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Developing a Data-Driven ESG Framework Integrating Carbon Emissions, Financial Performance and Supply Chain Risk Analysis

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As global awareness of climate change risks deepens, companies are facing increasing pressure from key stakeholders such as investors, regulators and consumers to adopt more transparent and structured approaches to environmental, social and governance (ESG) practices. ESG disclosures have emerged as critical tools for demonstrating corporate accountability and long-term value creation. Multinational corporations with complex global supply chains are under intensified regulatory scrutiny, particularly in response to new climate policy instruments such as the Carbon Border Adjustment Mechanism.

In addition to this mechanism, regulatory requirements related to supply chain due diligence, climate disclosure obligations and RE100 commitments are rapidly expanding. Recent European policies including the Corporate Sustainability Reporting Directive, the Corporate Sustainability Due Diligence Directive and the Digital Product Passport demand disclosure of emissions data and reduction targets across parent companies, subsidiaries and suppliers. In response, leading global firms such as Microsoft, Samsung Electronics and Hyundai Motor have committed to full supply chain net zero targets and RE100 membership, reflecting a growing recognition that carbon accounting capabilities are now central to global market competitiveness and access.

This study proposes a data driven ESG assessment framework that integrates key performance indicators, value chain emissions commonly referred to as Scope 3 and TS2000 based financial performance metrics. The framework is designed to diagnose corporate sustainability by linking operational efficiency with climate risk exposure. Unlike traditional ESG approaches that rely on qualitative reporting, the model leverages structured quantitative data to enhance objectivity and cross-company comparability.

At its core, the framework employs an artificial intelligence powered analytical engine that assesses upstream and downstream emissions, supplier level risks and financial resilience in the face of shifting climate regulations. By linking ESG metrics with financial data, the model provides an integrated view of how carbon intensity and sustainability strategies affect long-term competitiveness and regulatory vulnerability.

The framework also incorporates emissions trading system data and corporate carbon allowance allocations to quantify the financial implications of surplus or excess emissions. It evaluates the effects of these variables on profitability, operational efficiency and investment capacity, ultimately enabling a more precise valuation of carbon assets and exposure.

Additionally, the model includes a practical climate response portfolio composed of emissions compliance tools, supplier diagnostics and emissions mitigation planning. It is particularly relevant for firms operating in jurisdictions preparing for carbon adjustment enforcement and similar pricing regimes. The model supports transparency by identifying emission hotspots using Scope 3 data and enables collaborative decarbonization strategies across the supply chain.

The framework further introduces a materiality based supply chain risk management approach that focuses on early identification of ESG risks, incorporates them into supplier selection and establishes risk mitigation strategies through continuous monitoring. More than an evaluative tool, this system serves as a due diligence mechanism directly linked to strategic corporate decision making.

Ultimately, this framework offers actionable insights for companies aiming to align with evolving sustainability regulations. It equips organizations with robust, data centric tools to proactively manage ESG performance, carbon responsibility and long-term resilience in a changing global environment.

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