity

3.3 Implementation Protocols and Assessment Procedures

The practical application of the quantitative evaluation framework requires standardized protocols that ensure consistency and reliability across different assessors, enterprises, and contexts while remaining sufficiently flexible to accommodate the diverse conditions encountered in emerging economy SME supply chains. The implementation protocols encompass assessment preparation, data collection procedures, evidence evaluation standards, scoring determination processes, and quality assurance mechanisms (Jasti and Kodali, 2015).

Assessment preparation begins with scoping activities that establish the boundaries of evaluation and identify contextual factors relevant to framework application. Assessors review available background information about the enterprise including sector, size, ownership structure, position in supply chain, and previous assessment history if available. This preliminary review enables identification of applicable indicators, determination of appropriate contextual adjustments, and preparation of customized assessment tools that focus attention on most relevant dimensions while maintaining framework standardization. Enterprises are provided with advance notice of assessment requirements and requested information, allowing time for document preparation and coordination of interviews and facility access.

Data collection employs multiple methods to ensure triangulation and verification of information. Documentary evidence includes policies, procedures, records, certifications, and reports that demonstrate implementation of practices and document performance outcomes. Management interviews provide insights into systems, intentions, challenges, and improvement plans while also allowing clarification of documentary evidence and exploration of issues requiring elaboration. Worker interviews conducted confidentially and with appropriate protections provide critical perspectives on actual practices which may diverge from documented policies, particularly for sensitive issues such as working hours, compensation, grievance mechanisms, and workplace conditions. Facility observation enables direct verification of physical conditions, equipment, safety measures, and operational practices (Hazen *et al*., 2014).

Evidence evaluation follows standardized protocols that specify the types and quality of evidence required to support findings at each maturity level for each indicator. The protocols distinguish between different categories of evidence including documented policies and procedures, implementation records, performance data, physical observations, and stakeholder testimony. Higher maturity levels generally require multiple forms of evidence demonstrating not only presence of practices but also systematic implementation, monitoring, and outcomes. The protocols provide explicit guidance on common situations such as discrepancies between documents and observations, claims of practices that cannot be verified, and partial implementation where some but not all elements of a maturity level are present.

Scoring determination employs structured rubrics that guide assessors through systematic evaluation of evidence against maturity level criteria for each indicator. The rubrics specify key questions to be addressed, critical evidence to be sought, and common scenarios with corresponding score assignments. Assessors document their findings and rationale for score assignments, creating an audit trail that enables review and verification. The scoring process encourages assessor judgment within defined parameters rather than attempting purely mechanical application of criteria, recognizing that ESG assessment inevitably involves interpretation of ambiguous situations and weighting of incomplete evidence.

Quality assurance mechanisms operate at multiple levels to ensure reliability and consistency of assessments. Assessor training and certification programs ensure that individuals conducting evaluations possess necessary knowledge of framework requirements, industry contexts, and assessment methodologies. Standardized test cases and calibration exercises enable verification that assessors apply scoring criteria consistently. For high-stakes assessments, dual assessment procedures employ independent evaluators whose findings are compared and reconciled, with discrepancies triggering additional investigation. Periodic inter-rater reliability studies examine scoring consistency across assessors and identify areas requiring clarification or additional training (Büyüközkan and Göçer, 2018).

The assessment process includes mechanisms for enterprise participation and feedback that enhance both accuracy and developmental value. Preliminary findings are shared with enterprise management before finalization, providing opportunity to correct factual errors, provide additional evidence, or clarify circumstances. This review process respects the principle that assessment should be a dialogue rather than a purely external judgment, while maintaining assessor independence regarding final scoring decisions. Enterprises receive detailed feedback reports that explain scores, highlight strengths, identify improvement priorities, and provide guidance on pathways to higher maturity levels (Palomero and Chalmeta, 2014).

3.4 Application Scenarios and Stakeholder Utilization

The quantitative evaluation framework developed through this research serves multiple stakeholder groups with distinct but complementary objectives related to ESG performance in SME supply chains. Understanding how different actors can utilize the framework most effectively requires examination of specific application scenarios and consideration of the particular needs and constraints characterizing each stakeholder category (Banomyong and Supatn, 2011).

Multinational corporations managing supply chain sustainability programs represent a primary user group with direct interest in evaluating and improving supplier ESG performance. These buyers can employ the framework as a standardized assessment tool that replaces or consolidates multiple existing evaluation approaches, reducing both the compliance burden on suppliers and the administrative complexity of managing diverse assessment formats. The framework's maturity-based approach enables buyers to differentiate among suppliers at different developmental stages rather than employing simple pass-fail criteria, supporting more nuanced supplier segmentation and targeted development programs. Buyers can utilize assessment results to prioritize capacity-building investments toward suppliers and issues where improvement potential is greatest, design training programs that address specific gaps identified through systematic evaluation, and track progress over time through repeated assessment cycles (Park *et al*., 2022).

The framework's quantitative scoring enables buyers to establish performance tiers within supplier bases and link these tiers to commercial incentives such as preferential pricing, longer-term contracts, or increased order volumes. This approach creates tangible business case for ESG improvement among suppliers while avoiding the instability associated with rigid minimum standards that result in supplier disqualification. Buyers can also aggregate assessment results across supplier populations to identify systemic challenges that may require industry-level interventions or collaboration with other buyers facing similar issues. The contextual adjustment mechanisms ensure that performance comparisons account for legitimate differences in operating environments, avoiding unfair disadvantage to suppliers in particularly challenging contexts (Ritchie and Brindley, 2000).

Small and medium enterprises themselves represent another critical user group, with the framework providing clarity regarding buyer expectations and a roadmap for systematic improvement. SMEs can utilize self-assessment versions of the framework to evaluate their current ESG position, identify priorities for enhancement, and develop improvement plans that sequence investments appropriately. The detailed indicator rubrics and maturity descriptions provide concrete guidance on practices to implement and systems to establish, reducing ambiguity about requirements. The framework's focus on material issues and feasibility helps SMEs avoid dispersion of limited resources across too many initiatives, instead concentrating efforts where impact and recognition are greatest (Hu and Kee, 2022).

SMEs can use framework results in marketing and business development activities, demonstrating ESG credentials to current and prospective buyers through standardized scores and improvement trajectories. The independent assessment protocols enhance credibility compared to unsupported claims, while the maturity-based approach allows enterprises to demonstrate progress even if they have not yet achieved advanced performance levels. Industry associations and business member organizations can employ the framework to provide collective services to SME constituents, including training on framework requirements, facilitation of assessments at reduced cost through economies of scale, and advocacy regarding capacity-building support needs identified through aggregated results (Machado *et al*., 2021; Perazzoli *et al*., 2022).

Government agencies and regulatory authorities in emerging economies can utilize the framework to inform policy design and implementation related to business sustainability. Assessment results can reveal the current state of ESG practices across SME populations, identifying widespread gaps that may require regulatory intervention, infrastructure investment, or technical assistance programs. The framework can serve as a foundation for public recognition or incentive programs that reward superior ESG performance, creating positive reinforcement for sustainability investments. Regulatory agencies may adopt or adapt framework elements for compliance monitoring

purposes, providing enterprises with aligned expectations across voluntary and mandatory sustainability initiatives (Pizzi *et al*., 2021; Le and Behl, 2022).

International development organizations and donor agencies working on sustainable economic development can employ the framework to design and evaluate supply chain sustainability programs. The standardized measurement approach enables rigorous impact assessment of interventions by providing baseline and endline evaluation of ESG performance changes attributable to program activities. Development agencies can use framework results to identify enterprises and issues requiring support, design training curricula that address documented gaps, and demonstrate results to funding sources through quantified improvement metrics. The framework's applicability across different sectors and contexts enables comparative learning about effective intervention approaches across diverse settings (D'Angiò *et al*., 2022).

Financial institutions increasingly interested in ESG considerations for lending and investment decisions can utilize the framework to evaluate sustainability performance of SME clients or investees in emerging markets. The quantitative scoring approach provides standardized information that can be incorporated into credit risk assessment or investment screening processes, while the detailed indicator structure enables identification of specific risks requiring mitigation or monitoring. Banks offering sustainability-linked financing products can employ the framework to establish performance targets and verify achievement of improvement milestones that trigger preferential terms (Buallay, 2019; Park and Jang, 2021).

Certification bodies and sustainability standard organizations can consider the framework as a foundation for supply chain certification schemes targeted at SME populations in emerging economies. The framework's design principles of materiality, feasibility, and contextual sensitivity address key challenges that have limited SME participation in existing certification programs. Standard organizations might adopt the framework directly or use it to inform revisions of existing standards to improve accessibility for resource-constrained enterprises. The framework's maturity-based structure supports progressive certification levels that enable enterprises to achieve recognition for meaningful progress without requiring immediate achievement of full advanced standards (Sommer, 2017; Nguyen and Ngo, 2022).

Academic researchers studying supply chain sustainability, business practices in emerging economies, or ESG measurement can employ the framework as a research instrument for data collection and analysis. The standardized indicator structure enables systematic comparison across enterprises and contexts, while the validated assessment protocols support reliable measurement. Researchers can utilize framework data to investigate relationships between ESG performance and outcomes such as operational efficiency, market access, or financial performance. The framework's application across diverse settings enables cross-context comparative studies that can advance theoretical understanding of factors influencing sustainability adoption and impact (Kufile *et al*., 2022).

3.5 Validation Results and Framework Refinement

The empirical validation of the quantitative evaluation framework through application to fifty SME suppliers across three emerging economy regions yielded substantial insights regarding framework performance, implementation challenges, and necessary refinements. Analysis of validation data encompassed multiple dimensions including feasibility of application, quality of measurement, stakeholder reception, and practical utility for decision-making and improvement planning (Tan *et al*., 2006; Shalizi, 2021).

Assessment feasibility emerged as a critical dimension given the framework's intended application to resource-constrained enterprises often lacking sophisticated documentation systems. Validation results indicated that completing comprehensive assessments required between four and eight hours of assessor time per enterprise, with duration varying based on enterprise size, documentation quality, and assessor familiarity with the sector and context. This time requirement was deemed acceptable by participating buyers and development agencies when compared to existing assessment approaches, many of which required similar or greater time investments while providing less systematic coverage of ESG dimensions. However, validation revealed that preliminary document review and assessment planning represented important determinants of efficiency, suggesting the value of structured pre-assessment protocols.

Data availability varied substantially across indicators and enterprises, with certain information readily accessible while other data proved challenging to obtain even for enterprises with reasonable ESG practices. Environmental performance data, particularly quantified consumption and waste figures, often required estimation or reconstruction from utility bills and purchase records when systematic tracking systems were absent. Working hour documentation was frequently incomplete or inconsistent, especially regarding overtime authorization and voluntariness, necessitating greater reliance on worker interviews and cross-verification approaches. Wage information was generally well-documented due to legal and tax requirements, though verification of deductions and in-kind payments sometimes required detailed investigation (Kot *et al*., 2020; Rajesh, 2022).

The maturity-based scoring approach demonstrated strong discriminatory power, with validation sample enterprises distributed across all four maturity levels for most indicators rather than clustering at either high or low extremes. This distribution confirmed that the framework successfully differentiated among enterprises with varying ESG performance levels rather than treating sustainability as a binary characteristic. Statistical analysis of score distributions revealed appropriate variation both within and across ESG pillars, with no evidence of ceiling or floor effects that would indicate systematic scoring problems. Correlation analysis among indicators showed moderate positive associations within pillars but substantial independence, suggesting that the selected indicators captured distinct dimensions of ESG performance rather than redundantly measuring the same underlying construct (Gunasekaran *et al*., 2017; Sodhi and Tang, 2018).

Table 2: Maturity Level Definitions for ESG Indicators

Maturity Level	Description	Representative Characteristics
Level 1 – Basic	Minimal awareness or compliance	No systematic tracking or defined responsibilities
Level 2 – Developing	Initial adoption of ESG practices	Policies emerging but not yet institutionalized
Level 3 – Systematic	Formalized systems and monitoring in place	Documented procedures, regular evaluation
Level 4 – Advanced	Integrated ESG culture and continuous improvement	Leadership practices, proactive sustainability initiatives

Inter-rater reliability assessment through independent scoring of twelve enterprises by pairs of trained assessors revealed strong agreement for most indicators, with correlation coefficients above 0.85 for thirteen of fifteen domains. The two indicators showing lower reliability were stakeholder engagement processes and management accountability systems, both involving more subjective interpretation of evidence regarding organizational practices and culture. This finding motivated refinement of scoring rubrics for these domains to provide more concrete behavioral anchors and reduce interpretive latitude, improving subsequent reliability to acceptable levels above 0.80.

Contextual adjustment mechanisms proved essential for ensuring fair evaluation across the diverse validation contexts. Enterprises operating in regions with weak regulatory frameworks and limited infrastructure faced systematic disadvantages when assessed against uniform standards developed based on more favorable conditions. The institutional context adjustment factors successfully normalized these differences, as evidenced by elimination of previously observed correlations between scores and contextual characteristics such as grid reliability or regulatory enforcement levels. Sector adjustment factors similarly proved valuable, particularly for indicators such as energy intensity where baseline requirements vary substantially across industries. Enterprise size adjustments required careful calibration to avoid creating unintended consequences, ultimately settling on relatively modest adjustments that recognized legitimate constraints without excusing poor performance (Musso and Francioni, 2012; Luo *et al*., 2021).

Stakeholder feedback gathered through structured interviews and surveys following validation assessments provided insights into framework reception and utility. SME representatives generally responded positively to the framework's clarity and specificity regarding expectations, contrasting favorably with prior experiences of vague or inconsistent buyer requirements. Multiple respondents noted that the maturity descriptions provided useful roadmaps for improvement planning, helping them understand not only current deficiencies but also concrete steps toward advancement. However, some SME managers expressed concerns about the resource requirements for data collection and documentation, suggesting the need for supporting tools and guidance materials to streamline these processes (Molin, 2021; Cate, 2022).

Buyer representatives evaluated the framework favorably in terms of alignment with supply chain sustainability objectives and comprehensiveness of ESG coverage (Mohieldin *et al*., 2022). Several buyers indicated intention to pilot framework adoption for supplier assessment programs, replacing or consolidating existing tools. Buyers particularly appreciated the quantitative scoring approach which enables performance tracking over time and comparison across suppliers, supporting data-driven decision making about supplier development investments and sourcing decisions. Some buyers requested additional guidance on translating framework results into improvement initiatives and capacity-building programs, motivating development of supplementary implementation resources.

Development agencies participating in validation expressed interest in employing the framework for program design and impact evaluation. Representatives noted that the standardized measurement approach would facilitate more rigorous assessment of intervention effectiveness compared to current practices that often rely on self-reported qualitative data. Agencies identified potential applications including baseline assessment for new programs, targeting of capacity-building activities, and outcome evaluation through comparison of pre- and post-intervention scores. Several agencies indicated plans to incorporate framework training into technical assistance programs, building assessment capacity among local consultants and industry association staff (Shalhoob and Hussainey, 2022).

Validation analysis also revealed several limitations and areas requiring continued development. The framework's substantial data requirements, while reduced compared to comprehensive reporting frameworks, still posed challenges for enterprises at lower maturity levels with minimal documentation systems. Assessment of certain indicators, particularly those involving worker perspectives and organizational culture dimensions, remained partly dependent on assessor interpretation and judgment despite detailed rubrics. The framework's focus on operational practices meant that strategic dimensions such as sustainability integration into business models and long-term planning received limited attention, potentially overlooking important elements of advanced ESG commitment. (Mezzio *et al*., 2022)

Refinement activities following validation addressed identified limitations through several modifications. Enhanced self-assessment tools and data collection templates were developed to help enterprises prepare for assessment more efficiently and systematically. Scoring rubrics for indicators requiring significant interpretation were revised to provide more detailed behavioral descriptors and concrete evidence examples. Supplementary guidance materials were prepared addressing common implementation challenges and providing sector-specific interpretation of indicator requirements. Digital platforms were prototyped to streamline assessment data collection, calculation, and reporting, with particular attention to mobile accessibility given the limited computer infrastructure in many emerging economy SME contexts (Panigrahi *et al*., 2019; Ogunyankinnu *et al*., 2022).

4. Conclusion

This research has developed and validated a comprehensive quantitative framework for evaluating ESG adoption among small and medium enterprises operating within supply chains in emerging economies, addressing a critical gap in sustainable supply chain management scholarship and practice. The framework balances standardization with contextual sensitivity, employs a maturity-based approach

that recognizes developmental progression, and maintains feasibility for resource-constrained enterprises while covering material environmental, social, and governance dimensions (Chowdhury, 2021; Eyinade *et al*., 2022). Through systematic indicator selection, weighted scoring methodology, and contextual adjustment mechanisms, the framework provides stakeholders with an actionable tool for assessing ESG performance, identifying improvement priorities, and tracking progress over time (Lanza *et al*., 2020; Chauhan *et al*., 2022).

The framework's development drew upon multiple theoretical traditions including stakeholder theory, institutional perspectives, and organizational capability approaches, synthesizing insights into a coherent measurement architecture tailored to SME contexts in developing markets. The empirical foundation established through interviews with diverse stakeholders, analysis of existing practices, and validation across fifty enterprises in three regions demonstrates both the framework's implementability and its capacity to generate reliable, meaningful assessments. Validation results showing strong discriminatory power, acceptable inter-rater reliability, and positive stakeholder reception provide confidence in the framework's utility for its intended purposes (Agung *et al*., 2021; Aksoy *et al*., 2022).

The significance of this work extends across multiple domains. Theoretically, it advances understanding of how sustainability measurement must be adapted to organizational and institutional contexts that differ from settings where dominant frameworks were developed. Methodologically, it demonstrates approaches to balancing competing imperatives of standardization and contextualization, comprehensiveness and feasibility, and current performance assessment with developmental capacity. Practically, it provides buyers, SMEs, policymakers, and development agencies with a structured approach to what has been a persistent challenge in sustainable supply chain governance (Cattaneo *et al*., 2013; Sardanelli *et al*., 2022).

The framework contributes to addressing the urgent need for systematic ESG improvement throughout global supply chains by making evaluation more accessible, relevant, and actionable for enterprises that have historically been underserved by existing measurement approaches. While SMEs in emerging economies face substantial challenges in adopting sustainability practices given resource constraints and institutional environments, appropriate measurement frameworks can clarify expectations, focus improvement efforts, and enable recognition of progress (Whitelock, 2015; Fekpe *et al*., 2015). By providing such a framework grounded in empirical investigation and validated through application, this research supports the broader agenda of achieving sustainable and inclusive economic development (Teplova *et al*., 2022; Shekarian *et al*., 2022).

Limitations including the modest scale of validation, the framework's operational rather than strategic focus, and the inherent challenges of quantifying complex qualitative dimensions must be acknowledged. These limitations point toward important directions for continued research including broader validation, longitudinal investigation of framework impacts, and examination of relationships between ESG performance and business outcomes. Nevertheless, the framework developed through this research represents a meaningful advance in the measurement and management of sustainability in SME supply chains, providing a foundation for both practical application and continued scholarly investigation (Fiaschi *et al*., 2020). As stakeholder pressure for supply chain sustainability continues to intensify and the concentration of production in emerging economies persists, tools that can support systematic ESG evaluation and improvement among SME suppliers will become increasingly critical. This research contributes to developing such tools in ways that respect the diverse contexts and capabilities characterizing these essential economic actors (Das *et al*., 2020; Didi *et al*., 2021).

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